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Annex 820

Embassy of the People's Republic of China in Canada, *An Interview on China's Construction Activities on the Nansha Islands and Reefs* (27 May 2015)

An Interview on China's Construction Activities on the Nansha Islands and Reefs

2015/05/27

On 26 May 2015, Mr. Ouyang Yujing, Director-General of the Department of Boundary and Ocean Affairs of the Ministry of Foreign Affairs of the People's Republic of China, received a written interview by journalists from Xinhua News Agency and China Daily on China's construction activities on some garrisoned islands and reefs of the Nansha Islands. The full text of the interview is as follows:

1. Why is China conducting construction activities on the Nansha islands and reefs? What are the purposes? Does China intend to increase military presence in the South China Sea as other parties have argued?

China's construction activities on the Nansha islands and reefs are aimed at first and foremost improving the working and living conditions for personnel stationed there and better fulfilling China's relevant international responsibilities and obligations. It needs to be emphasized that the Nansha Islands is China's territory, and China has every right to deploy on relevant islands and reefs necessary facilities for military defense. However, the facilities on relevant islands and reefs are primarily for civilian purposes.

China is committed to a path of peaceful development, a defense policy that is defensive in nature and a foreign policy of building friendship and partnership with her neighbors. Therefore, China is a staunch force for peace and stability in the region. China has signed with ASEAN countries the Declaration on the Conduct of Parties in the South China Sea (DOC), acceded to the Treaty of Amity and Cooperation in Southeast Asia (TAC), and undertaken to peacefully resolve differences or disputes with countries directly concerned through negotiation or consultation without resorting to the threat or use of force. On the South China Sea issue, China is always committed to resolving relevant disputes through negotiation and consultation with countries directly concerned on the basis of respect for historical facts and international law, and making joint efforts with ASEAN countries to maintain peace and stability in the South China Sea.

2. What civil and public facilities will China develop on the islands and reefs? What services will be provided to the region and the international community?

The Nansha Islands is in a distant sea area with busy shipping routes and vulnerable to marine perils. One of the important purposes of China's construction activities on the islands and reefs is to fulfill her relevant international responsibilities and obligations, such as maritime search and rescue, disaster prevention and mitigation, marine scientific research, meteorological observation, ecological environment preservation, safety of navigation and fishery production, and to provide necessary services to vessels from China, her neighbors and other countries sailing in the South China Sea. To that end, it is necessary to build runway, pier, telecommunication, meteorological, navigation safety, and environmental observation facilities, etc.

3. China has been emphasizing the civil and public nature of her construction activities. Will the facilities to be developed be open to the international community?

The primary purpose of China's construction activities on the Nansha islands and reefs is to better fulfill her relevant international responsibilities and obligations. When conditions are ripe, China will invite relevant countries and international organizations to use relevant facilities for cooperation in maritime search and rescue as well as in other areas. China will make overall plans about what facilities to be open to the international community based on comprehensive planning after the completion of development.

4. Some believe that China's construction activities on the islands and reefs are aimed to intensify the legal status of the Nansha Islands and the country's claim on the dotted line. What is your comment?

China's sovereignty and relevant claims of rights in the South China Sea have been formed in the long course of history and upheld by successive Chinese governments. This position has adequate historical and legal basis. There is no need to have it strengthened through construction activities on relevant islands and reefs.

5. Will China's construction activities on the islands and reefs do harm to the ecological environment in the South China Sea? What steps has China taken to mitigate the impact on the environment?

The Nansha Islands is China's territory. No one cares more than China about the ecological preservation of relevant islands, reefs and sea areas. It needs to be pointed out that China's relevant construction project has gone through science-based evaluation and assessment, with equal importance given to construction and protection. We have taken into full account issues of ecological preservation and fishery protection, followed strict environmental protection standards and requirements in the construction process, and adopted many effective measures to preserve the ecological environment. We will further step up our efforts of ecological monitoring and preservation on the relevant islands, reefs and waters. In addition, as a State Party to the United Nations Convention on Biological Diversity (CBD) and the United Nations Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), China will strictly observe provisions of the conventions and honor her obligations in good faith.

6. Will China's construction activities on the islands and reefs affect freedom of navigation and overflight in the South China Sea? Will China establish an Air Defense Identification Zone (ADIZ) in the South China Sea once the construction activities are completed?

Freedom of navigation and overflight in the South China Sea that countries enjoy in accordance with international law has never been affected because of the relevant disputes in the South China Sea. China's construction and maintenance of facilities on some garrisoned islands and reefs of the Nansha Islands will help improve the capacity of China and the international community in maritime search and rescue, meteorological observation and safety of navigation. It will not undermine countries' freedom of navigation in the South China Sea. On the contrary, it will facilitate joint response to challenges on the sea and provide more guarantee for safety of navigation.

China has the right to establish an ADIZ. This has nothing to do with territorial or maritime disputes. Whether China will set up an ADIZ in the South China Sea depends on whether and to what extent the security of airspace is threatened as well as other factors. Currently, the situation in the South China Sea is stable on the whole. China and ASEAN countries are committed to the full and effective implementation of the DOC in an effort to maintain peace and stability in the South China Sea.

7. Are China's construction activities on the islands and reefs a response to the arbitration initiated by the Philippines concerning the South China Sea and to influence the proceedings by the arbitral tribunal?

China has indisputable sovereignty over the Nansha Islands and their adjacent waters. The construction activities there are within China's sovereignty and have nothing to do with any other matters. China does not accept or participate in the arbitration initiated by the Philippines. This is the position of the Chinese government, fully supported by international law.

8. Some say China's construction activities on the islands and reefs contravene the DOC. Is this the case?

China is committed to the full and effective implementation of the DOC and respects and abides by the principle, spirit and provisions of the DOC. China's construction activities on relevant islands and reefs in Nansha are lawful and justified, and do not run counter to the DOC.

It must be pointed out that the DOC applies to China as much as to ASEAN countries concerned. A certain country, in disregard of the DOC, has been acting provocatively to infringe on China's rights and interests and obstruct practical cooperation within the framework of the DOC. Its unilateral initiation of arbitration complicates and escalates the disputes in the South China Sea and jeopardizes peace and stability in the South China Sea. China calls on parties concerned to work with the Chinese side to ensure the full and effective implementation of the DOC and stay committed to the "dual track approach" to properly handle the South China Sea issue and manage the differences, so as to promote joint development and practical maritime cooperation and contribute to peace and stability of the region and to sound growth of China-ASEAN relations.

9. China has been stressing that her construction activities on the islands and reefs are lawful, reasonable and justified. But why does China criticize other countries for their construction activities on the islands and reefs?

The Nansha Islands has been an inseparable part of China's territory since ancient times. It is within China's sovereignty to conduct construction activities on her own islands and reefs, which are lawful, reasonable, justified and beyond reproach. Since the 1970s, the Philippines and some other countries have illegally occupied and then engaged in massive construction on some islands and reefs of China's Nansha islands. It has seriously violated China's territorial sovereignty, the Charter of the United Nations and the basic norms governing international relations. China is firmly against such moves. The construction activities by China and those by these countries are totally different in nature. China urges the Philippines and other countries to immediately withdraw their personnel and facilities from the islands and reefs they have illegally occupied, and immediately stop all activities that undermine China's territorial sovereignty and her legitimate rights and interests.

10. Some countries say China's construction activities outpace and outsize those by other countries in the South China Sea. What is your response?

China is a big country that shoulders more international responsibilities and obligations. China is conducting construction activities at a pace and with a scale as befitted her international responsibilities and obligations in the field of search and rescue, disaster prevention and mitigation, meteorological observation, ecological conservation, navigation safety and fishery services. These activities are designed to serve practical needs and provide better services to the ships of China, her neighbors and other countries whose ships and boats pass through the South China Sea.

11. Do China's construction activities on the islands and reefs signal a shift in her policy regarding the South China Sea?

It is China's consistent strategy to uphold peace and stability in her neighborhood. China is the last country that wants to see chaos in the South China Sea. Still less will China do anything to stir up troubles. While working to maintain her territorial sovereignty and maritime rights and interests, China will stay committed to the basic policy of upholding peace and stability in the South China Sea and the fundamental solution to the South China Sea issue through negotiation and consultation. China seeks to effectively manage differences by fully and effectively implementing the DOC and formulating a Code of Conduct (COC) and other institutions and rules. Pending the final solution, China will pursue the win-win approach of joint development and maritime cooperation. Such is China's policy on the South China Sea issue, a policy that shall not and will not change.

Related News:

China refutes Vietnam's accusations, citing historical facts (Xinhua) (2014-06-14)
UN General Assembly president denies Vietnamese news report (2014-06-13)
Video: History of Chinese sovereignty over the Xisha Islands (Xinhua) (2014-06-11)
The Operation of the HYSY 981 Drilling Rig: Vietnam's Provocation and China's Position (2014-06-09)
China's position on Huangyan island (Scarbourough Shoal) (2014-04-04)
China's Position on the Territorial Disputes in the South China Sea between China and the Philippines (2014-04-04)
Remarks by Foreign Ministry Spokesperson Hong Lei on the Philippines' Submission of a Memorial to the Arbitral Tribunal in Relation to Disputes with China in the South China Sea (2014-04-01)

Annex 821

China State Oceanic Administration, "Construction Work at Nansha Reefs Will Not Harm Oceanic Ecosystems" (18 June 2015), *available at* http://www.soa.gov.cn/xw/hyyw_90/201506/t20150618_38598.html

Construction Work at Nansha Reefs Will Not Harm Oceanic Ecosystems

Source: State Oceanic Administration; Issue Date: June 18, 2015; [print this page] [close window]

The land reclamation work at some of the reefs of China's Nansha Islands will be completed in the near future. In order to ascertain the effects of the construction work on oceanic ecosystems, scientific studies have been conducted by a team of experts and researchers from the fields of civil engineering, marine engineering, marine ecology, environment protection, and hydrogeology.

1. The construction work will abide vigorously by the rules of environment protection.

The expansion of the Nansha reefs will abide rigorously by the concept of "Green Construction, Eco-Friendly Reefs" in protecting the ecosystems. This protection of the ecosystems is integrated in the stages of planning, design, and construction. Based on the premise that the affected area, duration of construction, effects on the environment, and the ecological recovery time will be kept to a minimum, and through thorough research, rigorous logic, and dynamic protective measures, we strive to minimize the ecological effects during construction, heeding the requirements of engineering as well as ecological protection, in realizing the goal of sustainable development of the Nansha reefs.

2. The construction work employs the method of nature simulation.

The expansion of the Nansha reefs uses the "nature simulation" method as its comprehensive technical concept. This method simulates the displacement of bioclasts such as corals and sands during wind storms and high waves; this biological detritus settles on the combined equilibrium points of the shallow reef flats to form stable supratidal zones which then evolve into oceanic oases. Big cutter suction dredgers are used to collect the loose coral fragments and sands in the lagoon and deposit them on bank-inset reefs to form supratidal platform foundation on which certain kinds of facilities can be built. Through the natural functions of the air, the rain, and the sun, paving it with some quick man-made material, the land reclamation area will produce the ecological effects by going from desalination, solidification, efflorescence, to a green coral reef ecological environment.

3. The construction work adopts the measures of ecological protection.

   a. To plan construction projects on bank-inset reefs made of basically dead corals: use a cutter suction dredger to collect loose coral fragments and sands from flat lagoon basins, which do not constitute hospitable environment for corals, to fill the land reclamation areas.
   b. We used a new "dig, cutter suction, blow, and fill" land reclamation method to integrate digging, transporting, and filling into the construction work; this results in the least ecological impact to the coral reefs.
   c. At the same time that the land reclamation work is in progress, use slope model of concrete to build permanent protective banks and walls around the land area to fend off waves. We have to enclose, to fill, and to protect at the same time, and also to contain floating substances.
   d. The construction embraces the concepts of containment of scope, high efficiency, and sustainability. The duration of construction for every land reclamation project on the reefs will only be about several months.

4. Conclusion

The construction work on the Nansha reefs stresses ecological protection. Many protection measures were adopted in the stages of planning, design, and construction. Good results have been obtained, and the ecological impact on the coral reefs is partial, temporary, controllable, and recoverable.

南沙岛礁扩建工程不会对海洋生态环境造成破坏

来源：国家海洋局 发布时间：2015-06-18 ［打印本页］［关闭窗口］

中国在南沙群岛部分驻守岛礁上的建设将于近期完成陆域吹填工程。针对该工程建设可能对海洋生态环境产生的影响，由土木工程、海洋工程、海洋生态、环境保护、地质水文等专业的院士和专家组成的专家组进行了科学论证。

一、工程建设坚持生态环保理念

南沙岛礁扩建工程坚持“绿色工程、生态岛礁”的生态环境保护理念，坚持生态环境保护与工程规划、设计、施工同步进行，在保证波及范围最小、持续时间最短、影响程度最轻、生态恢复最快的前提下，经过深入研究、严谨论证，采取了全程动态保护措施，努力把工程建设对生态环境的影响最小化，使工程与生态环境保护两者兼顾，实现南沙岛礁可持续发展目标。

二、工程建设采用“自然仿真”的技术思路

南沙岛礁扩建工程采用“自然仿真”的总体技术思路，模仿海洋中暴风浪吹移、搬运珊瑚砂砾等生物碎屑，在浅水礁坪的综合动力平衡点上持续堆积，形成稳定的潮上堆积体，并逐渐进化为海上绿洲的自然过程，利用大型绞吸式挖泥船绞吸、泵送泻湖中松散的珊瑚砂砾，在内礁坪上吹填堆积，形成潮上陆域基础平台，建造部分设施，并通过大气、雨水、阳光的淋溶淀积等自然力作用，辅之以人工加速措施，吹填区域将产生淡化--固化--风化--绿化的生态效应，逐渐形成珊瑚礁绿色生态环境。

三、工程建设采用生态环境保护措施

（一）在珊瑚基本死亡的内礁坪上规划工程建设项目，在不适宜珊瑚生长的平坦泻湖盆中，绞吸松散的珊瑚沙砾吹填陆域。

（二）应用了新型的“绞吸开挖与吹填造陆工法”，形成了“挖-运-填”施工一体化，对珊瑚礁生态环境的影响程度最轻。

（三）在吹填造陆工程同时，及时在陆域周边利用斜坡模袋混凝土建造永久护岸与挡浪墙，边围、边填、边护，控制悬浮物漂浮扩散。

（四）工程采取控制规模、提高效率、连续作业等方式，使得每个岛礁的陆域扩建工期仅为几个月时间。

四、结论

南沙岛礁扩建工程高度重视生态环境保护，按照“生态岛礁”的环保理念，在规划、设计、施工中同步采取

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第八届全国大中学生海洋...

多项保护措施，取得了良好效果，对珊瑚礁生态环境的影响是局部的、暂时的、可控的，也是可恢复的。

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相关文章

Annex 822

Memorandum from United Kingdom Foreign Office to the United Kingdom Commonwealth Relations Office, No. F.2591/39 (24 Oct. 1950)

To Mr. Peter Scott, Foreign Office.

Office reference No. F.2591/39.

Subject. The Spratley Islands.

Reference to previous correspondence:

PW. F

~~Top SECRET~~

With the compliments of

Mr. I. Maclennan

A similar communication has been addressed to

Mr. Huijsman, Colonial Office
Brig. Price, C.O.S. Secretariat.

Commonwealth Relations Office,
Downing Street,
London, S.W.1.

24/10/1950.

DS 33873/1/33 5m 4/50 DL C.R.O. 3a.

CATE.

...alth Relations Office,

Downing Street.

24th October, 1950.

F1081/2.

...taken us so long to examine ... letter No.L.50/3/1/23 of ...hat the United Kingdom ... seeking trusteeship of the

...ant consideration in the ...s their strategic importance. ...should not object to the ... France, but we should not ... to Japan, the Philippines, ...cularly, the Central Peoples

...nsider these Islands to be of ...ance to the democratic powers ...lom Government taking any ...r trusteeship) which might ...r relations with Communist ...al stage in Far Eastern affairs. ...e possible occupation of the ...rnment of China in peace-time ... war" reverse, nor do we ...ccupation in war would be a ...s long as the democratic powers retained control of the South China sea.

4. Apart from our assessment of their strategic value and the question whether these Islands (which appear to be uninhabited) would be suitable for trusteeship, we doubt

the/

J.P. Quinn, Esq.,
Australia House.

DUPLICATE.

Commonwealth Relations Office,

Downing Street.

24th October, 1950.

F.2591/39

TOP SECRET

F1081/2.

Dear Quinn,

I am sorry that it has taken us so long to examine the suggestion made in your letter No.L.50/3/1/23 of the 21st June to Metcalf, that the United Kingdom Government should consider seeking trusteeship of the Spratley Islands.

2. In our view, the dominant consideration in the disposal of these Islands is their strategic importance. From that point of view we should not object to the ownership of the Islands by France, but we should not wish their ownership to go to Japan, the Philippines, Nationalist China or, particularly, the Central Peoples Government of China.

3. We do not, however, consider these Islands to be of sufficient strategic importance to the democratic powers to warrant the United Kingdom Government taking any action (such as applying for trusteeship) which might cause a deterioration in our relations with Communist China at the present critical stage in Far Eastern affairs. We do not ourselves rate the possible occupation of the Islands by the Peoples Government of China in peace-time as more than a minor "cold war" reverse, nor do we consider that even enemy occupation in war would be a serious strategic threat as long as the democratic powers retained control of the South China sea.

4. Apart from our assessment of their strategic value and the question whether these Islands (which appear to be uninhabited) would be suitable for trusteeship, we doubt

the/

J.P. Quinn, Esq.,
Australia House.

the wisdom of bringing before the United Nations any proposal for United Kingdom trusteeship over them. Such a proposal would undoubtedly arouse fierce opposition on the part of the anti-Colonial member states, including the Philippines (we are assuming that we would only act in consultation with the French and would not encounter any opposition from them), and it seems to us highly improbable that the necessary two-thirds majority could be found for it. In fact, the result of any such proposal would probably be that, far from obtaining our object, we should run the risk that the General Assembly might place the Islands under some form either of direct United Nations trusteeship or of Philippine trusteeship, neither of which courses would, we feel, be agreeable to the Australian Government. You mentioned in your letter that your Government would be prepared to support a French trusteeship, but we think that a proposal for French trusteeship would run into the same difficulties as one for United Kingdom trusteeship.

5. Our view on the disposal of the Islands is, therefore, as stated in Commonwealth Relations Office telegram Circular D.No.605 Saving of the 9th December 1947, and in paragraph 2 of this letter. We think, however, that any attempt either by ourselves or the French at this time to settle the question of the disposal of the Islands could only have the effect of focusing international attention on them with probably undesirable political results, unaccompanied by any

compensating/

compensating strategic advantages. We do not, therefore, see any benefit in pursuing this matter at present, and propose to let it rest for the time being.

(I.M.R. Maclennan)

Annex 823

Telegram from Embassy of France in Japan to the Ministry of Foreign Affairs of France, No. 1071 (30 May 1952)

[stamp:] **DUPLICATE** *E 117-7* 109

FOREIGN AFFAIRS

Decryption

INCOMING TELEGRAM

JD

TOKYO, JAPAN, May 30, 1952 at 1:00 a.m.
Received on May 31, 1952 at 9:05 a.m. *AS*

[stamp:]

FOREIGN AFFAIRS
JUNE 1, 1952
SECRETARIAT [initials]

[illegible] *Yey*

No. 1071

Press Release in: Saigon No. 706.
London [No.] 10139
Washington [No.] 9197

I am writing in reference to my Telegram No. 1007.

In response to my letter dated May 23, Japanese Minister of Foreign Affairs confirmed to me by a letter dated the 28th that:
"Article 2 of the Peace Treaty between Japan and the Republic of China signed on April 28, 1952 cannot contain meanings or interpretations other than those implied by Article 2, paragraph (F) of the Treaty of San Francisco."

I am sending to the Department the Japanese original of this letter, which reached me accompanied by an English translation.

9 The Japanese Ministry of Foreign Affairs will certainly be very sensitive to the decision made by the Department not to publish the documents exchanged in order to prevent any risk of polemics with Taipei./.

DEJEAN

DUPLICATA 1177 109

AFFAIRES ÉTRANGÈRES

DÉCHIFFREMENT

TÉLÉGRAMME A L'ARRIVÉE

JD TOKIO, le 30 mai 1952 à 1 H

reçu le 31 " " " 9 H 05

AFFAIRES ETRANGERES
-1 JUIN 1952
SECRETARIAT

N° 1071

Communiqué Saigon n° 706.
Londres 10139
Washington 9197

Je me réfère à mon télégramme 1007.

En réponse à ma lettre du 23 mai le Ministre des Affaires Etrangères japonais m'a confirmé par lettre en date du 28 que : "l'article 2 du Traité de Paix entre le Japon et la République chinoise signé le 28 avril 1952 ne peut comporter d'autre signification ou adaptation que celle qu'implique l'article 2 paragraphe f) du traité de San Francisco".

J'adresse au Département l'original en japonais de cette lettre qui m'est parvenue accompagnée d'une traduction en anglais.

Le Ministère des Affaires Etrangères japonais sera certainement très sensible à la décision prise par le Département de ne pas publier les documents échangés afin de prévenir tout risque de polémique avec Taipeh./.

DEJEAN

Annex 824

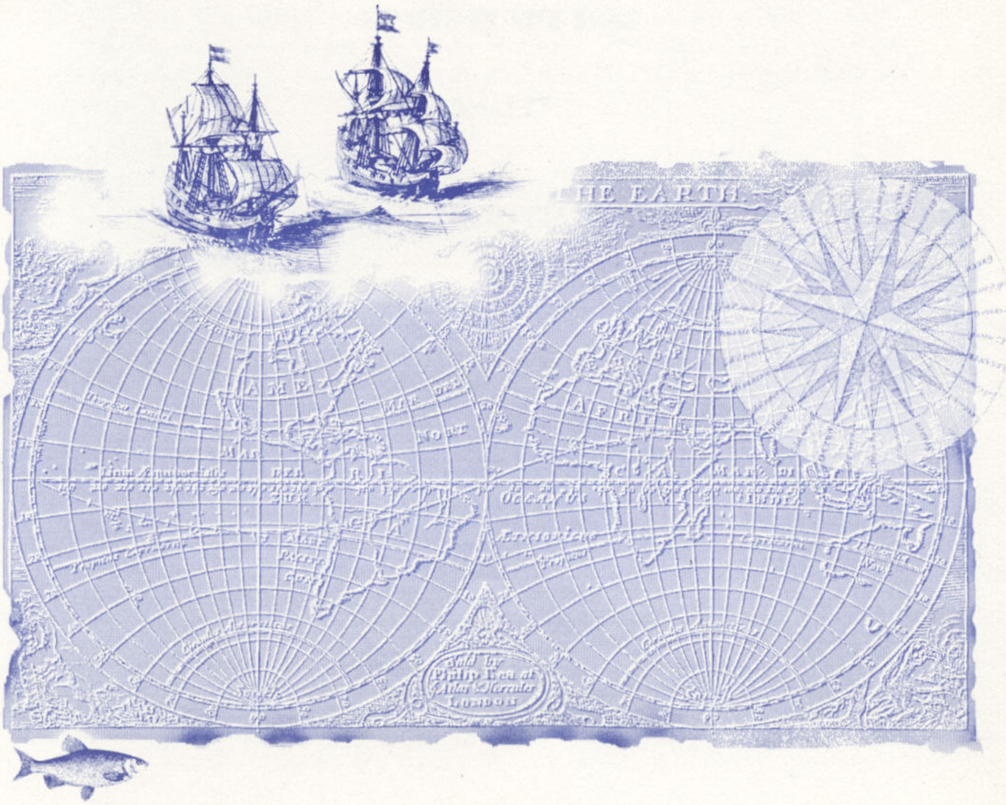
U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, "Taiwan's Maritime Claims", *Limits in the Seas*, No. 127 (15 Nov. 1995), *available at* http://www.state.gov/documents/organization/57674.pdf

United States Department of State
Bureau of Oceans and International Environmental and Scientific Affairs

Limits in the Seas

No. 127

TAIWAN'S MARITIME CLAIMS



This paper is one of a series issued by the Office of Oceans Affairs, Bureau of Oceans and International Environmental and Scientific Affairs in the Department of State. The aim of the series is to set forth the basis of arrangements for the measurement of marine areas. It is intended for background use only. This paper does not represent an official acceptance by the United States Government of the limits claimed.

Principal analysts for this study: J. Ashley Roach and Robert W. Smith.
Requests for additional copies should be addressed to the Office of Oceans Affairs, Room 5805, United States Department of State, Washington, D.C. 20520.

LIMITS IN THE SEAS

No. 127

TAIWAN'S MARITIME CLAIMS

November 15, 2005

Office of Oceans Affairs
Bureau of Oceans and International
Environmental and Scientific Affairs
U.S. Department of State

This study reviews Taiwan's maritime claims for consistency with the international law of the sea, as reflected the 1982 UN Convention on the Law of the Sea (LOS Convention).[1] The review is based on the English texts of Taiwan's maritime claims set out in three laws and a Notice to Mariners:[2]

Law on the Territorial Sea and Contiguous Zone of the Republic of China of 1998;[3]
Law on the Exclusive Economic Zone and the Continental Shelf of the Republic of China of 1998;[4]
Marine Pollution Control Act of 2000;[5] and
Republic of China—Territorial Sea Baseline, Outer Limits of the Territorial Sea and Contiguous Zone.[6]

I. SUMMARY

In general, the Law on the Territorial Sea and the Contiguous Zone is consistent with customary international law as reflected in the LOS Convention. However, the provisions on baselines and innocent passage deviate significantly from those rules. In addition, some of the activities listed as making passage not innocent are not consistent with article 19.2 of the LOS Convention.

The Law on the Exclusive Economic Zone and the Continental Shelf is also generally consistent with customary international law as reflected in the LOS Convention. However, the provisions on Taiwan's rights and the course of submarine cables deviate significantly from those rules.

Taiwan has promulgated a number of laws and regulations to protect the marine environment. The provisions most comparable to Part XII of the LOS Convention on protection and preservation of the marine environment are contained in articles 10-13 of the Law on the Exclusive Economic Zone and the Continental Shelf. A few of the provisions of this Law are not consistent with the comparable provisions of the LOS Convention.

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[1] While the laws make reference to international law, this study expresses no opinion on whether Taiwan is an entity referred to in the international law of the sea. An earlier version of this study appears in the **Taiwan International Law Quarterly**, volume 2, number 1, March 2005, at pages 249-321. The LOS Convention opened for signature Dec. 10, 1982, entered into force Nov. 16, 1994, 1833 UNTS 297. Text available at http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm.
[2] The analyses are based on unofficial English translations; the official texts are in Chinese.
[3] The unofficial English translation by the Ministry of Interior is reproduced in 16 **Chinese YB Int'l L. & Affairs** 124-129 (1997-1998) and, as annotated by the authors, in Annex 1 of this study.
[4] The unofficial English translation by the Ministry of Interior is reproduced in *id.* at 129-137 and, as annotated by the authors, in Annex 3 of this study.
[5] An English translation may be found at http://law.epa.gov.tw/en/laws/759702163.html (visited Nov. 9, 2005).
[6] Chinese Naval Hydrographic and Oceanographic Office Pub. No. 3, Notice to Mariners No. 19 of 1999, Mar. 22, 1999, available at http://www.dtic.mil/whs/directives/corres/html/20051m.htm (U.S. Department of Defense, **Maritime Claims Reference Manual**, 2005 ed.)(visited Nov. 9, 2005). The coordinates of the baseline segments are reproduced in Annex 2 of this study.

Marine scientific research (MSR) is addressed in article 9 of the Law on the Exclusive Economic Zone and the Continental Shelf. The regime of MSR is specifically addressed in Part XIII of the LOS Convention. In a number of aspects, involving supervision, suspension and cessation of MSR activities, interference with exercise of rights, information on results of research, and security, article 9 of this Law is not consistent with the LOS Convention.

II. TERRITORIAL SEA AND CONTIGUOUS ZONE

A. Law on the Territorial Sea and the Contiguous Zone

In general, the Law on the Territorial Sea and the Contiguous Zone is consistent with customary international law as reflected in the LOS Convention. However, the provisions on baselines and innocent passage deviate significantly from those rules. In addition, some of the activities listed as making passage not innocent are not consistent with article 19.2 of the LOS Convention.

Normal baseline

The normal baseline defined in the LOS Convention, and in its predecessor the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone,[7] is the low water line; straight baselines are the exception and can be applied only when specific geographic conditions are met. The Taiwan territorial sea law states the reverse.

Article 4 provides:

> The delimitation of the baseline of the territorial sea of the Republic of China shall be determined by a combination of straight baseline in principle and normal baseline as exception.

On the other hand, article 5 of the LOS Convention provides:

> Except where otherwise provided in this Convention, the normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State.

Article 7 of the LOS Convention provides the limited geographic circumstances where straight baselines may be used:

> 1. In localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity, the method of straight baselines joining appropriate points may be employed in drawing the baseline from which the breadth of the territorial sea is measured.

The baselines declared by Taiwan are examined in the next section of this paper.

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[7] Done at Geneva April 29, 1958; entered into force Sept. 10, 1964; 15 UST 1606, TIAS 5639, 516 UNTS 205.

Innocent passage

Article 7 of the Taiwan territorial sea law provides that the right of innocent passage by foreign vessels is enjoyed on the basis of reciprocity. On the other hand, article 17 of the LOS Convention provides that the "ships of *all* States … enjoy the right of innocent passage through the territorial sea." (Emphasis added.) The international right of innocent passage is not conditioned on reciprocity.

Article 7 of the Taiwan territorial sea law also provides that:

> Foreign military or government vessels shall give prior notice to the authorities concerned before their passage through the territorial sea of the Republic of China.

No such requirement appears in section 3 of Part II of the LOS Convention, including subsection C on rules applicable to warships.[8]

Acts making passage not innocent

Article 8 of the Taiwan territorial sea law sets out those acts that make passage not innocent. Most of them follow the text of article 19.2 of the LOS Convention. However, three provisions are not consistent with article 19.2.

Subparagraph five lists "[t]he launching or landing of any aircraft or taking on board of any navigation equipment." Paragraph 19.2(e) of the LOS Convention lists "the launching, landing or taking on board of any aircraft". No mention is made of "navigation equipment".

Subparagraph seven lists "[t]he loading or unloading or any commodity, currency or person contrary to the customs, fiscal, trade, inspection, immigration, sanitary or environmental protection laws and regulations of the Republic of China." Article 19.2(g) of the LOS Convention makes no mention of trade, inspection and environmental protection.

Subparagraph eight lists "Any act of serious pollution". Article 19.2(h) of the LOS Convention requires the act be more than "serious pollution". It requires the act to be "willful and serious pollution" and that it be "contrary to this Convention."

Suspension of innocent passage

The purposes for which innocent passage may be suspended set out in Article 10 of the Taiwan territorial sea law are broader than those authorized by the LOS Convention. Article 10 provides in part that innocent passage may be suspended "[f]or protecting national security and national interests". Article 25.3 permits a coastal State to

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[8] See J. Ashley Roach and Robert W. Smith, **United States Responses to Excessive Maritime Claims** 251-267 (2nd ed., Martinus Nijhoff Publishers, 1996) (hereinafter, Roach and Smith) and II **Cumulative Digest of United States Practice in International Law** 1981-1988, at 1844-1854 (1994).

suspend innocent passage only if the suspension is “essential for the protection of its security, including weapons exercises.”[9]

Laws and regulations of the coastal State relating to innocent passage

Article 11 of the Taiwan territorial sea law lists the laws Taiwan may adopt in relation to innocent passage through its territorial sea. While consistent for the most part with article 21 of the LOS Convention, there are a number of minor differences that are identified in the footnotes to article 11 in Annex 1.

Sea lanes and traffic separation schemes in the territorial sea

Article 12 of the Taiwan territorial sea law authorizes Taiwan to require ships in innocent passage to use designated sea lanes or traffic separation schemes. While consistent for the most part with article 22 of the LOS Convention, article 11 lists more reasons for this requirement than are set out in article 22: “protecting the safety of navigation, preventing their destruction of on-the-sea and under-the-sea installations or marine resources, as well as preventing marine environment pollution”. Article 22.1 authorizes designation of sea lanes and traffic separation schemes only “where necessary having regard to the safety of navigation”.

Regulation of transit passage

Article 13 of the Taiwan territorial sea law lists a number of laws Taiwan might enact regarding that “part of the Taiwan Straits not part of the territorial sea of the Republic of China used for international navigation”. Article 13 has no basis in the LOS Convention.

While article 13 appears to be based on article 42 of the LOS Convention (which pertains to laws and regulations of States bordering straits relating to transit passage), article 36 of the LOS Convention provides that Part III of the Convention, including section 2 on transit passage, “does not apply to a strait used for international navigation if there exists through the strait a route through the high seas or through an exclusive economic zone of similar convenience with respect to navigation and hydrographical characteristics; in such routes, the other relevant Parts of this Convention, including the provisions regarding the freedoms of navigation and overflight, apply.” The Taiwan Straits meet this definition.

Contiguous zone

Article 14 of the Taiwan Law on the territorial sea and contiguous zone provides for a 24-mile[10] wide contiguous zone, consistent with article 33.2 of the LOS Convention.

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[9] See Roach and Smith 233-235 and II **Cumulative Digest of United States Practice in International Law** 1981-1988, at 1838-1840 (1994).

[10] Unless otherwise noted, miles in this study are nautical miles. One nautical mile equals 1,852 meters.

The Convention's Article 33.1 lists the categories of law and regulations that are subject to control in the contiguous zone: customs, fiscal, immigration and sanitary. There is no precedent for the expansion of categories in Article 15 of the Taiwan territorial sea law to include trade, inspection, environmental protection and unauthorized broadcasting.

Unauthorized broadcasting on the high seas

Article 15 of the Taiwan territorial sea law also permits enactment of laws and regulations to prevent and punish unauthorized broadcasting on the high seas or other sea areas beyond its territorial sea and contiguous zone. Unauthorized broadcasting is addressed in article 109 of the LOS Convention. The contiguous zone is part of the high seas, or EEZ if declared. Article 58.2 provides that article 109 applies in the EEZ insofar as it is not incompatible with Part V on the EEZ.

Archaeological and historical objects found at sea

Article 16 of the Taiwan territorial sea law provides:

> All objects of a historical nature or relics found in the territorial sea and the contiguous zone of the Republic of China, while undertaking archaeological and scientific research, or other activities, shall belong to the Republic of China and be administered by the Government in accordance with related laws and regulations.

Pursuant to the LOS Convention article 303.2, pertaining to archaeological and historical objects found at sea, article 303 may be applied in the contiguous zone. However, article 303.3 provides that nothing in that article "affects the rights of identifiable owners, the law of salvage or other rules of admiralty". Title to foreign government property, such as sunken foreign warships and military aircraft, is not lost by the mere passage of time, but must be renounced in accordance with that government's law. This rule applies anywhere at sea, including in foreign territorial seas.[11]

B. Claimed Baselines

This section analyzes the baselines claimed by the Taiwan Executive Yuan on February 10, 1999[12] that were published in a Notice to Mariners by the Chinese Naval Hydrographic and Oceanographic Office on March 22, 1999. Taiwan established a system of straight baselines around most of its coast from which to measure the outer limits of its territorial sea and other maritime zones. In very few areas the low water line is used. The straight baselines will be analyzed using international law standards, i.e., the Law of the Sea Convention.[13]

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[11] See Roach, *Sunken Warships and Military Aircraft*, 20 Marine Policy 351-354 (1996) and Title XIV, Sunken Military Craft, of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Public Law 108-375, Oct. 28, 2004, available at http://thomas.loc.gov and http://www.gpoaccess.gov/plaws/index.html.

[12] Decree No. Tai 88 Nei Tze #06161, Executive Yuan Gazette, vol. 5, no. 6, Feb. 10, 1999, at 36-37.

[13] The authors express their appreciation to Sarah Morison, at the time with the Office of Oceans Affairs, U.S. Department of State, who prepared the initial draft of this section.

The geographical coordinates of the baseline turning points are given in Annex 2, where an English translation of the attachment to the notice to mariners is reproduced in full. It should be noted that the Chinese text would prevail over any discrepancies in the English translation.

Basis for Analysis

The LOS Convention reflects customary international law for the principles that underlie the proper and legal establishment of baselines. The rules for drawing baselines are contained in articles 5-11 and 13-14 of the Convention. Article 5 states that "except where otherwise provided in this Convention, the normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast." Paragraph 1 of article 7 is the paramount paragraph that establishes the geographical conditions that must be met should a coastal State elect to claim straight baselines in particular locations. This paragraph states that straight baselines may be drawn only in two specific geographic situations, that is, (a) "in localities where the coastline is deeply indented and cut into", or (b), "if there is a fringe of islands along the coast in its immediate vicinity".[14]

In its 2001 decision on the merits of the *Case Concerning Maritime Delimitation and Territorial Questions between Qatar and Bahrain (Qatar v. Bahrain)*, the International Court of Justice affirmed that these are the applicable rules of international law and that they must be "applied restrictively":[15]

184. The Court, therefore, will accordingly now turn to the determination of the relevant coasts from which the breadth of the territorial seas of the Parties is measured. In this respect the Court recalls that under the applicable rules of international law the normal baseline for measuring this breadth is the low-water line along the coast (Art. 5, 1982 Convention on the Law of the Sea).

185. In previous cases the Court has made clear that maritime rights derive from the coastal State's sovereignty over the land, a principle which can be summarized as "the land dominates the sea" (*North Sea Continental Shelf, I.C.J. Reports 1969*, p. 51, para. 96; *Aegean Sea Continental Shelf, I.C.J. Reports 1978*, p. 36, para. 86).

* * * *

210. Bahrain has contended that, as a multiple-island State, its coast consists of the lines connecting its outermost islands and such low-tide elevations as lie within their territorial waters. Without explicitly referring to Article 4 of the 1958 Convention on the Territorial Sea and the Contiguous Zone or Article 7 of the 1982 Convention on the Law of the Sea, Bahrain in its reasoning and in the maps provided to the Court applied the method of straight baselines. This is also clear from its contention that the area of sea to the west of the Hawar Islands, between these islands and Bahrain's main island, is comprised of internal waters of Bahrain.

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[14] LOS Convention, article 7.1; also found in article 4.1 of the 1958 Convention on the Territorial Sea and the Contiguous Zone.

[15] Case Concerning Maritime Delimitation and Territorial Questions between Qatar and Bahrain (Qatar v. Bahrain), 2001 ICJ Rep, paras. 184-185, 210-215, available at http://www.icj-cij.org/icjwww/idocket/iqb/iqbframe.htm.

211. Bahrain maintains that as a multiple-island State characterized by a cluster of islands off the coast of its main islands, it is entitled to draw a line connecting the outermost islands and low-tide elevations. According to Bahrain, in such cases the external fringe should serve as the baseline for the territorial sea.

212. The Court observes that the method of straight baselines, which is an exception to the normal rules for the determination of baselines, may only be applied if a number of conditions are met. **This method must be applied restrictively**. Such conditions are primarily that either the coastline is deeply indented and cut into, or that there is a fringe of islands along the coast in its immediate vicinity. [Emphasis added.]

213. The fact that a State considers itself a multiple-island State or a *de facto* archipelagic State does not allow it to deviate from the normal rules for the determination of baselines unless the relevant conditions are met. The coasts of Bahrain's main islands do not form a deeply indented coast, nor does Bahrain claim this. It contends, however, that the maritime features off the coast of the main islands may be assimilated to a fringe of islands which constitute a whole with the mainland.

214. The Court does not deny that the maritime features east of Bahrain's main islands are part of the overall geographical configuration; it would be going too far, however, to qualify them as a fringe of islands along the coast. The islands concerned are relatively small in number. Moreover, in the present case it is only possible to speak of a "cluster of islands" or an "island system" if Bahrain's main islands are included in that concept. In such a situation, the method of straight baselines is applicable only if the State has declared itself to be an archipelagic State under Part IV of the 1982 Convention on the Law of the Sea, which is not true of Bahrain in this case.

215. The Court, therefore, concludes that Bahrain is not entitled to apply the method of straight baselines. Thus each maritime feature has its own effect for the determination of the baselines, on the understanding that, on the grounds set out before, the low-tide elevations situated in the overlapping zone of territorial seas will be disregarded. It is on this basis that the equidistance line must be drawn. . . .

The purpose of authorizing the use of straight baselines is to allow the coastal State, at its discretion, to enclose those waters that have, as a result of their close interrelationship with the land, the character of internal waters. According to the LOS Convention, "the sea areas lying within the lines must be sufficiently closely linked to the land domain to be subject to the regime of internal waters".[16] By using straight baselines, a State may also eliminate complex patterns, including enclaves, in its territorial sea, that would otherwise result from the use of normal baselines.[17]

A United Nations study stated that when determining whether "conditions apply which would permit the use of straight baselines it is necessary to focus on the spirit as well as the letter of the first paragraph of article 7" of the LOS Convention.[18] And, as a noted geographer has stated, "proper straight baselines usually have a number of segments, each composed of several legs, interspersed with sections of the low-water mark of island and mainland coasts. ... The length of individual legs is short and the baseline is rarely more than 24 nautical miles from an exposed coast".[19] Article 14 of the LOS Convention acknowledges that a combination of methods is appropriate for determining the type of baselines in particular areas: "The coastal State may determine

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[16] LOS Convention, article 7.3.
[17] Roach and Smith 60.
[18] **United Nations, Baselines: An Examination of the Relevant Provisions of the United Nations Convention on the Law of the Sea**, 1989, at 17.
[19] Victor Prescott, **The Maritime Political Boundaries of the World** 69 (1985).

baselines in turn by any of the methods provided for in the foregoing articles to suit different conditions."

Neither the LOS Convention nor its predecessor, the Convention on the Territorial Sea and the Contiguous Zone, place a specific distance limit on the length of a straight baseline. However, several analyses have suggested limits ranging from 24 to 48 miles.[20] The position of the United States is that as a general rule baseline segments should not exceed 24 miles.[21] The following analysis supports 24 miles as the ordinary maximum baseline length.

The maximum segment length of 24 miles is supported by a close reading of the relevant articles of the LOS Convention. Article 7.1 speaks of the "immediate vicinity" of the coast. Article 7.3 states that "the sea areas lying within the line must be sufficiently closely linked to the land domain to be subject to the regime of internal waters." In both of these descriptions, the implication is strong that the waters to be internalized would otherwise be part of the territorial sea. It is difficult to envision a situation where international waters (beyond 12 miles from the appropriate low-water line) could be somehow "sufficiently closely linked" as to be subject to conversion to internal waters.

This implication is reinforced by article 8.2 that guarantees the right of innocent passage in areas converted to internal waters by straight baselines. Innocent passage is a regime applicable to the territorial sea (with a maximum breadth of 12 miles). Preservation of innocent passage carries over pre-existing rights in waters that were territorial in nature before the application of straight baselines.

Finally, Article 10 of the LOS Convention allows a coastal State to draw a closing line between the low-water marks of the natural entrance points of a bay that meets the geographic criteria set forth in that Article. The maximum length of such closing lines may not exceed 24 miles.

Given these linkages to the territorial sea, it follows that, as a rule, no straight baseline segment should exceed 24 miles.[22]

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[20] See Roach and Smith 64 (24 miles); Robert D. Hodgson and Lewis M. Alexander, *Towards an Objective Analysis of Special Circumstances: Bays, Rivers, Coastal and Oceanic Archipelagoes and Atolls*, Law of the Sea Institute Occasional Paper No. 13, 1971, at 8 (45 miles); Peter B. Beazley, **Maritime Limits and Baselines: A Guide to their Delineation**, The Hydrographic Society Special Publication No. 2 (2nd ed., revised August 1978), at 9 (45 miles); U.S. Dep't State, Limits in the Seas No. 106, *Developing Standard Guidelines for Evaluating Straight Baselines*, August 31, 1987 (48 miles).

[21] U.S. Department of State Dispatch Supplement, Law of the Sea Convention, Letters of Transmittal and Submittal and Commentary, Vol. 6, February 1995, at 8; J. Ashley Roach and Robert W. Smith, *Straight Baselines: The Need for a Universally Applied Norm,* 31 **Ocean Dev. & Int'l L.** 47-80 (2000).

[22] Roach and Smith, n.24, at 64-65.

Analysis of Taiwan's Baselines

The following analysis was made using three Chinese Navy charts (the US chart does not depict the baseline system) that depict the 1999 baseline system, and one U.S. chart that does not depict the baseline system:

0106, Yang-Tzu Chiang Entrance to Hsia-Men including Northern Part of Taiwan, 1:1,000,000, June 30, 2000, WGS 84;
0307, Min-Chiang Entrance to Hong Kong including Taiwan, 1:1,000,000, June 30, 2000, WGS 84;
0471, South China Sea, Northern portion, Eastern sheet, 1:1,200,000, June 30, 2000, WGS 84; and
U.S. National Imagery and Mapping Agency chart 94004, 1:600,000, 6th ed., Sept. 2, 1995, WGS 84.

Specific baselines are claimed for three areas: "Taiwan and its appurtenant islands", the Pratas Islands and Macclesfield Bank.[23] The main island of Taiwan is egg-shaped, slanting from the east in the north to the west in the south. It is surrounded by the South China Sea to the southwest, the Taiwan Strait to the west, the East China Sea to the north, Luzon Strait to the south and the Pacific Ocean off its eastern coast. The coastline, in general, is relatively smooth, with a peninsula jutting from the southern tip. A deep indentation also exists in the northeastern coast. Two small islands, Lü Tao and Lan Yü, are situated off to the southeast, 17 miles and 34 miles respectively from the mainland. Finally, off the western coast, the Pescadores are approximately 25 miles from the mainland. Along this same portion of coast lie small islands, anywhere from less than 1 to over 3 miles from the coast, running parallel to the mainland. The longest is approximately 4.5 miles long. See the illustrative map on page 10.

Taiwan and its appurtenant islands

Of the 22 segments for the main island of Taiwan, all but four are straight baselines. These segments range in length from 4.5 miles (segment T11-T12) to almost 110 miles (segment T8-T9). See Table 1. Over half the straight baseline segments (11 of 18) are more than 24 miles long. The normal baseline segments are each no more than one mile long. The segment-by-segment analysis below gives further details.

Segments T1 to T6 enclose a small rock (Mien-hua Yü) and a small island (P'eng-chia Yü) situated 23 and 33 miles off the northern coast of Taiwan with the mainland. The two segments connecting these features with the mainland are each longer than 24 miles: segment T1-T2, which runs from the mainland to Mien-hua Yü is four miles longer than 24 miles and segment T5-T6, which connects P'eng-chiaYü with the mainland, is over 36 miles long. Segment T3-T4, which connects Mien-hua Yü and

[23] Attachment to Notice to Mariners No. 19 of 1999. The attachment notes that baselines for the Spratly Islands (Nansha Chiundau) "shall be promulgated in the future." It should be noted that not all the "appurtenant islands" are "islands" as defined in article 121 of the LOS Convention, and that the normal baseline is claimed for the Senkakus.

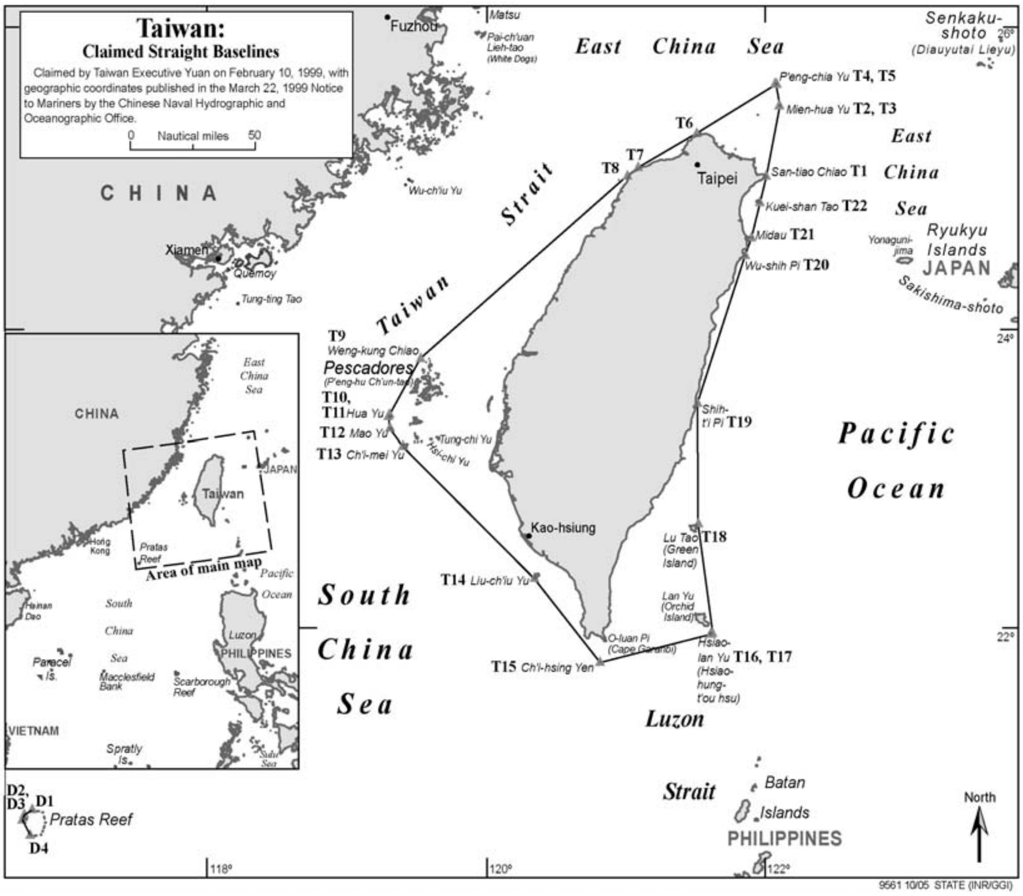
Taiwan:
Claimed Straight Baselines
Claimed by Taiwan Executive Yuan on February 10, 1999, with geographic coordinates published in the March 22, 1999 Notice to Mariners by the Chinese Naval Hydrographic and Oceanographic Office.
0 Nautical miles 50
CHINA
Fuzhou
Matsu
Pai-ch'uan Lieh-tao (White Dogs)
East China Sea
Senkaku-shoto (Diauyutai Lieyu)
P'eng-chia Yu T4, T5
Mien-hua Yu T2, T3
T6
T7
T8
Taipei
San-tiao Chiao T1
Kuei-shan Tao T22
Midau T21
Wu-shih Pi T20
Taiwan Strait
Wu-ch'iu Yu
Xiamen
Quemoy
Tung-ting Tao
Yonaguni-jima
Ryukyu Islands
JAPAN
Sakishima-shoto
T9 Weng-kung Chiao
Pescadores (P'eng-hu Ch'un-tao)
T10, T11 Hua Yu
T12 Mao Yu
T13 Ch'i-mei Yu
Tung-chi Yu
Hsi-chi Yu
Shih-t'i Pi T19
Pacific Ocean
Kao-hsiung
Lu Tao (Green Island) T18
Lan Yu (Orchid Island)
T14 Liu-ch'iu Yu
South China Sea
O-luan Pi (Cape Garanbi)
Hsiao-lan Yu T16, T17 (Hsiao-hung-t'ou hsu)
T15 Ch'i-hsing Yen
Luzon Strait
Batan Islands
PHILIPPINES
North
D2, D3 D1
Pratas Reef
D4
118°
120°
122°
22°
24°
26°
East China Sea
CHINA
Taiwan
JAPAN
Hong Kong
Pratas Reef
Area of main map
Pacific Ocean
Hainan Dao
South China Sea
Luzon
PHILIPPINES
Paracel Is.
Macclesfield Bank
Scarborough Reef
VIETNAM
Spratly Is.
Sulu Sea
9561 10/05 STATE (INR/GGI)

Table 1
Length of Taiwan's
Baseline Segments
(nautical miles)

Segment	Length	Type	Segment	Length	Type
T1-T2	28.6	straight	T12-T13	9.1	straight
T2-T3	0.2	normal	T13-T14	74.2	straight
T3-T4	8.6	straight	T14-T15	42.4	straight
T4-T5	0.6	normal	T15-T16	45.3	straight
T5-T6	36.3	straight	T16-T17	1.0	normal
T6-T7	26.4	straight	T17-T18	44.2	straight
T7-T8	5.7	straight	T18-T19	48.0	straight
T8-T9	109.0	straight	T19-T20	62.2	straight
T9-T10	25.5	straight	T20-T21	7.6	straight
T10-T11	0.9	normal	T21-T22	14.3	straight
T11-T12	4.5	straight	T22-T1	11.0	straight

P'eng-chia Yü, is 8.6 miles long. These two features should not be included as part of the delimitation of the internal waters of Taiwan. They are too small and too spread out to constitute a fringe of islands, and are too far from the mainland to "be sufficiently closely linked to the land domain." The waters between these two small features have the characteristics of territorial sea and high seas.

Segment T6-T7 encloses a long shallow indentation of the northwest coast that includes the mouth of the Tan-shui River leading to Taipei. The area does not meet the criteria for a bay. The low water line should have been used in this area.

Segment T7-T8 is a short straight baseline segment along a portion of the coastline that itself is generally straight. As charted, portions of the segment are landward of the low water line. The low water line should be used in this area.

Segments T8-T19 enclose the Pescadores and other small offshore features with the northwest and eastern coasts of Taiwan. Segment T8-T9, over 109 miles long, connects the northwest mainland with Weng-kung Chiao, a low-tide elevation, the northwestern most feature of the Pescadores. This feature is 34 miles from the mainland. The coastline of Taiwan along this line is very smooth. The low water line should have been used in this area. Segment T9-T10, 25.5 miles long, connects Weng-kung Chiao with the small island of Hua Yü, the western most island of the Pescadores. Segment T11-T12 connects Hua Yü with the small island Mao Yü, 4.5 miles to the south. Segment T12-T13 connects Mao Yü with larger island Ch'i-mei Yü, 9 miles to the south southeast. Segment T13-T14 connects Ch'i-mei Yü with the island Liu-ch'iu Yü, over 70 miles to the southeast. The mainland along the course of this segment is generally smooth, with a few off-shore islands quite close to the coast. Liu-ch'iu Yü lies 7 miles offshore.

If the Pescadores could be considered as a fringe of islands, segment T8-T9 would not be used; rather a line due west from the mainland to point T9 would be used. Further, the baseline should have been brought back from point T13 due east to the mainland connecting the islands of Hsi-chi Yü and Tung-chi Yü, the latter lying 23 miles off-shore.[24]

Segment T14-T15, over 42 miles long, connects Liu'ch'iu Yü with the rock Ch'i hsing Yen that lies 8 miles due south of the southern tip of Taiwan. This part of the southwest coast of Taiwan is gently concave but smooth. The low water line should have been used in this area.

Segments T8 to T15 enclose approximately 4,000 square miles of both territorial sea and high seas.

Segment T15-T16 connects Ch'I- hsing Yen and the small island Hsiao-hung-t'ou Hsu, more than 45 miles east north east in the Pacific Ocean. This small island lies over 40 miles from the mainland. Segment T17-T18 avoids the large island Lan Yü just to the north and connects with the island Lü Tao 48 miles to the north. Lü Tao is 16 miles east of the mainland. There are no other islands in the area. Segment T18-T19 connects Lü Tao with the mainland at Shih-t'i Pi, 48 miles to the north. The coastline between points T15 and T19 along the southeast and east coasts of Taiwan is generally smooth. The low water line should have been used along the coast between points T15 and T19. Segments T15-T19 encompass an area of approximately 2,200 square miles that are properly territorial sea and high seas.

Segment T19-T20 connects the coastal point Shih-t'i Pi with the coastal point Wu-shih Pi, 62 miles to the north. The coastline between these two points is also gently smooth. Only about 150 square miles of water is enclosed. The low water line should have been used in the area as well.

Segment T20-T21 connects Wu-shih Pi and a near shore rock Midau 7.6 miles to the north. While there are two indentations in the coast landward of this segment, it appears that they might be better served by drawing closing lines if they qualify as article 10 bays. Otherwise the low water line should be used in this area.

Segment T21-T22, 14 miles long, connects Midau with the island Kuei-shan Tao that sits 7 miles off shore a concave coastline. Segment T22-T1, 11 miles long, connects Kuei-shan Tao with the mainland at San-tiao Chiao on the northeast coast. The area enclosed by segments T21-T22 and T22-T1 does not meet the requirements for an article 10 bay.

Senkaku Islands[25]

The Senkaku Islands lie in the East China Sea about 100 miles east northeast of the northeastern tip of Taiwan, about 80 miles north of the Japanese islands of Sakishima,

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[24] It should be noted that article 35(a) of the LOS Convention provides that "where the establishment of a straight baseline in accordance with the method set forth in article 7 has the effect of enclosing as internal waters areas which has not previously been considered as such", Part III applies in those waters.

[25] Called the Diauyutai Islands in the listing in Annex 2. Also claimed by Japan. Located at 25°46'N, 123°32'E.

and about 170 miles west of Okinawa. Taiwan (and Japan) claim the normal baseline for these two islands.

Pratas Reef

The Pratas Reef lies 230 miles to the southwest of the southern tip of Taiwan.[26] It consists of an island in the mouth of a semicircular shoal open to the west. The segments D1-D4 close the mouth by connecting the headlands of the shoal with the island.

Table 2
Baselines of the Pratas Reef
(length in nautical miles)

Segment	**Length**	**Type**	**Segment**	**Length**	**Type**
D1-D2	3.7	Straight	D3-D4	6.9	Straight
D2-D3	2.4	Normal	D4-D1	-	Normal

Macclesfield Bank[27]

Macclesfield Bank lies about 280 miles west southwest of the Pratas Reef, 80 miles east of the Paracels, in the middle of the South China Sea, 270 miles west of the Luzon and 290 miles east of Vietnam. Taiwan claims the normal baseline for Macclesfield Bank.[28] However, this feature is submerged at high tide, and as it lies seaward of the outer limit of the territorial sea of an island, is entitled to no territorial sea of its own.[29]

In summary, Taiwan uses straight baselines in many areas where the normal baseline, the low-water mark, should be used. While the mainland coast has some indentations, most do not meet the geographic standards, as set forth in the LOS Convention, for using straight baselines. In addition, the off-shore features Taiwan uses as turning points for the straight baselines are not physically close enough to the mainland to justify incorporation. For the most part, the waters enclosed by the straight baseline system do not have the close relationship with the land as needed, but rather reflect the characteristics of the territorial sea or high seas. In these areas it would be appropriate to use the normal baseline, the low-water mark along the coastline.[30]

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[26] 20°42'N, 116°43'E.

[27] 15°50'N, 114°20'E. Macclesfield Bank is also claimed by the Philippines and Vietnam.

[28] It should be noted that chart 0471 depicts no territorial sea or contiguous zone limit around Macclesfield Bank, but does show 12 and 24-mile limits around Scarborough Reef. Scarborough Reef is also claimed by the Philippines and Vietnam.

[29] LOS Convention, article 13.2.

[30] The improper use of straight baselines in other areas of the Asia-Pacific region is examined in Roach and Smith, *Straight Baselines: The Need for a Universally Applied Norm, supra* n.21.

III. EXCLUSIVE ECONOMIC ZONE AND CONTINENTAL SHELF

As was the case with the Law on the Territorial Sea and the Contiguous Zone, the Law on the Exclusive Economic Zone and the Continental Shelf[31] is generally consistent with customary international law as reflected in the LOS Convention. However, the provisions on Taiwan's rights and the course of submarine cables deviate significantly from those rules.

Rights of Taiwan in the EEZ and on the Continental Shelf

Article 5 of this Taiwan law sets out the rights possessed and enjoyed in the EEZ and on the continental shelf.

Paragraph 28 addresses sovereign rights over "the resources, living or non-living" of the water column and the seabed and subsoil. This is broader than the sovereign rights in the EEZ accorded to the coastal State in article 56.1(a) of the LOS Convention, which are limited to "*natural* resources, living and non-living" (emphasis added). Excluded from "natural resources" are "wrecked ships and their cargoes (including bullion) lying on the seabed or covered by the sand of the subsoil."[32]

In asserting jurisdiction over all artificial islands, installations or structures in the EEZ, paragraph 29 does not make the distinction drawn in article 60.1 of the LOS Convention between (a) all artificial islands and (b) those installations and structures used for the purposes provided for in article 56 and other economic purposes and installations and structures that may interfere with the exercise of the coastal State in the EEZ. Thus the coastal State does not have jurisdiction pursuant to the LOS Convention over other installations and structures that do not have an economic purpose and that do not interfere with the exercise of the rights of the coastal State in the EEZ.

This Taiwan law does not contain any provisions addressing the definition of continental shelf natural resources such as that set out in article 77.4 of the LOS Convention, which provides:

> 4. The natural resources referred to in this Part [VI on the continental shelf] consist of the mineral and other non-living resources of the sea-bed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the sea-bed or are unable to move except in constant physical contact with the sea-bed or the subsoil.[33]

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[31] An annotated English text of the Law on the Exclusive Economic Zone and the Continental Shelf, promulgated on January 21, 1998, is attached as Annex 3. The text is reproduced from 16 **Chinese YB Int'l L. & Affairs** 129-137 (1997-1998) and appears to be based on the translation published by the Ministry of the Interior in 1999. "In case of any divergence of interpretation, the Chinese text shall prevail." *Id.* at 137.

[32] Report of the International Law Commission covering the work of its eighth session (A/31/39) on draft article 68 of the Convention on the Continental Shelf, and *Commentary*, II YB ILC 1956, at 253, 298; *also quoted in* II **Center for Ocean Law and Policy, United Nations Convention on the Law of the Sea 1982: A Commentary** 896 (M Nordquist ed., 1993).

[33] The United States considers sedentary species to include crustacea (crab), mollusks (abalone, conch, clam, quahog) and sponges. 16 U.S. Code §1802(7).

Submarine cables

Article 15 of the Law on the EEZ and Continental Shelf requires Taiwan's permission for "delineating the course for the laying, maintaining, or modifying any submarine cables or pipelines on the continental shelf". However, article 79.3 of the LOS Convention does not permit the coastal State to delineate the course of submarine cables not entering its territory or territorial sea.

IV. PROTECTION AND PRESERVATION OF THE MARINE ENVIRONMENT

Taiwan has promulgated a number of laws and regulations to protect the marine environment.[34] The provisions most comparable to Part XII of the LOS Convention are contained in articles 10-13 of the Law on the Exclusive Economic Zone and the Continental Shelf. However, a few of the provisions of the Law are not consistent with the comparable provisions of the LOS Convention.

Institution of proceedings

The second paragraph of article 11 provides that Taiwan may proceed to indict a vessel found to be engaged in vessel source pollution in its EEZ. Article 220.6 of the LOS Convention permits the institution of proceedings in such a situation only when "there is clear objective evidence that a vessel navigating in the exclusive economic zone or the territorial sea of a State has, in the exclusive economic zone, committed a violation referred to in paragraph 3 *resulting in a discharge causing major damage or threat of major damage to the coastline or related interests of the coastal State, or to any resources of its territorial sea or exclusive economic zone*, that State may, subject to section 7, provided that the evidence so warrants, institute proceedings, including detention of the vessel, in accordance with its laws." (Emphasis added.)

Adoption of special mandatory measures

Article 12 provides that in order to meet "special circumstances," Taiwan "in explicitly defined areas of its exclusive economic zone, may adopt special mandatory measures for the prevention of pollution resulting from vessels, either discharges, navigation, or other practices of vessels." This article contains none of the safeguards contained in the comparable article in the LOS Convention, i.e., article 211.6:

6. (a) Where the international rules and standards referred to in paragraph 1 are inadequate to meet special circumstances and coastal States have reasonable grounds for believing that a particular, clearly defined area of their respective exclusive economic zones is an area where the adoption of special mandatory measures for the prevention of pollution from vessels is required for recognized technical reasons in relation to its oceanographical and ecological conditions, as well as its utilization or the protection of its resources and the particular character of its traffic, the coastal States, after appropriate consultations through the competent international organization with any other States concerned, may, for that area, direct a communication to that organization, submitting scientific and technical evidence in support and

[34] For links to these laws see http://law.epa.gov.tw/en/laws/water/marine.html (visited Oct. 27, 2005).

information on necessary reception facilities. Within 12 months after receiving such a communication, the organization shall determine whether the conditions in that area correspond to the requirements set out above. If the organization so determines, the coastal States may, for that area, adopt laws and regulations for the prevention, reduction and control of pollution from vessels implementing such international rules and standards or navigational practices as are made applicable, through the organization, for special areas. These laws and regulations shall not become applicable to foreign vessels until 15 months after the submission of the communication to the organization.
(b) The coastal States shall publish the limits of any such particular, clearly defined area.
(c) If the coastal States intend to adopt additional laws and regulations for the same area for the prevention, reduction and control of pollution from vessels, they shall, when submitting the aforesaid communication, at the same time notify the organization thereof. Such additional laws and regulations may relate to discharges or navigational practices but shall not require foreign vessels to observe design, construction, manning or equipment standards other than generally accepted international rules and standards; they shall become applicable to foreign vessels 15 months after the submission of the communication to the organization, provided that the organization agrees within 12 months after the submission of the communication.

The basic implementing law is the Martine Pollution Control Act, promulgated November 1, 2000.[35] The Act appears to be entirely consistent with the LOS and various IMO conventions.

V. MARINE SCIENTIFIC RESEARCH

The subject of marine scientific research (MSR) is addressed in article 9 of the Law on the Exclusive Economic Zone and the Continental Shelf. The regime of marine scientific research is specifically addressed in Part XIII of the LOS Convention.[36] In a number of aspects, involving supervision, suspension and cessation of MSR activities, interference with exercise of rights, information on results of research, and security, article 9 is not consistent with the LOS Convention.

Supervision

The first paragraph of article 9 provides that MSR conducted in the EEZ or on the continental shelf will be subject to Taiwan's "supervision". Part XIII of the LOS Convention contains no provision authorizing a coastal State to "supervise" the conduct of MSR by a foreign researcher.

Suspension or cessation of MSR activities

The first paragraph of article 9 also provides that permission may be withdrawn or suspended "when necessary". In contrast to article 253 of the LOS Convention, the law does not indicate the parameters of "when necessary". Article 253 provides:

1. A coastal State shall have the right to require the suspension of any marine scientific research activities in progress within its exclusive economic zone or on its continental shelf if:

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[35] An English language translation may be found at http://law.epa.gov.tw/en/laws/759702163.html (visited Oct. 27, 2005).
[36] See **Montserrat Gorina-Ysern, An International Regime for Marine Scientific Research** (2003) for a comprehensive examination of MSR and the practice of States.

(a) the research activities are not being conducted in accordance with the information communicated as provided under article 248 upon which the consent of the coastal State was based; or
(b) the State or competent international organization conducting the research activities fails to comply with the provisions of article 249 concerning the rights of the coastal State with respect to the marine scientific research project.
2. A coastal State shall have the right to require the cessation of any marine scientific research activities in case of any non-compliance with the provisions of article 248 which amounts to a major change in the research project or the research activities.
3. A coastal State may also require cessation of marine scientific research activities if any of the situations contemplated in paragraph 1 are not rectified within a reasonable period of time.
4. Following notification by the coastal State of its decision to order suspension or cessation, States or competent international organizations authorized to conduct marine scientific research activities shall terminate the research activities that are the subject of such a notification.
5. An order of suspension under paragraph 1 shall be lifted by the coastal State and the marine scientific research activities allowed to continue once the researching State or competent international organization has complied with the conditions required under articles 248 and 249.

Interference with exercise of rights

Regulation 33 in article 9 requires the researcher "not to interfere" with Taiwan's exercise of its rights in the EEZ or on the continental shelf. This unqualified obligation contrasts with Article 246.8 of the LOS Convention, which requires foreign MSR activities to not "unjustifiably" interfere with the coastal States activities in the exercise of their sovereign rights and jurisdiction provided for in the LOS Convention.

Information on results of research

Regulation 35 in article 9 requires the researcher "[t]o provide progress reports at all times, as well as preliminary conclusions and final conclusions". Part XIII of the LOS Convention contains no requirement for the foreign researcher to provide "progress reports". Rather article 249.1(b) of the LOS Convention requires the coastal State be provided, "at its request, with preliminary reports, as soon as practicable, and when the final results and conclusions after the completion of the research".

Security

Regulation 37 in article 9 provides the foreign researcher shall "ensure no prejudice to the security an[d] benefits" of Taiwan in using such research data. No similar provision is contained in Part XIII of the LOS Convention.

VI. CONCLUSIONS

The foregoing analysis show that, with a number of significant exceptions, the basic maritime laws of Taiwan are consistent with the LOS Convention and that the baseline system is, for the most part, not consistent with the LOS Convention.

In general, the Taiwan Law on the Territorial Sea and the Contiguous Zone is consistent with customary international law as reflected in the LOS Convention. However, as demonstrated in section II, the provisions on baselines and innocent passage deviate significantly from those rules. In addition, some of the activities listed as making passage not innocent are not consistent with article 19.2 of the LOS Convention.

The Taiwan Law on the Exclusive Economic Zone and the Continental Shelf is also generally consistent with customary international law as reflected in the LOS Convention. However, as demonstrated in section III, the provisions on Taiwan's rights and the course of submarine cables deviate significantly from those rules.

The Taiwan law with provisions most comparable to Part XII of the LOS Convention on protection and preservation of the marine environment is the Law on the Exclusive Economic Zone and the Continental Shelf, article 10-13. As explained in section IV, a few of the provisions of this Law are not consistent with the comparable provisions of the LOS Convention.

Marine scientific research (MSR) is addressed in article 9 of the Law on the Exclusive Economic Zone and the Continental Shelf. The regime of MSR is specifically addressed in Part XIII of the LOS Convention. As described in section V, in a number of aspects, involving supervision, suspension and cessation of MSR activities, interference with exercise of rights, information on results of research, and security, article 9 of this Law is not consistent with the LOS Convention.

Annex I
Law on the Territorial Sea and the Contiguous Zone
Promulgated on January 21, 1998[37]

Article 1

This Law is enacted to preserve the sovereignty over the territorial sea and the rights over the contiguous zone of the Republic of China.
Matters not covered by this law shall be governed by the provisions of other related laws.

Article 2

The sovereignty of the Republic of China extends to its territorial sea, the air space over its territorial sea, its seabed and its subsoil.[38]

Article 3

The territorial sea of the Republic of China shall be the sea area between the baseline and the outer limits measuring outwardly twelve nautical miles from the baseline.[39]

Article 4

The delimitation of the baseline of the territorial sea of the Republic of China shall be determined by a combination of straight baseline in principle and normal baseline as exception.[40]

Article 5

The baseline and the outer limits of the territorial sea of the Republic of China shall be decided by the Executive Yuan and may be promulgated in parts.

Article 6

In the event that the territorial sea of the Republic of China overlaps with the territorial sea of adjacent or opposite countries, the delimitation shall be the equidistant median line. Where there is an agreement, such an agreement shall govern.
The equidistant median line prescribed in the preceding paragraph is a line on which every point is equidistant from the nearest points on the baseline of the Republic of China and the adjacent or opposite countries.[41]

Article 7

Foreign civil vessels may, under the reciprocity principle,[42] enjoy the right of innocent passage through the territorial sea of the Republic of China as long as the passage is not prejudicial to the peace,

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[37] The text is taken from 16 **Chinese YB Int'l L. & Affairs** 124-129 (1997-98). "In case of any divergence of interpretation, the Chinese text shall prevail." *Id*. at 129. It appears to reproduce the English translation published by the Ministry of Interior in 1999.
[38] This provision appears to be based on paragraphs 1 and 2 of article 2 of the Law of the Sea Convention. This provision does not mention land territory and internal waters.
[39] This provision appears to be based on articles 3 and 4 of the LOS Convention.
[40] Inconsistent with articles 5 and 7 of the LOS Convention. Article 5 provides that the normal baseline is the low-water line along the coast; article 7.1 provides that straight baselines are permissible only "in localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity".
[41] This provision appears to be based on article 15 of the LOS Convention.

good order and security of the Republic of China. Passage shall be continuous and expeditious and be in accordance with this law and other international regulations.
An innocent, continuous and expeditious passage, complying with this law and other international regulations as prescribed in the preceding paragraph may include stopping and anchoring under necessity, provided the same are incidental to ordinary navigation or a rendered necessary by *force majeure* or distress or for the purpose of rendering assistance to person, vessels, or aircraft in danger or distress.[43]

Foreign military or government vessels shall give prior notice to the authorities concerned before their passage through the territorial sea of the Republic of China.[44]

While passing through the territorial sea of the Republic of China, foreign submarines and other underwater vessels are required to navigate on the surface and to display their flags.
Regulations governing innocent passage of foreign vessels shall be decided by the Executive Yuan.

Vessels of the Chinese mainland passing through the territorial sea of the Republic of China shall conform to the provisions of this law and that of the Statute Governing the Relations between the Taiwan Area and Mainland Area.

Article 8

A foreign vessel is not innocent in its passage through the territorial sea of the Republic of China if it engages in any one of the following activities:[45]

1. Any threat or use of force against the sovereignty or territorial integrity of the Republic of China;[46]
2. Any exercise or practice with any kind [of] weapons;
3. Any act aimed at collecting information to the prejudice of the defense or security of the Republic of China;
4. Any act of propaganda aimed at affecting the defense or security of the Republic of China;
5. The launching or landing of any aircraft or taking on board of any navigation equipment;[47]
6. The launching, landing or taking on board of any military device;
7. The loading or unloading or any commodity, currency or person contrary to the customs, fiscal, trade, inspection, immigration, sanitary or environmental protection laws and regulations of the Republic of China;[48]
8. Any act of serious pollution;[49]
9. Any activity concerning catching living beings[sic];[50]
10. Any activity of research or survey;[51]
11. Any act aimed at interfering with any systems of communication or any other facilities or installations of the Republic of China;[52] or
12. Any other activity not having a direct bearing on innocent passage.[53]

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[42] Article 17 of the LOS Convention provides that the "ships of all States … enjoy the right of innocent passage through the territorial sea." It is not conditioned on reciprocity.
[43] This provision appears to be based on paragraph 2 of article 18 of the LOS Convention.
[44] Prior notification is not authorized y the LOS Convention.
[45] This provision appears to be based on paragraph 2 of article 19 of the LOS Convention.
[46] Paragraph 19.2(a) also includes "political independence of the coastal State, or in any other manner in violation of the principles of international law embodied in the Charter of the United Nations."
[47] Paragraph 19.2(e) states "the launching, landing or taking on board of any aircraft". No mention is made of "navigation equipment".
[48] Article 19.2(g) makes no mention of trade, inspection and environmental protection.
[49] Article 19.2(h) requires the act be more than "serious pollution". It requires the act to be "willful and serious pollution" and that it be "contrary to this Convention."
[50] Article 19.2(i) refers to "fishing activities".
[51] Article 19.2(j) refers to the "carrying out of research or survey activities."
[52] This provision is consistent with article 19.2(k).
[53] Article 19.2(l) refers merely to "passage", not "innocent passage."

Article 9

Foreign nuclear-powered vessels and vessel carrying nuclear or other inherently dangerous or noxious substances shall, when exercising the right of innocent passage through the territorial sea of the Republic of China, carry documents authorized in accordance with international agreements and such vessels shall be permitted and monitored by the Government of the Republic of China.[54] The Executive Yuan shall decide the permission and monitoring regulations.

Article 10

For protecting national security and national interests, [55] the Government of the Republic of China may suspend temporarily in specified areas of its territorial sea the innocent passage of foreign vessels.[56]

The Executive Yuan shall promulgate the specified areas and the duration of suspension of innocent passage as prescribed in the preceding paragraph.[57]

Article 11

The Government of the Republic of China may adopt laws and regulations relating to innocent passage through its territorial sea, in respect of any or all of the following:

13. The maintenance of navigation safety and the regulation of maritime traffic;
14. The protection of navigational aids and facilities and other installations or facilities;
15. The protection of cables and pipelines;
16. The conservation of living marine resources;
17. The prevention and punishment of infringement of the fisheries laws and regulations of the Republic of China;[58]
18. The preservation of the environmental[sic] of the Republic of China and the prevention, reduction and control of any possible pollution thereof;[59]
19. The prevention and punishment of any marine scientific research and hydrographic surveys undertaken without prior permission;[60]
20. The prevention and punishment of infringement of the customs, fiscal, immigration or sanitation laws and regulations of the Republic of China;[61] and,
21. The prevention and punishment of other activities without direct being on innocent passage.[62]

The laws and regulations relating to innocent passage in the territorial sea prescribed in the preceding paragraph shall be duly promulgated by the Executive Yuan.

Article 12

The [G]overnment of the Republic of China may, for the purposes of protecting the safety of navigation, preventing their destruction of on-the-sea and under-the-sea installations or marine resources,

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[54] Article 23 also requires such ships to "observe special precautionary measures" established for such ships by international agreements. Article 23 has no provision authorizing such vessels to be "permitted and monitored by the" coastal State.

[55] Article 25.3 permits a coastal State to suspend innocent passage only if the suspension is "essential for the protection of its security, including weapons exercises."

[56] This provision is otherwise consistent with the first sentence of article 25.3 of the LOS Convention.

[57] This provision is consistent with the second sentence of article 25.3 which provides that "such suspension shall take effect only after being duly published."

[58] Article 21.1(e) does not mention "punishment".

[59] Article 21.1(f) does not mention "any possible" pollution.

[60] Article 21.1(g) refers only to "the carrying out of research or survey activities."

[61] Article 21.1(h) does not mention "punishment".

[62] Article 21.1 contains no such authorization.

as well as preventing marine environment pollution,[63] require the foreign vessels exercising the right of innocent passage through its territorial sea to observe designated sea lanes or traffic separation schemes.

The designated sea lanes or traffic separation schemes prescribed in the preceding paragraph shall be established and duly promulgated by the Executive Yuan.

Article 13[64]

In the part of the Taiwan Straits not part of the territorial sea of the Republic of China used for international navigation, the Government of the Republic of China may enact laws and regulations relating to the transit passage of foreign vessels and aircraft, in respect of any or all of the following:

22. The maintenance of navigation safety and the regulation of maritime traffic;
23. The prevention, reduction and control of pollution of the environment;
24. The prohibition of fishing;
25. The prevention and punishment of loading or unloading of any commodity, currency or person in contravention of the customs, fiscal, immigration or sanitary laws and regulations of the Republic of China.

The laws and regulations relating to transit passage prescribed in the preceding paragraph shall be duly promulgated by the Executive Yuan.

Article 14

The contiguous zone of the Republic of China is the sea area contiguous to the outer limits of the territorial sea and to a distance of twenty-four nautical miles measured from the baselines.[65] The outer limits of the contiguous zone shall be decided by the Executive Yuan and may be promulgated in parts.

Article 15

The Government of the Republic of China may enact laws and regulations in the contiguous zone for the following purposes:

26. To prevent infringement of customs, fiscal, trade, inspection, immigration, sanitation or environmental protection laws and regulations within its territory and territorial sea, and unauthorized broadcasting;[66]
27. To punish infringement of customs, fiscal, trade, inspection, immigration, sanitation or environmental protection laws and regulations within its territory and territorial sea, and unauthorized broadcasting.[67]

The Government of the Republic of China may enact laws and regulations to prevent and punish unauthorized broadcasting on the high seas or other sea areas beyond its territorial sea and contiguous zone.[68]

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[63] Article 22.1 authorizes designation of sea lanes and traffic separation schemes only "where necessary having regard to the safety of navigation".

[64] Article 13 has no basis in the LOS Convention. While article 13 appears to be based on article 42 of the LOS Convention, article 36 of the LOS Convention provides that Part III of the Convention, including section 2 on transit passage, "does not apply to a strait used for international navigation if there exists through the strait a route through the high seas or through an exclusive economic zone of similar convenience with respect to navigation and hydrographical characteristics; in such routes, the other relevant Parts of this Convention, including the provisions regarding the freedoms of navigation and overflight, apply." The Taiwan Straits meet this definition.

[65] This provision appears to be based on article 33 of the LOS Convention.

[66] Article 33.1(a) makes no mention of trade, inspection, environmental protection or unauthorized broadcasting.

[67] Article 33.1(b) makes no mention of trade, inspection, environmental protection or unauthorized broadcasting.

[68] Unauthorized broadcasting is addressed in article 109 of the LOS Convention. The contiguous zone is part of the high seas or EEZ if declared. Article 58.2 provides that article 109 applies in the EEZ insofar as it is not incompatible with Part V on the EEZ.

The laws and regulations prescribed in the aforementioned two paragraphs shall be promulgated by the Executive Yuan.

Article 16

All objects of a historical nature or relics found in the territorial sea and the contiguous zone of the Republic of China, while undertaking archaeological and scientific research, or other activities, shall belong to the Republic of China and be administered by the Government in accordance with related laws and regulations.[69]

Article 17

If the authorities of national defense, police, customs or other authorized agencies of the Republic of China consider that a person or an object which is in the territorial sea of the Republic of China or the contiguous zone is engaged in an activity violating laws and regulations of the Republic of China, such as authorities may engage in hot pursuit,[70] boarding,[71] inspection, and when necessary, detaining or arresting such persons or objects.

The authorities prescribed in the preceding paragraph may replace each other consecutively in undertaking hot pursuit, boarding, and inspection.[72]

Article 18

This law shall enter into force on the day of promulgation.

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69 Pursuant to paragraph 2 of article 303, archaeological and historical objects found at sea, article 303 may be applied in the contiguous zone. However, article 303.3 provides that nothing in that article “affects the rights of identifiable owners, the law of salvage or other rules of admiralty”.
70 The rules for hot pursuit are set out in article 111 of the LOS Convention.
71 The rules for exercise of the right of visit are set out in article 110 of the LOS Convention.
72 This provision is consistent with article 111.5 and 111.6(b) of the LOS Convention.

Annex 2

The First Part of the Baselines of the Territorial Sea of Taiwan*

AREA	NUMBER OF THE POINT	NAME OF THE POINT	CO-ORDINATES		CONNECT-ING TO	TYPE OF BASELINE
			LONGITUDE (E)	LATITUDE (N)		
Taiwan and its Appurtenant Islands	T1	Sandiaujiau	122°00.00'	25°00.60'	T2	straight
	T2	Mianhuayu 1	122°05.80'	25°28.80'	T3	normal
	T3	Mianhuayu 2	122°05.80'	25°29.00'	T4	straight
	T4	Pengjiayu 1	122°04.50'	25°37.50'	T5	normal
	T5	Pengjiayu 2	122°03.90'	25°37.80'	T6	straight
	T6	Linsanbi	121°30.40'	25°17.70'	T7	straight
	T7	Dajiueshi	121°05.40'	25°04.20'	T8	straight
	T8	Danioulanshian	121°00.65'	25°00.55'	T9	straight
	T9	Wuenggungshi	119°32.00'	23°47.20'	T10	straight
	T10	Huayu 1	119°18.70'	23°24.80'	T11	normal
	T11	Huayu 2	119°18.20'	23°24.00'	T12	straight
	T12	Mauyu	119°18.80'	23°19.50'	T13	straight
	T13	Chimeiyu	119°24.40'	23°12.00'	T14	straight
	T14	Liouchiouyu	120°20.90'	22°19.10'	T15	straight
	T15	Chishingyian	120°48.90'	21°45.45'	T16	straight
	T16	Shiaulanyu 1	121°36.10'	21°56.70'	T17	normal
	T17	Shiaulanyu 2	121°37.10'	21°57.00'	T18	straight
	T18	Feiyian	121°31.00'	22°41.00'	T19	straight
	T19	Shtibi	121°30.53'	23°29.20'	T20	straight
	T20	Wushbi	121°51.10'	24°28.70'	T21	straight
	T21	Midau	121°53.70'	24°35.90'	T22	straight
	T22	Gueitouan	121°57.30'	24°49.90'	T1	straight
	-	**Diauyutai Lieyu (Diauyutai Islands)**	-	-	-	normal
Dungsha Chiundau (Pratas Islands)	D1	Shibeigiau	116°45.45'	20°46.16'	D2	straight
	D2	Dungshabeijiau	116°42.13'	20°44.16'	D3	normal
	D3	Dungshananjiau	116°41.30'	20°41.92'	D4	straight
	D4	Shinanjiau	116°44.80'	20°35.78'	D1	normal
Jungsha Chiundau (Maccles-field Bank)	-	Huangyiandau	-	-	-	normal
Nansha Chiundau (Spratly Islands)	All islands and atolls of the Nansha Chiundau surrounded by the Chinese traditional U-shape lines are the territory of the Republic of China. The delimitation of the baselines in this region shall be determined by a combination of straight baselines and normal baselines. The related information concerning names of the base points, their co-ordinates, and charts shall be promulgated in the future.					

* This document was translated by Dr. Kuan-Hsiung Wang while a post-doctoral research fellow at the Sun Yat-sen Centre for Policy Studies, National Sun Yat-sen University, Kaohsiung, and is unofficial. It is available at http://www.jiscmail.ac.uk/cgi-bin/webadmin?A2=ind99&L=int-boundaries&T=0&F=&S=&P=2751. In case there is any dispute on the wording of this translation, the Chinese language shall be the authentic one.

Annex 3
Law on the Exclusive Economic Zone and the Continental Shelf[73]
Promulgated on January 21, 1998

Article 1

This law is enacted to preserve and exercise the rights in the exclusive economic zone and on the continental shelf of the Republic of China

Matters not covered by this law shall be governed by the provisions of other related laws.

Article 2

The exclusive economic zone of the Republic of China denotes the sea area contiguous to the other limits of the territorial sea and to a distance measuring outwardly 200 nautical miles from the baseline of the territorial sea.[74]

The exclusive economic zone prescribed in the preceding paragraph comprise the water body, the seabed and the subsoil.[75]

The continental shelf of the Republic of China is the submarine area that extends beyond its territorial sea through the natural prolongation of its land territory to the outer edge of the continental margin.

The submarine area prescribed in the preceding paragraph compromises [sic] the seabed and subsoil.[76]

Article 3

The outer limits of the exclusive economic zone and the continental shelf of the Republic of China shall be decided by the Executive Yuan and may be promulgated in parts.

Article 4

In the event that the exclusive economic zone or the continental shelf of the Republic of China overlaps with the adjacent or opposite countries, the Republic of China may negotiate, on the principle of equality, a delimitation line with those of the adjacent or opposite countries.[77]

Prior to the agreements mentioned in the preceding paragraph, the Republic of China and the adjacent or opposite countries, in a spirit of understanding and co-operation, may reach a *modus vivendi*.

Such a *modus vivendi* as prescribed in the preceding paragraph shall be without prejudice to the final delimitation.[78]

Article 5

The Republic of China shall, in its exclusive economic zone or on its continental shelf, enjoy and exercise the following rights:

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[73] The text is taken from 16 **Chinese YB Int'l L. & Affairs** 129-137 (1997-98). "In case of any divergence of interpretation, the Chinese text shall prevail." *Id*. at 137.

[74] Compare with articles 55 and 57 of the Law of the Sea Convention.

[75] Article 56.1(a) of the LOS Convention refers to the "waters superjacent to the seabed and … the seabed and its subsoil".

[76] Article 76.1 of the LOS Convention defines the continental shelf as "the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin".

[77] Articles 74.1 and 83.1 of the LOS Convention require the EEZ and continental shelf to be delimited "by agreement on the basis of international law, as referred to in Article 38 of the Statute of the International Court of Justice, in order to achieve an equitable solution."

[78] These two paragraphs are consistent with articles 74.3 and 83.3, which speak of "provisional arrangements" rather than "*modus vivendi*".

28. Sovereign rights for the purpose of exploring, exploiting, conserving, and managing the resources, living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil.[79]

29. Jurisdiction over the construction, use, modification, or dismantlement of artificial islands, installations or structures.[80]

30. Jurisdiction over marine scientific research.[81]

31. Jurisdiction over preservation of marine environment;[82] and

32. Other rights in accordance with international law.[83]

The Republic of China shall enjoy and exercise sovereign rights of utilizing the energy stemming from the water, currents and winds or other activities.[84]

The Republic of China shall enjoy and exercise jurisdiction over laying, maintaining, or modifying submarine cables or pipelines.[85]

Article 6

For the undertaking of exploration, exploitation, conservation, or management of living or non-living resources in the exclusive economic zone or on the continental shelf of the Republic of China, an application for permission shall be made in accordance with related laws and regulations of the Republic of China.

Article 7

For utilizing energy from the water, currents and winds or other activities in the exclusive economic Zone of the Republic of China, permission from the Government of the Republic of China shall be required. The related permission regulations shall be decided by the Executive Yuan.

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[79] Similar to article 56.1(a) of the LOS Convention regarding the EEZ, except that the rights are limited to "natural resources". Paragraph 28 does not address the definition of continental shelf natural resources set out in article 77.4 of the LOS Convention: "The natural resources referred to in this Part [VI, on the continental shelf,] consist of the mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil."

[80] Similar to article 56.1(b)(i) of the LOS Convention, which does not mention "modification or dismantlement". Article 60.1 of the LOS Convention limits the exclusive rights of the coastal State in the EEZ to those pertaining to the construction, operation and use of (a) artificial islands, (b) installations and structures for the purposes provided for in article 56 and other economic purposes, and (c) installations and structures which may interfere with the exercise of the rights of the coastal State in the EEZ. Article 60.2 gives the coastal State exclusive jurisdiction over *such* artificial islands, installations and structures, including jurisdiction with regard to customs, fiscal, health, safety and immigration laws and regulations. Article 60.3 of the LOS Convention addresses, *inter alia*, the removal of abandoned or disused artificial islands, installations or structures. Article 80 of the LOS Convention applies article 60 *mutatis mutandis* to artificial islands, installations and structures on the continental shelf.

[81] Similar to article 56.1(b)(ii) of the LOS Convention.

[82] Article 56.1(b)(iii) of the LOS Convention refers to "the protection and preservation of the marine environment."

[83] Article 56.1(c) of the LOS Convention refers to "other rights and duties provided for in this Convention."

[84] Article 56.1(a) gives the coastal State sovereign rights "with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds".

[85] This is broader than article 79 of the LOS Convention which limits the rights of coastal States in a number of ways. *See further* article 15 below.

Article 8

For the undertaking of construction, use, modification, or dismantlement of artificial islands, installations, or structures in the exclusive economic zone or on the continental shelf of the Republic of China, permission from the Government of the Republic of China shall be required. The related permission regulations shall be decided by the Executive Yuan.

Laws and regulations of the Republic of China shall apply to artificial islands, installations, or structures prescribed in the preceding paragraph.

A safety zone shall be established around artificial islands, installations, or structures prescribed paragraph 1 where appropriate measures shall be taken to ensure the safety both of navigation and of the artificial islands, installations, or structures.[86]

The width of the safety zones prescribed in the preceding paragraph shall be in accordance with general international standards or a recommended by the related international organizations.[87]

Article 9

For the undertaking of marine scientific research in the exclusive economic zone or on the continental shelf of the Republic of China, permission from the Government of the Republic of China shall be required.[88] Such research will be subject to the Government of the Republic of China's supervision.[89] The Government of the Republic of China, when necessary, may withdraw permission or may suspend or cease marine scientific research activities in progress.[90]

The undertaking of marine scientific research in the exclusive economic zone or on the continental shelf of the Republic of China shall comply with the following regulations:

33. Not to interfere with the Republic of China's exercise of rights in its exclusive economic zone or on its continental shelf;[91]

34. To ensure the right of the Government of the Republic of China to designate its representatives for participation;[92]

35. To provide progress reports at all times, as well as preliminary conclusions and final conclusions;[93]

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[86] Article 60.4 of the LOS Convention permits the coastal State, "where necessary, [to] establish reasonable safety zones around such artificial islands, installations and structures in which it may take appropriate measures to ensure the safety both of navigation and of the artificial islands, installations and structures."

[87] Article 60.5 provides that the "breadth of the safety zone shall be determined by the coastal State, taking into account applicable international standards." Article 60.5 also provides that such zone "shall be designed to ensure that they are reasonably related to the nature and function of the artificial islands, installations or structures, and shall not exceed a distance of 500 metres around them, measured from each point of their outer edge, except as authorized by generally accepted international standards or as recommended by the competent international organization." Article 60.5 also requires that "[d]ue notice shall be given of the extent of safety zones."

[88] This requirement for permission to conduct marine scientific research (MSR) is consistent with article 246.2 of the LOS Convention.

[89] Part XIII on MSR of the Convention does not authorize a coastal State to "supervise" the conduct of MSR by a foreign researcher.

[90] The Law does not indicate the parameters of "when necessary". The authority of a coastal State to withdraw permission, suspend or terminate MSR is limited to the situations described in article 253 of the LOS Convention.

[91] Article 246.8 of the LOS Convention requires foreign MSR activities to not "unjustifiably" interfere with activities undertaken by coastal States in the exercise of their sovereign rights and jurisdiction provided for in the LOS Convention.

[92] Article 249.1(a) of the LOS Convention permits the coastal State to participate in the research project.

[93] Part XIII of the LOS Convention contains no requirement for the foreign researcher to provide "progress reports". Rather article 249.1(b) of the LOS Convention requires the coastal State be provided, "at its request, with preliminary reports, as soon as practicable, and when the final results and conclusions after the completion of the research".

36. To furnish copied data, figures, or samples, complete and without detriment to their scientific value,[94] and various assessment reports;[95]

37. To ensure no prejudice to the security an [sic] benefits of the Republic of China in using such research data;[96]

38. To inform the Government of the Republic of China immediately of any major change in the research project;[97]

39. Unless otherwise agreed, not to investigate marine resources;[98]

40. Not to harm the marine environment;[99]

41. Unless otherwise agreed, to dismantle research installations and equipment once the research is completed;[100] and,

42. To comply with the provisions of related laws and international agreements.

Article 10

Any activity concerning dumping, discharging, or disposing of waste or other substances in the exclusive economic zone or on the continental shelf of the Republic of China shall comply with the laws and regulations of the Republic of China.[101]

Article 11

For any vessel navigating in the exclusive economic zone of the Republic of China which commits a discharge violation causing marine environmental pollution, the Republic of China may request that vessel to give information regarding its identity, its port of registry, its last and its next port of call and other relevant information required to establish whether a violation has occurred.[102]
In case the suspected vessel prescribed in the preceding paragraph refuses to give information, or the information supplied by the vessel in [sic] manifestly at variance with the evident factual situation, or the vessel does not carry valid certificates or records, or the circumstances of the case justify such inspection, the Government of the Republic of China may undertake physical inspection of the vessel[103] and, provided that the evidence so warrants, indict the vessel through due process.[104]

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[94] Article 249.1(c) of the LOS Convention requires the coastal State to be provided access, "at its request, to all data and samples and likewise to furnish it with data which may be copied and samples which may be divided without detriment to their scientific value".

[95] Article 249.1(d) of the LOS Convention requires the coastal State, if requested, to be provided "with an assessment of such data, samples and research results or provide assistance in their assessment or interpretation".

[96] Part XIII contains no such provision.

[97] This is consistent with article 249.1(f) of the LOS Convention.

[98] Article 246.5(a) and (b) of the LOS Convention permits the coastal State to withhold consent in such circumstances. See also article 250.2 of the LOS Convention.

[99] This is consistent with article 240(d) of the LOS Convention.

[100] This is consistent with article 249.1(g) of the LOS Convention.

[101] Article 210 of the LOS Convention pertains to pollution by dumping. "Dumping" is defined in article 1.1(5)(a) of the LOS Convention, in part, as "any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea". *See further* article 17 below.

[102] The parallel provision in the LOS Convention is article 220.3, which provides:

> 3. Where there are clear grounds for believing that a vessel navigating in the exclusive economic zone or the territorial sea of a State has, in the exclusive economic zone, committed a violation of applicable international rules and standards for the prevention, reduction and control of pollution from vessels or laws and regulations of that State conforming and giving effect to such rules and standards, that State may require the vessel to give information regarding its identity and port of registry, its last and its next port of call and other relevant information required to establish whether a violation has occurred.

[103] The parallel provisions in the LOS Convention are articles 220.5 and 226.1(a), which provide:

> 5. Where there are clear grounds for believing that a vessel navigating in the exclusive economic zone or the territorial sea of a State has, in the exclusive economic zone, committed a violation referred to in paragraph 3

For any suspected or indicted vessel as prescribed in the preceding paragraph, whenever appropriate procedures have been taked [sic] in accordance with international agreements, whereby compliance with requirements for any bond or other appropriate financial surety has been assured, that vessel shall be allowed to proceed.[105]

Article 12

In order to meet special circumstances, the Republic of China, in explicitly defined areas of its exclusive economic zone, may adopt special mandatory measures for the prevention of pollution resulting from vessels, either discharges, navigation, or other practices of vessels.[106]

Article 13

Unless otherwise provided in other laws and regulations, any activity conducted in the exclusive economic zone or on the continental shelf of the Republic of China shall not damage natural resources or harm natural ecology.

Whoever willfully or negligently damages or harms the natural resources or ecology of the exclusive economic zone or the continental shelf of the Republic of China shall be charged along with their employer with joint responsibility for compensation for the damage.

Article 14

The Government of the Republic of China reserves the right to conserve and manage fish stocks straddling both within and beyond its exclusive economic zone. Foreign fishing vessels conducting fishing

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resulting in a substantial discharge causing or threatening significant pollution of the marine environment, that State may undertake physical inspection of the vessel for matters relating to the violation if the vessel has refused to give information or if the information supplied by the vessel is manifestly at variance with the evident factual situation and if the circumstances of the case justify such inspection.

1. (a) States shall not delay a foreign vessel longer than is essential for purposes of the investigations provided for in articles 216, 218 and 220. Any physical inspection of a foreign vessel shall be limited to an examination of such certificates, records or other documents as the vessel is required to carry by generally accepted international rules and standards or of any similar documents which it is carrying; further physical inspection of the vessel may be undertaken only after such an examination and only when:

(i) there are clear grounds for believing that the condition of the vessel or its equipment does not correspond substantially with the particulars of those documents;

(ii) the contents of such documents are not sufficient to confirm or verify a suspected violation; or

(iii) the vessel is not carrying valid certificates and records.

[104] The institution of proceedings is authorized by article 220.6 of the LOS Convention only when "there is clear objective evidence that a vessel navigating in the exclusive economic zone or the territorial sea of a State has, in the exclusive economic zone, committed a violation referred to in paragraph 3 resulting in a discharge causing major damage or threat of major damage to the coastline or related interests of the coastal State, or to any resources of its territorial sea or exclusive economic zone, that State may, subject to section 7, provided that the evidence so warrants, institute proceedings, including detention of the vessel, in accordance with its laws."

[105] The parallel provision in the LOS Convention is article 220.7, which provides: "Notwithstanding the provisions of paragraph 6, whenever appropriate procedures have been established, either through the competent international organization or as otherwise agreed, whereby compliance with requirements for bonding or other appropriate financial security has been assured, the coastal State if bound by such procedures shall allow the vessel to proceed."

[106] While apparently inspired by article 211.6 of the LOS Convention, this provision contains none of the safeguards set out in article 211.6.

of such stocks shall give due regard to the conservation and management measures of the Republic of China of these stocks.[107]

The conservation and management measures of such fish stocks prescribed in the preceding paragraph shall be enacted and promulgated by Executive Yuan.

Article 15

In delineating the course for the laying, maintaining, or modifying any submarine cables or pipelines on the continental shelf of the Republic of China, permission of the Government of the Republic of China is required.[108] The permission regulations shall be decided by the Executive Yuan.

The Government of the Republic of China may withhold its permission as prescribed in the preceding paragraph on the grounds of exploring, exploiting, managing, conserving the non-living or sedentary resources over [sic] its continental shelf, or preventing, reducing, or controlling pollution from such pipelines.[109]

Article 16

Where the authorities of national defense, police, customs, or other authorized agencies of the Republic of China consider that a person or an object, which is in its exclusive economic zone or on its continental shelf, is engaged in any activity violating laws and regulations[] of the Republic of China, such authorities may engage in hot pursuit,[110] boarding,[111] and inspection. When necessary, the aforementioned authorities may expel or arrest the suspected person, or detain the vessels, aircraft, aircraft [sic], equipment, or other articles belonging to the suspected person, and institute legal proceedings.

Article 17

Whoever dumps, discharges or disposes of waste or other substances in the exclusive economic zone or on the continental shelf without complying with the laws and regulations of the Republic of China shall be punished with imprisonment not exceeding ten years, or detention in lieu thereof, or in addition thereof, a fine not exceeding one hundred million New Taiwan Dollars.[112]

Article 18

Whoever willfully damages or harms the natural resources or ecology of the exclusive economic zone or the continental shelf of the Republic of China shall be punished with imprisonment not exceeding five years or detention in lieu thereof, or in addition thereto, a fine not exceeding fifty million New Taiwan Dollars.[113]

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[107] The general requirements for conservation and management of fish stocks are set out in articles 61 and 62 of the LOS Convention. The general rules for the conservation and management of straddling fish stocks are set out in article 63 of the Convention, and have been detailed in the United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, in force as from 11 December 2001, and available at http://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm.

[108] Article 79.3 of the LOS Convention does not permit the coastal State to delineate the course of submarine cables not entering its territory or territorial sea.

[109] A similar provision is found in article 79.2 of the LOS Convention.

[110] The rules for hot pursuit are set out in article 111 of the LOS Convention.

[111] The rules for exercise of the right of visit are set out in article 110 of the LOS Convention.

[112] See article 10 above.

[113] See articles 9.40 and 13 above. There does not appear to be a comparable provision for the punishment of vessel source pollution; see article 230 of the LOS Convention for the comparable provision.

Article 19

Whoever undertakes construction, use, modification, or the dismantling of artificial islands, installations or structures in the exclusive economic zone or on the continental shelf of the Republic of China without obtaining permission from the Government of the Republic of China shall be punished with a fine of between ten million and fifty million New Taiwan Dollars. The court may confiscate the constructed artificial islands, installations or structures or order the said person to restore the environment to the original condition.

Whoever violates terms or objects of the granted permission shall be punished with a fine of between five million and twenty million New Taiwan Dollars and a set time limit to remedy the violation shall be established. Without improvement until then, the permission shall be canceled and the artificial islands, installations or structures must be dismantled.[114]

Article 20

Whoever conducts any one of the following activities without obtaining permission from the Government of the Republic of China shall be punished with a fine of between one million and five million New Taiwan Dollars and the vessels, equipment, and catches belonging to the said person may be confiscated:

43. Conducting exploration, exploitation, management, or conservation of living or non-living resources in the exclusive economic zone of the Republic of China;

44. Conducting exploration, exploitation, management, or conservation of non-living resources or sedentary living resources on the continental shelf of the Republic of China. [115]

Whoever violated the terms or objects of any permission granted shall be punished with a fine of between two hundred thousand and two million New Taiwan Dollars. Products (catch or haul) may be confiscated.

Article 21

Whoever produces energy from the water, currents and winds or other activities in the exclusive economic zone or on the continental shelf of the Republic of China without obtaining permission from the Government of the Republic of China shall be punished with a fine of between two hundred thousand and one million New Taiwan Dollars and the related equipment may be confiscated.[116]

Article 22

Whoever undertakes marine scientific research in the exclusive economic zone or on the continental shelf of the Republic of China without obtaining permission from the Government of the Republic of China shall be punished with a fine of between five hundred thousand and two million New Taiwan Dollars and the related exploring instruments and data may be confiscated.[117]

Article 23

Whoever undertakes the laying[,] maintaining, or modifying of submarine cables and pipelines on the continental shelf of the Republic of China without obtaining permission on the delineation of the course shall be punished with a fine of between twenty mission and one hundred million New Taiwan Dollars and the said person my [sic] be prohibited from using such cables and pipelines or be ordered to dismantle them.[118]

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[114] See article 8 above.
[115] See article 6 above.
[116] See article 7 above.
[117] See article 9 above.
[118] See article 15 above and accompanying note.

Article 24

Whoever conducts the following activities in the exclusive economic zone or on the continental shelf of the Republic of China shall be punished in accordance with the Criminal Code of the Republic of China:

45. Threats or violence against a public official who is engaged in the lawful discharge of his duties;

46. Organizing an open assembly at which an offense specified in the preceding sub-paragraph occurs;

47. Activities conducted to abandon, damage, hide, or render useless the letters, books, articles taken in its custody by a public official or entrusted by such public official of the ROC to a third person;

48. Activities conducted to damage, remove, [or] stain the seal or notice affixed by a public official of the ROC;

49. Public insults to a public official of the ROC during or with respect to the legal discharge of his duties; and,

50. Threats or violence with intent to compel a public official of the ROC to perform an act relating to his public duties or with intent to obstruct the lawful discharge of such public duties.

Article 25

Fines imposed in accordance with this law not paid within the designated time limit shall be transferred to the court for mandatory enforcement.

Article 26

This law shall enter into force on the date of promulgation.

Annex 178(bis)

Government of the Republic of the Philippines and Government of the People's Republic of China, *Joint Statement: Philippine-China Experts Group Meeting on Confidence Building Measures* (23 Mar. 1995)

1999 - 34

JOINT STATEMENT
PHILIPPINES-CHINA EXPERTS GROUP MEETING
ON CONFIDENCE BUILDING MEASURES
MANILA, 22-23 MARCH 1999

In accordance with the agreement reached at the Philippines-China Consultations in Manila in March 1996, an Experts' Group Meeting on Confidence-Building Measures was convened in Manila on 22-23 March 1999.

Undersecretary of Foreign Affairs Lauro L. Baja Jr., and Assistant Minister Wang Yi led their respective delegations.

The Philippine and Chinese sides agreed that a tradition of friendship has been established between their two countries through intensive official exchanges and mutual efforts to promote relations in various areas. In this regard, they had an extensive exchange of views on confidence-building measures. They also had a candid exchange of views on the latest developments relating to the Mischief Reef (Meiji Reef).

On confidence-building measures, the two sides reiterated their commitment to:

1. The understanding to continue to work for a settlement of their differences through friendly consultations;

2. Settle their dispute in accordance with the generally-accepted principles of international law, including the United Nations Convention on the Law of the Sea;

3. Maintain peace and stability of the region and refrain from the use or threat of force;

4. Improve existing systems of contact and dialogue on matters involving fisheries, marine environment, meteorology, marine scientific research, safety of lives at sea, disaster reduction and prevention, and safety of navigation;

5. Expand bilateral military dialogue and cooperation, including more exchanges of visits by senior defense and military officials, improvement of information exchange and establishment of measures for avoiding conflict at sea.

On the Mischief Reef (Meiji Reef), the two sides stated their respective positions. The Philippine side expressed its serious concern over the recent developments. The Chinese side stated that the facilities on the Mischief Reef (Meiji Reef) will remain for civilian purposes. The two sides exchanged views on ideas to ease tension and build up confidence, including the idea raised by the Philippine side for access to the above civilian facilities and the Chinese request for stopping the arrest and detention of fishermen. In response to the concerns on possible further development in this area, the two sides agreed to exercise self-restraint and not to take actions that might escalate the situation.

The two sides considered the convening of the Meeting of Experts Group on Confidence-Building Measures (CBM) as a CBM by itself, which enhanced mutual understanding.

The two sides believe that the channels of consultation between China and the Philippines are unobstructed. They have agreed that the dispute should be peacefully settled through consultation and that the normal development of bilateral relations should not be affected by their differences. They reaffirmed that they would exert efforts to resolve outstanding problems in a constructive, friendly and accommodating spirit. The two sides agreed to hold the second Meeting on Confidence-Building Measures at the earliest opportunity. The Chinese side offered to host this meeting at a date and venue to be mutually agreed upon.

Annex 825

C. Schofield & D. Wang, “The Regime of Islands under the United Nations Convention on the Law of the Sea: Implications for the South China Sea”, in *Maritime Energy Resources in Asia: Legal Regimes and Cooperation*, NBR Reports, No. 37 (C. Schofield ed., Feb. 2012)

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Legal Regimes and Cooperation

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The Regime of Islands under UNCLOS: Implications for the South China Sea

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EXECUTIVE SUMMARY

This essay explores the contentious issue of islands and their associated claims to maritime jurisdiction in international law with particular reference to the islands/rocks in East and Southeast Asia and especially the disputed islands of the South China Sea.

MAIN ARGUMENT

Islands remain a critical factor in maritime and territorial disputes in East and Southeast Asia, both with respect to sovereignty disputes over island territories and with regard to their capacity to generate maritime jurisdictional claims for the delimitation of maritime boundaries. The regime of islands, as provided in Article 121 of the UN Convention on the Law of the Sea (UNCLOS), remains unclear, and no authoritative ruling or consensus on its interpretation has yet emerged. Recent developments, however, have clarified the positions of some of the parties to the South China Sea islands disputes on this issue. There is also a trend toward reducing the effect of sparsely inhabited or uninhabited islands in the generation of maritime claims and the delimitation of maritime boundaries. The latter development suggests that disputed islands, even if deemed capable of generating extended claims to maritime jurisdiction, would have only a limited capacity to generate such claims compared with the surrounding mainland and main island territories. Acceptance of this view by, for example, the South China Sea claimant states would result in considerable narrowing of the area of overlapping maritime claims, thus significantly simplifying the dispute.

POLICY IMPLICATIONS

- An authoritative interpretation of Article 121 of UNCLOS, though highly desirable, is presently lacking, and both state practice and international jurisprudence are of only limited utility on this issue.
- It is increasingly clear that the parties to disputes over East and Southeast Asian islands take distinctly differing views on the capacity of certain features to generate broad maritime claims. This remains a key obstacle to the achievement of a peaceful settlement of regional maritime and territorial disputes.
- The trend toward minimizing the role of small, remote islands in the generation of claims to maritime space and the delimitation of maritime boundaries is encouraging and suggests approaches to overcoming the island/rock conundrum in the South China Sea. This should help moderate or reduce the scope of overlapping maritime claims and subsequently "defuse the bomb" of potential conflict over disputed islands in the region.

A critical source of dispute in both the East China Sea and South China Sea is the question not only of sovereignty over numerous disputed islands, but also their status in terms of international law and thus their capacity to generate extended claims to maritime jurisdiction. That is, the question is whether a particular insular feature is either an island capable of generating claims to exclusive economic zone (EEZ) and continental shelf rights, or a mere "rock" incapable of doing so. A related issue is the potential role of such features in the delimitation of international maritime boundaries. Consideration of the regime of islands in the international law of the sea is fundamental to such disputes and has proved to be an enduring source of contention among states and international legal scholars.

It is worth noting that a key cause of uncertainty and disputes internationally is that states tend to claim as much in terms of their rights as possible. While in principle such claims need to be made in accordance with international law, interpretations of international legal provisions can vary greatly. It is easy to observe such phenomena in the application and interpretation of certain articles provided in the United Nations Convention on the Law of the Sea of 1982 (UNCLOS).[1] A notable example in this context is provided by Article 121 of UNCLOS, concerning the regime of islands, and the contrasting interpretations of the article that different states adopt according to their national interests. As the interpretation of Article 121 deals with the status of rocks and islands, this inevitably affects a state's national interests in terms of claiming or not claiming potentially expansive areas of maritime jurisdiction.

This essay explores the regime of islands under UNCLOS and thus the interpretation of Article 121, paragraph 3, specifically, so that the legal context can be clarified and applied, as far as is possible, to the disputed islands and rocks in the South China Sea region. The development of Article 121 of UNCLOS is addressed, and the question of defining islands is examined prior to consideration of the critical question of distinguishing between islands capable of extended claims to maritime jurisdiction—that is, continental shelf and EEZ rights—and "rocks" which are, in accordance with Article 121, paragraph 3, of UNCLOS, deemed incapable of generating such claims. Relevant state practice as well as the judgments and decisions of the International Court of Justice (ICJ) and other international tribunals are assessed, including in particular appraisal of the 2009 case *Maritime Delimitation in the Black Sea (Romania v. Ukraine)*. Discussion then turns to the question of the role of islands in generating claims to maritime jurisdiction and in the delimitation of maritime boundaries. The implications of the foregoing questions for the disputed insular features of the South China Sea are then explored.

It is not this essay's purpose to undertake a comprehensive review of the substantial literature that already exists on the regime of islands in international law.[2] However, the key elements of the regime of islands—its drafting history and subsequent practice concerning the treatment of islands—are addressed to provide necessary context. The authors suggest in particular that the critical issue is not the well-worn island/rock debate, but the role of small and often remote and

1 The convention was adopted in Montego Bay, Jamaica, on December 10, 1982, and entered into force on November 16, 1994. UN Division for Ocean Affairs and the Law of the Sea, "United Nations Convention on the Law of the Sea (UNCLOS)."

2 See, for example, Jonathan I. Charney, "Rocks that Cannot Sustain Human Habitation," *American Journal of International Law* 93, no.4 (1999): 863–78; Alexander G.O. Elferink, "Clarifying Article 121 (3) of the Law of the Sea Convention: The Limits Set by the Nature of International Legal Processes," *Boundary and Security Bulletin* 6, no. 2 (1998): 58–68; Barbara Kwiatkowska and Alfred H.A. Soons, "Entitlement to Maritime Areas of Rocks Which Cannot Sustain Human Habitation or Economic Life of Their Own," *Netherlands Yearbook of International Law*, vol. XXI (1990), 139–81; J.R. Victor Prescott and Clive H. Schofield, *The Maritime Political Boundaries of the World* (Leiden: Martinus Nijhoff, 2005), 61–75; Jon M. Van Dyke and Robert A. Brooks, "Uninhabited Islands: Their Impact on the Ownership of the Oceans' Resources," *Ocean Development and International Law* 12, no. 3–4 (1983): 265–84; and Jon M. Van Dyke, Joseph Morgan, and Jonathan Gurish, "The Exclusive Economic Zone of the Northwestern Hawaiian Islands: When Do Uninhabited Islands Generate an EEZ?" *San Diego Law Review* 25, no. 3 (1988): 425–94.

sparsely inhabited or uninhabited islands in generating claims to maritime jurisdiction and in influencing the course of international maritime boundaries. It is suggested here that some clarity is emerging in the latter respect. These developments are, in the view of the authors, of direct relevance to the numerous island-related disputes in East and Southeast Asia, and it is hoped that they may have a positive impact in terms of alleviating regional tensions, especially those concerning, for example, the Spratly Islands disputes in the South China Sea. In essence, it is hoped that, although the issue of islands and rocks remains an enduring source of disagreement and dispute, ways to minimize and overcome such disputes also exist.

The Regime of Islands under UNCLOS

In order to decide whether a particular insular feature can generate extended zones of maritime jurisdiction, that is, EEZ and continental shelf rights, it is necessary to closely examine the international legal regime of islands, as provided by Article 121 of UNCLOS:

> *Regime of islands*
>
> An island is a naturally formed area of land, surrounded by water, which is above water at high tide.
>
> Except as provided for in paragraph 3, the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf of an island are determined in accordance with the provisions of this Convention applicable to other land territory.
>
> Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf.

Paragraph 1 of Article 121 identifies four key requirements for a feature to qualify legally as an island: an island must be "naturally formed," an "area of land," "surrounded by water," and "above water at high tide"—requirements for insular status that are relatively uncontroversial.[3] Further, paragraph 2 of Article 121 establishes that the maritime claims made from islands should be determined in the same manner as for "other land territory." This suggests that islands should be treated in the same fashion as mainland coasts.

However, Article 121, paragraph 3, of UNCLOS provides for a subcategory of islands, "rocks," which are incapable of supporting human habitation or an economic life of their own. Such features "shall have no exclusive economic zone or continental shelf."

It should be noted that the regime of islands does not include either artificial islands or low-tide elevations. According to Article 60, paragraph 8, of UNCLOS, artificial islands, together with artificial installations and structures, "do not possess the status of islands," "have no territorial sea of their own," and are to have no impact on the delimitation of maritime boundaries.[4] Low-tide elevations, which are submerged at high tide but above water at low tide, are incapable of generating maritime claims in their own right but may be used as base points for the measurement

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3 Prescott and Schofield, *Maritime Political Boundaries of the World*, 58–61.

4 Safety zones of up to 500 meters (m) in breadth may be defined around such structures in accordance with UNCLOS, Article 60, paragraph 5, however.

of such claims if located wholly or partially within the breadth of the territorial sea as measured from the normal baseline of a state's mainland or island coasts.[5]

The Island/Rock Conundrum

It is clear that the distinction between an island capable of extended maritime claims (EEZ and continental shelf) and a mere "rock" that cannot generate such claims is a critical issue and a potential source of dispute between neighboring states.[6] What might be termed "full" island status confers an enormous advantage in terms of capacity to generate claims to maritime jurisdiction as compared to a feature being classified as a rock: if an island had no maritime neighbors within 400 nautical miles (nm), it could generate 125,664 square nautical miles (nm^2)—or 431,014 square kilometers (km^2)—of territorial sea, EEZ, and continental shelf rights. In stark contrast, a rock could generate a territorial sea claim of only 452 nm^2 (1,550 km^2).[7]

From an ordinary understanding, the term "islands" may be translated to mean anything from tiny sandbanks to large landmasses, all depending on the functional purposes of the usage by the state that owns it. As noted above, UNCLOS provides the international legal definition and maritime entitlements of an island through paragraphs 1 and 2 of Article 121. However, Article 121, paragraph 3, leaves unclear how the disadvantaged subcategory of island (the "rock") is to be identified. More specifically, there is no plain interpretation of the terms "sustain human habitation" or "an economic life of its own," which are both stipulated in Article 121, paragraph 3. Yet, as noted above, the distinction between an insular feature being capable of generating extended maritime claims as opposed to being a rock has enormous potential consequences in terms of the scope of maritime claims that can be made as well as in relation to the role of such features in maritime boundary delimitation. Moreover, this issue directly impacts the national interests of the coastal states claiming maritime zones from islands—that is, territorial sea, EEZ, and continental shelf rights within 200 nm and potentially even beyond the 200-nm limit. Inevitably, within the maritime claims potentially made from islands, valuable marine resources are also at stake in these debates.

These issues remain highly relevant to the island-related disputes that exist in the East China Sea and, particularly, the South China Sea. With respect to the South China Sea specifically, due to its complicated geographical, geological, geopolitical, and legal features, this region is often considered a key potential "flashpoint" in East Asia and is treated as one of the indicators for Southeast Asian security. There are more than one hundred insular features, including reefs, rocks, sandbanks, islets, and islands in the Spratly Islands group alone, which are claimed in whole or in part by Brunei, China, Indonesia, Malaysia, the Philippines, Taiwan, and Vietnam. As far as the "islands" in the Spratlys are concerned, the aforementioned island/rock issue is a crucial consideration as enormous potential claims to maritime areas, and the marine resources within them, are viewed as being at stake. Indeed, uncertainty over this issue might be one of the most important factors in amplifying conflicts in the region.

The inherently vague and imprecise wording in Article 121, paragraph 3, has led to sustained criticism of that section of UNCLOS.[8] For example, what do terms such as "human habitation,"

5 "UNCLOS," art. 13, par. 1.

6 It should be noted in the context of a section devoted to island/rock issues that "rocks," as defined under Article 121 of UNCLOS, are a type of island such that the question of a feature being "an island or a rock" does not arise.

7 For the purposes of these theoretical calculations, it is assumed that the insular features in question have no land area.

8 See, for example, the literature cited in fn. 2.

"economic life," and "of their own" mean? Is there any qualitative element that could be employed to distinguish a rock from an island capable of being used to advance broad claims of maritime jurisdiction, specifically EEZ and continental shelf rights? It can, however, be noted that use of the word "or" between "human habitation" and "economic life of their own" suggests that an insular feature does not need both human habitation and an economic life of its own. Only one of these criteria must be met to remove the feature from the restriction of this provision.[9]

The absence of precise definitions for these terms has provided ample scope for often radically differing interpretations and therefore disputes on this issue. In seeking clarification on the interpretation of the regime of islands, the drafting history of Article 121 is considered with a view to offering insights as to the intentions of the drafters of these provisions of UNCLOS. The subsequent practices of states in their interpretation and application of Article 121, as well as the rulings of international courts and tribunals, may also play an important role in such clarification over time.

The Drafting History of Article 121 of UNCLOS

One key potential source of clarification is the drafting history of Article 121. Unfortunately, this article provides little assistance in terms of delivering clarity on the island/rock interpretational conundrum. Instead, examination of the drafting history merely tends to highlight the diversity of views adopted by interested states.[10]

For example, the physical size or area of the insular feature in question was a prominent theme in discussions regarding the means by which some insular features should have a restricted capacity to generate claims to maritime jurisdiction. This issue has generated intense debates as well as multiple, various proposals from individual states or groups of countries. For instance, during one of the early sessions of the Third UN Conference on the Law of the Sea (UNCLOS III) held in Caracas in 1974, Malta proposed draft articles that distinguished between "islands" and "islets" on the basis of size. While both islands and islets were defined as a "naturally formed area of land," the former were to be "more than one square kilometer in area" and the latter "less than one square kilometer in area."[11] According to the Maltese proposal, maritime claims from islands "less than 10 square kilometers in area" were to be restricted, and a special convention was to be drafted in respect of the maritime claims of other, larger islands, "taking into account all relevant circumstances."[12]

Additionally, Ireland proposed that features deemed to be islands should possess at least 10% of the land area and 10% of the population of the claimant state.[13] A group of fourteen African states similarly suggested that the maritime spaces of islands should be determined "according to equitable principles taking into account all relevant factors and circumstances," including island size, island population (or lack of), "contiguity to the principal territory," whether the island was "situated on the continental shelf of another territory," and the feature's geological and geomorphological

9 Charney, "Rocks that Cannot Sustain Human Habitation"; and Jonathan L. Hafetz, "Article 121(3) and the Treatment of Islands under International Law," *American University of International Law Review* 15 (2000): 587–95.

10 See United Nations, *United Nations Conferences on the Law of the Sea, Official Records, Third Conference*, (1980; repr., Buffalo, New York: William S. Hein & Co., 2000). See also UN Division for Ocean Affairs and the Law of the Sea, *Régime of Islands: Legislative History of Part VIII (Article 121) of the United Nations Convention on the Law of the Sea* (New York: UN, 1988); and S.N. Nandan and S. Rosenne, eds., *United Nations Convention on the Law of the Sea 1982: A Commentary*, vol. 3 (Dordrecht: Kluwer Law International, 1995), 321–29.

11 UN Doc.A/AC.138/SC.II/L.28, art. 1. See Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 328.

12 UN Doc.A/AC.138/SC.II/L.28, art. 9, 11, and 15. See ibid., 328–29.

13 UN Doc.A/CONF.62/C.2/L.43 (1974).

structure and configuration.[14] The Romanian draft suggested a new category of insular feature—"islets and small islands."[15] According to this view, such features being "uninhabited and without economic life, which are situated on the continental shelf of the coast, do not possess any of the shelf or other marine space of the same nature."[16] Romania's proposals, similar to those of Malta and the aforementioned African states, were aimed at denying or restricting small insular features from the status of maritime zones accorded definition as "true" islands.[17]

Contrary views were, however, also prominent. Indeed, a number of states represented at the UN Convention on the Law of the Sea III were keen to preserve the status quo. Some states argued on principle that no distinctions of any kind should be made so long as an island was above water at high tide, arguing that it would not be possible to define a set of criteria for small islands or islets that could be applied to every geographical situation without producing an inequitable result in some cases. As the United Kingdom delegate pointed out,

> There was an immense diversity of island situations, ranging from large and populous islands of even larger continental states to small islands with self-sufficient populations, and that, inter alia, the attempt by some delegations to categorise islands in terms of size would not result in any generally applicable rules which would be equitable in all cases; and there was grave danger of discounting many islands of both absolute and relative importance.[18]

States in possession of numerous islands were keen to ensure that these features remained able to generate considerable associated maritime entitlements. For example, the representative of Greece reacted to the Maltese proposal by observing:

> The regime of islands could not be legally based on criteria of size, population, geographical location or geological configuration without jeopardising the principles of sovereign equality and the integrity of territorial sovereignty.[19]

Greece proposed draft articles that, while repeating the familiar formula that an island was "a naturally formed area of land surrounded by water which is above water at high tide," emphasized that islands form "an integral part of the territory of the State to which it belongs," that the territorial sea applicable to an island was to be determined in the same manner as for continental parts of the state, and that with regard to the continental shelf and the zones of national jurisdiction claimable from continental parts of the state, such claims "are as a general rule applicable to islands."[20] Regarding the breadth and limits of the territorial sea, a proposal by China echoed that of Greece, stating that these were "in principle, applicable to the islands belonging to [a] State."[21] Turkey suggested that the existence of islands should be a consideration in

14 UN Doc.A/AC.138/SC.II/L.40. See Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 329–30. The fourteen states were Algeria, Cameroon, Ghana, Ivory Coast, Kenya, Liberia, Madagascar, Mauritius, Senegal, Sierra Leone, Somalia, Sudan, Tunisia, and Tanzania.

15 UN Doc.A/AC.138/SC.II/L.53. See Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 330.

16 Ibid.

17 Janusz Symonides, "The Legal Status of Islands in the New Law of the Sea," in *The Law of the Sea*, ed. Hugo Caminos (Dartmouth: Ashgate, 2001), 118; and John R. Stevenson and Bernard H. Oxman, "The Third United Nations Conference on the Law of the Sea: The 1974 Caracas Session," *American Journal of International Law* 69 (1975): 24–25.

18 C.R. Symmons, *The Maritime Zones of Islands in International Law* (The Hague: Martinus Nijhoff, 1979), 40.

19 UN Doc.A/AC.138/SC.II/L.29. See also Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 329.

20 The Greek proposal did further state that these provisions were "without prejudice to the regime of archipelagic islands." UN Doc.A/AC.138/SC.II/L.29. See also Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 329.

21 UN Doc.A/AC.138/SC.II/L.29. See also Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 329.

the delimitation of the continental shelf between opposite and adjacent states, which led Greece to essentially restate its position.[22]

Similarly, small island states argued that given their limited land resources, they should be entitled to an EEZ around all of their islands, irrespective of their size and characteristics. A proposal made by four Pacific island states sought to ensure that the maritime entitlements of islands were to be determined "in accordance with the provisions of the Convention applicable to other land territory," but without prejudice to the question of the delimitation of maritime boundaries or the regime of archipelagos.[23]

An attempt to tackle the problem of defining islands by size was undertaken by Robert Hodgson, a geographer at the U.S. Department of State. His 1973 research study, *Islands: Normal and Special Circumstances*, included a categorization of islands as follows: (1) rocks, less than .001 square mile in area, (2) islets, between .001 and 1 square mile, (3) isles, greater than 1 square mile but not more than 1,000 square miles, and (4) islands, larger than 1,000 square miles.[24]

Perhaps then, inevitably conflicting national interests dominated the shaping of the regime of islands at the UN Convention on the Law of the Sea III. While certain notable contributors to the debate, such as Romania, Turkey, and Denmark, were keen to minimize the effect of islands because doing so served their particular circumstances, other states in possession of such features, such as Greece and Venezuela, were keen to maximize potential claims from them. The ultimate consequence of these conflicting perspectives and proposals was the intentionally vague and ambiguous text of Article 121, paragraph 3. Accordingly, an assessment of the drafting history of Article 121 of UNCLOS appears to lead to a dead end as far as clarifying interpretation of the regime of islands is concerned. Some limited guidance is, however, provided by subsequent state practice and the decisions of international courts and tribunals.

State Practice

State practice regarding the regime of islands is, perhaps unsurprisingly, mixed. As previously noted, states tend to lean toward the maximum possible in respect of their claim to jurisdictional rights, as long as such claims are in accordance with international law. Thus, those states in possession of islands have naturally tended to advance expansive maritime claims from even extremely small, uninhabited, and remote insular features.

Perhaps the most extreme example of this type of practice is Japan's ongoing claims regarding the islets that make up Okinotorishima.[25] This feature, or features, also known as Douglas Reef, is a reef platform surmounted by a number of very small rocks, which are marginally above the high-tide level.[26] While the reef platform itself is reasonably substantial, measuring approximately five by two kilometers, at high tide only two small rocks measuring just a few meters in area are

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22 Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 329, 331–32.

23 UN Doc.A/CONF.62/C.2/L.30. See also Nandan and Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, 331.

24 R. Hodgson, *Islands: Normal and Special Circumstances*, Research Study (Washington, D.C.: U.S. Department of State, Bureau of Intelligence and Research, 1973).

25 See, for example, Y.H. Song, "Okinotorishima: A 'Rock' or an 'Island'? Recent Maritime Boundary Controversy between Japan and Taiwan/China," in *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea*, ed. S.Y. Hong and Jon M. Van Dyke (The Hague: Martinus Nijhoff, 2009), 145–76.

26 Prescott and Schofield, *Maritime Political Boundaries of the World*, 84–85. Yann-huei Song notes that at "highest tide" the two above-tide features are only 16 and 6 centimeters above the surface of the water, respectively. See Song, "Okinotorishima: A 'Rock' or an 'Island?'" in Hong and Van Dyke, *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea*, 148.

left above water. Indeed, both of these features have been described as being no "larger than king-size beds" at high tide.[27]

Nonetheless, Japan takes the view that these features are islands that generate claims to EEZ rights. Further, when Japan made its submission to the UN Commission on the Limits of the Continental Shelf (CLCS) on November 12, 2008, it included continental shelf areas extending to the south of Okinotorishima and seaward of its claimed 200-nm limit from that feature, along the Kyushu-Palau Ridge, apparently on the basis that these areas of seabed form a natural prolongation of Japan's land mass as represented by Okinotorishima.[28] It is notable, however, that the Chinese government responded to Japan's submission with the wording that "States Parties shall also have the obligation to ensure respect for the extent of the International Seabed Area…which is the common heritage of mankind, and not to affect the overall interests of the international community as a whole."[29]

In contrast to this expansionist trend, there are also instances, albeit somewhat more isolated in frequency, of states taking a more restrained approach in their maritime claims from islands. The most notable example in this context is the United Kingdom's reclassification of one small and remote feature, Rockall, from the status of an island previously considered a valid base point for 200-nm claims to one only able to generate territorial sea rights. Consequently, the United Kingdom executed a "roll-back" in its maritime jurisdictional claims from Rockall, resulting in the loss to the United Kingdom of around 60,000 nm^2 of maritime space previously claimed as part of the country's fishery zone.[30] Overall, therefore, state practice on this issue can therefore be viewed as somewhat contradictory and therefore does not offer conclusive guidance.

Resolutions Derived from International Courts and Tribunals

With regard to the jurisprudence of international courts and tribunals, unfortunately an authoritative interpretation of Article 121 from a body such as the ICJ remains lacking, not least because the court has opted to effectively sidestep the issue. While there were hopes, based on the pleadings of the parties to the Black Sea case, which featured detailed arguments on the interpretation of Article 121 of UNCLOS, that the ICJ would provide an authoritative ruling on this problematic provision of UNCLOS, this ruling did not eventuate. Rather than addressing the interpretation of Article 121, the court found that it did not need to address the island/rock question in order to delimit the maritime boundary at issue and in accordance with the request of the parties to the case.[31] The court did, however, address the specific role of the problematic island

27 See Jon Van Dyke, "Speck in the Ocean Meets Law of the Sea," letter to the editor, *New York Times,* January 21, 1988; A.L. Silverstein, "Okinotorishima: Artificial Preservation of a Speck of Sovereignty," *Brooklyn Journal of International Law* 16, no. 2 (1990): 409; and Song, "Okinotorishima: A 'Rock' or an 'Island?'" in Hong and Van Dyke, *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea*, 147–49.

28 Japan's Submission to the Commission on the Limits of the Continental Shelf, http://www.un.org/Depts/los/clcs_new/submissions_files/jpn08/jpn_execsummary.pdf.

29 For the Chinese reaction to the submission made by Japan, see http://www.un.org/Depts/los/clcs_new/submissions_files/jpn08/chn_6feb09_e.pdf.

30 House of Commons, *Hansard, Written Answers*, July 21, 1997, cols. 397–98. An identical statement was made in the House of Lords a day later on July 22, 1997 (House of Lords, *Hansard, Written Answers*, July 22, 1997, cols. 155–56), quoted in D.H. Anderson, "British Accession to the UN Convention on the Law of the Sea," *International and Comparative Law Quarterly* 46 (1997): 761–86, 778. See also C.R. Symmons, "Ireland and the Rockall Dispute: An Analysis of Recent Developments," *Boundary and Security Bulletin* 6, no.1 (1998): 78–93.

31 *Maritime Delimitation in the Black Sea (Romania v. Ukraine)*, ICJ Rep. (2009), par. 187, http://www.icj-cij.org/docket/files/132/14987.pdf.

in question, Serpents' Island,[32] with respect to the delimitation of a maritime boundary between the states involved, Romania and Ukraine.[33]

Nonetheless, there have been several cases before the ICJ that illustrate the methodology used by the court in terms of the treatment of islands in the delimitation of maritime boundaries. The following discussion will focus on the island issue in the respective cases. The first case is the 1985 *Case Concerning the Continental Shelf (Libyan Arab Jamahiriya/Malta)*, in which an islet, Filfla, became the center of discussion. Filfla is an uninhabited islet located about 2.7 nm south of Malta and was utilized by Malta as one of the base points to construct its straight baselines.

In considering whether the islet of Filfla could be used as a base point, the ICJ did not express any opinion on whether the inclusion of Filfla in the Maltese baselines was legally justified. Instead, the court took the position that "the equitableness of an equidistance line depends on whether the precaution is taken of *eliminating the disproportionate effect* [emphasis added] of certain islets, rocks and minor coastal projections."[34] The court thus found it equitable not to take account of Filfla in the calculation of the provisional median line between Malta and Libya so that the disproportionate effect could be eliminated.

The second case concerns the maritime delimitation between Qatar and Bahrain. In this case, whether Qit'at Jaradah is an island or a low-tide elevation was brought to attention. Qit'at Jaradah is a maritime feature located off the northwestern coast of the Qatari peninsula and to the northeast of the main island of Bahrain. At high tide, this maritime feature's length and breadth are about 12 and 4 meters (m), whereas at low tide they are 600 and 75 m. At high tide, its altitude is approximately 0.4 m.[35] The court recalled that the legal requirements for defining an island are that the feature be a "naturally formed area of land," "surrounded by water," and "above water at high tide," as provided in Article 121, paragraph 3, of UNCLOS. The ICJ concluded that the maritime feature of Qit'at Jaradah satisfied these criteria and that it was in fact an island.[36] However, the court also observed that Qit'at Jaradah is a very small island, uninhabited and without any vegetation. The tiny island is situated about midway between the main island of Bahrain and the Qatar peninsula. The ICJ therefore determined that if its low-water line were to be used for determining a base point in the construction of the equidistance line, and this line was taken as the delimitation line, a "disproportionate effect" would be given to an insignificant maritime feature. Consequently, in order to eliminate the disproportionate effect, the court deemed it necessary to ignore the effect of Qit'at Jaradah in the process of delimitation.[37]

The third case is the *Territorial and Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea*. In this case, the legal status of Bobel Cay, Savanna Cay, the Port Royal Cays, and South Cay were examined. The court noted that the parties did not dispute the fact that all of the cays remain above water at high tide. They thus fall within the definition and regime of islands under Article 121 of UNCLOS.[38] However, due to the fact that the 12-nm territorial

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32 Ostrov Zmeinyy ("Serpents' Island" or "Insular Serpilor" in Romanian) is a small (0.135 km^2) Ukrainian island, located approximately 19 nm from the terminus of the land boundary between the two states on the Black Sea coast. The location of Serpents' Island is such that it could substantially influence a maritime boundary delimitation between the two states on the basis of equidistance.

33 *Maritime Delimitation in the Black Sea*, par. 187.

34 *Case Concerning the Continental Shelf (Libyan Arab Jamahiriya/Malta)*, ICJ Rep. 13 (1985), par. 64.

35 *Maritime Delimitation and Territorial Questions between Qatar and Bahrain (Qatar v. Bahrain)*, ICJ Rep. (2001), par. 197.

36 Ibid., par. 195.

37 Ibid., par. 219.

38 *Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea*, ICJ Rep. (2007), par. 137.

seas of Bobel Cay, the Port Royal Cays, South Cay (Honduras), and Edinburgh Cay (Nicaragua) would create overlapping areas between them, the court found that delimitation of the territorial sea was necessary.[39]

The final and most recent decision is *Maritime Delimitation in the Black Sea (Romania v. Ukraine)* (hereafter referred to as the Black Sea case) delivered by the ICJ on February 3, 2009. The Black Sea is an inland sea area bounded by Russia, Georgia, Turkey, Bulgaria, Romania, and Ukraine. The delimitation concerned the area in the northwestern part of the Black Sea in the concavity formed by Romania's coast to the west and Ukraine's coast to the west, north, and east. The adjacent coasts of the parties, Romania and the Ukraine, meet at their shared land boundary terminus on the Danube River delta. Serpents' Island lies approximately 19 nm east of the Danube delta and belongs to Ukraine.[40] It is a natural feature that is above water at high tide, and has a surface area of approximately 0.17 km2 and a circumference of approximately 2,000 m.[41]

There was no sovereignty dispute over Serpents' Island; instead, the issue in large part concerned the maritime zones that the island could, or could not, claim. Indeed, the potential maritime claims from Serpents' Island played an important role throughout the drafting of Article 121 of UNCLOS, with particular reference to the role of this feature on the delimitation of maritime boundaries. The classification of Serpents' Island as a rock or as an island capable of generating extended maritime claims therefore has had significance beyond maritime delimitation issues between Romania and Ukraine, and has played a broader role in the development of the international law of the sea. More specifically, and unsurprisingly, the status and role of Serpents' Island became a key issue in the ICJ case.

Romania and Ukraine expressed different views on the status of Serpents' Island. Romania argued that no account should be taken of Serpents' Island as a base point for the purposes of constructing the provisional equidistance line, based on the following points:[42]

1. Romania claimed that Serpents' Island is a rock incapable of sustaining human habitation or an economic life of its own—in other words, no one can live on it without assistance. Therefore, Serpents' Island should have "no exclusive economic zone or continental shelf, as provided for in Article 121 (3) of the 1982 UNCLOS."
2. Romania further pointed out that when Ukraine notified the UN of the coordinates of its baselines used for measuring the breadth of its territorial sea, it made no reference at all to Serpents' Island.
3. In addition, Romania asserted that the use of Serpents' Island as a base point would result in an inordinate distortion of the coastline.

However, Ukraine, on the other hand, claimed that Serpents' Island was an island because it has inhabitants. Furthermore, Ukraine argued that because Serpents' Island has a coast, it follows that it has a baseline. As a result, it stated that there are base points on that baseline that can be used for plotting the provisional equidistance line. Ukraine pointed out that, contrary to Romania's claims and unlike with straight baselines, the UN does not need to be notified of "normal"

39 *Maritime Dispute between Nicaragua and Honduras*, par. 302–5, 320.

40 "Treaty between Romania and Ukraine on the Romanian-Ukrainian State Border Regime, Collaboration and Mutual Assistance on Border Matters," June 17, 2003, UN *Treaty Ser*. 2277. See also *Maritime Delimitation in the Black Sea*, par. 35; and "Treaty on the Relations of Good Neighbourliness and Cooperation between Romania and Ukraine," June 2, 1997, UN *Treaty Ser*. 2159.

41 *Maritime Delimitation in the Black Sea*, par. 16.

42 Ibid., par. 124.

baselines, defined as the low-water mark around the coast. Ukraine therefore contended that given the island's proximity to the Ukrainian mainland, Serpents' Island should clearly be taken into account as one of the relevant base points for the construction of the provisional equidistance line. It noted that the belt of territorial sea that surrounds Serpents' Island partly overlaps with the area of territorial sea bordering the Ukrainian mainland. Consequently, "this island therefore represents what is commonly termed a coastal island."[43]

What, then, was the effect of Serpents' Island on the course of the maritime boundary delimited by the ICJ? During the process, Ukraine argued that Serpents' Island should be considered part of Ukraine's coast, because it "forms part of the geographical context and its coast constitutes part of Ukraine's relevant coasts."[44] In terms of this argument, Romania responded by arguing that Serpents' Island "constitutes merely a small maritime feature situated at a considerable distance out to sea from the coasts of the Parties";[45] therefore it is debatable that this island could be regarded as part of the coast. The court accepted Romania's perspective on this matter. The ICJ also expressed that "the coast of Serpents' Island is so short that it makes no real difference to the overall length of the relevant coasts of the parties."[46] The court went on to say that Serpents' Island cannot be viewed as part of Ukraine's coast because it is "lying alone and some 20 nautical miles away from the mainland" and thus "is not one of a cluster of fringe islands constituting 'the coast' of Ukraine."[47] Furthermore, the court stated that "to count Serpents' Island as a relevant part of the coast would amount to grafting an extraneous element onto Ukraine's coastline: the consequence would be a judicial refashioning of geography, which neither the law nor practice of maritime delimitation allows."[48]

In the Black Sea case, Romania argued that Serpents' Island should be ignored because it is "a rock incapable of sustaining human habitation or economic life of its own" under Article 121, paragraph 3, and because "using this island as a base point would result in an inordinate distortion of the coastline."[49] Ukraine asserted that Serpents' Island should be considered a "coastal island" because it is within 20 nm of Ukraine's coast and thus its territorial sea "partly overlaps with the area of territorial sea bordering the Ukrainian mainland."[50] Ukraine also argued that Serpents' Island is "indisputably an 'island' under Article 121, paragraph 2, of UNCLOS, rather than a 'rock' due to the reason that it can readily sustain human habitation and that it is well established that it can sustain economic life of its own. In particular, the island has vegetation and a sufficient supply of fresh water as well as appropriate buildings and accommodation for an active population."[51] In addition, Ukraine argued that Article 121, paragraph 3, "is not relevant to this delimitation because that paragraph is not concerned with questions of delimitation but is, rather, an entitlement provision that has no practical application with respect to a maritime area that is, in any event, within the 200-nm limit of the exclusive economic zone and continental shelf of a mainland coast."[52]

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43 *Maritime Delimitation in the Black Sea*, par. 126.

44 Ibid., par. 96.

45 Ibid., par. 92.

46 Ibid., par. 102.

47 Ibid., par. 149.

48 Ibid., par. 149.

49 Ibid., par. 124.

50 Ibid., par. 126.

51 Ibid., par. 184.

52 Ibid., par. 184.

Despite the parties directly addressing the definitional issues presented by the regime of islands and specifically Article 121, paragraph 3, of UNCLOS, the ICJ's ruling avoided giving a definition of the wording in Article 121, paragraph 3; it instead addressed the role that Serpents' Island should play in the delimitation and determined that this islet should have a 12-nm territorial sea, but otherwise no effect on the delimitation. The court also compared the Black Sea case with the continental shelf case between Libya and Malta in 1985. In the latter decision, the effect of Filfla was ignored.[53]

Following the discussion mentioned above, the ICJ started the process of delimitation "by drawing a provisional equidistance line" between the adjacent and opposite coasts of Romania and Ukraine in the north part of the Black Sea,[54] and then examined "whether there are factors calling for the adjustment or shifting of the provisional equidistance line in order to achieve an equitable result" so that the resolution could be consistent with Articles 74 and 83 of UNCLOS.[55] The court would then verify that the line did not lead to an inequitable result by reason of any marked disproportion between the ratio of the respective coastal lengths and the ratio between the relevant maritime area of each state by reference to the delimitation line. A final check for an equitable outcome entailed a confirmation that no great disproportionality of maritime areas is evident by comparing the ratio of coastal lengths.[56]

Putting this three-stage process into practice, the court found that Serpents' Island was entitled to 12 nm of territorial sea around it, but that the island had no other impact on the maritime delimitation between Romania and Ukraine: "As the jurisprudence has indicated, the Court may on occasion decide not to take account of very small islands or decide not to give them their full potential entitlement to maritime zones, should such an approach have a disproportionate effect on the delimitation line under consideration."[57] In other words, the "disproportionate effect" that Serpents' Island might have had in the delimitation process is the result that the court wanted to avoid. This was achieved by awarding Serpents' Island a 12-nm territorial sea and no impact on the EEZ boundary, though without specifying that the island is a mere "rock" within the meaning of Article 121, paragraph 3, of UNCLOS (see **Map 4**, p. vi).

The Role of Islands in the Delimitation of Maritime Boundaries

Overall, the text of Article 121, paragraph 3, of UNCLOS remains ambiguous. The relevant drafting history generally does not help clarify interpretations of the article. There is also no consistent trend in state practice on the issue, and an authoritative ruling from an international court or tribunal is presently lacking. Accordingly, at the time of writing, no reliable way to distinguish between these types of insular features has emerged, despite the fact that the definition of features is critical to determining their capacity to generate claims to maritime jurisdiction.

That said, as illustrated above, coastal states and international adjudicative bodies have been and continue to be faced with problematic issues related to islands, especially in the context of the delimitation of maritime boundaries. As a result, they have developed practical ways in which to

53 *Maritime Delimitation in the Black Sea*, par. 184.

54 Ibid., par. 119.

55 Ibid., par. 120.

56 Ibid., par. 122.

57 Ibid., par. 185.

deal with the challenge posed by islands in the context of the delimitation of maritime boundaries. Such approaches include, for example, affording islands reduced weight in the construction of equidistance lines or partially or wholly enclaving them. Indeed, it can be argued that the trend, in international jurisprudence at least, is toward awarding small islands a reduced effect in maritime boundary delimitation. This can be illustrated by reference to numerous cases, including several outlined above, especially in instances where such islands are located at a considerable distance offshore and the opposing coast or coasts are long enough such that a great disparity in relevant coastlines is evident.[58] This treatment of islands predominantly arises from the fact that such features would inevitably have a disproportionate and therefore inequitable impact on the construction of an equidistance-based boundary line.

While state practice and the rulings of international courts and tribunals are generally unhelpful with respect to directly addressing the island/rock issue, some rulings are instructive by implication. For example, in some instances islands have been used in the construction of continental shelf and EEZ boundaries. This necessarily implies that the feature in question is not a rock in accordance with Article 121, paragraph 3, of UNCLOS. An especially instructive example is the *Jan Mayen* case between Denmark and Norway.[59] Despite the great disparity in relevant coastal lengths between Norway's Jan Mayen Island and Greenland (around 9.2:1 in Greenland's favor),[60] as well as the enormous difference in area (377 km^2 for Jan Mayen compared to 2,166,086 km^2 for Greenland)[61] and the fact that Jan Mayen is uninhabited except for the personnel posted to the scientific research station located on the island, the court awarded Jan Mayen some, though not full, effect in constructing the maritime boundary line.[62] This result is consistent with state practice in maritime delimitation involving the island. Although in bilateral negotiations between Norway and Iceland the latter had initially argued that Jan Mayen was not entitled to an EEZ or continental shelf, these objections were subsequently abandoned by Iceland when it concluded two boundary agreements with Norway that recognized Jan Mayen's entitlement to an EEZ and continental shelf. The main reason appears to have been that Jan Mayen is too large to be regarded as a "rock," with an area of 373 km^2.[63] This experience suggests that even islands lacking a permanent, indigenous population may, under certain circumstances, be capable of generating extended maritime jurisdictional rights.

Implications for the Disputed Islands of the South China Sea

The South China Sea, with an area of approximately 3 million km^2 (equivalent to around 874,660 nm^2)[64] is not only the largest maritime area in the Southeast Asian region but also the

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58 For other related cases, see *Libya v. Malta*, *Jan Mayen*, *Libya v. Tunisia, Gulf of Maine*, *Qatar v. Bahrain*, and *Maritime Delimitation in the Black Sea*, all cases brought before the ICJ.

59 *Case Concerning Maritime Delimitation in the Area between Greenland and Jan Mayen (Denmark v. Norway)*, ICJ Rep. 38 (1993); hereafter cited as *Jan Mayen* case.

60 *Jan Mayen* case, par. 61.

61 Area figures are according to "Greenland," CIA World Factbook, November 2011; and "Jan Mayen," CIA World Factbook, May 2011.

62 *Jan Mayen* case, par. 61–69.

63 Robin R. Churchill, "Claims to Maritime Zones in the Arctic—Law of the Sea Normality or Polar Peculiarity?" in *The Law of the Sea and Polar Maritime Delimitation and Jurisdiction,* ed. Alex G. Oude Elfenink and Donald Rothwell (The Hague: Martinus Nijhoff, 2001), 120.

64 Hasjim Djalal, "South China Sea Island Disputes," in *Security Flashpoints: Oil, Islands, Sea Access and Military Confrontation*, ed. M.H. Nordquist and J.N. Moore (The Hague: Martinus Nijhoff, 1998), 109.

26th largest basin in the world.[65] The littoral states, in clockwise order from the north, are China, Taiwan, the Philippines, Malaysia, Brunei, Indonesia, Singapore, Thailand, Cambodia, and Vietnam. Influenced and motivated by the sea's geographical proximity, strategic importance, and economic interests, littoral states around the South China Sea started claiming territorial sovereignty over those islands or islets as early as the 1960s.[66] The current political situations of the islands in the South China Sea are as follows.

Pratas Islands. The Pratas Islands (*Dong-sha-chun-dao* in Chinese), 240 nm southwest of Taiwan at latitude 20°30'–21°31' north and longitude 116°–117° east, consist of two banks and an island.[67] This group of islands is under the administration of Taiwan. The Taiwanese Coast Guard is stationed on the biggest island, Pratas Island (*Dong-sha-dao*). There is a concrete runway of 4,500 m in length on Pratas, which is capable of accommodating C-130H cargo planes.[68] The sovereignty of the Pratas Islands is not contested.

Macclesfield Bank and Scarborough Shoal. Macclesfield Bank is a wholly and permanently submerged feature that is situated at latitude 15°20'–16°20' north and longitude 113°40'–115°00' east.[69] However, a rock feature, called Scarborough Shoal (or Reef), is located to the east of this bank. Sovereignty over Scarborough Shoal is disputed between China/Taiwan and the Philippines, as demonstrated by the inclusion of Scarborough Shoal in the 2009 revision of the baselines law of the Philippines.[70] Scarborough Shoal consists of a narrow belt of coral enclosing a lagoon and surmounted by small rocks, the tallest of which, South Rock, is 3 m high.[71]

Paracel Islands. The Paracel Islands (*Hsi-sha-chun-dao*) is an archipelago lying approximately 150–200 nm from both Hainan Island and Vietnam. It consists of about 130 barren uninhabited islands, all clustered in two groups, the Crescent group to the west and the Amphitrite group to the east.[72] The largest island, Woody Island (*Yung-hsin-dao*), is situated in the northeast and is about 1,950 m long and 1,350 m wide.[73] The People's Republic of China (PRC) has been in possession of the entire Paracel archipelago since a battle between the PRC and the former South Vietnam in January 1974.[74]

Spratly Islands. The Spratly Islands (*Nan-sha-chun-dao*) are located approximately 300 nm west of the Philippine island of Palawan, 300 nm east of Vietnam, and 650 nm south of Hainan. The Spratlys consist of approximately 150–180 insular features of various types.[75] Among these

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65 Mansor Mat Isa and Raja Mohammad Noordin, "The Status of the Marine Fisheries in the South China Sea" (paper presented at the First Working Group Meeting on Marine Scientific Research in the South China Sea, Manila, May 30–June 3, 1993), 2; and J. Morgan and M. Valencia, eds., *Atlas for Marine Policy in Southeast Asian Seas* (Berkeley: University of California Press, 1983), 4.

66 For a discussion on the causes of the overlapping claims among the littoral states, see Kuan-Hsiung Wang, "Bridge over Troubled Waters: Fisheries Co-operation as a Resolution to the South China Sea Conflicts," *Pacific Review* 14, no. 4 (2001): 531–51.

67 Chi-Kin Lo, *China's Policy towards Territorial Disputes: The Case of South China Sea Islands* (London and New York: Routledge, 1989), 5–6. See also United Kingdom Hydrographic Office (UKHO), *China Sea Pilot*, vol. 1, *Admiralty Sailing Directions*, 9th ed. (UKHO, 2010), 78.

68 Peter Kien-hong Yu, "Issues on the South China Sea: A Case Study," *Chinese Yearbook of International Law and Affairs* 11 (1991–92): 170–71.

69 Gerardo M.C. Valero, "Spratly Archipelago Dispute: Is the Question of Sovereignty Still Relevant?" *Marine Policy* 18 (1994): 315.

70 Republic Act No. 9522, March 10, 2009. See also "RP Stakes Claim to Part of Disputed Spratlys," Agence France-Presse, February17, 2009.

71 UKHO, *China Sea Pilot*, vol. 2, *Admiralty Sailing Directions*, 9th ed. (UKHO, 2010), 74.

72 John K.T. Chao, "South China Sea: Boundary Problems Relating to the Nansha and Hsisha Islands," *Chinese Yearbook of International Law and Affairs* 9 (1989), 68–69; and Jeanette Greenfield, *China's Practice in the Law of the Sea* (Oxford: Clarendon, 1992), 151. See also UKHO, *China Sea Pilot*, vol. 1, 75–78.

73 Ewan Anderson, *An Atlas of World Political Flashpoints: A Sourcebook of Geopolitical Crisis* (London: Pinter Reference, 1993), 160–61; and Choon-ho Park, *East Asia and the Law of the Sea* (Seoul: Seoul National University Press, 1983), 203.

74 For information on the battle, see Lo, *China's Policy towards Territorial Disputes,* 53–63.

75 For instance, D.J. Dzurek states that there are "more than 170 features with English names in the Spratly Islands." See D.J. Dzurek, *The Spratly Islands: Who's On First?* vol. 1 (Durham: International Boundaries Research Unit, 1996), 1.

features, only perhaps 48 are above water at high tide.[76] Inevitably, complex overlapping maritime claims are associated with the Spratlys. Taiwan, China, Vietnam, Malaysia, Brunei,[77] and the Philippines all lay claim to one or more parts of this disputed area. Currently, the largest island, Itu Aba Island (*Tai-pin-dao*), is under the control of the Taiwanese government, which has a coast guard corps of about 600 persons on the island.[78] The Taiwanese government built an airstrip on Tai-pin-dao in 2008.

Based on the language of Article 121, paragraph 3, of UNCLOS, there may be at least three elements to examine with regard to the status of islands and rocks in the Spratlys group, namely size, human habitation, and economic life. As noted above, there is no precise indication as to the size required for an island to be capable of generating EEZ and continental shelf rights.[79] Therefore, it would be difficult to decide if a feature is a rock or an island according to its size, though it can be observed that none of the disputed South China Sea islands are anywhere near the size of Jan Mayen Island.

As to the element of "human habitation," water supply might be one of the most important factors in clarifying the situation. This is because the existence of fresh water is an important indication that human habitation could be sustained. Furthermore, with the existence of fresh water, the island could provide food, including vegetables and fruits. According to reports, there are two islands in the Spratlys that could supply fresh water for daily use—these are Tai-pin-dao (Itu Aba Island), which is under the control of Taiwan, and Pagasa Island, which is occupied by the Philippines. Is it feasible then to conclude that only Taiwan and the Philippines could claim maritime zones around those two islands? Such a conclusion would be controversial and likely to raise objections.

With regard to "economic life," does fishing or oil and gas resource exploration and exploitation in waters surrounding the islands fulfill this requirement? If this is the case, then arguably the joint marine seismic undertaking agreements for parts of the South China Sea close to the Spratlys group would serve to render these islands as being capable of generating EEZ and continental shelf rights. Two such joint agreements were concluded in 2004 and 2005—the first was signed between the Philippines and China on September 1, 2004, and the second was signed between the two countries and Vietnam on March 14, 2005, and is known as the "Tripartite Agreement for Joint Marine Seismic Undertaking in the Agreement Area in the South China Sea."[80] The area covered by the agreements is 142,886 km^2 in size and was to be studied for a three-year period. Signatories to the agreements were the countries' respective state-owned oil companies—the China National Offshore Oil Corporation (CNOOC), the Philippine National Oil Company (PNOC), and the Vietnam Oil and Gas Corporation (PetroVietnam). Such cooperation implied a significant improvement of the relations among those parties that have disputes regarding the islands' sovereignty in the agreement area. These agreements have, however, since lapsed. The

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76 The figure of 48 is provided by D.J. Hancox and John Robert Victor Prescott in *A Geographical Description of the Spratly Islands and an Account of Hydrographic Surveys amongst Those Islands* (Durham: International Boundaries Research Unit, University of Durham, 1995). However, some commentators offer lower figures. For example, Dzurek offers the number 36; see Dzurek, *Who's On First?* vol. 1.

77 Brunei claims at least two islands that are situated in its exclusive economic zone. See C.C. Joyner, "The Spratly Island Dispute: Rethinking the Interplay of Law, Diplomacy and Geopolitics in the South China Sea," *International Journal of Marine and Coastal Law* 13, no. 2 (1998): 195–230.

78 Itu Aba Island is 1,358 m long and 350 m wide, the total area is about 0.5 km^2.

79 Marius Gjetnes, "The Spratlys: Are They Rocks or Islands?" *Ocean Development and International Law* 32, no. 2 (2001): 199.

80 See Ministry of Foreign Affairs of the People's Republic of China, "Oil Companies of China, the Philippines and Vietnam Signed Agreement on South China Sea Cooperation," March 15, 2005, http://www.fmprc.gov.cn/eng/wjb/zwjg/zwbd/t187333.htm.

counterpoint to this view is that if seismic operations, or indeed fishing activities around islands, qualify as providing an "economic life" for the feature in question, then all islets, however small, could escape the disadvantageous categorization of being a rock. It is hard to imagine that this was truly the intent of the drafters of Article 121 of UNCLOS.

Overall, the potential capacity of even some of the islands to generate maritime zones has stimulated the littoral states to claim sovereignty over those islands or rocks. This, in turn, makes maritime delimitation in the South China Sea area more complicated. On the other hand, if these insular features are not capable of being used to advance such expansive maritime claims, their effect in maritime delimitation would be minimized. In other words, in the latter case, the outer limits of 200 nm shall be drawn from the coastline of the mainland and other accepted offshore islands. As a result, a high seas area would be created in the middle of the South China Sea and the area encompassed by overlapping claims to maritime jurisdiction would be significantly reduced.

Conclusion

Islands remain at the heart of the maritime and territorial disputes that bedevil the East China Sea and the South China Sea particularly. At present it remains impossible to discern with certainty whether a particular insular feature qualifies as an island capable of generating EEZ and continental shelf rights or is a mere rock that cannot. That said, it is clear that the majority of the features encompassed by the term "Spratly Islands" are not, in fact, islands or rocks at all, as only a limited number of the insular features in the group emerge above the high-tide level and are thus capable of generating claims to maritime jurisdiction in their own right.

A number of the disputed islands of the East China Sea and South China Sea do rise above high tide and so can be used as base points for the generation of maritime claims. Arguably some of these features may be capable of generating such extended maritime claims. It is also becoming clear, however, that the interested states hold different positions on this issue. The recent submissions relating to outer continental shelf limits and extended continental shelf rights in the South China Sea and the reactions and counter-reactions to these submissions suggest that while some South China Sea states, notably Malaysia and Vietnam, regard the disputed islands as incapable of generating EEZ and continental shelf rights, China takes the opposing view.

The developing trend in international jurisprudence (and to a lesser extent in state practice) toward awarding small, isolated, sparsely inhabited or uninhabited islands a reduced effect in the generation of maritime claims and in the context of the delimitation of maritime boundaries should, however, be taken into account. These developments strongly suggest that even if some of the disputed islands of the South China Sea are deemed capable of generating extended claims to maritime jurisdiction, their maritime entitlements will likely be severely restricted, especially when pitted against the surrounding mainland and main island territories. Acceptance of this view by the South China Sea claimant states would result in a significant narrowing of the area of overlapping maritime claims, thus simplifying the dispute.

Annex 826

C. Schofield & W. Stormont, “An Arms Race in the South China Sea?”, *Ocean Yearbook* Vol. 12, No. 1 (1996)

Military Activities

An Arms Race in the South China Sea?

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INTRODUCTION

The South China Sea is host to a complex web of overlapping maritime jurisdictional and sovereignty claims, complicated by the presence of two disputed archipelagos of islands and reefs known as the Spratly and Paracel Islands. The South China Sea represents a strategic waterway of global significance, providing the key maritime link between the Indian Ocean and East Asia. Furthermore, there is a widely held perception among the littoral states that in addition to important fishery resources the area under dispute also boasts considerable seabed resources, most especially hydrocarbons.

Six coastal states—People's Republic of China (hereafter referred to as China), Taiwan (Republic of China, hereafter referred to as Taiwan), Vietnam, the Philippines, Malaysia, and Brunei—lay claim to all or part of the Spratly and Paracel archipelagos and their surrounding maritime space. Of these six claimants, all save Brunei maintain a military presence on one or more islands or other insular features.

In light of the seemingly intractable nature of these complex jurisdictional disputes, coastal states have placed increasing emphasis on their ability to enforce their sovereignty claims militarily. In the 1980s this tendency led to increased military activity in and around the Spratly Islands, culminating in a bloody Sino-Vietnamese clash off Johnson/Landsdowne Reef in 1988.[1]

This trend has been reinforced by more recent Chinese and Vietnamese actions relating to hydrocarbon explorations. China's award, on 8 May 1992,

1. Reported by various sources, for example, Nayan Chanda, "Treacherous Shoals," *Far Eastern Economic Review*, 13 August 1992, pp. 14–17, and M. Spick, "Dangerous Ground!" *Air Forces Monthly* (December 1993): 10–15. A fuller account of the action is provided by J. W. Garver, "China's Push through the South China Sea: The Intersection of Bureaucratic and National Interests," *China Quarterly* 132 (December 1992): 1008–17.

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of the Wan'an Bei Block-21 in the vicinity of the Vanguard Banks in the southwestern South China Sea to the U.S. Crestone Energy Corporation heightened tensions considerably. Crestone's subsequent announcement of the commencement of seismic surveys in 1994 led to Vietnamese licensing of the Blue Dragon Block to Mobil in an area adjoining the Crestone block. Both countries sent warships to the area to protect their interests. In July of the same year the Chinese reportedly blockaded a Vietnamese drilling rig, preventing its resupply, and the following month the Vietnamese retaliated by forcing a Chinese survey vessel to leave the area covered by the Crestone concession.

Furthermore, in January 1995 the Chinese occupied Mischief Reef, in the eastern Spratly Islands, which thus gained the dubious distinction of becoming the 44th occupied feature in the Spratlys. The reef lies approximately 240 km west of Palawan Island in the Philippines and around 100 km equidistant from the two nearest Spratly features occupied by the Philippines and by Vietnam, well within the Philippines' Kalayaan maritime claim in the South China Sea. The Philippines, unable to seriously challenge the Chinese militarily, retaliated by arresting Chinese fishermen and destroying Chinese markers on other reefs in the area.[2]

Clearly, while sovereignty disputes remain unresolved, in the absence of adequate cooperative security arrangements and while the states continue to enhance their military presence in the region as a means of physically reinforcing their territorial claims, the potential for confrontation and ultimately conflict remains. The Sino-Vietnamese clashes in the Paracels (1974)[3] and Spratlys (1988), coupled with the Mischief Reef incident and military posturing in relation to oil exploration activities, illustrate that parties to the dispute have not been afraid to use military force to assert their claims.

These developments have led several observers to the conclusion that the claimant states are on the verge of—or, indeed, in the midst of—an undeclared regional arms race.[4] This view has been largely based on high procurement expenditure coupled with expanding domestic arms production to facilitate force modernization throughout Southeast Asia in general, and in China in particular.[5]

The ongoing and ambitious transformation of the Chinese navy from an essentially coastal or "brown-water" force to a fully fledged "blue-water" navy

2. Daniel J. Dzurek, "China Occupies Mischief Reef in Latest Spratly Gambit," *Boundary and Security Bulletin* 3, no. 1 (April 1995): 65–71.

3. *Far Eastern Economic Review,* 13 August 1992, pp. 14–17; (n. 1 above), p. 1001.

4. For instance Justus M. Van der Kroef, "Territorial Claims in the South China Sea: A Strategic Irrelevancy," paper presented at a conference on territorial claims in the South China Sea, Centre for Asian Studies, University of Hong Kong, 4–6 December 1990, pp. 4–5.

5. Stockholm International Peace Research Institute, *SIPRI Yearbook* (Oxford: Oxford University Press and Stockholm International Peace Research Unit, 1993–95).

capable of projecting sustained military force over hundreds if not thousands of kilometers from bases in mainland China has fueled this argument considerably.[6] A recent confrontation between a People's Liberation Army (Navy) (PLAN) nuclear submarine and the U.S. aircraft carrier *Kitty Hawk,* together with Chinese land-based fighters and the U.S. carrier's own aircraft, in international waters where PLAN vessels were rarely encountered in the past, vividly illustrates China's evolving blue-water capability. China's promise to "shoot to kill" the next time such an encounter takes place demonstrates some of the dangers this evolution may represent.

The ambiguous nature of Chinese sovereignty claims coupled with the way in which Chinese military modernization is shrouded in secrecy and China's increased military assertiveness is a source of alarm to other South China Sea states.[7] A frequently expressed fear in the region is that China has hegemonic ambitions in the South China Sea. Despite Beijing's repeated and often strenuous denials that China constitutes a threat to its southern neighbors, a severe gap is perceived between China's words and deeds. The other littoral states have therefore taken steps to upgrade their own air and naval forces with a view to securing their maritime interests—a situation that some observers view as inevitably leading to an upward spiral of arms purchases.

Developments such as the sale of 18 Russian MiG-29 Fulcrum fighters to Malaysia, confirmed in June 1994, reinforce this argument. Despite the Malaysian defense minister's statement that the sale "should not be construed as contributing to a regional arms race, but as our contribution to regional security," the *Far Eastern Economic Review's* (*FEER*) analysis of the reaction of Malaysia's neighbors to the MiG deal was that it had lead to an "unmistakable" scaling up of their own military purchases.[8]

The aim of this paper is thus twofold. First it provides a brief survey and assessment of the relative military strengths of the claimant nations, with particular reference to their ability to project force in order to back up sovereignty claims in the South China Sea. Particular attention will also be paid to recent arms procurements and development projects. Second, it attempts to answer the question of whether it is correct to characterize the sustained increases in military expenditure in the region as constituting an "arms race."

6. T. M. Cheung, *Growth of Chinese Naval Power,* Pacific Strategic Papers no. 1 (Singapore: Institute of Southeast Asian Studies, 1990), p. 5; N. Lee, "Chinese Maritime Power and Strategy in the South China Sea," paper presentd at a conference on territorial claims in the South China Sea, Centre for Asian Studies, University of Hong Kong, 4–6 December 1990, p. 7.

7. For example, Singaporean prime minister Goh Chok Tong recently commented that "in Asia, China's rising power and arms build-up has stirred anxiety. . . . It is important to bring into the open this underlying sense of discomfort—and even insecurity—about the political and military ambitions of China" (N. Holloway, "Jolt from the Blue," *Far Eastern Economic Review,* 3 August 1995, pp. 20.

8. M. Vatikiotis, "Wings of Change," *Far Eastern Economic Review,* 16 June 1994, p. 20.

It should be noted in this context that accurate, authoritative information on defense procurements is hard to come by and thus often suspect.[9]

THE REGIONAL ARMS BUILDUP

China

By far the strongest force among the claimants, unsurprisingly, is that of China. The PLAN embarked upon an ambitious modernization program over the last two decades. Prior to the 1974 action whereby Chinese forces evicted (South) Vietnamese troops from the Paracel Islands, the PLAN was essentially a coastal defense force. Since that time the PLAN has striven to transform itself from a brown-water to a full-fledged blue-water navy.[10]

This change in emphasis reflects a shift away from a continentalist military doctrine dominated by fears of a massive Soviet air, naval, and (predominantly) land attack where the navy's role was envisaged as merely providing maritime support for land forces. China's other postwar strategic concerns were all also land-bound, notably the Korean War (1950–53) and border conflicts with India (1962) and Vietnam (1979). Essentially the PLAN was viewed as little more than a "coastal appendix of the ground forces."[11]

Naval modernization was initially spurred in the mid-1970s by the rapid buildup of the Soviet Pacific Fleet and the presence of Soviet bases in Vietnam at Cam Ranh Bay and Da Nang. These developments "extended the Sino-Soviet border confrontation into the maritime arena."[12] A major reappraisal of Chinese strategy, however, came about only with the waning of Cold War tensions and with it the threat of Soviet invasion, discernible from mid-1980s. Improved relations with both China's continental rivals, Russia and India, has allowed China to redeploy air units to its eastern and southern coast,[13] to self-conciously shift toward a strategy of offshore defense and sea control rather than coastal defense and to "focus its conventional weapon programmes on power projection on and over the sea."[14]

In addition, the opening up of the Chinese economy to the West has led to a phenomenal growth in international trade with China. As a result China has become increasingly reliant on seaborne trade for economic survival, so

9. Unless otherwise stated military figures are drawn from the International Institute for Strategic Studies (IISS), *Military Balance.*

10. For example, Lee (n. 6 above), p. 7.

11. Cheung, *Growth of Chinese Naval Power* (n. 6 above), p. 3.

12. Ibid., p. 4.

13. Lee (n. 6 above), pp. 4–5.

14. A. Arnett, "Military Technology: The Case of China," in Stockholm International Peace Research Institute, *SIPRI Yearbook* (Oxford: Oxford University Press and Stockholm International Peace Research Unit, 1995), pp. 359–86.

that the projection of maritime power in order to protect and control strategic lines of communication and choke points (such as the sea-lanes passing through the Spratly area) has become a vital consideration.[15] Furthermore, in light of the booming Chinese population and economy, China is keen to secure as large a share of the resources (both living and mineral) of the South China Sea as possible. China's newly acquired status as a net energy importer reinforces both these concerns.

The Chinese Fleet

Although the bulk of the PLAN's surface fleet consists of vessels of some antiquity (1960s and 1970s designs), they have been extensively refitted and improved. New designs such as the Luhu-class destroyer, described as a "major step forward,"[16] are also gradually entering service, with the first of the Luhu-class commissioned in 1994.

With regard to the South China Sea it should be noted that the South Sea Fleet has always suffered in terms of resources allocated to it in comparison to the North Sea Fleet. This bias reflects the perceived threat of the large Russian Pacific fleet in comparison with the relatively modest naval forces of the other South China Sea coastal states.[17] However, the recent warming of Sino-Russian relations will offer the Chinese considerable flexibility in terms of naval deployments allowing forces from the North Sea Fleet to be transferred to other fleets as required.[18]

The PLAN has also significantly enhanced it "reach" as well as interfleet and interservice cooperation. The introduction (from 1977) of large (about 10,000 tons) long-range logistic support ships, including tankers, has greatly extended the PLAN's combat range and sustainability of its operations at sea.[19] This capability was amply illustrated by the navy's and air force's successful staging of a long-range combined arms exercise in the western Pacific near Iwo Jima in May 1986.[20] Similarly, in October 1988 units drawn from the East Sea Fleet were able to conduct another major exercise in the western Pacific, cruising as far south as the southern tip of the Spratly archipelago in

15. Cheung, *Growth of Chinese Naval Power* (n. 6 above), p. 5.
16. Arnett (n. 14 above), p. 384.
17. Gheung, *Growth of Chinese Naval Power* (n. 6 above), pp. 32–34.
18. For example, it was reported in April 1993 that China had "recently redeployed three Romeo-class conventional submarines from its North Sea Fleet where they were used to monitor Russian naval activity, to the South Sea Fleet. Their new mission is to patrol the contested areas of the South China Sea" (T. M. Cheung, "Sukhois, Sams, Subs," *Far Eastern Economic Review*, 8 April 1993, p. 23).
19. Garver (n. 1 above), p. 1024.
20. According to Lee (n. 6 above), p. 8: "The 'Iwo Jima' exercise of May 1986 demonstrates great progress made by the Chinese in joint operations. Success in conducting task force level exercises over 1,000 nautical miles from the coast demonstrate Chinese capability both in force projection and probable far-reaching consequences for the naval balance in the Asia-Pacific."

coordination with elements of the South Sea Fleet.[21] To some analysts these exercises prove that the PLAN is "successfully developing 'blue water' capabilities."[22]

Submarines

In addition to its main surface assets, the PLAN boasts a numerically impressive inventory of as many as 130 submarines.[23] This seeming strength is, however, composed almost exclusively of virtually obsolete designs borrowed from the Soviets from as early as the 1950s. Estimates of the number of Chinese submarines actually in operation vary considerably, as it is unknown how many of the older models have been mothballed or are simply no longer seaworthy. The Chinese submarine fleet therefore appears to be of dubious value.

In order to overcome these technological deficiencies, China has purchased or ordered as many as 10 Kilo-class conventional submarines from Russia with the possiblity of a further 12 in the future.[24] In addition China apparently launched the first of a new class of diesel submarine, the Song or 39 class, in May 1994. The 39 class, capable of launching antiship missles while submerged, therefore represents a significant improvement in China's "forward defense" capabilities.

While it is believed that Chinese submarines "are capable of forming an adequate ambush platform at strategic choke points,"[25] their long-range patrol capabilities are questionable. It should be stressed, however, that the limited nature of other claimant states' navies' capabilities in antisubmarine warfare (ASW) means that even China's aging submarine fleet might conceivably pose a potent threat to shipping in the South China Sea.

Air Power

Without adequate air cover the PLAN's surface units, however much improved, merely represent so many floating targets for an opponent's air force. Even Vietnam's antiquated inventory of Soviet-supplied planes has been viewed as a significant threat to the Chinese navy's operations in the South China Sea.[26]

The PLAN's large naval air force is predominantly made up of relatively old and short-range fighters but does include 30 Hong-6 type (Tu-16 Badger)

21. Cheung, *Growth of Chinese Naval Power* (n. 6 above), pp. 34–36; Lee (n. 6 above), pp. 7–8.

22. Lee (n. 6 above), p. 7.

23. Cheung, *Growth of Chinese Naval Power* (n. 6 above), p. 23.

24. N. Chanda, "Fear of the Dragon," *Far Eastern Economic Review,* 13 April 1995, p. 25.

25. Lee (n. 6 above), p. 7.

26. T. M. Cheung, "Fangs of the Dragon," *Far Eastern Economic Review,* 13 August 1992, p. 20.

bombers. Armed with C-601 antiship cruise missiles, the Chinese Hong-6s can reach the Spratlys without recourse to in-flight refueling.[27] On arrival, however, their loiter time over the islands is likely to be highly restricted. The remainder of the naval aircraft offer air cover only as far as the Paracels. As the *Economist* noted in early 1993: "Most of China's fighter aircraft, whether in the airforce or the navy, are decrepit."[28] Coming to terms with these shortcomings in naval aviation has been identified as a priority by the Chinese military and is being addressed in a number of ways. Foremost among these developments has been the boosting of frontline airpower through the acquisition of 26 sophisticated, Su-27 Flanker fighter aircraft from Russia in 1992. These aircraft are reported to be close to attaining operational status. In addition it has been reported that China is keen to acquire another batch of Su-27s as well as MiG-29s, MiG-31s, Su-24s, Su-30s, and possibly several supersonic Tu22M Backfire strategic bombers, as well as airborne early warning (AEW) and transport aircraft.[29]

A fleet of these proportions would represent a potent tactical force and a major enhancement of Chinese airpower in the region and would virtually ensure air superiority over the Spratlys.[30] In 1994, however, China acquired only 1 old Il-28 bomber and 4 transports to add to its 26 Su-27s. None of the other rumored orders have been confirmed, and at least some are almost certainly incorrect. It remains unclear whether the Chinese Su-27s will be deployed in the south of the country. However, in early 1996 it was reported that China was set to receive a further 48 Su-27s as well as securing an agreement to produce the planes under license from Russia.[31]

In order to extend the naval air force's power projection into the South China Sea, China may have extended its airstrip on Woody Island in the Paracels to more than 2,500 m, providing a forward base and staging area for extending the range of its aircraft, including the already long-legged Su-27.[32] Priority has also been given to the development of in-flight refueling

27. The first patrol of Chinese Hong-6 aircraft to the Spratlys area reportedly occurred on 8 November 1980, when two planes visited the area and undertook extensive aerial photography. By 1983 there were apparently frequent PLAN air patrols over the Spratlys (Garver [n. 1 above], p. 1008).

28. "Asia's Arms Race," *Economist,* 20 February 1993, pp. 21–24.

29. "Russian arms manufacturers are believed to have offered the supersonic Tu22M bomber to Peking, which would substantially increase China's military 'reach.' The Tu22M has a range of more than 4,000 km, has air-refueling capabilities, can carry heavy bomb and missile loads" (T. M. Cheung, "Loaded Weapons," *Far Eastern Economic Review,* 3 September 1992, p. 21).

30. Cheung, "Sukhois, Sams, Subs" (n. 18 above), p. 23.

31. A. Higgins, "Beijing Divided on Taiwan Strategy," *Guardian,* 8 February 1996.

32. Cheung, *Growth of Chinese Naval Power* (n. 6 above), p. 28; Garver (n. 1 above), p. 1014; Spick (n. 1 above), p. 14.

technology. It was reported in 1990 that China has acquired the necessary "probe and drogue" systems from Iran.[33]

It has also frequently been suggested that the Chinese navy is keen to acquire an aircraft carrier or carriers. These rumors have been fueled by reports that the carrier HMAS *Melbourne,* bought from Australia in 1985 for scrap, was meticulously examined prior to being broken up;[34] that the Chinese navy had begun training for carrier-based operations;[35] and that PLAN delegations had visited the Ukraine in June and December 1992 with a view to buying the uncompleted former Soviet carrier *Varyag.*[36]

It seems unlikely in the extreme, however, that a carrier will enter service with the PLAN in the near future. Severe technical, operational, and ultimately financial constraints have apparently forestalled progress down the path to a carrier-based force. The cost of either domestically building[37] or purchasing[38] a carrier is viewed as being prohibitively high and if opted for would dominate the defense budget for years. Even if funds were made available for such a project, including the expense of acquiring suitable aircraft and training, serious questions would remain. For a start some commentators have argued that a single carrier would make little operational sense, as it would be forced to spend much time in port for routine maintenance, thus lessening its effectiveness.[39]

The implications for the rest of the PLAN would also be significant. Realistically, a carrier requires a battle group to afford it adequate protection. At present the Chinese navy, weak as it is in terms of ASW and antiaircraft technology, would simply be unable to muster such a force. Given the South China Sea's semienclosed nature, were a carrier to operate there it would also be highly vulnerable to attack from shore-based missiles or aircraft.[40]

A brief study of the 1982 Anglo-Argentinean conflict illustrates the point.

33. Lee (n. 6 above), p. 11; "Asia's Arms Race" (n. 28 above), p. 24.

34. Spick (n. 1 above), p. 14.

35. Cheung, *Growth of Chinese Naval Power* (n. 6 above), p. 27; Spick (n. 1 above), p. 14.

36. Spick (n. 1 above), p. 14; G. Greenwood, "Carried Away," *Far Eastern Economic Review,* 9 July 1992, pp. 8–9; Cheung, "Loaded Weapons" (n. 29 above), p. 21; T. M. Cheung, "Arm in Arm," *Far Eastern Economic Review,* 12 November 1992, p. 28.

37. According to Cheung, *Growth in Chinese Naval Power* (n. 6 above), p. 27: "It is also estimated that it would cost at least two to five renminbi (US$420 million to $1.08 billion) to build a relatively modest 30,000-ton to 48,000-ton carrier."

38. Estimated at US$2–2.4 billion in Cheung, "Loaded Weapons" (n. 29 above), p. 21; Cheung, "Arm in Arm" (n. 36 above), p. 28.

39. Greenwood (n. 36 above), p. 8.

40. As Arnett (n. 14 above), p. 384, has noted: "A surface action group centred around a single helicopter-carrier and accompanying landing ships is vulnerable to air attack, even when supported with land-based fighters refueled in the air, unless warning and control systems were supporting them," something that China presently has a very limited capacity to provide.

While the Royal Navy was forced to deploy numerous dedicated antiaircraft ships in a cordon to shield the carrier group (incidentally sustaining several casualties in doing so), the Argentine navy, lacking escorts with sophisticated ASW capabilities, had no option but to confine its carrier to port for fear of British submarines.[41]

It was therefore widely believed that the idea of a Chinese carrier-based force had been shelved. In 1993, however, a report to the National People's Congress revealed that the PLAN intends to build two 48,000-mt carriers by 2005, spending US$2 billion in the process. In light of the problems outlined above, at best some credence might be given to the rumors that China may be modifying a container, or roll-on roll-off, ship into a "carrier." If true, this is likely to be some form of helicopter platform or assault ship, since it is unlikely in the extreme that such a vessel could function as a base for fixed-wing aircraft and highly doubtful that the Chinese possess the necessary technical expertise to build a full-fledged carrier.[42]

Despite major and wide-ranging improvements to the PLAN, there is clearly a lot of scope for further development. Indeed, according to some assessments, "the vast majority of their arsenal is woefully obsolete."[43] It is important to keep in mind the fact that the PLAN is starting from a very low base and faces serious technical obstacles to the development of its military modernization program.

Among these problems are poor command and control, electronics, and electronic warfare systems for land, air, and naval forces that must still be classed as "obsolete" and "inadequate."[44] In addition PLAN deficiencies, such as the limited capabilities of the vast majority of the surface fleet—particularly in terms of ASW and antiaircraft and missile technology, a strategy that relies on "numbers rather than capabilities,"[45] insufficient fleet-defense systems, limited replenishment capabilities, and a largely antiquated submarine force—persist in spite of improved armaments. The limited range and defensive nature of China's fast attack craft and mine-warfare vessels coupled with the PLAN's restricted amphibious assault capabilities further restricts China's offensive options.

Similarly, despite the recent purchase of Su-27s, the Chinese air force's ability to project force via airpower remains strictly limited. Outdated airframes, a defensive fighter force, restrictions on the importation of technology to fill the qualitative gap, and insufficient training have all served to perpetuate this situation.

41. Cheung, *Growth in Chinese Naval Power* (n. 6 above), p. 27.
42. Ibid.; Spick (n. 1 above), p. 14.
43. M. Vatikiotis, "Mix and Match," *Far Eastern Economic Review,* 8 July 1993, p. 13.
44. Arnett (n. 14 above), p. 385
45. S. E. Speed, "Chinese Naval Power and East Asian Security," *Canadian Consortium on Asia Pacific Security Bulletin* 7 (August 1995): 6–8.

It therefore seems fair to conclude that, although the Chinese are upgrading their armed forces, this development is long overdue. Overall, the Chinese navy has been described as a "technically backward and operationally immature navy with rudimentary command and control systems and little high sea experience."[46] Chinese air and naval forces continue to lag significantly behind Western standards, and even behind the forces of other Southeast Asian nations. It can therefore be convincingly argued that the Chinese military threat has been overemphasized.

Taiwan

Although Taiwan is a South China Sea claimant and maintains a garrison on Itu Aba Island, its armed forces are almost exclusively devoted to the protection of Taiwan itself from mainland aggression, rather than projecting power into the South China Sea. While the key threat Taiwanese forces face is that of an outright invasion,[47] Taiwan, as the most trade-dependent state in the region save Singapore and Hong Kong, is also concerned with countering any threat of blockade, particularly by the PLAN's large submarine force.[48]

The Taiwanese navy is equipped mainly with relatively old but significantly upgraded U.S. designs and is in the process of being modernized and strengthened. The addition of 6 (reduced from the 16 planned, due to budgetary pressures)[49] French-built Lafayette-class frigates plus 8 U.S.-designed and Taiwanese-built Perry-class frigates will make the navy a relatively small but technologically advanced and effective force for the limited purpose of defending Taiwan and perhaps of breaking any blockade imposed on the island by virtue of advanced ASW capabilities.

The air force, reliant in the past mainly on a substantial fleet of U.S.-supplied F-5s and F-104s, will in the near future be greatly boosted by the purchase of 150 F-16s plus 60 Mirage 2000s, due to be delivered in mid-1996, as well as continued development of the indigenous Ching-Kuo fighter. These purchases may be seen as a response to China's acquisition of advanced Su-27s from Russia. The air force also took delivery of the first of four E-2T AEW aircraft from the United States in May 1994.

46. G. Till, "Trouble in Paradise," *Jane's Intelligence Review Special Report* (London: Jane's Information Group, 1995), 7:18, quoting the 1990–91 edition of *Jane's Fighting Ships*.

47. Although there is growing interdependence between the Chinese and Taiwanese economies and the threat of invasion has waned, the two parties' relationship is delicate, as Chinese testing of surface-to-surface missiles 140 km off Taiwan's northern coast in July 1995 illustrates.

48. Greenwood (n. 36 above), pp. 9–11.

49. J. Baum, "Arms and Greased Palms," *Far Eastern Economic Review*, 3 March 1994, p. 15.

Theoretically, with in-flight refueling, these aircraft could provide air cover for Taiwanese forces operating on and around the Spratlys, but "proximity to the Chinese mainland would make the use of tanker aircraft a very dubious proposition in the event of hostilities."[50] In contrast, their main role is likely to be the maintenance of local air superiority over Taiwan Strait.

Vietnam

The Vietnamese armed forces are in a parlous state. The air and naval forces possess largely obsolete and frequently inoperable equipment due to a paucity of spares and adequate maintenance. As far as the navy is concerned, "On paper, the Vietnamese navy has seven rusting US and Soviet Petya II frigates and 40 fast patrol craft but analysts say these ships are virtually non-operational for lack of spare parts.[51] At best these vessels have a very limited operational capacity and pose little competition to the naval forces of other coastal states and in particular those of China's South Sea Fleet.[52]

The mainstay of the air force is a fleet of some 175 short-range MiG-21 Fishbeds. Of a slightly more threatening nature are Vietnam's complement of around 30–36 MiG-23 Floggers and 65 Su-20/-22 ground attack aircraft, which have been described as "a major deterrent against the Chinese navy."[53]

While it is true that equipped with drop tanks these relatively out-of-date aircraft could conceivably reach the westernmost islands of the Spratly archipelago, it is likely that they would have extremely limited loiter time over the area.[54] It is, however, an open question as to what proportion of Vietnam's antiquated inventory is still operational. Furthermore, none of Vietnam's aircraft would prove any sort of a match for China's new Su-27s once they attain operational status.

At present Vietnam is in no position economically to afford an inevitably expensive modernization program for its armed forces. As a result the Vietnamese have sought to redress the technological imbalance by resorting to fortification of its numerous occupied islands and reefs in the Spratlys.[55] One asset Vietnam does have in this context is a substantial reserve of some 30,000

50. Spick (n. 1 above), p. 14.
51. Cheung, "Fangs of the Dragon" (n. 26 above), p. 20.
52. S. E. Speed, *Competing Interests in the South China Sea: An Overview of the Paracels and Spratlys Disputes* (Ottawa: Operational Research and Analysis Establishment, Department of National Defence, 1989), p. 12, for example, assesses the Vietnamese navy as being "incapable of fighting a major naval engagement."
53. Cheung, "Fangs of the Dragon" (n. 26 above), p. 20.
54. Spick (n. 1 above), p. 14.
55. For example, "To compensate for its lack of frontline equipment, Vietnam has been beefing up its garrisons on some of the islands in the Spratlys, including burying tanks into the ground and using them as gun emplacements" (Cheung, "Fangs of the Dragon" [n. 26 above], p. 20).

naval infantry, even if amphibious capability is severely limited to three old ex-Soviet and four ex-U.S. landing craft of World War II vintage plus 30 smaller craft.

In some senses this is a strategy inspired by desperation. Bereft of adequate air and naval support, such isolated outposts are highly vulnerable to blockade, assault, and piecemeal capture. Given the parlous state of its air and naval assets, however, it is probable that Vietnam currently has few military alternatives.

Instead Vietnam has been forced to rely on shrewd diplomatic maneuvering to support its claim to the Spratlys and hence a large portion of the South China Sea. Vietnam's policy of *doi moi* (literally, renovation) seeks to involve former enemies such as the United States and Association of Southeast Asian Nations (ASEAN) members in Vietnam's economic future and thus increase these countries' economic stake in the region while simultaneously rejuvenating its struggling economy. Vietnam's formal membership in ASEAN, confirmed in August 1995, represents a major success for this strategy.

Philippines

The Philippine armed forces have been spurred into an attempt to modernize partly by the departure of U.S. forces from the country and, more recently, by the Mischief Reef incident. Scant resources were devoted to the navy and air force in the past, as it was taken for granted that the United States would look after the Philippines' external defense requirements and the armed forces were preoccupied with action against domestic insurgents.

As a result the Philippine navy is restricted to just one outmoded frigate and ten corvettes of various types, all dating from World War II. The navy has therefore embarked on a modernization program that includes the acquisition of fast patrol boats and mine-warfare ships from Spain and Australia. The navy does possess some amphibious capability in the form of nine old ex-U.S. landing craft backed up by 8,500 marines. The Philippine air force is also extremely poorly equipped. Its only planes of note amount to seven F-5s, only two of which appear to be operational.[56]

Like Vietnam, the Philippines has sought to compensate for its weak position in terms of hardware by pursuing a policy of fortification of the garrisons it maintains on the Spratlys. It has been estimated that the Philippines has the strongest military presence among the claimant states dug in on the islands themselves.

Although the Philippines maintains a valuable mutual security treaty with the United States, the extent of the American commitment has been

56. C. A. Snyder, "Making Mischief in the South China Sea," unpublished paper.

questioned with regard to the Spratlys: "Washington has stated that its umbrella covers only the metropolitan territory [of the Philippines] as defined in 1951."[57] As the Philippine-claimed Spratlys, known as the Kalayaan group, were officially annexed only in 1978, they presumably fall outside the scope of the United States's defense commitment.

China's occupation of Mischief Reef in early 1995 has accelerated the Philippines' modernization program. The Chinese move prompted the Philippine parliament to commit 50 billion pesos (about US$2 billion) to improving the armed forces. Reportedly high on the Philippines' shopping list are F-16 fighters, fast patrol craft, and radar equipment.

Malaysia

The Malaysian navy and air force are faced with severe geographical difficulties. In addition to defending a substantial maritime area, the services must divide their attentions between peninsular Malaysia and the provinces of Sarawak and Sabah on Borneo, across the southern reaches of the South China Sea. To make matters worse, the intervening sea is interrupted by the presence of several Indonesian islands (the Natuna group).

The key elements of the Malaysian navy's modest forces, viewed by some defense analysts as approximately half the size required to fulfill its portfolio of tasks, are four frigates, although these forces have recently been supplemented by the addition of six new Jerong fast attack craft. It is in the sphere of airpower, however, where much of Malaysia's military modernization has been concentrated. In addition to 18 MiG-27s, Malaysia is also acquiring 8 high performance F/A 18 Hornets from the United States plus 28 British-made BAe Hawk 100 and 200 ground attack aircraft. These new acquisitions join an aging U.S.-supplied fleet of 33 A-4 Skyhawks and 13 F-5Es, marking a major enhancement of Malaysia's airpower. Malaysia also has the advantage of possessing land bases in relatively close proximity to the Spratlys, particularly at Labuan in Sabah, which lies approximately 150 nm from Swallow Reef.

Brunei

The Royal Brunei Armed Forces have very limited power-projection capabilities, possessing just three fast patrol boats and a few armed helicopters. This insignificant force may soon be upgraded with the possible addition of between 1 and 3 corvettes and 16 Hawk 100 armed trainers. Brunei's forces, however, are likely to remain modest.

57. N. Chanda, "Treacherous Shoals," *Far Eastern Economic Review*, 13 August 1992, p. 17.

Other Potential Combatants

In addition to the claimant states, several other countries or organizations have been touted as having significant strategic and military interests in the region, making them potential combatants in a South China Sea conflict.

Association of Southeast Asian Nations

Although ASEAN—a disparate group of states comprising Brunei, Malaysia, Indonesia, the Philippines, Thailand, Singapore, and Vietnam—is gradually building a framework for security cooperation in the region, these faltering steps fall well short of an integrated defensive alliance and military command. As O'Neill notes, "Prospects for military co-operation are limited because the assessments of Asean members still differ markedly on both threats and the issues for which force could usefully be employed."[58] Even so, any conflict in the South China Sea would necessarily threaten trade routes and therefore lead to the risk of ASEAN states becoming involved. While ASEAN is not a military alliance and shows little inclination to become one, military exercises and agreements between ASEAN members and nonmembers continue and are growing.

The United States

The departure of U.S. forces from Subic Bay naval base and Clark air base in the Philippines marks a significant scaling down of the U.S. military presence in the region, spurred by the absolute demise of a Soviet/Russian threat (at least for the foreseeable future) in the Pacific theater. This is not to say that the United States does not retain extremely impressive power-projection capabilities and the ability to rapidly deploy overwhelming air and naval assets to the region—*if* it wants to. It is highly questionable whether the United States would become directly involved in a conflict over the Spratlys unless the conflict were to escalate or interrupt international navigation through the region. The United States has made it clear, however, that it considers it "essential that we resist any maritime claims beyond those permitted by the Law of the Sea Convention," and the U.S. assistant secretary of state for international security, Joseph Nye, stated on 16 June 1995 that, if hostilities in the Spratlys interfered "with freedom of the seas, then we would be prepared to escort and make sure that free navigation continues."[59]

Russia

The former superpower's Pacific fleet has been described as possessing "fighter pilots without fuel and rusting ships."[60] Having quit its bases in Cam

58. R. O'Neill, *Security Challenges for Southeast Asia after the Cold War* (Singapore: Institute of Southeast Asian Studies, 1992).
59. Holloway (n. 7 above), p. 22.
60. J. Lilley, "Far Eastern Satraps," *Far Eastern Economic Review,* 13 January 1994, p. 21.

Ranh Bay and Da Nang, Russia's defensive alliance with Vietnam may be viewed as a dead letter, and it seems unlikely that the Russians will be able to mount sustained operations in the South China Sea for some time yet, even if they wanted to. In any case Russia would in all probability not wish to jeopardize her deepening and lucrative defense ties with China by supporting Russia's former client over the Spratlys.

The Five Power Defence Arrangement

Set up to compensate for British military withdrawal from the Far East in 1975, the Five Power Defence Arrangement (FPDA) links Britain, Australia, New Zealand, Malaysia, and Singapore. The agreement provides for consultations among the parties, leading to a combined response in the event of aggression against the latter two states. The FPDA's worth in the context of a conflict over the Spratlys is open to question. It seems unlikely that the agreement would be triggered by such a clash unless the fighting were to spread to the territory of Malaysia and Singapore proper.

Japan

Japanese dependence on strategic seaways passing through the South China Sea, particularly for its crucial oil supplies from the Persian/Arabian Gulf; an expansion in the scope of operations of the Japanese Maritime Self-Defense Force (JMSDF) in the early 1980s to 1,000 nm from Japan, partly in response to U.S. demands for "burden-sharing"; the impressive nature of those forces; and the country's economic dominance and history of aggression in the region—all have contributed to an alarmist scenario of a reemergent militaristic Japan.

For example Spick notes that if Japan's vital oil supply route were threatened "a response would seem inevitable."[61] Similarly, *Xiandai Jianchuan* (Modern naval vessels), the monthly publication of a Chinese navy think tank, alleged that Japan had embarked upon a "new militaristic path" as recently as June 1994.

Despite such fears the JMSDF retains a very defensive posture, lacking carrier-based aircraft and adequate logistical support to sustain long-distance operations. Were Japanese naval forces to deploy to the South China Sea, they would be bereft of air cover unless provided with friendly bases in the region—highly unlikely given Japan's historic baggage from World War II. As the *Economist* aptly summarizes, Japan remains "a power but a neutered one."[62]

India

According to some commentators, India's development of a blue-water navy plus long-range air and missile capabilities is cause for alarm on the part of

61. Spick (n. 1 above), p. 15.
62. "Asia's Arms Race" (n. 28 above), p. 22.

South China Sea littoral states. Although India is perhaps the only Asian state to posses aircraft carriers, it may be argued that Indian military power-projection capability "remains seriously flawed."[63] India's two carriers hail from World War II, and neither boasts conventional rather than short take-off and landing aircraft. In addition the Indian navy is probably incapable of providing the sort of heavily armed battle group vital to carrier operations, particularly as the Indians lack antimissile missiles. Furthermore, lack of support ships limits range and sustainability of operations while the Indian navy's amphibious capability is dismissed by Sridharan as "marginal."[64] India is therefore very unlikely to become involved in a South China Sea firefight.

China and India are, however, potential rivals in the approaches to the South China Sea where their strategic spheres of interest intersect. Recent developments suggest that China is at least partly responsible for the operations of the signals intelligence base on Coco Island in the Indian Ocean. Indications are that China is pressing Burma to allow it access to the sensitive listening posts of Ramree island, south of Sittwe off the coast of Arakan state, and, more importantly, to an island off Victoria Point near the northern entrance to the Strait of Malacca—a source of real concern to India as well as other Southeast Asian states.[65]

AN ARMS RACE IN THE SOUTH CHINA SEA?

Do the developments outlined above constitute an arms race in the region? If not a full-fledged arms race, what then is the significance of Asia's undeniable military buildup against the backdrop of conflicting claims in the South China Sea?

Defining an Arms Race

A traditional arms race consists of an action-reaction dynamic, with one side attempting to gain a technical or material advantage over the other. The result is a "race" characterized by upward-spiraling arms procurement motivated by outside factors, rather than by the largely domestic concerns that seem to motivate many of the arms aquisitions in the Asia Pacific today.

It is not enough to characterize the proliferation of arms in Southeast Asia as an arms race on the grounds that the aquisition of new weapons

63. K. Sridharan, "India-ASEAN Relations," in *China, India, Japan, and the Security of Southeast Asia,* ed. C. Jeshurun (Singapore: Institute of Southeast Asian Studies, 1993), p. 138.

64. Ibid., p. 137.

65. B. Lintner, "Enter the Dragon," *Far Eastern Economic Review,* 22 December 1994, p. 23.

and military material is on the increase in strict numerical terms. As Amitav Acharaya has noted, "Theoretical insights derived from Western experience might not adequately capture the diverse and unique range of factors behind national security decision making processes in Southeast Asia."[66]

It is our contention that, although there have been significant arms procurements and there exists an inevitable tendency for states to try to keep pace with one another, there are in fact many plausible, alternative explanations for the arms buildup in Southeast Asia, none of which necessarily suggests an overt arms race. The need for enhanced internal security, technology transfer, supply-side pressures, regional balance-of-power concerns, increasing emphasis on self-reliance, prestige, imitation, and bargaining power have been identified by many analysts as factors contributing to the growth of Asia's arsenals in recent years.

Internal Security

Countries with concerns over domestic unrest and insurgent movements require the ability to airlift troops, light armored vehicles, and other equipment to hot spots with a minimum of delay. Therefore, spending on rapid-deployment forces has increased in the region in recent years. Indonesia's ongoing need for vigilance in East Timor, and Irian Jaya; Malaysia's determination to be able to react to incidents on the island of Borneo, with its strong separatist movement; and the Philippines' need to contain insurgent movements the length of its archipelago require rapid-deployment, counterinsurgency forces that are capable of reacting to situations quickly and effectively.

Self-Reliance and Technology Transfer

Since the inception of the British "East of Suez policy," the end of the Vietnam War, the demise of the Cold War, and the closure of the Subic Bay naval base, the states of the Asia Pacific increased their emphasis on the need for a self-reliant defense capability. However, though increased self-reliance is intended to lead to a greater level of autonomy for the countries concerned, the theory may promise more than it can deliver. To borrow from an extra-regional example, Israeli-designed and -built fighter jets powered by U.S.-designed engines cannot be exported without prior approval from the United States. Thus, while a country may produce its own military equipment, due to the sensitive nature of some of its components, it may not necessarily do as it pleases with that equipment.[67]

66. A. Acharaya, *An Arms Race in Post–Cold War Southeast Asia?* Pacific Strategic Papers (Singapore: Institute of Southeast Asian Studies, 1994), p. 31.

67. F. S. Pearson, *The Global Spread of Arms: The Political Economy of International Security* (Boulder, Colorado: Westview, 1994), p. 45.

The acquisition of sophisticated weapons systems is also often seen as a means of both developing indigenous defense industries and enhancing existing civilian commercial enterprises. There is also a perceived need to keep abreast of rapidly evolving high-technology weaponry. In the case of Indonesia, for example, the acquisition of 12 F-16s provides a basis from which to expand quickly in the event of an emergency.

Supply and Demand

Often the impetus to purchase armaments emanates from extraregional arms producers. The end of the Cold War has eliminated secure arms markets and forced producers to look elsewhere for clients. Competition between the United Kingdom, France, Russia, and the United States for markets has contributed to what the *Economist* has described as the "greatest buyer's market ever" in Asia. The perception that the availability of sophisticated armaments will not continue unabated and thus must be taken advantage of while it lasts may also be fueling the rush for arms.

The so-called peace dividend, which has meant less money for weapons research and development, forecasted at the end of the Cold War has forced defense contractors to look elsewhere to ply their wares. Politicians, faced with a diminished domestic arms market, the loss of the traditional Cold War markets, and pressure from their constituents, aggressively seek out new markets abroad to prop up beleaguered defense industries. The states of Southeast Asia have been eager consumers.

Furthermore, it should be noted that the decline in Western Military expenditures throws Southeast Asian purchases into higher relief, since they now compose a significantly higher proportion of global expenditure on arms. The rapid growth of many of these nations' economies has naturally led to a corresponding increase in defense expenditure. Indeed, in comparison to other developing areas such as the Persian/Arabian Gulf, the "Asia-Pacific defence effort as measured against GNP is neither particularly high nor dramatically increasing."[68]

CONCLUSIONS

A number of points may be drawn from the preceding brief survey. With regard to the claimant states' relative military strengths, it is clear that by virture of sheer numbers if not superior qualities the Chinese have a significant edge and, in the absence of extraregional intervention, particularly from the United States, could be expected to deal with any single opponent in the South China Sea comfortably.

68. Till (n. 46 above), p. 23.

That China would win any duel in the South China Sea may be true in strict numerical military terms. However, the argument that proceeds along the lines that China is powerful, could take the Spratly Islands at its leisure, and therefore, it should be appeased, ignores other factors—both military and, especially, nonmilitary.

Although China's rapid naval expansion, its entrenched position on the Spratly Islands, and its demonstrated willingness to use force provide compelling reasons for concern among the states of Southeast Asia, it has been suggested that fears of an aggressive, expansionist China are exaggerated, as both international and domestic constraints severely limit China's options. Aside from the previously mentioned military impediments to any Chinese expansionist aspirations, China is confronted with increasingly sophisticated armed forces throughout the region.

Furthermore, the dynamic economies of the ASEAN countries, their links with the international community, and the important strategic shipping lanes in the vicinity of the Spratly Islands would inevitably provoke international opposition to any overt attempts by China to dominate the region. Perhaps the country that would sustain the greatest injury in the South China Sea would be the ostensible "winner" of any battle there, China, whose own economy is becoming increasingly interdependent with those in the region and beyond. Just as trade repercussions followed the Tienanmen Square massacre, a war in the South China Sea, initiated by China, would call into question China's role in the international community as well as choke its drive to modernization. It can therefore be argued that China has too much at stake economically to risk confrontation and conflict.

It is also well to recognize that although seemingly aggressive actions such as the Chinese seizure of Mischief Reef in early 1995 are alarming, the event hardly set a precedent, since Mischief Reef duly became the 44th Spratly feature to be occupied since the 1950s and without resort to violence.[69] Furthermore, the Chinese have recently made positive assertions relating to the South China Sea disputes. Most notable among these statements was that of Chinese vice premier and foreign affairs minister Qian Qichen in the course of the ASEAN Regional Forum on 30 July 1995, that China was willing to settle disputes carefully using the "UN Convention on Maritime Law" as a basis. He went on to state the most realistic and practical way forward was to "shelve the dispute and go for joint development" and that China itself "attaches great importance to safe and free-passage in the international sea lanes" in the South China Sea and anticipated no problems occurring on that issue.[70] It remains to be seen whether future Chinese deeds will match up to these reassuring statements.

69. Dzurek (n. 2 above), p. 71.

70. Xinhua news agency, 30 July 1995, in British Broadcasting Corp. Summary of World Broadcasts, Far East Section 2370, August 1, 1995.

As far as an arms race in the region is concerned, that force modernization is proceeding apace is undeniable. Whether this constitutes an arms race is more debatable. In virtually all cases there is a dire need to replace antiquated equipment. Arms procurements have been driven by rapid economic growth after generally more depressed expenditures in the 1980s. In addition, such acquisitions reflect an understandable reaction to the removal of Cold War certainties, the power vacuum (real or imagined) left by a scaling down of the U.S. presence in the region, and the perception that one can't rely on the traditional suppliers of arms. Hence the increased emphasis on self-reliance and technology transfer. Continuing insurgencies in the Philippines and Indonesian uncertainty in East Timor also necessitate a rapid reaction capability.

Clearly the single greatest missing ingredient in the South China Sea is a level of confidence, or transparency, between the states of Southeast Asia. There are, however, signs that this may be slowly changing. Thailand, for example, has released a defense white paper that itemizes its military forces for all to see. The informal, Indonesian-sponsored, Canadian-funded workshops continue. The fact that a collection of countries, with no history of dialogue or cooperation in multilateral forums, continue to sit down around the table to discuss those issues that keep them apart is no small achievement. More, obviously, remains to be done.

Annex 827

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Toward Establishing a Spratly Islands International Marine Peace Park: Ecological Importance and Supportive Collaborative Activities with an Emphasis on the Role of Taiwan

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The Spratly Islands constitute one of the earth's most ecologically significant areas, hosting a high diversity of marine species, providing critical habitats for endangered species, and providing marine larvae to reestablish depleted stocks among the heavily overfished and degraded coastal ecosystems of the South China Sea. Territorial disputes have led to the establishment of environmentally destructive, socially and economically costly military outposts on many of the islands. Given the rapid proliferation of international peace parks around the world, it is time to take positive steps toward the establishment of a Spratly Islands Marine Peace Park. Its purpose would be to manage the area's natural resources and alleviate regional tensions via a freeze on claims and claim supportive actions.

Keywords Coral Triangle, Marine Peace Park, marine protected areas, Spratly Islands

Geographical Features and Legal Aspects of the Spratly Islands

The South China Sea is a marginal sea partially enclosed by the lands of the People's Republic of China, the Republic of China (referred to as Taiwan), the Philippines, Malaysia, Brunei, Indonesia, Singapore, and Vietnam. Covering an area of 800,000 square kilometers and containing more than 200 identified islands, islets, reefs, shoals, sand cays, and banks, four major archipelagos named the Pratas Islands (Dongsha 東沙), Paracel Islands (Xisha

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西沙), Macclesfield Bank (Chungsha 中沙), and Spratly Islands (Nansha 南沙) are distributed from north to south.

The Spratly Islands are scattered between 12∞ and 6∞ north, and 109∞ and 117∞ east in the southern part of South China Sea. The water area of the Spratly Islands is substantial, encompassing approximately 160,000–360,000 square kilometers, depending on how limits are chosen. There are approximately 150 named landforms, and innumerable unnamed spits of land. The majority of these are rocks, reefs, sandbanks, or other types of partially submerged landforms. They rest primarily on partially submerged coral reef atolls, ranging in length up to approximately 40 kilometers. The largest island in the Spratly group is called Taiping Island (太平島) or Itu Aba by others. Taiping Island and six other reefs form a lagoon-shaped Tizard Bank or Zhenghe Reefs (鄭合群礁) near the center of the South China Sea. The island itself has an elliptical shape, 1,289 meters in length and 365 meters in width, with 0.49 square kilometers of area. The altitude is less than 5 meters. The geographical distance between Taiping Island and Kaohsiung (Taiwan) is about 850 nautical miles; to Hainan (China) 550 nautical miles; Ho Chi Minh City (Vietnam) 330 nautical miles; Palawan (the Philippines) 220 nautical miles. Taiping Island has been under control of Taiwan since 1956.

The Spratly archipelago is the focus of complex sovereignty disputes. There are competing claims to island territories, exclusive economic zones (EEZs), and continental shelf by Taiwan, China, Malaysia, the Philippines, Vietnam, and Brunei. Though these countries claim the sovereignty of part or all of the Spratly Islands, each major island is controlled and governed by only one country that, in many cases, has installed military facilities. The eight largest islands and the controlling nations are listed accordingly: Taiping Island (Taiwan), Thitu Island (the Philippines), West York (the Philippines), Spratly Island (Vietnam), Northwest Cay (the Philippines), Southwest Cay (Vietnam), Grierson Cay (Vietnam), and Swallow Reef (Malaysia). Mainland China controls several reefs and emergent features scattered throughout the area, including Mischief Reef.

Ecological Significance of the Spratly Islands

The Spratly Islands are subject to a tropical climate. The average annual temperature is 27°C. During summer, from May to August, the high temperature is approximately 30°C while, in winter, the average temperature is about 25°C. The Spratlies experience a 7-month dry season and a 5-month rainy season, with an annual average rainfall of 1,800 to 2,200 millimeters. Southeast monsoon winds blow from March to April, and then shift to a southwest monsoon wind from May to November. Few of the islands have surface freshwater. However, on some, wells were successfully dug that, over the years, have provided a source of water to troops, tourists, and visiting fishermen. Thirteen islands, including Taiping Island, have terrestrial vegetation that indicates a significant degree of soil formation.[1]

Due to the remote distance and limited accessibility to the Spratly Islands, only a few surveys have been conducted during the past few decades. The earliest Taiwanese ecological inventory in Taiping Island was led by K. H. Chang with a group of experts from the Institute of Zoology, Academia Sinica (中央研究院) in 1980. They recorded 33 families and 173 species of fish within an 800-square-meter sea area south of Taiping Island. They published a fish guide book[2] and a fish checklist in a scientific journal.[3] In 1994, a group led by the National Museum of Marine Biology and Aquarium recorded 399 reef fish species from 49 families, 190 coral species from 69 genera from 25 families, 99 mollusk species, 91 invertebrate species from 72 genera, 27 crustacean species, 14 polychaete species, 4 echinoderm species, and 109 terrestrial vascular plant species. There were also 59 bird species observed, which indicates that Taiping Island is a major stop for migratory birds in East Asia.[4] According to BirdLife International (2001), the species mainly included streaked shearwater (*Calonectris leucomelas*), brown booby (*Sula leucogaster*), red-footed booby (*S. sula*), great crested tern (*Sterna bergii*), and white tern (*Gygis alba*).[5] Both the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) were often reported to be nesting even on islands inhabited by military personnel in the Pratas and Spratly Islands, though their numbers have gradually declined.[6] The richness of marine biodiversity, spectacular coral reefs, and threatened species such as the crested tern and green turtle together add considerable value to Taiping Island as a future conditional ecotourism reserve.

The Spratly Islands hosts a high diversity of marine organisms. White included the islands as a priority area for marine conservation and management in 1983.[7] However, the importance of the island group to regional fisheries was identified in the early 1990s based on studies of water circulation relative to the presettlement pelagic times of coral reef fish.

Currently, there is a project evaluating whether Taiping Island should be established as a marine park, similar to the Pratas Islands (Dungsha) Group, which was successfully established as a Taiwanese National Marine Park in 2007.[8] In their expedition in June 2009, the project personnel added more records of terrestrial and marine species in Taiping Island.[9] For example, there were 40 newly recorded terrestrial invertebrate species, 3 newly recorded bird species, and 66 newly recorded fish species. However, they also noticed that many coral-eating crown-of-thorns starfish (*Acanthaster planci*) occurred in one station.

Along the coasts of the South China Sea, many of the coral reef fisheries are heavily overfished, especially along southern mainland China, Vietnam, Malaysia, and the Philippines. Harvests of adult fish are in decline. Coastal fish populations are periodically renewed via influxes of presettlement pelagic juveniles. Wyrtki determined that a cyclonic (counterclockwise) circulation predominates across the basin in the winter and an anticyclonic circulation (clockwise) caused by the annual shift in monsoon starting from the south in summer.[10] Various recent studies have confirmed that this general pattern does indeed exist, although a number of smaller subgyres and vortices also occur periodically.[11] Using the circulation charts of Wyrtki and a 24-day pelagic time determined from a compilation of published studies of various reef fish species, McManus determined that the seasonally shifting currents of the South China Sea could disperse presettlement fish from the Spratly Islands throughout the coasts of the South China Sea.[12] Some coasts could be reached within 24 days, while others could be reached in a process in which fish from the Spratly Islands settle on intermediate reefs and then pass in a second generation to the coast. This finding indicates the importance of the water area of Spratly Islands for conservation.

During the period 2000 to 2002, the WorldFish Center, along with Academia Sinica Taiwan and institutional partners from other neighboring countries, organized a collaborative project to examine interreef connectivity patterns by analyzing genetic groupings among marine organisms. The results showed that each genetic subgroup may include portions of the Spratly area.[13] This was consistent with the idea that juvenile pelagic fish could be transported from the Spratlies to rejuvenate dwindling populations around the region, including the reefs of Taiwan.

There have been many reports emanating from other investigations of the South China Sea, but few have focused on the Spratly Islands or specifically on Taiping Island. Thus, it is also difficult to sort out the species of marine animals or plants from which collections were made. The *Raffles Bulletin of Zoology* from Singapore has devoted two issues to the South China Sea biomes and biodiversity.[14] They included comprehensive species checklists of marine fauna and flora as well as papers with newly recorded species.

Types and Severity of Threats

The South China Sea is the site of major fishing operations. According to the Global International Waters Assessment (GIWA), "Regional Assessment 54 South China Sea," the South China Sea ranks fourth among the world's 19 fishing zones with regard to total annual marine production.[15] However, unsustainable exploitation of fish has led to difficulty in finding adult fish of heavily exploited species in the region. China estimated that the total fishery production in the Spratly Islands was less than 7000 tons each year, about 0.3 tons per square kilometer.[16]

Between 1980 and 1990, the Taiwan Fisheries Research Institute collected harvests from experimental and commercial fishing vessels, and published reports on the fisheries potential and the situation in the Spratlies. For example, Wu investigated the marine environment, biological resources, and fishery resources around Taiping Island.[17] Chi and Huang both inventoried the fisheries of the Spratly Islands with the records of 20 families (72 species) and 45 families (245 species) of fishes.[18]

Since 1985, China, Vietnam, and the Philippines have upgraded their fisheries in the Spratly Islands to include large-scale explosive and cyanide fishing operations that have depleted the resources at a high speed. Additionally, the El Niño conditions in 1998–1999 and 2007–2008 caused short-term increases in water temperature, resulting in widespread coral bleaching and subsequent mortality. The combination of destructive fishing and coral bleaching has created a serious threat to the reef resources of the area.

Being bordered by some of the world's most rapidly industrializing countries, as well as being located amid some of the world's busiest shipping lanes, has proven detrimental to the island ecosystems in many ways. Concerns with political disputes, maximizing economic growth, and ensuring adequate energy supplies have taken precedence over the preservation of the bordering nations' common maritime environment. Although it is effectively the oceanic hub of Asia's industrial revolution, the Spratlies and other South China Sea islands have been and are being degraded by physical disruption of native flora and fauna, by overexploitation of natural resources such as guano and turtles, and by severe environmental pollution.

Marine Protected Area Development and Regional Cooperation

The Convention on Biological Diversity targets the establishment of 10% of marine protected area coverage throughout the world by 2012.[19] With regard to the Spratlies, transboundary protected area arrangements have often been proposed. There is a well-established precedent for these, although they are primarily in the form of parks on land. In 1988, the Commission on National Parks and Protected Areas of the International Union for the Conservation of Nature (IUCN) listed 70 protected areas in 65 countries that straddle national borders.[20] In 2007, there were 227 complexes surveyed by the United Nations Environment Programme (UNEP), including both terrestrial and marine.[21]

The conflicting territorial claims over parts of the South China Sea have not totally dampened cooperation among the claimant countries. Cooperative activities in the fields of marine scientific research, environmental protection, and defense are regularly carried out on bilateral or multilateral bases. These have included two major expeditions in 2002 and 2004 under the auspices of the South China Sea Workshop series[22] and a joint scientific expedition between Vietnam and the Philippines in 2006. These and other studies are believed to have contributed to a certain degree of stability in the area as "confidence-building exercises," and gathered valuable information on the area's natural resources. The important question, however, is whether the present level of cooperation can be enhanced and extended to ensure natural resource stability in the South China Sea.

One option for regional cooperation that has often been proposed is the initiation of a Large Marine Ecosystem (LME) study. The LME concept was developed by the U.S. National Oceanic and Atmospheric Administration (NOAA) to agglomerate consensus, and to monitor and assess the changing of the world's coastal ecosystems. It is widely recognized that such an international cooperative study would improve international relationships and facilitate knowledge-based management of the South China Sea, although no such study has yet been initiated in the region.

Examples of Regional Joint Programs

The Philippines-Vietnam Joint Research in the South China Sea, 1996–2007

In 1994, the presidents of the Philippines and Vietnam signed a bilateral agreement to conduct a Joint Oceanographic and Marine Scientific Research Expedition in the South China Sea (JOMSRE-SCS). After 11 years of research, the findings on marine biodiversity showed that the Spratly Islands could be a source of coral propagules for destroyed reef areas in the southern and western Philippines. However, the densities of marine species associated with offshore coral reefs were found to have been drastically reduced, particularly in shallow waters where blast and poison fishing are common. The biomasses of target fish species in 2007 had been reduced to approximately one-third of their levels in the late 1990s. This project not only provided strong evidence that heavy exploitation of the fishery resources has occurred in the South China Sea, but also demonstrated a cooperative governance mechanism for larger-scale research, safety navigation, and conservation.[23]

UNEP/GEF South China Sea Project, 2002–2008

The UNEP/Global Environment Facility (GEF) funded the project Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand, which involved a partnership of seven countries bordering the South China Sea (Cambodia, China, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam). The project consisted of 59 organizations as a "networked institution," plus around 100 subcontracted institutions and more than 400 institutions involved through individual participation. An important by-product of this project is an interactive project Web site that serves as an information portal for 1,800 relevant documents and a metadatabase containing 1,428 entries.[24]

Coral Triangle Initiative

The Coral Triangle Initiative is an intergovernmental, multiply-sponsored, coordinated effort to improve the management of coral reefs and related resources.[25] It covers a triangular area previously determined to be high in coral diversity, encompassing Indonesia, the Philippines, Timor Leste, Papua New Guinea, and the Solomon Islands. The total area is approximately 18,000 square kilometers and includes, for many groups of organisms, the richest species diversity in the world. This area hosts more than 600 species of coral, over 3,000 species of fish, and the world's largest mangrove forests.

The objective of the initiative is to protect the region's marine resources for future generations. In May 2009, six heads of state from the region met in Manado, North Sulawesi, Indonesia and signed a declaration approving the Coral Triangle Initiative.[26] Although there is no legal enforcement power, the whole process is based on strong political will among neighboring countries.

The Spratly Islands is located at the border of the Coral Triangle Initiative area as presently defined. Because of the demonstrated potential influence of the Spratly Island reefs on coral reef ecosystems within the initiative area, it would be rational to extend initiative resources to improve their protection. However, the sovereignty complexity and lack of research data might be an obstacle preventing this important archipelago from being included in the initiative's activities.

The Proposed Spratly Islands Marine Peace Park

The term *peace park* does not necessarily imply that it is sited within an area in conflict, although the term does indicate a propensity for this kind of protected area to reduce violent conflict and bring more harmony to a region.

The IUCN defined *parks for peace* as: "Transboundary protected areas that are formally dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and to the promotion of peace and cooperation."[27]

During the past century, many peace parks have been established around the world. The first was established between Canada and the United States in 1932, and named the Waterton-Glacier International Peace Park. Another milestone was the Red Sea Marine Peace Park, one of the most well-known examples of a marine peace park. The term refers to an area in the northern Gulf of Aqaba in which Israel and Jordan have developed a binational partnership to share natural resources and confront ecological pressure together. Some aspects of this park are under further development, including an extension into Egypt.[28]

In the South China Sea, the Spratly archipelago is characterized not only by territorial claimant disputes, but also by the multifaceted importance of waterways, fisheries, tourist value, and possible deposits of hydrocarbons. The process of gathering consensus among claimant countries is troublesome. Valencia et al. summarized the political situation and proposed various scenarios of international cooperation in the area.[29] They expressed the concern that making the whole area a marine park might be difficult because of, in addition to strategic military concerns, the strong interest in exploiting oil in the area. However, Townshend-Gault, summarizing the results of an international workshop on the South China Sea, pointed out that there was little evidence that substantial, economically extractable oil actually exists in the area, and reemphasized that the protection of the natural resources of the Spratly Islands was vital to maintaining fisheries and economically important ecosystems throughout the coastlines of the entire South China Sea.[30] Valencia and van Dyke replied, clarifying the view expressed in a 1997 book that the concerns about exploitation of oil were secondary to sovereignty and the strategic significance of the Spratlies in general.[31]

Strategic concerns and vague possibilities of hydrocarbon deposits have led each country in the region to station troops in the area, resulting in occasional violent confrontations and environmental stress. The feasibility of establishing a Marine Peace Park when originally proposed was enhanced by the high cost of military maintenance in the area. As suggested by Valencia et al., confidence-building activities are important and could lead to a lessening of regional tension and to increased regional support for the marine park.[32] Scientific collaboration and the further development of economic trade would be helpful. In some cases, it might be easier to set up informal international activities by sponsoring participation in scientific and conservation activities by nongovernmental organizations (NGOs), rather than to concentrate efforts solely on sponsoring participation by representatives of governmental agencies. A concept for a full-area Spratly Island Marine Peace Park, which may have sounded unrealistic in 1994, gained substantial credibility by 2009 in a world that had come to understand the value of this approach.[33]

Following up on suggestions from previous investigators, McManus suggested that a treaty for the Spratlies might follow the leads of the 1959 Antarctic Treaty[34] and the 1978 Torres Strait Treaty[35] for raising the flag of truce and freezing ownership claims for a definite period, such as 50 years, with an option for review and indefinite renewal.[36] A possible management strategy might include five elements: (1) an international board of directors, (2) a contracted research and management institution, (3) a private ranger/air-sea rescue force, (4) tourism facilities, and (5) research facilities and programs.

The engaged countries would provide representatives and form a board of directors. A scientific research group with the extra function of planning for international collaboration on research programs in the area would be a good first step. Park management would involve monitoring activities in order to head off possible deterioration from such things as regional oil spills from tanker incidents, or diminishing supplies of larvae from other areas. An international organization might be contracted to oversee management and conduct activities such as air-sea rescue, charting, channel marking, and antipiracy enforcement. These suggestions are generally in keeping with the multiuse cooperation scenario presented in Valencia et al.,[37] with the exception of replacing their suggested "managed multi-use approach" with the more natural resource and regional fisheries protection oriented and tourism industry supportive full-area marine peace park.

Taiwan's Role in Working Toward a Spartly Island International Marine Peace Park

Taiwan's policy toward the South China Sea sovereignty was considered self-restrained and moderate from the 1970s to 1990s. In 2000, jurisdiction of the islands of the South China Sea shifted from the Ministry of National Defense to the newly established Coast Guard Administration, which is considered a law enforcement agency under the administration of the Executive Yuan. In 2007, Tungsha (the Pratas Islands) National Marine Park became the seventh national park in Taiwan. In 2008, former President Chen Shui-bian announced the Spratly Initiative at the opening ceremony for the airstrip on Taiping Island.[38] He was Taiwan's first president to set foot on Taiping Island. The Spratly Initiative is an ecofriendly invitation toward surrounding countries to cooperate in regional environmental protection and sustainable development.[39] President Ma also announced a marine policy to gradually open the South China Sea and cooperate with international conservation organizations for a Marine Peace Park in order to enhance positive interaction with neighboring countries, and to conserve ecosystem and cultural heritages.[40]

Neither a member of the United Nations nor of the Association of Southeast Asian Nations (ASEAN), Taiwan cannot join the Convention on Biological Diversity (CBD),[41] the Law of the Sea Convention,[42] and any other major political international organizations, except APEC and the International Council for Science (ICSU). This diplomatic impediment has limited Taiwan's participation in many international collaborations. However, Beckman highlighted the importance of Taiwan's participation in regional cooperation because Taiwan occupies the largest island and is a major fishing entity in the South China Sea.[43] Recently, the relationship between Taiwan and China has greatly improved. In 2002, China and the ASEAN countries signed the breakthrough Declaration on the Conduct of Parties in the South China Sea,[44] which has helped to make the South China Sea relatively calm and peaceful. The signing in 2010 of the Economic Cooperation Framework Agreement (ECFA) between Taiwan and China[45] may give Taiwan a better chance to promote the Spratlies as an international Marine Peace Park.

Given Taiwan's significant capacity for biodiversity research, the following priorities are recommended for further activities.

1. Creating a taxonomy and compilation of fauna and flora of the South China Sea.
2. Establishing a long-term ecological research and monitoring program, including a centralized information portal that will make all data widely accessible in a Geographic Information System (GIS) format with real-time remote sensing data, links to onsite sensors and video systems, and the ability for users to explore scientific hypotheses and management action scenarios via online simulation systems.
3. Undertaking ecological community studies of both terrestrial and marine organisms as well as their metapopulation relationships such as the dependence of one reef system on the larvae washed in from a downstream reef (connectivity).
4. Conducting phylogeographical studies on selected groups of organisms (e.g., the relationships among taxonomic groups and their spatial distributions).
5. Undertaking population studies for certain important species in South China Sea.
6. Engaging in fishery resource analyses and simulations to guide sustainable use and conservation biology.
7. Ensuring other database integration, including links to the catalog of life (COL), barcode of life (BOL), encyclopedia of life (EOL), tree of life (TOL), ReefBase, FishBase, and expert's name lists.
8. Studying the effect of climate change on marine biodiversity, ecological connectivity and fisheries in the South China Sea.

The establishment of state-of-the-art marine stations at several islets would greatly facilitate the long-term research needed to unravel the complexities of South China Sea ecology. Sufficient research facilities and equipment including dry and wet labs, living accommodations, diving boats, and wireless Internet access will be essential to support this research. The research at these stations would benefit greatly by being open to international visiting scientists. As with the scientific exchange provisions of the Antarctic Treaty, a system for freely exchanging specimens, physical oceanographic observations, and ecological distribution data should be established based on agreements among collaborating countries. Gradually, opposing military installations could be supplanted with collaborating scientific research laboratories. Military and political disputes should be supplanted with scientific debates and jointly agreed, effective, natural resource management. Ultimately, it is envisioned that, under the guidance of an international natural resource management authority, any scientist or tourist would be able to enter any part of the Spratly Islands, passing in freely on vessels and aircraft from any international destination, and then move on to any other destination with no more difficulty than is found in traveling among the nations of the European Union.

Conclusion

The Spratly Islands have considerable ecological and biodiversity value, both intrinsically, and as the source of larvae for coastal ecosystems throughout the South China Sea. Sovereignty disputes have limited the implementation of effective measures to protect these resources from overexploitation and destructive fishing. Recently, strong support from some, including the government of Taiwan, has spurred renewed interest in the incorporation of the islands and surrounding waters into an international Marine Peace Park. Agreements associated with this park would include a freeze on claims and claim-supportive activities for a specified but renewable period of time, thus easing tensions and facilitating collaborative research and resource management activities. Whether it is achieved via a single agreement, or via the accumulation of nationally declared parks into a coordinated network, a Spratly Islands International Peace Park would be an achievement of considerable regional and global significance.

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Annex 828

Clive Schofield, “Islands or rocks - is that the real question?: the treatment of islands in the delimitation of maritime boundaries”, in *The Law of the Sea Convention: US Accession and Globalization* (M. H. Nordquist, et al., eds., 2012)

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ISLANDS OR ROCKS – IS THAT THE REAL QUESTION? THE TREATMENT OF ISLANDS IN THE DELIMITATION OF MARITIME BOUNDARIES

*Clive Schofield**

Abstract

Islands remain a key ingredient in maritime disputes, especially in the context of the delimitation of maritime boundaries between neighbouring States. Such disputes frequently revolve around the question of whether the island in question has the capacity to generate extensive claims to maritime jurisdiction and therefore influence the course of a maritime boundary line, or whether the feature is a mere "rock", incapable of generating extensive maritime claims. The importance of islands to the maritime claims of coastal States and in maritime delimitation is highlighted. The salient elements of the regime of islands are then outlined. The role of islands in the delimitation of maritime boundaries is then reviewed. On the basis of this assessment it is suggested that although a clear means of distinguishing between types of island remains out of reach, this debate is not necessarily the critical issue as a clear trend is emerging in terms of how small islands are dealt with in the delimitation of maritime boundaries.

Introduction: The Trouble with Islands

Islands represent a perennial source of discord between neighbouring coastal States. Such disputes frequently relate to small, remote and, at first glance at least, apparently intrinsically worthless, features. Disputes relate both to sovereignty over certain islands and also to their insular status, and thus their capacity to generate claims to maritime jurisdiction (though it is recognized that these issues are frequently intertwined). Discussions relating to the latter type of dispute often tend to be framed in the following manner: is the feature in question an island or a rock?

Whether a feature is an island capable of generating extended zones of jurisdiction (exclusive economic zone (EEZ) and continental shelf rights) or is, in fact, a "rock" which cannot, is a crucial one in terms of the capacity of the island in question to generate claims to maritime jurisdiction. However, distinguishing between these two types of insular feature remains a conundrum. This

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question has been the subject of intense scholarly investigation but without a conclusive outcome being achieved.

This paper suggests that the question "island or rock" is, a misleading one. This is the case firstly because rocks are dealt with within under the same article of the United Nations Convention on the Law of the Sea (LOSC),[1] Article 121 dealing with the *Regime of Islands*. It is therefore more appropriate to regard rocks as a disadvantaged subcategory of island. Moreover, near forensic examination of the drafting history of Article 121 of LOSC merely reveals the opposing interests and positions of the States involved leading to a deliberately ambiguous outcome. Further, the subsequent practice of States and international courts and tribunals has thus far failed to provide an adequate route to clarifying the distinction between 'full' or 'fully-fledged' islands capable of generating EEZ and continental shelf rights and mere rocks which are restricted from doing so.

It is suggested that the more profitable avenue for discussion focuses on the treatment of islands in the delimitation of maritime boundaries and the generation of claims to maritime jurisdiction. A review of the treatment of islands drawn from relevant State practice and the jurisprudence of international judicial and arbitral courts suggests that, although practice remains somewhat diverse, there are signs of a consistent trend emerging and, at the least, numerous examples exist which indicate how disputes related to islands can be equitably resolved.

The Importance of Islands

Islands are the focus of numerous maritime boundary disputes. Such disputes tend to fall into two broad categories: those relating to sovereignty over islands themselves, their land territories and their related maritime space; and those concerned with the role of particular insular features in the delimitation of maritime boundaries. These factors are, however, often inextricably entangled with the potential role of islands in delimitation and the generation of claims to maritime jurisdiction also proving to be a key factor influencing and informing any dispute over sovereignty.

In many cases such sovereignty disputes relate to title over a few remote, barren, small and often uninhabited islands, rocks, low-tide elevations and reefs. Nonetheless, such features have proved to be a long-standing source of discord

[1] United Nations, *United Nations Convention on the Law of the Sea*, Publication no. E97.V10. (United Nations, New York, 1983). See 1833 UNTS 3, opened for signature 10 December 1982. Montego Bay, Jamaica (entered into force 16 November 1994). Also available at: <http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm> (hereinafter "LOSC").

between States which, at the least, can exert a negative influence on bilateral relations and, at the worst, can provide the trigger (or excuse) for military confrontation. Salient examples in the latter category include the Falkland Islands (Islas Malvinas) and South Georgia in the southern Atlantic Ocean,[2] and the Paracel and Spratly Island groups in the South China Sea.[3] The underlying historical and geopolitical dimensions of disputes over islands are frequently highly influential, however. Despite the considerable impacts and influences of globalisation, sovereignty and territory remain powerful forces and States are inextricably linked to their territory. Any potential loss of claimed territory, however slight, can therefore be construed as a threat to a State's sovereignty, security and integrity, especially for domestic political audiences and gain. Profound reserves of patriotism and nationalism are consequently often invested in boundary and territorial disputes. Furthermore, while the territory at stake may be relatively insignificant, possession of it can be invested with significance out of proportion to its apparent intrinsic merits, especially in the context of a historically acrimonious relationship between the parties. Arguably Greece and Turkey's 1996 confrontation over the small islets of Imia (to Greece) or Kardak Rocks (to Turkey) can be seen in this light.[4] A further notable feature of sovereignty disputes over islands is for one (or more) of the parties to a given dispute (often the State in possession of the disputed feature itself) to simply deny that the grounds for a dispute exist and thus, any basis to engage in negotiations on the issue. Frequent assertions that a claimant State's sovereignty over a disputed feature or features is "indisputable" in the context of exchanges over the disputed islands in the South China Sea fits this pattern. For example, in 2009, in response to submissions related to the outer limits of the continental shelf in the South China Sea made to the relevant United Nations body, the Commission on the Limits of the Continental Shelf (CLCS)[5] by Vietnam and

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2 The military conflict between Argentina and the United Kingdom over the Falkland Islands (Islas Malvinas) and South Georgia in 1982 cost the lives of 655 Argentine and 236 British troops. See, for example, P. Armstrong and V. Forbes, *The Falkland Islands and their Adjacent Maritime Area*, Maritime Briefing, Volume 2, no. 3, (Durham, International Boundaries Research Unit, 1997), pp. 4–12.

3 Similarly, in the "Battle of Fiery Cross Reef" between China and Vietnam in March 1988. In this engagement over possession of one of the disputed Spratly Islands 75 Vietnamese personnel were reported to have lost their lives and three Vietnamese ships were set ablaze. Chinese casualties were reported to be slight. See, D.J. Dzurek, *The Spratly Islands: Who's On First?*, Maritime Briefing, Vol. 2, no. 1, (Durham, International Boundaries Research Unit, 1996), p. 23.

4 See, M.A. Pratt and C.H. Schofield, 'The Imia/Kardak Rocks Dispute in the Aegean Sea', 4 *Boundary and Security Bulletin*, No. 1 (Spring 1996), 62–69.

5 The Commission is a body consisting of 21 scientists tasked with evaluating whether coastal States through their submissions have fulfilled the requirements of Article 76 of LOSC. On the basis of this assessment the CLCS makes "recommendations" to the coastal State on the

jointly by Malaysia and Vietnam, China issued a protest note in which it stated that it had "indisputable sovereignty over the islands in the South China Sea." Vietnam responded with a diplomatic note of its own stating that it similarly possessed "indisputable sovereignty" over both the Paracel (Hoang Sa) and Spratly (Truong Sa) Islands.[6]

In respect of the disputes concerning the maritime jurisdictional zones associated with islands, crucially, the second paragraph of Article 121 of LOSC dealing with the regime of islands provides that islands, in an identical fashion to mainland coasts, are capable of generating a full suite of maritime zones (see below). Consequently, even small islands potentially have the capacity to generate huge claims to maritime jurisdictional zones with significant resource/security implications. Critically, if an island had no maritime neighbours within 400nm, it could generate 125,664 sq.nm [431,014km^2] of territorial sea, EEZ and continental shelf rights. In contrast, if deemed a mere "rock" incapable of generating EEZ and continental shelf rights, a territorial sea of 452 sq. nautical miles (1,550km^2) could be claimed.[7]

The vexed issue of distinguishing between types of island is explored below. However, the potential capacity of insular features to act as base points for the claiming of extensive maritime zones goes a long way to explaining both the significance attached to islands and the rise in the number of international disputes involving islands. This is primarily because of the marine resource, both living and non-living that are, or, importantly, are perceived to be, present within the maritime areas that can potentially be claimed from islands. While such living resources tend to be associated with fisheries, and these certainly continue to play a significant food security role for many coastal States (despite increasing rates of stock depletion), other living resource opportunities include those derived from marine genetic resources and these are of increasing importance to coastal States.[8] With regard to non-living resources, focus has traditionally been on seabed hydrocarbon resources (oil and natural gas) and it

basis of which the coastal State can establish limits that are "final and binding" (LOSC, Article 76(8)). See, <http://www.un.org/Depts/los/clcs_new/clcs_home.htm>.

[6] See, Note from the Permanent Mission of the People's Republic of China addressed to the Secretary General of the United Nations, CML/17/2009, 7 May 2009, available at, <http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm>; and, Note from the Permanent Mission of the Socialist Republic of Vietnam to the United Nations addressed to the Secretary General of the United Nations, 86/HC-2009,<http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm>.

[7] It should be noted that these theoretical calculations assume that the island or rock in question has no area. As such features inevitably comprise some territory and therefore area, the potential maritime claims that can be generated from them are likely to be greater.

[8] For example, it has been estimated that marine biotechnology related products were estimated to be worth USD$100 billion in 2000 alone. See, S. Arico and C. Salpin, 'Bioprospecting

is notable in this context that oil production has increasingly shifted offshore.[9] Additionally, disputes concerning and control over certain islands have strategic and security dimensions. For example, the proximity of the contested Spratly Islands in the South China Sea to a strategic waterway of global significance, providing the key maritime link between the Indian Ocean and East Asia, is often cited as an example of this consideration.[10]

The Regime of Islands under International Law

As noted above, the question of the definition of islands is a complex and crucially important one to many coastal States, essentially because of the impact of island status on the capacity of insular features to generate maritime claims and influence the course of maritime boundary delimitation lines. A key consideration is the Regime of Islands outlined in Article 121 of LOSC:

Article 121
Regime of islands

1. *An island is a naturally formed area of land, surrounded by water, which is above water at high tide.*
2. *Except as provided for in paragraph 3, the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf of an island are determined in accordance with the provisions of this convention applicable to other land territory.*
3. *Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf.*

Although the question of the definition of islands has provoked fierce debate over the years, particularly during the drafting of LOSC, the four requirements for a feature to legally qualify as an island under LOSC Article 121(1) are relatively uncontroversial.[11] These insular criteria are that an island must be "naturally formed", be an "area of land", be "surrounded by water" and, critically, must be "above water at high tide".

of Genetic Resources in the Deep Seabed: Scientific, Legal and Policy Aspects', UNU-IAS Report, (United Nations University, 2005), p. 17.

[9] It has been estimated that around 60 per cent of global oil production is now derived from offshore exploration operations. See, "Offshore oil and gas around the World", Ministry of Energy, Mines and Petroleum Resources, Government of British Columbia, available at, <http://www.empr.gov.bc.ca/OG/offshoreoilandgas/Pages/OffshoreOilandGasAroundtheWorld.aspx>.

[10] See, for example, R. Emmers, *Maritime Disputes in the South China Sea: Strategic and Diplomatic Status Quo*, (Institute for Defence and Strategic Studies (IISS) Working Paper No. 87, Singapore, September 2005): pp. 7–9.

[11] J.R.V. Prescott and C.H. Schofield, *The Maritime Political Boundaries of the World* (Leiden/Boston: Martinus Nijhoff Publishers, 2005), pp. 58–61.

However, one of the key issues under debate prior to and during the drafting of LOSC related to island size and habitability. Many proposed that there should be some size limit coupled with the definition of what constitutes an island, such as to prevent each tiny isolated islet, even if permanently above water, from generating maritime claims. Malta, Ireland, a group of 14 African States and Romania all advanced proposals essentially aimed at denying or restricting small insular features from the maritime zones to be accorded to 'full' islands.[12] Contrary views on the part of States such as China, Greece, the United Kingdom and a group of Pacific island States were, however, also strongly voiced.[13] The then-Geographer at the United States Department of State also published a notable study suggesting a categorisation of insular features into rocks (less than .001 square mile in area), islets (.001 and 1 square mile), isles (greater than 1 square mile but not more than 1,000 square miles) and islands (larger than 1,000 square miles).[14]

Ultimately, no size criteria for defining islands were included in LOSC. Concerns over size and habitability were included in the form of Article 121(3) of LOSC states that: "Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf." Rocks therefore represent a disadvantaged sub-category of island whose zone-generative capacity, and thus value to a potential claimant, is significantly reduced. Distinguishing between islands capable of generating EEZ and continental shelf rights and rocks which cannot remains hazardous (see below).

It is worth noting that the regime of islands does not include either artificial islands or low-tide elevations. Artificial islands are dealt with under Article 60 of LOSC, paragraph 8 of which states clearly that artificial islands, together with artificial installations and structures, "do not possess the status of islands," and "have no territorial sea of their own." Artificial islands are also specifically excluded from affecting maritime boundary delimitation.[15] Low-tide elevations, that is, features that are inundated at high tide but emerge above water at low tide, are dealt with under Article 13 of LOSC. Low-tide elevations are not

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[12] See, United Nations, *United Nations Conferences on the Law of the Sea, Official Records, Third Conference*, (Buffalo, New York: William s. Hein & Co., 1980, reprinted 2000). See also, United Nations, Division for Ocean Affairs and the Law of the Sea, *Régime of islands: Legislative history of Part VIII (Article 121) of the United Nations Convention on the Law of the Sea*, (United Nations: New York, 1988); and, S.N. Nandan and S. Rosenne (eds.) *United Nations Convention on the Law of the Sea 1982: A Commentary*, Volume II (Dordrecht: Kluwer Law International, 1993), pp. 321–339.

[13] *Ibid.*

[14] D. Hodgson, *Islands: Normal and Special Circumstances*, (U.S. Department of State, Bureau of Intelligence and Research, Research Study, 1973).

[15] LOSC, Article 60(5) does, however, provide that safety zones of not more than 500 metres may be declared around such artificial islands or installations.

capable of generating claims to maritime space independently. However, if a low-tide elevation falls wholly or partially within the breadth of the territorial sea measured from the normal baseline of a State's mainland or island coasts, it can be used as a territorial sea base point.[16] Incidentally, it remains unclear whether low-tide elevations constitute territory as such and therefore questionable whether they can be subject to a claim to sovereignty.[17]

Distinguishing between Types of Island

Distinguishing between islands capable of generating extended maritime claims and rocks which cannot remains highly problematic. Article 121(3) provokes questions not only as to what constitutes a "rock" but also how to ascertain whether a feature "cannot sustain human habitation" or what constitutes the "economic life" of its own as no definition for these terms is offered in LOSC. The text of Article 121 of LOSC therefore remains opaque and essentially of little help on this issue. There exists no objective way to achieve this based on Article 121 and its supporting drafting history alone. Indeed, rather than providing a useful aid in clarifying interpretation of these provisions, the drafting history of Article 121 instead reveals the scope and depth of the disagreements that were evident during the negotiations on the regime of islands during the Third United Nations Conference on the Law of the Sea (UNCLOS III). States adopted widely divergent views on the issue of islands. These distinct positions led States to propose substantively differing and frequently directly conflicting proposals which tended to reflect particular and opposing national interests.[18]

A review of the considerable scholarly literature that has evolved on this question[19] indicates that no consensus has been reached on key interpretational

[16] LOSC, Article 13(1).

[17] See, *Case Concerning Maritime Delimitation and Territorial Questions between Qatar and Bahrain* (Qatar v. Bahrain) (Merits) [2001] ICJ Rep 40, available at <http://www.icj-cij.org/docket/files/87/7027.pdf>, paras. 205–206; and, *Case concerning Sovereignty over Pedra Branca/Pulau Batu Puteh, Middle Rocks and South Ledge* (Malaysia/Singapore), Judgment of 23 May 2008, available at <www.icj-cij.org/docket/files/130/14492.pdf> (hereinafter, the *Pedra Branca Case*), paras. 295–296. See also, R. Beckman and C.H. Schofield, 'Moving Beyond Disputes over Island Sovereignty: ICJ Decision Sets Stage for Maritime Boundary Delimitation in the Singapore Strait', *Ocean Development and International Law*, 40, 2009, 1, 4.

[18] C.H. Schofield, 'The Trouble with Islands: The Definition and Role of Islands and Rocks in Maritime Boundary Delimitation', in S.-Y. Hong and J.M. Van Dyke (eds.) *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea*, Publications on Ocean Development, Volume 65 (The Hague: Martinus Nijhoff, 2009), pp. 19–37, at pp. 27–28.

[19] See, for example, J.I. Charney, 'Rocks that cannot sustain human habitation', *American Journal of International Law*, 93, no. 4, 1999 863–78; A.G.O. Elferink, (1998) 'Clarifying Article 121 (3) of the Law of the Sea Convention: the limits set by the nature of international legal

questions, notably regarding the question of distinguishing between islands within the meaning of Article 121(1) and rocks in keeping with Article 121(3). Divergent views linger on despite exhaustive analysis of both the text of LOSC and its associated drafting history. This scenario is a direct consequence of the regime of islands having been drafted in an intentionally vague and ambiguous fashion.[20]

Some limited guidance can be gleaned from subsequent practice and jurisprudence. However, this experience is somewhat contradictory and therefore does not offer conclusive guidance. With regard to State practice, the picture is mixed. On one hand Mexico has opted to ignore a group of small and remote features, Roca Alijos, for the purposes of generating continental shelf and EEZ claims in the Pacific Ocean. The United Kingdom has gone a step further and unilaterally reclassified a similarly small and remote feature, Rockall, from the status of an island within the meaning of LOSC Article 121(1) to an Article 121(3) rock and consequently executed a 'roll-back' in its maritime jurisdictional claims from that feature.[21] Other States have, however, taken contrary views and opted to make full 200nm claims (and, in some cases, beyond the 200nm limit in respect of outer continental shelf rights) from frequently remote, uninhabited and small islands. Japan's Okinotorishima represents only one of the more extreme examples of this type of practice.[22] State practice on this issue can therefore be considered confused and conflicting. That said, it can be observed that States in possession of small islands have generally sought to maximise their maritime jurisdiction by advancing expansive maritime claims from such features.

processes', *Boundary and Security Bulletin*, 6, no. 2, 1998 58–68; B. Kwaitkowska and A.H.A. Soons, 'Entitlement to maritime areas of rocks which cannot sustain human habitation or economic life of their own', *Netherlands Yearbook of International Law*, XXI, 1990, 139–81; Prescott and Schofield, *supra* note 11, pp. 61–75; J.M. Van Dyke and R.A. Brooks, 'Uninhabited islands: their impact on the ownership of the oceans' resources', *Ocean Development International Law Journal*, 12, 1983, 265–84; and, J.M. Van Dyke, J. Morgan and J. Gurish, 'The exclusive economic zone of the northwestern Hawaiian Islands: when do uninhabited islands generate an EEZ?, *San Diego Law Review*, 25, no. 3, 1988, 425–494.

[20] Prescott and Schofield, *supra* note 11, p. 58.

[21] House of Commons (HC) *Hansard, Written Answers*, 21 July 1997, cols. 397–398. An identical statement was made in the House of Lords a day later on July 22, 1997 (*Hansard* (HL) *Written Answers*, 22 July 1997, cols. 155–156). Quoted in D.H. Anderson, 'British Accession to the UN Convention on the Law of the Sea', *International and Comparative Law Quarterly*, 46, 1997 761–786, at 778. See also, C.R. Symmons, 'Ireland and the Rockall dispute: an analysis of recent developments', 6 *Boundary and Security Bulletin*, no. 1, 1998, 78–93.

[22] See, for example, Y.H. Song, 'Okinotorishima: A "Rock" or an "Island"? Recent Maritime Boundary Controversy between Japan and Taiwan/China', in: S.Y. Hong and J.M. Van Dyke (eds.) *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea*, Publications on Ocean Development, Volume 65 (The Hague: Martinus Nijhoff, 2009), pp. 145–176.

With regard to the jurisprudence of international courts and tribunals, unfortunately an authoritative interpretation of Article 121 from a body such as the International Court of Justice (ICJ) remains lacking, not least because the ICJ has opted to effectively sidestep the issue. While there were hopes, based on the pleadings of the parties to the *Black Sea Case*, which featured detailed arguments on the interpretation of Article 121 of LOSC, that the ICJ would provide an authoritative ruling on this problematic provision of the UN Convention on the Law of the Sea, this did not eventuate. Rather than addressing the interpretation of Article 121 the Court contented itself with the specific role of the problematic island in question, Serpent's Island,[23] with respect to the delimitation of a maritime boundary between the States involved, Romania and the Ukraine (see below).[24]

Despite this, coastal States and international adjudicative bodies have and continue to be faced with problematic issues related to islands, especially in the context of the delimitation of maritime boundaries. Practical ways in which to deal with islands in the context of the delimitation of maritime boundaries are examined below. It is suggested that this is the 'real' question: what role should islands have in the context of the delimitation of maritime boundaries and what mechanisms are there to overcome the presence of islands in the maritime delimitation scenario. Such an approach arguably offers a more profitable line of inquiry than the sterile debates over whether a particular feature is "an island or a rock" that tend to characterise many maritime disputes involving islands as the latter question is itself an inappropriate and unhelpful one.

The Delimitation of Maritime Boundaries

What, then, are the international law rules applicable to the delimitation of maritime boundaries involving islands, rocks and low-tide elevations? Fundamentally, the LOSC rules, such as they are, that apply to the delimitation of maritime boundaries generally also apply where islands are involved in the delimitation equation.

Wherever the maritime claims of neighbouring States overlap, a potential maritime boundary situation exists. In the context of a maritime boundary

23 Ostrov Zmeinyy (Serpents' Island or Insular Serpilor in Romanian) is a small (0.135km^2) Ukrainian island, located approximately 19 nautical miles from the terminus of the land boundary between the two States on the Black Sea coast. The location of Serpents' Island is such that it could substantially influence a maritime boundary delimitation between the two States on the basis of equidistance.

24 *Case Concerning Maritime Delimitation in the Black Sea* (Romania v. Ukraine), Judgment of 3 February 2009, available at <http://www.icj-cij.org/docket/files/132/14987.pdf>, para. 187 (hereinafter, "*Black Sea Case*").

determined by an international court or tribunal, delimitation depends on applicable international legal principles. These same legal principles are frequently influential in where a maritime boundary is delimited through negotiations between States. However, the States involved have considerable discretion to take into consideration any factor deemed relevant to the negotiation and agree on any boundary line mutually acceptable to the parties involved, so long as the rights of third States are not jeopardised. Accordingly, therefore, it is worth emphasizing that maritime boundary delimitation through negotiations is essentially a political act. While there are clear and essential legal and technical components to the delimitation of maritime boundaries, it is the political component that is crucial.

The provisions of LOSC governing the delimitation of maritime boundaries provide only limited guidance as to how such disputes may be resolved. In relation to the delimitation of the territorial sea, Article 15 of LOSC does offer a clear preference for the use of an equidistance or median line. This does not apply, however, if the States concerned agree to the contrary or there exists an "historic title or other special circumstances" in the area to be delimited which justify a departure from the equidistance line. Under the 1958 Conventions, delimitation of the continental shelf was also to be effected by the use of median lines unless, similarly, an agreement to the contrary or "special circumstances" existed that justified an alternative approach. However, under LOSC there was a distinct shift away from equidistance as a preferred method of maritime delimitation. Articles 74 and 83 of LOSC, dealing with delimitation of the continental shelf and EEZ respectively, merely provide, in identical general terms, that agreements should be reached on the basis of international law in order to achieve "an equitable solution". No preferred method of delimitation is indicated and thus the LOSC's 'rules' on delimitation, such as they are, can be viewed as being open to conflicting interpretation and thus dispute. Indeed, as the Arbitral Tribunal in the Eritrea-Yemen Arbitration stated in reference to the drafting of Article 83, this was "a last minute endeavour… to get agreement on a very controversial matter", and therefore, "consciously designed to decide as little as possible".[25]

In order to achieve delimitation of the continental shelf and/or EEZ in accordance with LOSC, therefore, a theoretically limitless list of potentially relevant circumstances needs to be taken into consideration in the delimitation equation in order to reach the goal of an equitable result. Nonetheless, it has become abundantly clear from the practice of coastal States, allied to the rulings of international courts and tribunals that geography, and particularly

[25] *Eritrea/Yemen Arbitration, Award of the Arbitral Tribunal in the Second Stage of the Proceedings (Maritime Delimitation)*, Award of 17 December 1999, available at, <http://www.pca-cpa.org/showpage.asp?pag_id=1160>, para. 116 (hereinafter, "*Eritrea/Yemen Arbitration*").

coastal geography, has a critical role in the delimitation of maritime boundaries. Aspects of coastal geography that have proved especially influential include the configuration of the coasts under consideration, the relative coastal length and the potential impact of outstanding geographical features, notably islands.[26]

The salient role of coastal geography in maritime boundary delimitation is linked to the widespread use of equidistance lines. While, as noted, there has been a shift away from equidistance as a preferred method of delimitation over time in the law of the sea, not least because in certain circumstances the application of strict equidistance can lead to clearly inequitable results,[27] equidistance has nonetheless proved extremely popular as a basis for maritime boundary delimitation in practice. The construction of equidistance lines offer considerable advantages – if there is agreement on the baselines to be used, there is only one strict equidistance line and this provides the appeal of mathematical certainty and objectivity as well as affording coastal States with the not inconsiderable attraction of jurisdiction over those maritime areas closest to their own coasts. Equidistance lines can also be flexibly applied and may be simplified, adjusted or modified to take specific geographical circumstances into account.[28]

In practice the equidistance method has proved more popular than any alternative method by far and most agreed maritime boundaries are based on some form of equidistance.[29] Consequently, equidistance lines are often constructed at least as a means of assessing a maritime boundary situation or as the starting point for discussions in the context of maritime boundary negotiations. Such lines have also frequently been adopted as the basis for the final delimitation line. Furthermore, it is the case that in recent cases the ICJ's approach has been to construct an equidistance line as a provisional delimitation line in the first instance. Indeed, in its, at the time of writing, most recent judgment, that in the *Black Sea Case* between Romania and Ukraine, the Court was explicit in stating that "[i]n keeping with its settled jurisprudence on maritime delimitation", a provisional delimitation line should be established consisting of an equidistance line "unless there are compelling reasons that make this unfeasible

[26] Prescott and Schofield *supra* note 11, pp. 221–2.

[27] Notable as a consequence of the North Sea Continental Shelf Cases. See, *North Sea Continental Shelf (Federal Republic of Germany/Denmark; Federal Republic of Germany/Netherlands) (1967–1969)*, Judgment of 20 February 1969, [1969] ICJ Reports, 3, at para. 89 and 101.

[28] C.M. Carleton and C.H. Schofield, *Developments in the Technical Determination of Maritime Space: Delimitation, Dispute Resolution, Geographical Information Systems and the Role of the Technical Expert*, Maritime Briefing, Volume 3, no. 4 (Durham: International Boundaries Research Unit, 2002), pp. 7–31; L. Legault and B. Hankey, (1993) 'Method, Oppositeness and Adjacency, and Proportionality in Maritime Boundary Delimitation', in: J.I. Charney and L.M. Alexander (eds.), *International Maritime Boundaries*, Vol. I (Dordrecht: Martinus Nijhoff, 1993), pp. 203–242; Prescott and Schofield, *supra* note 11, p. 236.

[29] Legault and Hankey *supra* note 18, p. 205; and, Prescott and Schofield *supra* note 11, p. 239.

in the particular case".[30] The ICJ's practice has then been to determine whether there exist any reasons to modify the provisional equidistance line in order to achieve an equitable result.[31]

The Role of Islands in Maritime Boundary Delimitation

The treatment of islands in the context of maritime boundary delimitation inevitably represents a developing area in terms of the practice of States given that less than half of potential maritime boundaries globally have been even partially delimited.[32] Nonetheless, there exists abundant experience regarding the treatment of islands in the delimitation of maritime boundaries. Contentious and seemingly intractable island-related disputes are often why coastal States seek third-party means of dispute settlement. This has, in turn, led international courts and tribunals to develop a number of mechanisms to deal with this scenario, even if an authoritative ruling on the interpretation of Article 121(3) has been lacking. Similarly, in negotiating bilateral maritime boundary agreements, States have faced analogous challenges and adopted numerous and diverse solutions to the potential problems posed by the presence of islands in the area to be delimited. Such approaches include, for example, affording islands reduced weight in the construction of equidistance lines or partially or wholly enclaving them.

A review of both State practice and the rulings of international courts and tribunals suggests several key means of addressing the challenge of dealing with islands in maritime delimitation. These approaches range from awarding all features, including small offshore islands, full effect on the maritime boundary delimitation line, applying partial effect to islands, enclaving or partially enclaving islands or, alternatively to wholly ignoring islands in the selection of base points relevant to the construction of the delimitation line.

Although definitive conclusions regarding the treatment of islands in the delimitation of maritime boundaries remain elusive, there has been a sustained trend in international jurisprudence towards awarding small islands a reduced effect in maritime boundary delimitation. This has proved to be especially the case where such islands are located at a considerable distance offshore and opposed to mainland coasts such that a great disparity in relevant coastlines is evident. Such features would tend to have a disproportionate impact on the construction of an equidistance-based boundary line. Consequently, the potential influence of such exceptional features on maritime boundary delimitation

[30] *Black Sea Case Case*, para. 116.

[31] Prescott and Schofield *supra* note 11, pp. 240–241.

[32] *Ibid.*, pp. 217–218.

lines has generally been discounted. Thus islands were awarded a reduced effect in the *Libya/Malta*[33] and *Jan Mayen*[34] *Cases*, half effect was accorded to the Isles of Scilly in the *Channel Arbitration*,[35] to the Kerkennah Islands in the *Libya/Tunisia Case*[36] and to Seal Island in the *Gulf of Maine Case*.[37] Moreover, the Channel Islands were enclaved in the *Anglo-French Arbitration*,[38] while the Hanish Islands were in effect semi-enclaved in the *Eritrea/Yemen Arbitration*[39] and arguably St Pierre and Miquelon were semi-enclaved in the *Canada/France Case*.[40] Furthermore, islands have, on occasion, been entirely ignored for the purpose of constructing the maritime boundary delimitation line, for instance in the context of the *Gulf of Maine Case* where numerous small islets and low-tide elevations were ignored,[41] in the *Eritrea/Yemen Arbitration* where isolated islands had no influence on the delimitation line[42] and in the *Qatar/Bahrain Case* where a potentially influential small island, Qit'at Jaradah, was discounted.[43] Similarly, Serpents' Island was deemed inappropriate for use as a base point in the construction of a provisional equidistance-based boundary line in the *Black Sea Case*.[44]

In contrast, where numerous islands which in combination have a long coastal front are located in relatively close proximity to a mainland coast such that they can be considered to be representative of the general configuration of the mainland coast or effectively geographically integrated with it, there is a tendency to accord such islands full weight in maritime delimitation. A salient

33 *Case Concerning the Continental Shelf* (Libyan Arab Jamahiriya/Malta), [1985] *ICJ Reports* 13, para. 73.

34 *Case Concerning Maritime Delimitation in the Area between Greenland and Jan Mayen (Denmark v. Norway)*, [1993] *ICJ Reports* 38, paras. 61–69.

35 *Arbitration between the United Kingdom and France on the Delimitation of the Continental Shelf*, Decision of 30 June 1977, *International Legal Materials*, Volume XVIII (1979): 3–129 (hereinafter, "*Anglo-French Arbitration*").

36 *Case Concerning the Continental Shelf* (Libyan Arab Jamahiriya/Tunisia), [1982] *ICJ Reports* 18, para. 129.

37 *Delimitation of the Maritime Boundary in the Gulf of Maine Area* (Canada v. United States), [1984] *ICJ Reports* 246 (hereinafter, "*Gulf of Maine Case*"), para 218.

38 *Anglo-French Arbitration*, para. 199.

39 *Eritrea/Yemen Arbitration*, paras. 154–162.

40 *Delimitation of the Maritime Areas between France and Canada*, Decision of 10 June 1992, 31 *International Legal Materials*, Volume 31 (1992): 1149. See also, T. McDorman, 'The Canada-France Maritime Boundary Case: Drawing a Line around St. Pierre and Miquelon', *American Journal of International Law*, 84, 1990, 157–189.

41 *Gulf of Maine Case*, para. 210.

42 *Eritrea/Yemen Arbitration*, paras. 147–148.

43 *Case concerning Maritime Delimitation and Territorial Questions between Qatar and Bahrain* (Qatar v. Bahrain), [2001] *ICJ Reports* 40, para. 219.

44 *Black Sea Case*, para. 149.

example of this type of scenario is provided by the Tribunal's treatment of the Dahlak archipelago in the Eritrea/Yemen Arbitration.[45]

As noted above, there are therefore numerous examples of islands being accorded a reduced effect, being partially or wholly enclaved or even being ignored altogether. State practice is diverse, and there have been cases of even extremely small features being accorded considerable effect in the delimitation of maritime boundaries. Nonetheless, these examples in State practice appear to be more the exception than the rule and the general trend in State practice in the treatment of islands appears to be toward giving islands a reduced effect. This is especially the case in respect of smaller, less significant (in terms of coastal front, area and population for instance) islands located at considerable distances offshore mainland coasts, as these features would be likely to have the most excessive and disproportionate impacts on potential delimitation lines were they to be granted full effect.

Implications for Insular Status

International courts and tribunals have tended to address the potentially disproportionate effect of particular, outstanding coastal geographical features, frequently islands, by according them reduced effect on the final delimitation line. This is often achieved by constructing strict equidistance lines and then modifying the line so as to give the feature concerned only partial effect. Alternatively, outstanding geographical features such as islands that would unduly influence an equidistance line may be ignored and not used as base points for construction of the equidistance-based boundary line, as was the case for Serpents' Island in the *Black Sea Case*.

Where these maritime delimitations involve the continental shelf and EEZ, this necessarily implies that the court or tribunal concerned has taken the view that the feature in question is an island within the meaning of LOSC, Article 121(1) rather than a rock in accordance with LOSC, Article 121(3). Islands that fall into this category include the Isles of Scilly belonging to the United Kingdom, Tunisia's Kerkennah Islands, Canada's Seal Island, France's St. Pierre and Miquelon Islands, Norway's Jan Mayen Island, and the islands of the Dahlak archipelago. Perhaps of particular significance in this context are those islands located at a considerable distance offshore such as the Isles of Scilly, St. Pierre and Miquelon and Jan Mayen. Whilst the Isles of Scilly and St. Pierre and Miquelon have fairly substantial populations (numbering in the thousands of people) of longstanding, it can be observed that Jan Mayen does

45 *Eritrea/Yemen Arbitration*, paras. 139–146.

not, boasting only personnel stationed there to man a scientific research station. It is also notable that Jan Mayen is a mere 377km² in area as compared with Greenland's area of 2,166,086km².[46] The disparity between the lengths of the relevant coastal fronts of the two islands was also significant (9.2:1 in Greenland's favour).[47] This decision seems to run somewhat counter to the trend, even if Jan Mayen was accorded a reduced effect, largely on the basis of the great disparity in relevant coasts, in delimiting the maritime boundary line between Denmark (Greenland) and Norway (Jan Mayen).

In the context of the above-mentioned cases a number of insular features have also been accorded no weight in maritime delimitation beyond the territorial sea. It is, however, less easy to draw clear implications and conclusions from these findings, at least as far as Article 121 of LOSC is concerned. This is because the islands in question may have been given no weight in the construction of the relevant continental shelf or EEZ delimitation line for reasons other than their not qualifying as islands capable of continental shelf or EEZ claims. For example, islands are frequently discounted or ignored in the delimitation of maritime boundaries where their geographical position is such that taking them into account in the construction of a strict equidistance line-based boundary would lead to an inequitable result, rather than because such features are mere rocks within the meaning of LOSC, Article 121(3). It is the case that an international court or tribunal has yet to specifically discount an island on the basis that it is a "rock" within the meaning of Article 121(3) of LOSC.

The Value of Precedents from Case Law and State Practice

The value of the above experience in terms of precedents for yet to be delimited maritime boundaries and the treatment of islands is questionable. Strictly speaking, the arbitral and judicial decisions are only binding on the parties to the particular case and each case features its own particular facts and circumstances. Nonetheless, the decisions of the ICJ and *ad hoc* international arbitration tribunals are clearly influential – as demonstrated by the written and oral pleadings which are replete with references to past cases and judgments in support of either side's arguments. According to one eminent commentator, the rulings of such international courts and tribunals "carry special weight in international maritime boundary law" largely because of the "relative scarcity

[46] Area figures according to the CIA World Factbook, 2011. See <https://www.cia.gov/library/publications/the-world-factbook/geos/gl.html>. and <https://www.cia.gov/library/publications/the-world-factbook/geos/jn.html>.

[47] *Jan Mayen Case*, para. 61.

of authoritative pronouncements."[48] The same author goes on to observe that there are two key reasons for this: first, the existence of "a unique line of jurisprudence" stemming from a continuing series of decisions and, second, "the absence of clearer guidance from codification efforts, *opinion juris* and state practice,"[49] such that:

> *Even though there is no doctrine of stare decisis in international adjudication, it is not inaccurate to consider the impressive line of maritime boundary decisions as forming a common law in the classic sense.*[50]

The decisions of international courts and tribunals are capable of comparison and are likely to hold more value as potential precedents. In contrast, negotiated maritime boundary agreements frequently do not indicate the rules or principles on which they are based and, therefore, it is often unclear whether other factors, such as, for example, political or economic considerations unrelated to the delimitation question may have come into play: "While the Court and arbitration tribunals are required to apply the law, coastal states have greater latitude when fashioning voluntary settlements."[51] Consequently, State practice should be treated with caution with regard to its precedential value. While this is the case, State practice can, nonetheless, be helpful in providing examples of what the parties to a particular agreement have deemed to be an equitable result and this can be useful in the context of maritime boundary delimitation negotiations.

Practical Implications

What, then, are the implications arising from the foregoing analysis? That is, what are coastal States to do when faced with the prospect of delimiting maritime boundaries with neighbouring States where islands are present in the delimitation equation?

The practice in the delimitation of maritime boundaries generally indicates that application of the equidistance method has proved significantly more popular as the basis for international maritime boundary agreements over time.[52] As geometrically exact expressions of the midline concept, equidistance lines

[48] J.I. Charney, 'Progress in International Maritime Boundary Delimitation Law', *American Journal of International Law*, 88 (1994), p. 227.

[49] *Ibid.*: 227–228.

[50] *Ibid.*: 228.

[51] *Ibid.*

[52] Prescott and Schofield, *supra* note 11, p. 238.

offer objectivity, mathematical precision and, assuming agreement exists with regard to relevant baselines, lack of ambiguity.[53] This is especially the case for delimitations between opposite coasts where equidistance-based solutions represent the dominant approach to an overwhelming degree.[54]

Inevitably, in the construction of equidistance lines issues related to baselines, base points and thus coastal geography, including islands, become critical in the delimitation equation.[55] In this context, the question of how outstanding geographical features, such as islands significantly far offshore, are treated is one of the most contentious issues in maritime boundary delimitation and has given rise to numerous maritime boundary disputes. As previously discussed, a 'fully-fledged' island may generate the full suite of maritime zones known to the international law of the sea, and consequently such a feature may be crucial to a State's claims to maritime jurisdiction and position regarding maritime boundary delimitation with neighbouring States.

However, even if a feature can be categorised as a fully-fledged island under law of the sea rules, it must be borne in mind that islands are not always accorded 'full effect' in maritime boundary delimitations – achieved either through negotiations or with third-party assistance. Equidistance lines can, therefore, be flexibly applied to deal with the disproportionate effect of particular geographical features. Indeed, as demonstrated, there are numerous examples of State practice and case precedents where islands have received a substantially discounted or reduced effect, been partially or wholly enclaved or even completely ignored.

With regard to the role of insular features of differing types in maritime boundary delimitation it is, however, worth emphasising that lack of certainty over the interpretation of LOSC Article 121 has led to diverse and, on occasion, contradictory State practice. Thus, in some instances extremely small insular features have been accorded a full role in the delimitation of continental shelf and EEZ rights, whilst in others substantial, populated islands have been given a partial or reduced effect.

53 *Ibid.*, at 236.

54 Equidistance based delimitation lines provide 89 percent of delimited maritime boundaries with an opposite coastal relationship. *Ibid.*, at 238. See also Legault and Hankey, *supra* note 18, pp. 203–242.

55 Prescott and Schofield, *supra* note 11, pp. 215–244 and 248–252. See also Legault and Hankey, *supra* note 18, pp. 203–242.

In a number of instances relatively large islands home to substantial populations (for instance the UK's Channel Islands[56] and Isles of Scilly)[57] have been accorded a reduced effect in the delimitation of the maritime boundaries. This variety in the treatment of islands could be considered unhelpfully inconsistent. Alternatively, this can be viewed as illustrating the flexibility with which the equidistance methodology can be applied.

Of particular note is the fact that islands are often accorded a reduced effect in maritime boundary delimitation in recognition of a disparity in the relevant coastal lengths of the coastlines involved, for example between a small island and a mainland coastline, and the consequent disproportionate impact an island may have on the construction of a strict equidistance line. In light of this considerable experience in terms of maritime boundary delimitation and the general but not comprehensive trend towards according islands a reduced impact on determining the course of maritime boundary delimitation lines, there are therefore strong reasons to doubt that small, isolated insular features, with restricted coastal fronts, would be awarded full effect in a delimitation against large island or mainland coastlines. It follows therefore, that the maritime jurisdictional claims often associated with small islands, frequently according these features full effect in the definition of strict equidistance lines, are often significantly overstated.

Concluding Thoughts

The practice of international courts and tribunals, when reviewed, suggests that a sustained trend is emerging towards awarding islands a significantly reduced effect with respect to maritime delimitation. This has proved to be especially the case where such islands are located at a considerable distance offshore and opposed to mainland coasts such that a great disparity in relevant coastlines is evident. Such features would tend to have a disproportionate impact on the construction of an equidistance-based boundary line. Consequently, the potential influence of such exceptional features on maritime boundary delimitation lines has generally been discounted. These decisions arguably offer more value

[56] Taken as a whole, the Channel Islands total area is approximately 130,000km^2 with a combined total population of approximately 150,000 people. The populations of the inhabited islands are approximately as follows: Jersey (87,000), Guernsey (60,000), Alderney (2,400), and Sark (600). See <www.jersey.com>; <www.gov.gg/ccm/portal>; <www.alderney.gov.gg>; and, <www.sark.gov.gg>.

[57] The Isles of Scilly comprise five inhabited islands and around 140 small rocky islets totalling approximately 16km^2, with a total population of around 2,000 people. See, <www.scillyonline.co.uk>.

as precedents applicable to yet to be delimited maritime boundaries since they base their rulings squarely on the relevant international law.

State practice is more diverse and it is worth noting that in the context of negotiations the States concerned are merely required under international law to negotiate in good faith and may give weight to any factor and decide on any line they choose between them as long as third State rights are not infringed and this may lead to political trade-offs impacting on the delimitation line.[58] State practice regarding islands includes cases of even extremely small features being accorded considerable effect in the delimitation of maritime boundaries. Nonetheless, these examples in State practice are the exception than the rule and the general trend in State practice in the treatment of islands appears to be toward giving islands a reduced effect.

Overall the above review and assessment of international jurisprudence and State practice on the issue of the treatment of islands in the delimitation of maritime boundaries demonstrates that past practice is replete with examples of how islands can be effectively dealt with in the delimitation of maritime boundaries between neighbouring States. Ultimately, however, political will is crucial, especially in the context of maritime boundary delimitation negotiations. Unless one or more of the parties to a dispute over the insular status of a particular feature possesses the political will to compromise in the course of negotiations, deadlock will inevitably occur.

Arguably, therefore, the frequent preoccupation of disputing States with the island/rock conundrum represents a misleading distraction from the critical issue, that is, the role of islands in the delimitation of maritime boundaries. In practice, the concerns that States expressed at UNCLOS III on the potential disproportionate and inequitable effects of small islands on maritime boundary delimitations have been addressed both in the decisions of international courts and tribunals and in the practice of States. These developments offer the enticing prospect of the emergence of increasingly clear trends and approaches regarding the treatment of islands in maritime boundary delimitation. This, in turn, has the potential to assist in the resolution of multiple maritime disputes between States.

[58] B.H. Oxman, 'Political, Strategic, and Historical Considerations', in: J.I. Charney and L.M. Alexander (eds.) *International Maritime Boundaries*, Vol. I (Dordrecht: Martinus Nijhoff, 1993), pp. 2–40, at pp. 11–12; Prescott and Schofield, *supra* note 11, p. 223.

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Clive Schofield, "Island Disputes and the 'Oil Factor' in the South China Sea Disputes", *Current Intelligence*, Vol. 4, No. 4 (2012)

ISLAND DISPUTES AND THE 'OIL FACTOR' IN THE SOUTH CHINA SEA

by Clive Schofield

THE SOUTH CHINA SEA has long been regarded as one of the key potential flashpoints for conflict in the Asia-Pacific, alongside North Korea and Taiwan. Recently tensions have been on the rise and relations between China and the other South China Sea littoral states have become more fraught – characterised not only by diplomatic claim and counter-claim (though frequently framed in less than diplomatic language) but also, more worryingly, by confrontations at sea.

Context, as they say, is everything. This article briefly outlines geopolitical drivers that sustain these complex and seemingly intractable disputes, and seeks to shed light on their international legal dimensions. It suggests that China in particular has been driven to adopt extreme positions in order to secure access to what Beijing tends to regard as its proper share of the resources, especially seabed energy reserves, of the South China Sea. However, such resources may not, in fact, prove to be the kind of panacea for regional energy security concerns that they are sometimes perceived to represent. Nonetheless, if present trends are sustained, further incidents are highly likely. Before proceeding to assessment of those issues, a brief consideration of the disputed South China Sea islands is in order.

Dangerous Ground

The South China Sea disputes tend to focus on possession of several groups of islands, sovereignty over which is contested among multiple claimants. Remarkably, for all of the attention devoted to the disputed South China Sea islands over the years, some uncertainty remains over their geographical characteristics.

Looking at a map of the region, the key island groups in the South China Sea are, clockwise from the northwest: the Paracel Islands (disputed between China and Vietnam), the Pratas Islands (administered by Taiwan but, inevitably, claimed by China also), Scarborough Reef (or Shoal) together with Macclesfield Bank (contested between China and the Philippines) and the Spratly Islands group (see Figure 1). The Spratly Islands are claimed in whole or in part by no few than six states or entities (in the case of Taiwan) – Brunei, China, Malaysia, the Philippines, Taiwan and Vietnam. With the exception of Brunei, all of these claimant states occupy and garrison at least one of the disputed features.

Accordingly, the Spratlys Islands represent the primary point of contention among the South China Sea littoral states. The Spratlys group comprises around 150-170 islands, islets, rocks, reefs, shoals and low-tide elevations. That different authors offer different figures regarding precisely how many Spratly Islands there in fact are, is testament to the bewilderingly varied character and types of insular features in question. This complexity has tended to lead to disagreement over which features to count, resulting in different figures. The Spratlys also have different names in multiple languages, including Chinese, English, French, Malay, Filipino and Vietnamese as well as variants within these languages, adding a further problematic dimension to the equation. For convenience this essay refers to the most commonly used English names of local features.

The Spratly Islands are uniformly small, isolated and uninhabited save for garrisons of occupying troops and government personnel. The tiny dimensions of the Spratly Islands is underscored by the fact that the largest, Itu Aba (Taiping Island), occupied by Taiwan, is a mere 1.4km long and 370m wide, with an area of approximately 50 hectares. Indeed, a review of hydrographic records suggests that as few as 36 of the Spratly "Islands" are actually above water at high tide. Collectively these features have an estimated total area of less than 8km2 (3 sq. miles) scattered over approximately 240,000km2 of the southern South China Sea (Figure 1).

The Spratly Islands are therefore almost vanishingly small specks of territory, in a broad swath of ocean space semi-enclosed by the surrounding mainland and main island coastlines of the littoral states. Indeed, for most of their history the Spratlys have been known as places to avoid because of the dire threat to the safety of navigation that they pose, rather than as the highly desirable real estate that they have become. This is well illustrated by the fact that on British Admiralty charting, the area now commonly known as the Spratly Islands group has traditionally, and aptly, been labelled "Dangerous Ground".

All the more remarkable, then, that these seemingly insignificant and intrinsically worthless features are the cause of such angst in regional relations.

What's at Stake?

As at least some of the Spratly Islands are indeed above water at high tide, they constitute land territory, no matter how small, that can be subject to sovereignty claims on the part of surrounding coastal states. Such territorial claims are notoriously hard to reach compromise on as they instantly engage with a core state interest: safeguarding territorial integrity. Such disputes are readily hijacked by nationalists, leaving extremely limited leeway for dispute resolution – a situation that, arguably, works to the advantage of governments keen to bolster legitimacy and popularity and prepared to do so by appearing firm on territorial and border issues.

The Spratly Islands are located in close proximity to sea lanes which are vital to the generally resource-poor and thus import-dependent major economies of East and Northeast Asia. In particular the South China Sea forms an important part of the sea lane of communication (SLOC) carrying seaborne energy supplies from the Middle East, Africa and Australia. The military significance of the installations on the Spratlys has also been touted in this context. That said, shipping tends to avoid rather than sail through the disputed islands, which remain hazards for navigation. The military worth of small bands of troops garrisoned on the disputed islands is also militarily questionable save perhaps for their role as listening posts.

It is noticeable, however, that many sovereignty disputes over small, sparsely inhabited and far-flung islands, including those of the South China Sea, have only manifested themselves in the post-World War II period, as extended claims to maritime jurisdiction became more prevalent. That such tiny features may have the potential to provide the basis for broad maritime claims offers a seductive additional dimension to the sovereignty disputes over them. This is particularly the case given strong, though not necessarily well-founded, presumptions that the ocean spaces associated with these disputed features contain valuable marine resources, especially seabed energy resources.

Two factors suggest that the ‘oil factor’ in the South China Sea disputes tend to be overplayed. The first of these relates to the international legal status of the disputed islands –and thus their capacity to generate extensive maritime claims or significantly influence the course of future maritime boundaries in the South China Sea. The second concerns the existence (or non-existence) of South China Sea hydrocarbon resources themselves, and their likely impact on the regional energy security picture.

When is an island a Rock?

The islands are often regarded as the key to the South China Sea disputes, not only because the disagreements represent the primary source of contention among the littoral states but also because they are viewed as having the potential to generate extensive claims to maritime jurisdiction and thus offer access to a significant prize in terms of marine resources. Such broad maritime claims would, however, only result if the disputed features were actually capable of generating such extensive maritime claims and, crucially, were awarded full weight in the delimitation of future maritime boundaries in the South China Sea. Both of these propositions are open to question.

All of the South China Sea states with the exception of non-UN member Taiwan are parties to the United Nations Convention on the Law of the Sea (UNCLOS). Article 121 of the Convention articulates the “regime of islands” in international oceans law. In accordance with UNCLOS an island is defined as “a naturally formed area of land, surrounded by water, which is above water at high tide”. In principle the maritime claims made from islands should be determined in the same manner as for “other land territory”. Islands can therefore be used as the basis for advancing claims to a 12 nautical mile broad territorial sea as well as continental shelf and exclusive economic zone (EEZ) rights out to 200 nautical miles.

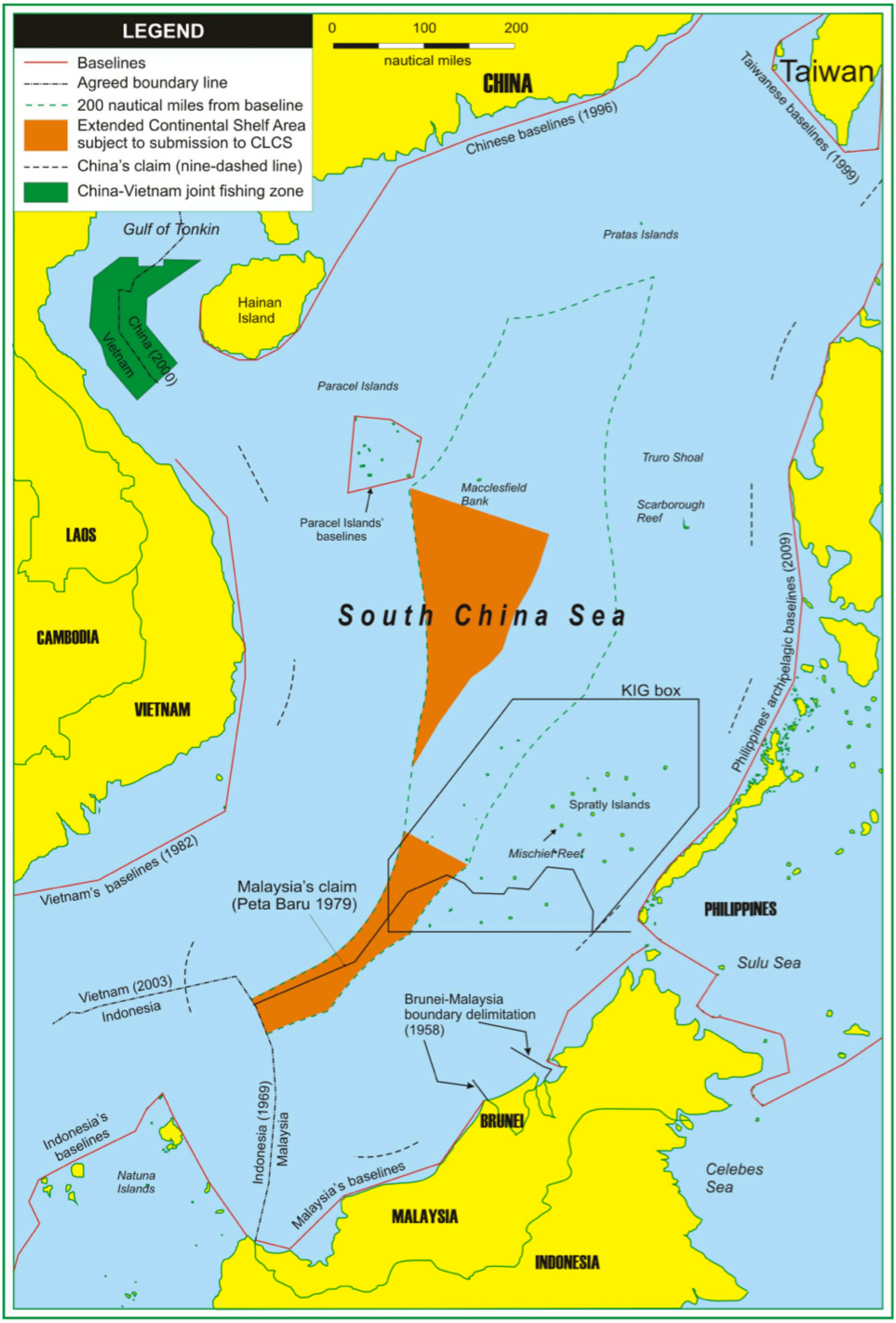
There is an exception to the rule, however. Article 121, paragraph 3 provides for a disadvantaged sub-category of islands, formally termed “rocks”, that are incapable of supporting human habitation or an economic life of their own. Such features “shall have no exclusive economic zone or continental shelf”. This represents an enormous disadvantage in terms of capacity to generate claims to maritime jurisdiction. Thus, if an island had no maritime neighbours within 400nm, it could generate 125,664 sq.nm [431,014km2] of territorial sea, EEZ and continental shelf rights as compared to the capacity of a “rock” to generate a territorial sea claim of 452 sq. nautical miles (1,550km2).

Great volumes of academic ink have been expended in the quest for clear distinctions between islands, capable of generating continental shelf and EEZ rights, and mere rocks, which cannot. To little avail. Such efforts have proved futile, as Article 121, paragraph 3 was drafted in a deliberately ambiguous manner in order to satisfy competing, indeed diametrically opposed, positions and interests among the drafters of UNCLOS. This provision of the Convention is, as a result, open to radically differing interpretations in order to enable consensus on a particularly controversial issue.

Clearly at least some of the disputed features of the Spratly Islands remain above water at high tide. At first glance many of these would, however, seem to most readily fit the description of rocks. There is, though, no way to be conclusive on this point because Article 121 of UNCLOS lacks an objective test. Some of the claimant states, notably Malaysia and Vietnam, have indicated that they are of the view that the disputed islands should be treated as rocks and therefore generate territorial seas of no more than 12 nautical miles. If all the claimant states were to accept this position, the maritime area in dispute would shrink significantly. It is clear, however, that China does not agree. It has stated in explicit terms that it not only possesses “indisputable” sovereignty over the disputed islands (despite the palpable reality that such disputes do indeed exist), but also that the islands are capable of generating the full suite of maritime zones, including EEZ and continental shelf rights.

Even if at least some of the Spratly Islands are, in fact, capable of generating EEZ and continental shelf claims, there is

Figure 1: Competing Maritime Claims in the South China Sea



Source: Adapted from Schofield, C.H., Townsend-Gault, I., Djalal, H., Storey, I., Miller, M. and Cook, T. (2011) *From Disputed Waters to Seas of Opportunity: Overcoming Barriers to Maritime Cooperation in East and Southeast Asia*, National Bureau of Asian Research Special Report No.30, July 2011, p.5.

little reason to anticipate that they would necessarily give rise to jurisdiction over broad maritime spaces on behalf of whichever coastal state is ultimately deemed to hold sovereignty over them. The putative delimitation of maritime boundaries is between small, isolated features among the Spratly Islands, on the one hand, and the long mainland and main island coasts surrounding them, on the other.

There is significant disparity in the length of relevant coasts under such a scenario. It is highly unlikely that the disputed islands would be accorded full effect in the delimitation of a maritime boundary. Indeed, there is a growing trend internationally of small islands, especially those that are remote, sparsely inhabited or completely uninhabited, and which possess restricted coastal fronts, being awarded only limited impact on their respective maritime boundaries. Instead, they have often been awarded only territorial sea rights as though they were indeed mere rocks.

Temptations and illusions: the "Oil Factor" in the South China Sea

There is a strong, long-standing perception of the South China Sea as a major potential repository of seabed oil and gas resources. It is a view not well supported by evidence. The South China Sea's reputation as an oil rich region arises in part from a fervent desire on the part of interested parties for this to be the case, and tends to be perpetuated through misinterpretation of oil reporting terminology and a general lack of reliable data.

All of the South China Sea states face increasing energy security concerns. The rapid industrialisation of East and Southeast Asian economies has led to sharp, and ongoing, increases in demand for natural gas and petroleum-derived products. At the same time many of the countries concerned are facing stagnating or declining domestic oil and gas production leading to growing reliance on imported energy resources to meet the gap between supply and demand. Of the six direct parties to the South China Sea islands disputes, China, the Philippines and Taiwan are already strong net importers of oil while Malaysia and Vietnam are on the cusp of becoming net importers. While Brunei Darussalam remains a net exporter of oil, on a global or even regional scale it is not a major player. Enhanced energy security concerns have created a compelling incentive for these states to seek sources of supply 'close to home'. This has made claimants extremely reluctant to concede any potential source of supply falling within the scope of their own potential jurisdiction, such as may underlie disputed parts of the South China Sea.

Estimates of the hydrocarbons resource potential of the South China Sea vary wildly. As a direct consequence of the existence of the island disputes and overlapping maritime claims, very little exploration work, such as 3D seismic surveys or exploratory drilling, has been undertaken. As a result, estimates tend to be restricted to geology-based assessment methodologies, and are necessarily highly speculative – something that helps to explain why such estimates vary so much. Geology-based assessments have their limitations, but can offer useful guidance. In particular, they can indicate areas where it is highly unlikely that oil and gas will be found, such as the broad swath of the central South China Sea to the north of the Spratly Islands, which is underlain with oceanic crust. There are key geological 'play elements' necessary for the formation of oil reservoirs: the presence of a highly porous and permeable sedimentary reservoir, organic rich source rock, and a low permeability seal or capping rock. While these geological conditions are required for oil to be present, they offer no guarantee that oil will, in fact, be found. There are several areas of the southern South China Sea which are geologically most attractive and apparently prospective. These include the peripheral parts of the South China Sea where sediment thicknesses are generally greater, localised areas of favourably thick tertiary sediments to the East of the Spratly Islands group (e.g. the Reed Tablemount), and some relatively thick sediments distributed over areas to the Southeast and West.

Crucially, estimates also tend to be loosely defined, often as a consequence of poor understandings of proper oil reporting terminology. In particular there is frequently a lack of distinction between estimates of resources versus estimates of reserves. Resource estimates, are estimates of the volume of oil in situ in the ground. Reserve estimates are the proportion of the resource that can be recovered in light of technical feasibility and market price. For example, for a frontier field a reserve estimate may equate to only around 10 per cent of the overall resource estimate. Many estimates also fail to distinguish between the hydrocarbon resource types (conventional oil, unconventional oil, natural gas, gas hydrates) under discussion. All of these factors lead to confusion and tend to inflate the potential significance of South China Sea seabed energy resources.

In this context it is worth noting that the South China Sea is generally considered to be predominantly gas-prone. While the region's oil resources remain a speculative quantity, East and Southeast Asian states are, in fact, comparatively rich in gas resources.. But there are considerable limitations on the potential for gas to be used as a substitute for oil, and there are significant transportation challenges associated with recovery and movement of gas deposits. In combination these factors undermine the business case for the development of South China Sea hydrocarbons resources. This is especially so for gas resources in light of declining gas prices globally, at least in part as a consequence of the ongoing rise of shale gas. Finally, the considerable time lag between discovery and delivery of "first oil" has to be factored in, This is yet another complicating element that has to be balanced against the realities of seabed energy resources and a political context governed by seemingly intractable multilateral disputes over ownership, and escalating regional energy security concerns. Governments and investors alike should therefore treat with a healthy degree of caution any suggestion that the South China Sea is "oil rich" or that it may even represent "the next Middle East".

A Hard Place...

In recent times Chinese maritime surveillance and enforcement agencies have undertaken a number of troubling activities in waters close to the coasts of Indonesia, Malaysia, the Philippines and Vietnam. These have included enforcement activities related to fisheries jurisdiction, as has been done with respect to waters that Indonesia considers part of its EEZ, as well as interventions to disrupt Malaysian, Philippine and Vietnamese oil and gas survey and exploration activities in those states' respective coastal waters. Further, in June 2012 the China National Offshore Oil Corporation (CNOOC) issued tenders for oil concessions in close proximity to the Vietnamese coastline.

All of these interventions and incidents have taken place in waters closer to the mainlands (or main islands) of the surrounding coastal states than to the disputed South China Sea Islands.

Even the provision of "maximum effect" – the claim to maritime zones based on the construction of a strict, equidistant line between the surrounding mainland coasts and the disputed islands – would be inadequate (and dubious) justification for Chinese enforcement activities. Instead, for all of its repeated assertions that its claims are "clear" and "indisputable", China's actions appear to be sustained only by questionable historical claims. The most notable example of this is its infamous nine-dashed line claim, the exact meaning of which has never been officially explained and remains opaque; it is now depicted graphically as a map embedded in Chinese passports, much to the chagrin of neighbouring South China Sea states.

Arguably China has been driven to adopt these positions, the "hard place" alluded to in the opening lines of this article, in order to sustain claims to the more prospective parts of the South China Sea: areas in the vicinity of the islands themselves, and peripheral parts of the Sea in close proximity to the shorelines of other South China Sea states, where substantial depths of sediment (and therefore oil) exist. China's increasingly pressing energy security concerns provide a backdrop and strong incentive in this regard. Further drivers underlying China's position are its long held sense that it has been poorly served by predominantly Western-inspired international law and treaty relations, as well as frustration that despite its own long coastline, China's maritime claims are constrained and hemmed in by its regional neighbours and their competing claims. In contrast, the other South China Sea claimants fundamentally reject any Chinese claim to what they regard as their rightful offshore, coastal maritime spaces. These states appear intent on exploiting the resources that their adjacent waters may offer, not least because they face their own energy security imperatives. In light of China's increasing propensity to flex its new-found maritime muscles in precisely these same areas, the scene appears set for further frictions and confrontations in the Sea, especially over access to marine resources.

ECONOMIC NATIONALISM IN ASIA

by Kit Dawnay

NATIONALISM (rarely low) is up in Asia. Disputes over islands, fisheries, oilfields, visits to shrines and even national dances are the current mainstay of regional press coverage. Manifestations of patriotism in Asia are nothing new, and have long sat along a continuum varying from acceptance to extreme resistance. The nastier forms of nationalism demand attention, though.

One notable example has been anger expressed in Chinese streets at Japan's purchase of the Senkaku/Diaoyu Islands in September 2012. This violent nationalism derives in part from China's Patriotic Education Campaign, introduced in the wake of the Tiananmen massacre, and at times its adherents show a fascist tinge. Of similar concern is the stance espoused by Japan's more nationalist politicians. Worrying, then, is that extreme rhetoric will rise as the 16 December elections in Japan draw near, raising the risk of tensions, perhaps even an accidental conflict between two of Asia's great powers.

Less violent expressions of nationalism, such as those defined through economic regulation, are also on the increase. They appear less egregious. It is not easy to identify when economic regulation shifts from being a reasonable, if burdensome, regulatory tool to something prejudicial. But as any investor would attest, the distinction is crucial. Two current examples have arisen, in Mongolia and Indonesia.

In Mongolia, people have gained little from a resources boom; they still live in "gers" (traditional tents) and scrape a living. Accordingly, politicians claim a desire to apportion some mining company earnings to the people, an ostensibly laudable aim. A tax increase for mining businesses, a new strategic investment law, and efforts to force major companies, such as Turquoise Hill, a subsidiary of mining giant Rio Tinto, to renegotiate contracts, all seem justified, then.

Similarly in Indonesia, a mining boom has encouraged politicians to pass laws obliging companies to build smelters near plants, thereby adding to local jobs, and to hand their interests to an Indonesian counterparty ten years after investment. The government has also restricted certain foodstuffs, and is channelling imports through particular ports, ostensibly so as to build local capacity and improve social conditions.

However, a nefarious motive often underlies these noble ends. In Indonesia, many measures favour the interests of powerful businesses, such as those controlled by the Bakrie family or by presidential hopeful Prabowo Subianto. Similarly, in Mongolia, nationalist ministers often turn out to be involved in the sector in question. Vested interests thus subvert measures, orchestrate their introduction, or rely on them to assist in seizing assets. Either way, unless states are careful, the rules come to favour only local robber barons.

A related fear is that economic nationalism can be self-defeating. Take coal. It is demand for coal in China that has led to much investment and has emboldened Ulaanbataar. Mongolia became China's biggest supplier of coal in 2011 (sending in some 43% of its imports), and expanded production from about 10 million tonnes in 2008 to nearly 20 million tonnes in 2011. Its industry, moreover, is still nascent.

Shifting policy to take account of demand seemed wise, even if it is actually quite risky. The first difficulty is that Ulaanbataar's tough stance towards investors relies on the assumption that China's fast growth will continue as before, a belief increasingly questioned. Indeed, the US Conference Board's Global Economic Outlook published projections in November 2012 that Chinese GDP will grow only 6.9% in 2013, falling to 5.5% from 2014 to 2018. The lack of demand in China's export markets, such as the European Union and the US, shows little sign of picking up.

A second, longer term concern is the shale gas revolution, which may ease pressure on energy markets. The US is now a major gas supplier. Russia is also claiming huge shale reserves, as have Canada and China. Coal, and, thereby Mongolia, may be the loser. Should prices fall, Ulaanbataar's longer term prognosis may appear based on a top of the market calculation, and the country may be misguidedly risking its relationship with the investor community.

For their flaws, though, these nationalisms have a purpose. They tie individuals and groups together, and unify territories disparate in language, geography and culture. But at what stage do they become self-defeating? Is it when they are hijacked by corrupt oligarchs to further their interests, or is it when they provoke a war?

Nationalism is not organic, after all. It is built by governments or groups with particular agendas, and is usually defined in opposition to something or somewhere. And, as Doctor Johnson would have it, it remains the refuge of scoundrels – in Asia today, as in Georgian England.

COLUMNS

THE DICTATORSHIP OF CIVIL SOCIETY IN TAJIKISTAN

Faisal Devji | OXFORD DIARY

The fall of the Soviet Union gave rise to a narrative about the "transition" to democracy, for which the concept of civil society was seen as being foundational. Represented by new-fangled NGOs on the one hand, and on the other by more traditional religious or economic institutions, civil society was meant to establish peace in post-Soviet societies by limiting the reach of the state and indeed politics in general, seen as the source of conflict and violence there. I want to argue here that the reverse is actually the case. Civil society in its post-Cold War incarnation, which is very often funded from abroad, serves both to prevent the establishment of democratic politics, as well as increase the risks of conflict and so the possibility of violence.

What the idea of civil society does in the post-Cold War period is to depoliticize the "people" in whose name it claims to speak. For unlike in its republican conception, the people's role is no longer revolutionary, to found a new political dispensation. It is meant rather to limit politics either in a libertarian or neoliberal way. Unlike the role it had played from the nineteenth century and late into the twentieth, civil society is not seen in liberal terms today. It is no longer supposed to make politics possible, because this would require the prior constitution of a people in some kind of explicitly political, if not necessarily revolutionary way. In fact the people can only be invoked by or in the name of the state, which also recognizes the presence of conflict and even enmity within it. That the people should be divided and possess enemies is crucial to its existence as a political entity.

What would it mean to be a people without the possibility of conflict and in the absence of a state? Outside this political context the people possesses no meaning, with any claim to represent it as a whole echoing the equally preposterous one made by dictators who rig elections in which they are endorsed by 99% of voters. Without the state and its institutionalization of conflict, in parties and parliaments, violence comes to mark social relations in a way that can lead to civil war. On its own civil society is unable to found a new politics, only to protest against an old one. Whether it is the Occupy movements in Europe and America, or the more successful Arab Spring, civil society activism can at most dislodge governments but never constitute them. And this means that it is condemned eventually to offer up the people to the state in a kind of sacrifice.

I shall take as my example of this sacrifice the recent violence in a region of Tajikistan inhabited by an ethno-religious minority. Previously known after their mountainous homeland as Pamiris, this group is today increasingly identified by the purely sectarian name of "Ismailis". The change in designation, which disconnects Pamiris from a local and indeed national politics to link them with a transnational and apolitical religious identity, came about as the devastating civil war in Tajikistan was drawing to a close in the late 1990s. At that time the Ismaili spiritual leader – the Aga Khan, based outside Paris – averted a humanitarian catastrophe by having his NGO, the Aga Khan Development Network (AKDN), provide food and other forms of relief in the region where his followers lived.

The role played by the AKDN in Tajikistan's Badakhshan province represented a victory for the "neutrality" of civil society in a sensitive region, preventing as it did the direct intervention of the UN, NATO or any regional power in a potentially "separatist" area located on the Afghanistan border. But despite its good work during the decade and a half in which it has dominated the area, the AKDN has come no closer to effecting a "transition" to democracy there, let alone in the country as a whole. This is due to the nature of civil society activism itself, more than to the peculiarities of Tajikistan. For the AKDN's "success" was due entirely to the weakness of Tajikistan's new government, with the autonomy of its civil society activism compromised with the regime's stabilization, and especially once Russia and the US started competing for influence and military bases there.

In July this year Tajikistan launched a large-scale and entirely unexpected military incursion into this technically autonomous region. Ostensibly, the move was about arresting former rebels who had been granted amnesty after the civil war, and who were apparently involved in drug trafficking and violence across the Afghan border. Vastly disproportionate to its apparent cause, this deployment resulted in the killing of at least twenty civilians and the assassination of a number of former rebels. Given that the AKDN had taken on the role of a state in its provision of services and employment over the past decade, these events in Badakhshan constituted a direct attack on its influence and left its reputation there in tatters. Indeed it may not be an overstatement to suggest that the AKDN was as much the target of the incursion as were the former rebels. But what could be more predictable than the attempt of a state to regain control of its territory, even if only to secure a share in the trafficking profits that seem to have bypassed Dushanbe?

With a naïve faith in its own resources and international connections, especially in the West, the AKDN had in effect destroyed its own bargaining position with the Tajik regime, not only by urging the disarmament of former rebels, but also by dismantling the structures of local authority in Badakhshan. Tying "development" there to an unrepresentative organization run and funded from abroad, the NGO set itself up as the chief spokesman for the Pamiris with the state, through the Aga Khan's "Resident Representative" in the capital of Dushanbe. This process of dismantling local authority was also extended to the cultural and religious life of Badakhshan, with arbitrary changes made in leadership, ritual and doctrine. It was all done in the name of efficiency, the same reason given for the AKDN's unrepresentative model of development. Their poverty has allowed the institutions of Pamiri religious as much as economic authority to be transferred into the hands of strangers in Europe.

The Tajik state no doubt appreciated the truly "efficient" way in which the AKDN, and the Ismaili religious bodies that it informally supported, deployed their political neutrality and resources to depoliticize the Pamiri population and speak on its behalf, purely in the language of development and civil society. Yet the AKDN's influence and foreign connections would also have worried any government concerned with its sovereignty and territorial integrity. In the process the Pamiris, who had long been a regional majority and a national minority – which is to say a recognizably political entity – were quickly being transformed into a transnational religious movement. And this only allowed them to be attacked as traitors and religious deviants with access to funds and assistance from abroad. And indeed, despite its wholesome reputation for development, the absorption of Pamiris into a non-state organization like the AKDN put them in the same structural position as more sinister movements of transnational militancy, some of which have also adopted a civil society model.

Having helped to save Pamiris from violence, pestilence and famine during the civil war, the AKDN, together with the Ismaili religious organizations that shadow it, ended up making them more vulnerable to attack. This is partly due to their entering into what appears to be an informal pact with the government, in which the latter is allowed to have its way while the AKDN and its religious shadows engage in murky financial and other transactions. A number of the Ismaili religious bodies, for example, seem to have no official existence in Tajikistan, though the funds they receive from abroad appear to be transmitted by the AKDN, even though its role is not meant to include this kind of support. These organizations then hire Pamiris who, in violation of Tajik law, possess no recognized employment status or identification, and can therefore be picked up at any time by the state's security agencies.

In addition to the uncertain tax implications involved in such arrangements, they guarantee the quiescence and loyalty of Pamiris. Unlike the expatriates who run the AKDN and its religious outliers, for instance, Pamiris are often kept for years on short-term consultancy contracts with no benefits such as pensions or health insurance, making them vulnerable to the state as much as to their employers, who can dismiss them at will for any reason at all. Their loyalty, in other words, is bought by insecurity as much as gratitude for the employment given them as a favour. However necessary these arrangements may be thought to be in a post-Soviet context, they also end up making the NGO sector dependent on the state and complicit in its actions. For the AKDN and its satellites require the government's favour to engage in such dealings in the same way as they dispense favours to others.

Tied as they are in a relationship of co-dependency, in which the state is increasingly coming to dominate civil society, the AKDN has itself become a threat to the security of Pamiris, partly because it appears to confuse its own protection with that of the people it claims to represent. In the wake of July's violence, for example, neither the AKDN nor any Ismaili religious body has issued any public statement condemning the state's actions or, indeed, giving Pamiris any instructions or advice, apart from demanding their further disarmament. Given the rumours of another attack by Tajik forces, this silence by the "neutral" institutions of a foreign-funded civil society works only to prevent a resolution to the problem brought to light by the violence this summer. So a letter recently sent to the Aga Khan by a number of Pamiris, an electronic copy of which I received over Skype from some of the authors in Dushanbe, contains the following plea:

> We are deeply concerned about the lack of responsibility, empathy and participation of the leaders of the National Council who, according to community members, do not attend community meetings when invited by the people through the local khalifas, stating that they must remain neutral in such a situation […]. We are confused by their response and are at a loss--whom can we turn to in such a dire situation that affects the lives and securities of all jamati members? We feel that the unwillingness of those appointed as your representatives, either in the AKDN or the jamati institutions, to engage with, advise or instruct members of the community, is a dereliction of leadership and responsibility that is deeply demoralizing. We have heard no word about the progress of any negotiations or the planning for any contingency in the uncertain political atmosphere of Tajikistan, and this can only increase the anxiety of your murids.

The passage quoted above is from the second letter sent their imam by some of the signatories. They had received not a word of response, no doubt for legal and diplomatic reasons, to a first letter sent to the Aga Khan late in August. At that time demonstrators had peacefully taken to the main square in Khorog, asking for its council to convene and legalize the gathering so that protestors could demand the army's withdrawal as well as the resignation of the provincial leadership for acquiescing in its violation of Badakhshan's autonomy. The head of the Aga Khan Foundation in Tajikistan, however, persuaded them to rely upon the informal negotiations that he and others were conducting with the government. While leading eventually to the army's replacement by the secret service, the agreement reached seems not to have addressed popular concerns, and those supporting the demonstrators continue to be harassed and arrested. The important thing to note about this event, however, is that it made clear the fundamentally anti-political attitude of Badakhshan's "civil society" institutions, which worked to dissuade people from acting as citizens and institutionalizing conflict in the political process. Surely if there was any sign of a transition to democracy in post-Soviet Badakhshan this was it, but such a move would threaten the ability of the AKDN to speak on behalf of Pamiris.

The AKDN, of course, together with the Ismaili religious bodies (known as jamati institutions) linked to it, are most likely involved in extensive behind the scenes negotiations with the government and other parties in order to secure the protection of the Pamiri population. This security they probably think will only be compromised by demonstrations and demands, but the question to ask is how responsible these civil society organizations might have been for the violence whose repetition they are now working to prevent? The authors of the letter to the Aga Khan are clear about the fact that the non-availability of political action, or rather its forestalling by the AKDN, together with the latter's own secrecy and silence, may well encourage a self-destructive resort to arms by some young Pamiris:

> We do not wish to hide from you the rumors that some of the younger members of the Jamaat have identified a weapons supply lines and are arming themselves as we speak, preparing themselves for the new offensive, and although they lack experience of warfare, many of them do not wish to act as passive observers to the unjust attack, and we therefore are concerned that the repercussions of this offensive will end in greater loss of human life. […] We, your spiritual children, feel helpless and scared right now, as we prepare ourselves for another attack. Unless something is done, we foresee a large number of us taking up arms to

> physically defend our land and community, while others are forced to leave the country.

Recognizing the fact that the AKDN and its associated "jamati institutions" have become the mainstays of Badakhshan's subservience, the Tajik government now flaunts its patronage of these organizations. The President claims to have made their operations possible, and newspapers report that permission for the Aga Khan to visit his followers might be withdrawn for his own security given prevailing conditions. In other words the institutions of civil society are being held hostage to guarantee the good behaviour of Pamiris, thus acting as a brake on their autonomy and political development. Facing the prospect of being humiliated before their own clients, who have until now been fed with unrealistic stories about the wealth and power of the Aga Khan, these institutions are not likely to do anything more than submit ever more unctuously to government decrees, if only in order to maintain their authority over the Pamiri population and continue the work of development which is somehow meant to lead to freedom. The fact that TCELL, the mobile phone company partly owned by the Aga Khan, ceased working during the army action in July and for a couple of months afterwards, is already being seen as a sign of civil society's capitulation to the state, in a move damaging to the AKDN as a whole.

This is the conclusion to which the supposedly smooth and efficient provision of services, achieved by the elimination of political rivalries, is inevitably driven. Politics cannot be avoided and must be engaged with, a fact that the transitory power of the AKDN and its form of civil society had only obscured over the last decade. Fractious though it may always have been, Pamiri society had at least possessed its own forms of cultural, religious and other authority even in the Soviet past. But their fragmentation and transportation abroad in the era of global civil society activism have done nothing more than limit the possibility of social integrity and political agreement in Badakhshan. Pamiris must realize that in some ways the AKDN and its religious satellites need them more than the reverse, since the profile and credibility of these institutions would be severely damaged without a role to play in Tajikistan. The task before them is therefore to take control of such institutions while at the same time participating in political life under their own name, and not as part of Ismailism's "frontierless brotherhood". In no other way can a transition to democracy, even if only at a provincial level, ever be achieved in Tajikistan.

OBAMA'S ASIA PIVOT: BETWEEN SOME ROCKS AND A HARD PLACE

Jon Western | THE QUIET AMERICAN

As tensions persist between China and Japan over the disputed islands in the East China Sea, the United States faces the almost impossible task of simultaneously reassuring and constraining its regional allies, while ensuring that it does not escalate its own tensions with Beijing. On one level it is hard to see how China and Japan could become so consumed over a small set of remote islands and it remains unclear how serious the crisis is. Yet, over the past several months, Chinese and Japanese ships have been patrolling the same waters with both laying territorial claims to the area. And, earlier this fall, U.S. Defense Secretary Leon Panetta warned that the escalating tensions and close proximity of Chinese and Japanese vessels could lead to some triggering event and conflict.

The island dispute, however, is only a small part of the much larger geostrategic dance and set of regional challenges associated with China's rise. In September 2012, The Economist wrote that all sides see their posturing as part of the future power alignment in the region:

> The islands matter, therefore, less because of fishing, oil or gas than as counters in the high-stakes game for Asia's future. Every incident, however small, risks setting a precedent. Japan, Vietnam and the Philippines fear that if they make concessions, China will sense weakness and prepare the next demand. China fears that if it fails to press its case, America and others will conclude that they are free to scheme against it.[1]

Washington has not taken a position on the sovereignty of the islands, but it has publicly announced that the islands fall within the commitments of its mutual security agreements with Japan. Nonetheless, Japan, South Korea, and other U.S. allies remain anxious. One cause for concern is China's assertiveness. The other is potential U.S. global retrenchment in the face of its internal debt and decade-long wars in Iraq and Afghanistan. In the absence on a comprehensive regional security framework, the United States has long played the role of regional balancer by providing its allies with an extensive set of bilateral security arrangements. With America's current debt burden, public exhaustion with the wars in Iraq and Afghanistan, and continued sluggish economic trends at home, uncertainty about America's commitment and overall strategic posture is creeping into the discussion. Many in the region worry that America's departure from Afghanistan in 2014 might lead to a retrenchment from global responsibilities, in a fashion similar to that which followed the American withdrawal from Saigon in 1975.

High levels of uncertainty about China's future have also exacerbated concerns about the future of American power in East Asia. It has been widely projected that China will continue to rise and may overtake the U.S. economy in the next half century. This led to a number of claims and concerns about the potential for conflict during this anticipated hegemonic transition or hegemonic parity.

Today, however, there are now increasing signs and worry that China will not keep up the same pace. While it may eventually reach and surpass the size of the U.S. economy, China faces a number of internal contradictions and challenges. Projections suggest that growth rates are likely to hover between six and eight per cent rather than the 10 and 12 per cent rates sustained over the past two-and-a-half decades. China's high domestic savings rate and low domestic consumption rate create extensive dependency on exports. The government is under intense pressure to ensure adequate job growth to absorb new migrants. And in at the beginning of a new leadership transition, the Communist Party is under pressure to control corruption and widespread economic criminal activity.

Longer-term trends suggest even greater challenges. Despite China's impressive economic gains, the shear size of its population means the country's per capita GDP is still well below the world average -- just above US$5,000 per year. Even if, or when, its aggregate GDP catches up to that of the United States, it will continue to face much higher levels of inequality than found in the West. Furthermore, a number of social challenges are looming that will create significant long-term fiscal pressures. China's population is aging with nearly 30 per cent of its population projected to be over the age of 60 by 2020. It currently does not have a comprehensive social security system to provide levels of care and support for this aging population once they leave the workforce. Likewise, environmental degradation and the associated affects on public health have not been addressed. The government has deferred efforts for comprehensive reforms on all of these fronts. But, it is clear it will need to address them, and they will require significant fiscal outlays.

All of this will put increasing pressure on the Communist Party and threaten its legitimacy and control. If history is any judge, we may well see greater regional and global aggressiveness both to demonstrate its power and deflect domestic dissent.

This is the context of America's current "pivot" to Asia. Thus far, the Obama administration has redeployed a modest number of naval assets to the region. It also has publicly confirmed that the disputed islands fall under the mutual defense treaty with Japan and that the United States would side with Japan in any dispute. Yet, unlike Europe, the region is not well institutionalized to help manage diplomatic or security challenges. A recent study from the London School of Economics warned, for example, that ASEAN has little capacity to cope with a significant conflict between Washington and Beijing.

This puts a much greater burden on Washington to develop a more comprehensive strategic posture. In a recent study, the Washington-based Center for Strategic and International Studies concluded that thus far the United States has fallen short. It argued:

> The top priority of U.S. strategy in Asia is not to prepare for a conflict with China; rather, it is to shape the environment so that such a conflict is never necessary and perhaps someday inconceivable. It is therefore critical that the United States can achieve and maintain a balanced combination of assurance and dissuasion to shape the environment. [2]

Identifying and reaching that delicate "balanced combination" is not going to be easy, given the dynamic nature and interconnectedness of events in the region, and the fluidity of perceptions and uncertainty about the future of U.S. and Chinese power in the region. Nonetheless, this is really the only viable approach, and the island dispute does demonstrate that is now time to think much more comprehensively about how to avoid escalating conflicts, and ensure long-term stability in East Asia.

NOTES

[1] "Can Asia Really Go to War Over These?" *The Economist*, September 22, 2012.

[2] "U.S. Force Posture Strategy in the Asia Pacific Region: An Independent Assessment," Center for Strategic and International Studies, Washington D.C., July 27, 2012.

THE FUTURE OF INFORMAL ECONOMIES

Scott Smith | DISCONTINUITIES

Economists, anthropologists and other social scientists have spent the past three decades probing, sizing and documenting so-called informal economies— from the structures and behaviors of deviant subcultures and black markets to informal production and labor dynamics. More recently, technologists, designers and social innovation experts have taken notice of these unstructured, unofficial, "unseen" economies as future growth sources and incubators for innovative practices. This past October, I was fortunate enough to speak at the Informal Economies Symposium in Barcelona organized by design group Claro Partners, where representatives from all of these groups came together to kick off a macro examination of the subject. The goal of the event was to improve understanding of the relationship between informality and formality, and to discern what the nature of this relationship can teach us about where global economies are headed.[1]

Our collective exploration started with Keith Hart, the anthropologist who himself coined the term "informal economies" in a seminal paper on labor in Ghana written for the International Labor Organization in 1973.[2] Hart's insights anchored subsequent talks and panel discussions. Informal economies were probed from multiple angles, by design and social innovation thinker John Thackara; strategic designer Richard Tyson; design strategist Niti Bhan, who has studied so-called "prepaid" economies in India and Africa; Steve Daniels of IBM and Makeshift Magazine, whose graduate research focused on "maker" economies; and a number of other technologists, social innovation experts and entrepreneurs.

Against the backdrop of resurgent informality in Spain itself (the result of seriously ailing local and global economies), the discussion was rich with reflection on recent experiences in the field, problems with current "casual" thinking about informal economies, and open questions about how informality impacts the prospects for our own economic and social design. Throughout the day, speakers shared field and research lab experiences alike. The symposium was exploratory and inquisitive rather than declarative. As the putative inception stage of a longer process of discovery, it fused together disciplines and insights, and set us on a path toward greater understanding of the role of informality.

Hart's opening call asked us to rethink how we define informality, particularly as the" formal/informal pairing", as he calls it, was shaped both by the polarities of the Cold War, and later fragmentation of the economic order that the global industrial powers had sought to impose after World War II. For Hart, this "we/they" construct has become increasingly meaningless. The global economy has blurred the lines between formality and Informality, leading to a growing informalization of the global economy, to use Hart's own phrase (for more on Hart's thinking, see his blog, The Memory Bank).[3] As with many of the day's discussions, Hart focused partly on the role of money in the formality/informality dynamic, pointing out that it, and therefore labor, became ungovernable after the oil shock of the 1970s. Add technology to this formula, as has happened in the past decade, and the shape and flow of informal economies look more like what we now think of as the formal. Formal definitions of work, commerce, innovation, and organization, in what we consider the formal and the informal, are increasingly indistinguishable, Hart told us. As such, we should focus on how to bridge formality and informality, instead of thinking of them as separate, oppositional spheres.

Richard Tyson, whose work with Caerus Associates focuses in part of systems design in frontier markets, and Adam White of Groupshot, who works in social innovation, focused on the need to "map" informal economies at a high level and understand how they relate to traditional systems. Informal economies are often understood endogenously, they argued, but to understand them exogenously, from the outside, we need to interact with them (interdict if necessary), manage the risks they present themselves and the larger world. Better definitions are needed, they pointed out. However, both suggested in different ways that strict codification of informal economies is more harmful than not. Tyson emphasized the need to establish flexible systems and frameworks for understanding them, particularly in a state of what he called "permanent crisis" created by formal sector breakdown. Now would be a good time to better chart how they work, Tyson said, as the emergent power structures of groups creating greatest tension for the formal sector, such as insurgencies in the Sahel, are coded by the dynamics of informal economies.

A separate panel on the role of money in informal economies really turned to the subject of flexibility—how much of it exists, and needs to exist, within modern economies. Here, Hart's point regarding the change to post-gold standard money flows: what we think of as flexibility in the formal economy is really just money and economies systems working in a natural state, not behaving according to some artificial freedom.

Within informal economies, money is situational. As Niti Bhan pointed out in her talk on prepaid economies, even something as "formal" as the iPhone ends up being converted, in an informal situation, to local currency that make sense locally (like an equivalent value in, say, goats). We are only now beginning to (re)recognize how many forms money takes in the formal world, and as a result, we are pushing its boundaries and templates with everything from mobile payments to time banks and barter systems in depressed economies such as Spain and Greece.

The final talks focused on where future opportunities might be found. Steve Daniels of IBM and Makeshift showed his ongoing research on the extent of innovation within informal economies. Many of his examples were particularly striking in the way they underpin the resilience needed for survival — they are incredibly efficient and show levels of resourcefulness we historically haven't had to develop in resource-rich formal economies. A tour through New York City, newly battered by Sandy, reminds us how well we would do to relearn these approaches in our own formalized lives. Tim Brown flipped this theme around and showed how Chinese and Taiwanese "Shanzai" culture has informalized massively formal cultures of technology development (something I've covered previously in the pages of this bulletin here).[4]

My own talk concluded the day. My intent was to inspire thinking about a possible future where the informal and formal come together on a local scale, to focus on sustainable, functional innovation. I argued that this is in the process of happening right now as the remaining hulk of the formal economy slowly composts into a large-scale informal economy, increasingly functioning on foundations – through communications networks, and open software and hardware, for example – that we presume to be purely formal.

Growth is problematic in a world of finite physical resources and limited ability to absorb the byproducts of endless growth. So is resilience, which too often becomes a defensive strategy. Rather than try to recapture either of these, I proposed we refocus on functional innovation as a lesson from informal economies, building what we need, when we need it, in ways that are locally sustainable. Bookending Hart's call to break down the barriers between formal and informal, I posited that this is where we increasingly stand, in a zone of traffic between the two demarcated by disappearing boundaries. Only those with a stake in keeping such boundaries intact seem to notice.

NOTES

[1] Abby Margolis, "Notes on the Informal Economy Symposium," theinformaleconomy.com, October 19, 2012, URL: http://www.theinformaleconomy.com/notes-on-the-informal-economy-symposium/.

[2] Keith Hart, "Informal income opportunities and urban employment in Ghana," Journal of Modern African Studies 11, 61–89, 1973. URL: http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=2494648

[3] Keith Hart, "How the informal economy took over the world," The Memory Bank, October 17, 2012. URL: http://thememorybank.co.uk/2012/10/17/the-informalization-of-the-world-economy/

[4] Scott Smith, "Shanzai! The Era of DIY Warfare," Current Intelligence (18 July 2011). URL: http://www.currentintelligence.net/columns/2011/7/18/shanzai-the-era-of-diy-warfare.html.

OBAMA'S CHRISTMAS WISH LIST AND NEW YEAR RESOLUTIONS

Stephen Saideman | XENOPHILE

Being re-elected President of the United States was a pretty nice gift, but what else could President Obama want for Christmas? What would I like to see him promise to do more or less of in the New Year?

If I were Obama, the first thing I would ask for would be a foreign policy team as strong as his first one. Hilary Clinton will be tough to replace, and Leon Panetta is not as strong in a time of defense budget cuts as Robert Gates could have been. Already, there has been much discussion about this, with Susan Rice dropping out and Chuck Hagel under fire. The risk of appointing Kerry is more about losing the Senate seat he occupies. Thus far, there has been far less speculation about the Department of Defense. A great but most unlikely gift would be a Republican Party with a bit of a learning curve. Sure, the Democrats would be better off in 2014 and 2016 with the Republicans of today as their opponents, but Obama is done with re-elections and would like to get some stuff done. A reasonable Republican Party would be an amazing gift.

If Santa were super-generous, Obama could wish for a bit more peace in the Mideast, starting with a a magical solution to the Syrian civil war. The Middle East is the Land Of Lousy Alternatives for American foreign policy. Syria presents a tremendous challenge, given that the US public is exhausted by a decade of war, that the Syrian opposition is hardly united and includes many folks the US would rather not arm, that Russia and China have very conflicting preferences, and so on. Perhaps Assad will fall off a horse. A more likely but still not quite probable gift would be a multilateral deal with Iran. The sanctions are biting hard, but Obama would want a deal negotiated by the coalition representing the international community. Unfortunately, Obama cannot return the earliest gift—more violence between Israel and Hamas. This is exactly what he didn't want for Thanksgiving or Christmas or anytime.

Of course, as the Beatles suggested, the love you take is equal to the love you make. So, Obama is probably shopping right now for a chill pill for China. The rising power has been testing and pushing its neighbors. A less assertive, more cooperative China would be a gift to the entire region. Perhaps Obama will give Vladimir Putin a new exercise machine for his abs, so that Russia focuses on building inward strength rather than serving as a spoiler. On the other hand, both countries' reluctance to allow NATO the freedom to do in Syria what it did in Libya is probably a gift to Obama, who would prefer to avoid yet another intervention in the wider region.

The winter season is not just for gift giving and receiving, but also making resolutions to do better in the New Year. So, what should Obama resolve to do or not do, besides giving up smoking? He should definitely try to keep the US at or under the number of wars it is currently fighting. He should resolve to rely less on drones as a hammer for every foreign policy problem. He should try to advocate less on austerity as a solution for everyone's economic problems.

I think the most important resolution for the American public would be to make counter-terrorism less extraordinary. A war on terrorism, as the truism goes, means fighting a technique and it can never be won. Instead, declare that some objectives have been reached and try to return to normalcy plus—not exactly how the US operated in 1999 or 2000 but how it should have been acting in a world where terrorism exists but causes far less damage than economic crises, climate change, domestic gun crimes, and all the rest.

Partly as a consequence of the "ending of the war on terrorism," the US could pivot not just towards Asia and the Pacific but away from the Middle East. Hard to do, but South America, Africa, Southeast Asia have promises and challenges of their own and some assistance could make a difference. Again, the Middle East is the land of bad policy choices, and it is no fun to keep having to figure out which option is the least bad one. Not that these other places are perfect, but they have been on the back, back burner for too long.

Obama should resolve to focus on Mexico as the most important foreign policy priority. The US has bet hundreds of billions of dollars and thousands of lives on far distant failed states. How about the very violent country next door for which the US bears considerable responsibility, with its thirst for drugs and its excess of guns?

The question is always raised during an election: who would want this job, that comes with such baggage? The US Presidency is a very tough role, with the greatest latitude in foreign policy. Obama's first post-election trip to Burma, Cambodia and Thailand was promising, but the crises du jour will drag his attention back to the usual suspects.

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Annex 830

Andrew Targowski, “The Myths and Realities of the Clash of Western and Chinese Civilizations in the 21st Century”, *Comparative Civilizations Review*, No. 67 (Fall 2012)

The Myths and Realities of the Clash of Western and Chinese Civilizations in the 21st Century

The Globalization and Comparative Approach

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Key Words: **Western Civilization, Chinese Civilization, USA, EU, China, civilization clash, wealth bifurcation, Death Triangle of Civilization, globalization, globalization waves, economic crisis, grand strategy, outsourcing, wise civilization, civilization future.**

Introduction[1]

The main purpose of this investigation is to evaluate a question: is there a clash between the Western and Chinese civilizations, and what is the myth and reality of this clash? The spectacular economic development of the Chinese and the concurrent decline of Western civilization provoke many predictions of the near-future world order. So far it seems that the West cooperates with China quite well, since through outsourcing of Western manufacturing, China can employ its large labor force and the Western financial elite benefit tremendously in business, due to cheap labor. However, the question is how long can that kind of cooperation last? It triggered the financial crisis of 2008-2011, due to the shrinking middle class in the West, and furthermore, increasing numbers of employed Chinese workers can buy more and will need to consume more strategic resources which are available in limited volumes on the earth.

Will the current cooperation be replaced by a clash for resources? That kind of question will be investigated in this paper. Also the wisdom-oriented abilities of both civilizations will be evaluated to see which one has better chances to survive a shortage of strategic resources.

The methodology of this investigation is based on the interdisciplinary big-picture view of the world scene, driven by a global economy and civilization, with an attempt to compare both civilizations according to key criteria. A set of conclusions will be provided at the end of this paper, with practical and social implications for eventual implementation.

1 The author is grateful to Professors Han, Rienzo and Tarn from Western Michigan University (USA) for providing suggestions on how to improve this investigation.

The Impact of Globalization on Western and Chinese Civilizations in the 21st Century

The development of the modern world began after the fall of Byzantium (1453) and the discovery of America (1492), that is, at the end of the 15th century. In each century since, usually one country has dominated the world. In the 16th century Portugal dominated, in the 17th century Spain was the hegemon, and in the 18th century Great Britain was the leader. At the beginning of the 19th century, the hegemon was France, which was later replaced by Great Britain. In the 20th century Great Britain, Germany, the United States, and to a certain degree Russia competed for the main role in world politics. In the 21st century the U.S.'s domination is fading, and many predict it will be replaced by China.

In the last 500 years, different targets and issues were at stake in world politics. For example, Portugal, Spain, and Great Britain were conquering new territories, with good results. Once the world became richer in the 19th century due to the gains of the Industrial Revolution, at stake were clashing ideologies. The English Revolution (1688-89) built the foundation for the parliamentary system, the American Revolution (1775-1783) provided the concept of modern democracy, and the French Revolution (1789-1799) created citizenship in France.

The Industrial Revolution (1760-1850-1960) contributed the factory system and industrially manufactured products, financed by capital. It led to accelerated wealth creation and rising inequality among society's members. To solve rising dissatisfaction and poverty, differing ideologies regarding the further development of civilization were at stake. None of those ideologies—capitalism, socialism, and later communism and Nazism—could solve societal problems. Eventually these ideologies led to the Bolshevik Revolution (1917), Spanish Revolution (1936), World War II, the Cold War (1945-1991), and to the very successful Scientific-Technological Revolution (1945-) and Information Revolution (1980-).

After the fall of communism and the end of the Cold War (1989-1991) in Europe, the Information Revolution accelerated its activities in Western civilization, triggering the fourth Globalization Wave.[2] Very soon this revolution embraced the whole world. Its effect has been the development of the global economy, controlled by global financiers. The latter developed global corporations which are outsourcing manufacturing to Asia, particularly to China, where the cost of labor is low and the market is the largest in the world.

Supposedly, "what is good for the global corporations" is good for their maternal countries. With the help of lobbyists, global corporations control governments in

[2] The first Globalization Wave (GW I) took place at the end of the 15th century (Discovery of America), GW II in 1837 (British Empire), GW III in 1945, GW IV in 1990.

Western civilization, which supports outsourcing its own industrial base, since this leads to better business that can create more jobs. This is true; however, those jobs are created outside of Western civilization. The economic crisis in 2008-2011 in the U.S. and the E.U. proves that turbo-capitalism led to the decline of Western civilization and the rise of China. Now Chinese civilization (China and diaspora) is awakening, full of energy to collect the benefits of the West's mistakes. Furthermore, Chinese civilization does not want to fully Westernize (however the young generation is more open to Westernization) since it appreciates its own values and principles that have developed over the last 5000 years.

In 2011, the Chinese economy took second place in the World, after the American and before the Japanese and German economies.[3] This supports arguments made by many authors and politicians that China will move to first place, before the U.S., in the second part of the 21st century. According to the Economist,[4] in 2011 the GDP of the U.S. was still two times bigger than China's (in market prices) and only 25 percent bigger in basket prices (ppp). If the current rate of economic development continues, China's economy will reach the same level as the U.S. in 2016 (ppp) and 2018 (market).

The Chinese economy looks even better if it is compared in certain categories to that of the U.S. For example, in 2011 in production of steel, China was producing 6.6 times more than the U.S. The production of goods was 1.1 times bigger, the sale of cars was 1.2 times bigger, export was 1.3 times bigger, 3.3 times more mobile phones were in use, investments were 1.4 times bigger, and energy consumption was 1.1 times bigger. These data should not mislead, since they are the result of the West's strategy to move production to China! If the American economy is two times bigger and the population is one fourth as great, the GDP per capita is still eight times bigger in the U.S. This is the subject of many negative comments about China. However, consumption in China should rise and could reach the American level by 2033.[5]

This type of forecasting is just a simple extrapolation of data, which can lead to erroneous conclusions. If what such a prognosis maintains would actually happen, it would imply that the world has limitless strategic resources and Western civilization is not able to self-correct its strategies. Since the reservoir of strategic resources is limited, the current spectacular development of Chinese civilization will bring the world civilization to an end sooner or later. Eventually, China could apply its wisdom and go back the Great Wall, as it did in the 15th century, when the Emperor ordered that the Chinese fleet be destroyed (1433).

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[3] Nominal GDP list of countries for the year 2010. World Economic Outlook Database September 2011, International Monetary Fund. Accessed on September 26, 2011.
[4] December 31, 2011, p. 61.
[5] China's Economic Heartland: Chongqing. http://www.theglobalist.com/countryoftheweek/sample.htm (retrieved 1-2-2012).

We can contemplate whether the Chinese civilization has an expansive character or whether that is a myth, since China's expansion was triggered by the West. Will China cleverly stay within its secure territory? Or, contrary to its history, can China change its character and promote not only economic but also cultural and even military expansion far beyond its borders?

The question is, if the West takes back its outsourced jobs, will China be able to continue its current, spectacular development?

Can China Transform from Robot to Master of Manufacturing and Be an Economic Superpower?

Most of our impressions about China's super economic power to a certain degree are myth.

China became the world's factory when the Internet eliminated the problem of distance. It became evident that outsourcing manufacturing wouldn't be so difficult since e-communication speeds up business. In addition, it could be cheaper and sometimes faster due to the Chinese ability to work hard and on time. In the past China did not design products or technological processes, invest in the production infrastructure, or even provide marketing for products it manufactured. Furthermore, Westerners taught Chinese workers how to work on given products in given manufacturing settings.

In such a way China became a "robot[6]" of Western civilization and is not an independent economic superpower. At least not yet. It is a myth, not reality, that China became such a strong economy due to its own internal ability. On the other hand, the Chinese are a very talented people, who learn fast from the West and sooner or later they will be able to develop their own products and manufacturing facilities. But it is less evident that they will also be able to be successful enough in developing marketing and selling to compete with the Americans and Europeans. First of all, the Chinese do not copy (as the Japanese used to do) foreign solutions, because they co-own them, usually in the range of 50%, through venture-oriented undertakings. Also, they have the ability to absorb (comprehend) foreign solutions, due to China's culture of leaving "room" in its Mindsphere.

In the past, a common stereotype was that the Chinese traditionally lack scientific and technological ability, despite the fact that somehow they stumbled upon paper making, printing, gunpowder, and the mariner's compass. Modern Chinese themselves are

[6] For example, the Chinese labor working for Apple in Faxconn City lives in company barracks and work 6 days per week and 12 hours per shift, making $17 per day. Faxconn employs nearly 300 guards to direct foot traffic so workers are not crushed in doorway bottlenecks. (The New York Times, January 22, 2012, p. 22). No wonder that the American workers cannot compete with the Asian ones. In order to do so the former should return to the working conditions of the 18th or 19th century to satisfy the appetite of the global corporations 200 years later. Is it progress?

sometimes surprised to realize that modern agriculture, shipping, astronomical observatories, decimal mathematics, paper money, umbrellas, wheelbarrows, multi-stage rockets, brandy and whiskey, the game of chess, and much more, all came from China. The sciences of astronomy, physics, chemistry, meteorology, seismology, technology, engineering, and mathematics can trace their early origins to China.

From 600 AD until 1500 AD, China was the world's most technologically advanced society. China was the leading maritime power in the years 1405-1433, when Chinese shipbuilders began to build massive oceangoing junks.[7] Between 1405 and 1433, the emperor of that time (the Yongle Emperor) sent Zheng He out on a series of seven naval expeditions, all designed to control trade and impress other nations (in Africa and India) with the power of the Chinese fleet. The successor emperor (the Hongxi Emperor) promptly cancelled Zheng He’s expeditions and proceeded to have much of the Chinese fleet burned or destroyed (in 1433) and went into isolation.[8]

Thus ended China’s period as the world’s greatest naval power. The interesting thing is that under the Hongxi Emperor and his son, the Xuande Emperor, many reforms were put in place that proved to be very popular amongst the people and which led to what is often referred to as one of China’s golden ages. “Where would China be now had they not ‘pulled back’ from their maritime explorations and had they continued to spread their influence out amongst the world? That’s not to take anything away from where China is at the moment, but it’s interesting to ponder whether or not things would have been different,” (Stanley Bronstein on July 7, 2009).[9]

Today in the 21st century, the Chinese are gaining self-confidence, knowledge, and skills and are awakening from the “opium” which was used by the British to colonize this talented people in the 19th century. This can be proved by the following facts. In 2011 the Chinese built the fastest computer in the world: Tianhe-1A (built at the National Supercomputing Center in Tianjin, China, with a performance at 2.6 petaflop/s).[10] Their accelerated program of technological development culminated in Yang Liwei's successful 2003 flight aboard Shenzhou 5. This achievement made China the third country to independently send humans into space. Future plans include a permanent space station and crewed expeditions to the Moon and Mars.

All this indicates that China has the ability to surpass the “robot” stage and to become a developer of science, technology, and production. In 2011 China patented 1.1 times more solutions than the U.S.[11] This means that the Chinese are developing their own

[7] http://www.basicrps.com/chine/histoire/china.htm (retrieved on 1-10-2012)
[8] http://www.sjsu.edu/faculty/watkins/treasurefleets.htm (retrieved on 1-2-2012).
[9] http://stanleybronstein.com/china-was-once-the-worlds-greatest-naval-power-but/ (retrieved on 1-2-2012).
[10] 1 petaflop/sec=10^{15} floating-point operations per second, or = 1,000 trillion operations/sec. In comparison, a hand held calculator makes about 10 oper/s.
[11] The Economist, December 31, 2011, p. 61.

intellectual potential, thus leading China to independence from the West. China also has a huge internal market to support its own production, if the West slows down importing. In such a way, China is en route to becoming a real economic superpower, particularly if Western civilization continues the suicidal de-industrialization and liquidation of the middle class. If this trend goes on, Western civilization will continue to provide the marketing and selling for China. On the other hand, it is rather doubtful whether China will accept payment in governmental bonds which will never be paid off.

The paradigm of China as a "robot" brings to attention Isaac Asimov's First Law of Robotics (1942): "A robot may not injure a human or, through inaction, allow a human being to come to harm." It is very evident that the West is pushing the Chinese robot to harm the master. It is no wonder that Western civilization is declining so rapidly in the 21st century. It is not China's fault but rather the West's lack of wisdom.

The question is whether or not such an economically strong China will try to convert the Global civilization into a Global-Chinese civilization (Glob-Chin Civilization)? Nowadays, China is installing 150 Confucius Institutes in the U.S. which will train future teachers of the Chinese language at American schools. Is this a long-term strategy of globalization *a la* China?

Can the West Surrender Manufacturing and Live on Borrowing?

The depth of the economic crisis in 2008-2011 indicates that it is not a classic cyclical recession but rather a new structural crisis. The majority of specialists and politicians agree with respect to the scope and depth of this crisis. But can none of them define a convincing diagnosis of this crisis?

In the U.S. a leading opinion is that this crisis was caused by easy credit (mortgages) for houses and an expanding federal government deficit. In Europe, a leading opinion is that the deficit of European governments using *euro* is so large that it cannot be paid off. In other words, those countries are in a practical sense bankrupt. As a result of these causes, Western civilization has entered a deep structural crisis. The solution recommended by top European leaders for how to get out of this crisis is to pay off debts. In practice, one must take out more loans to service the old loans. It is a suicidal strategy.

To increase the supply of money in the marketplace, one must increase the amount of money in the hands of consumers by employment. In effect those consumers will go to stores and buy goods which must be produced in higher volumes. However, this production will be increased in Asia, particularly in China, and local consumers (in the U.S. and Europe) won't be engaged in production and won't gain income through employment. The service economy in the U.S. and E.U. is too weak (since is based on low-paying jobs) to generate more money in the hands of consumers.

The presented diagnosis is simple and obvious. However, none of the important economists, politicians, and publicists has even mentioned the presented diagnosis and solution because the manufacturing lobby spends many millions of dollars to control the "mouths" of leading opinion-makers. So far those in the so-called "Top 1%" make very good money in China, where the labor costs are still low. In effect, the U.S. is deep in pending debts. For example, the federal government is $15 trillion in debt, local governments $5T, individuals $16T, and the accumulative deficit of the foreign exchange is $4.6T, totaling about $40.6T.[12]

This constitutes about 70 percent of the world GDP. In order to pay off the debts of 310 million American consumers, about 2.45 billion workers must work for a whole year.[13] Of course this is not feasible. The U.S. cannot pay off its debts; it can only take new loans to pay the annual interest of old loans. The same strategy is applied by the E.U. in countries using the *euro*.

In 2011 the politicians of Western civilization, whose society is steered by the global financiers, refused to regulate the global economy, because obviously, the present state of the global economy is beneficial for global corporations. On the other hand, those who are negatively impacted, the "99%," launched the "Occupy Wall Street" movement aiming against those "1%" who collect the enormous profits from outsourcing manufacturing to Asia and economically colonizing workers over there. This movement will continue to exist and grow, since the reasons for the crisis will not be removed soon.

From a logical point of view, Western civilization should regulate (through WTO, IMF, WB, G7, and national governments) its activities in the global economy to survive in a very broad, sustainable sense. Perhaps this issue will come out during the late stages of the 2012 presidential election campaign in the U.S, but up until now, nothing indicates that this will happen. There is no correct diagnosis of the crisis or political will to elaborate such a diagnosis and implement the obvious solution in practice.

The correct strategy is to bring back outsourced jobs and re-industrialize the West again. To do so one must implement tax credits14 to support insourcing for American products which used to be made abroad and imported to the U.S. Another issue is who should finance the safety net for those American workers whose jobs have been off shore outsourced, regardless of possible tax credits? Perhaps those corporations which make huge profit on it or just the society? But to avoid any form of protectionism and to support free trade, tariffs for products made by particular countries, such as China, Germany, Japan, France, and so forth, should be minimal, because the theory of free

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[12] http://www.usdebtclock.org/ (Retrieved on 1-10-2012)
[13] It is assumed that 50% of populations belong to the labor force (7 B x 0.5 x 0.75=2.45 B).
[14] On January 24, 2012 President Obama suggested this kind of credit in his State of the Union.

trade is not built upon the necessary transfer of industrial jobs from the developed to developing countries.

This strategy is simple and natural, but due to the conflicting interests and pressure from elites in the world, it is not implementable today. One must remember that "innovation does not happen in laboratories by researchers. It happens on the factory floor. The process of making stuff helps you experiment and produce new products. If everything is made in China, people there will gain the skills, knowledge and experience to innovate. And the Westerners will be behind."[15]

China's "Hidden" Culture: A Key to Understanding Its Economic Transformation[16]

Westerners look at the Chinese from the Western point of view, neglecting the 5000 year-long phenomenon of this very long-lasting nation. It may not be appropriate to equate China's economic accomplishment to that of Western civilization. Until about 30 years ago, Chinese civilization had not progressed much over the past 200 years. Its economic accomplishment in the past 30 years is simply a duplication of that of Western civilization (clothing, social behavioral changes, material consumption, etc.). However, the Chinese do have a deeply-rooted "hidden" culture which is not well understood by Westerners. Our writings are primarily focused on the "economic impacts" and "changes" due to the globalization and outsourcing caused by the availability of Internet. They cannot fully explain the intrinsic differences between Chinese people and those in the West. Following are a few culture-wide factors which shall be addressed to emphasize the ability of the Chinese culture to pursue its role in world economics:

a. Strong family values. Most Chinese people prefer not to reveal individual political interests until the whole society has a big problem. In other words, they can tolerate "less democracy" for more national stability, and this is the reason they accept "modified" communism without going against the communist leaders.
b. Hoarding of wealth. Similar to the Japanese, Chinese people do not spend all the money they earn. They care about holding long-term property such as land and gold, which makes their economy less sensitive to the outside world. I.e., the global crisis has less effect on the internal economy in China since most people manage their finances very well, even though they do not have the same life quality or living standards as the West.
c. Emphasis on education. Most parents will put education as the first priority for their children. In other words, they can let go of personal life quality or enjoyment if there is opportunity to upgrade their social status (or position) and

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[15] F. Zaharia. The Case for Making It in the USA. *TIME*, February 6, 2012, p. 19.
[16] This section is based on Professor Bernard Han's advice to this author, who is grateful to him for so honestly sharing his knowledge about the hidden Chinese culture.

knowledge. The Chinese value knowledge and social status more than anything else. They consider merchants the worst class in society. This is the big difference between the East and the West.

In fact, the above three factors are commonly shared by the Jewish culture. This could be the reason that Jews were assimilated by the Chinese 1200 years ago.[17] It also explains why the Chinese are as successful as Jews in commerce and education in the U.S. and beyond.

Most people in China understand that their political system is not good, but they keep silent since the Communist party is lopsided and there is no way to avoid persecution if you go against the system. But, if the Chinese government continues to allow more economic freedom or make improvements in living standards for the general public, then there will be no "Problem of Revolution" at all. Nevertheless, we cannot underestimate the potential danger embedded in these two factors since the Chinese leaders have to be willing to let go some of their given advantages, curb their corruptions, and maintain a pseudo-democracy to be considered as partners with Westerners.

According to the Chinese understanding of the 2008-2011 deep economic recession, its roots are not in outsourcing of Western jobs but come from the following factors:

a. Capitalists' selfishness. Most rich people (1%) do not care about others (99%) but only about their own benefits. This is very true in the United States and possibly true in the E.U.
b. Overemphasized individual rights. Everyone is equal, and this can be applied to people with different value systems, different religions, different life styles, and different morality. No wonder there are no standards of living in the society. Everyone is equal and it turns out everyone is great and everyone is equally distracted and confused.
c. The inability to conduct self-examination. As shown in Table 1, the poorest country in the whole world is India (not China). However, both India and China are really poor compared to the Western countries. Using the figures presented in Table 1, the U.S. owns 23 times more wealth per person compared to China, and 52 times more wealth per person than in India. All these numbers indicate that one of the real problems in the West is overspending and over-enjoyment of personal life.

If the previous factors do not change, the hope for self-correction in the West is very slim.

[17] see http://en.wikipedia.org/wiki/Kaifeng_Jews

The Chinese collaborate with Westerners from the position of a wiser partner who has patience and hope to gain power step by step.

Do We Face a Contest for Supremacy or for Civilizational Survival?

A China that has been resurrected by globalization in the 21st century has become the subject of fascination for intellectuals from the West. They are in a race to publish the most impressive book. Just a few examples illustrate this race: *A Contest for Supremacy, China, America, and the Struggle for Mastery In Asia*, by Aaron L. Friedberg (2011), *China Shakes the World*, by James Kynge (2006), *China on the Brink*, by Callum Henderson (1999), *When China Rules the World*, by Martin Jacques (2009), and *The Quest*, by Daniel Yergin (2011), among others. In these titles there is more myth than reality.

The West has always had well-defined enemies. In particular, the U.S. has always known which country is its enemy. The first enemy was Great Britain, later Germany and Japan, followed by USSR (until 1991). Today the enemy is China. This is an unintended enemy which was created because it is convenient for the U.S. to have an enemy besides terrorists.

China should be a good enemy since it is not a democracy, just ruled by a communistic party in an authoritarian manner (Walter and Howie, 2011). However, China does not want to propagate communism elsewhere. Contrary to the communistic dogmas, this country has been implementing a managed-market economy (a new type of capitalism[18] or a modified communism or socialism), which energizes individuals at the bottom of the hierarchical society. On the other hand, this system as the *Chinese model* has an inherited conflict between communism and capitalism. Furthermore, China does not want a war with the West, since it is winning without fighting because it is successfully following the main rule of its great sage Sun Tzu (544-496 B.C.). However, "an increasingly powerful China is likely to try to push the U.S. out of Asia, much the way the U.S. pushed European powers out of the Western Hemisphere," (Mearsheimer 2001).

However, an aircraft carrier, the Shi Lang, (which was purchased as the Varyag, a Kuznetsov-class carrier from Ukraine, refurbished, and is in service) is intended to show

[18] China, in terms of its economic systems, "makes 3 steps forward and 2 steps backward." In fact Chinese leadership is afraid of dividing the country into two parts; those who "have" and those who "do not have." In 2011-2012 China is "crack-downing on capitalism" (R. Foroohar, The Curious Capitalist. *TIME,* January 16, 2012, p.22). The government has intensified Internet controls, jailed a few intellectuals, and limited free speech and human rights in order to prevent a potential Chinese Spring or Summer. When Deng Xiaoping restored his authority in 1978 and said that "to be wealthy is not a sin," the Chinese economy begun growing; it flourished. Many officials use this new policy to make unexpected and huge profits. The state monopolies have fallen into the hands of small groups of party apparatchiks who maintain the political status quo for their own sake.

the world that China is a first-class naval power. Apparently, China is changing its strategic thinking, which was concentrated on crossing the sea to do battle on land, to looking to encircle Taiwan by adroitly deploying forces off Taiwan's east coast. In theory, a Chinese carrier-led naval task force could be used to deny the U.S. the ability to come to Taiwan's rescue[19]. The integration of Taiwan with mainland China is considered by China as an "internal issue."

Because Western civilization is intensively supporting its own development by transformation to a Global civilization, China has only to comply with this push and continue its own unprecedented development. According to popular estimations, China's economy should reach the level of the American economy in 2027, but it will be two times bigger in 2050 (Jacques, 2009). The question is, won't such a China that feels so strong want to disseminate its "winning" culture around the world? This author thinks as follows: If this becomes true, it will mean that China has abandoned its famous "middle of the road" politics. It will also mean that China will have entered a period when it will be risking what it has gained so far in the early 21st century and what it could not achieve in the last 500 years.

The most important question is -- will China be a superpower? Will there be a civilizational clash? The answer is reflected in the following "ifs"[20]:

a. If the Chinese leaders do not deal with corruption or maintain actual political stability, then China will never have a chance to become a superpower.
b. If, ironically, the U.S. helps (or even pushes) China to successfully become a country with a full democracy, then China will definitely become the leading superpower, given nothing changing in the United States and European Union.
c. If China Westernizes, then there will be no clash of "civilization" at all. Rather, there will be conflicts of interests.

The current Western approach to China follows step b, since the West thinks that it is the "best" and that every nation/state/civilization should Westernize. In this manner, the West is bringing up the future superpower, which will be its strategic competitor or perhaps even an enemy. Despite the wise opposition of Chinese seniors to Westernization, the younger generation and the huge Chinese diaspora are Westernizing quickly. A good proof of this is the decline of Chinatowns in the United States, which in the past were the hubs of Chinese culture and today are almost empty.

It is obvious that the development of Chinese civilization according to Western patterns sooner or later will lead to a shaking up of the balance of interests rather than to the hegemony of China in the global economy. We are already entering into this state of the

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[19] See "China's 65,000-ton secret." *Bloomberg Businessweek*. January 30-February 5, 2012, p. 65.
[20] These "ifs" were suggested by Professor Bernard Han, who consulted this author on the Chinese culture.

world civilization, because it is impossible to maintain the current rate of civilizational development for a population of 7-11 billion people. But such a number of potential customers is a dream of global corporations, which perceive good business lying ahead.

Therefore we face not the race for who will rule the world, but in reality we deal with the race for who will have the best access to the largest sources of energy and other strategic resources which are necessary to maintain our civilization in good shape. In this area, China has shown many initiatives and has successfully gained access to sources of oil in Africa, South America, and the Near East.

For example, in 2011 China signed contracts to import 65 percent of the world's reserves of iron ore and 40 percent of copper and aluminum. To secure these supplies, China operates mines from Zambia to Peru, extracts crude oil in Ethiopia, Kazakhstan, and Sudan, and invests in the extraction of natural gas in Australia and Turkey. China even invests in the extraction of coal in North America, since Chinese coal is of low quality. China is the largest importer of soybeans and also corn, which is needed for the rising consumption of meat.[21]

China was self-sufficient in its consumption of oil in the 20th century. In the 21st century, China became the second largest consumer of oil after the U.S. By about 2020, China may surpass the U.S. in consuming oil (Yergin, 2011:192). China has 170 cities with populations of one million and several cities with populations of ten million. The rising urbanization of China requires energy. To maintain good social order, China should create 25 million jobs every year.

Today, the economic powers race for access to strategic resources. The most important strategic resource is oil. The question is, will such an expanding global economy lead to a war between the U.S. and China?

From China's Rise to the Troubled Future of Civilization

China and the Business Growth Trap

The nonsense of the strategy of continuous economic growth is illustrated in Table 1, which compares the U.S. China, India, and the rest of the world's growth at the rate of the so-called "American Way of Life" in 2011. If the Chinese and Indians would like to live as the Americans do, then the world resources consumed would need to be 309 percent larger than are available now, even assuming that the rest of the world would be satisfied with the same material standards of living as they currently have.

[21] China's Buy List, *TIME,* January 9, 2012, p. 46-47.

Table 1. What Will Happen if China and India Grow as the U.S. Has?

COUNTRIES	Population (millions) 2011	% of World Resources Used 2011	American Way of Life - % of Resources Used 2011
USA	312	27	27
China	1,348	5	117
India	1,204	2	99
The Rest	4,136	66	66
Total	7,000	100	309

Source: Pocket World in Figures, *The Economist*, 2011, official centers and the Author's estimations

This comparison's conclusion can be supported by the analysis done by Lester Brown (2001:17) who noticed that:

- If the Chinese would like to eat as much beef as the Americans, then they will need 343 million tons of grain a year, an amount equal to the entire U.S. grain harvest.
- If the Chinese would like to eat as much fish as the Japanese, then they will need to consume 100 million tons of seafood – the entire world fish catch.
- If the Chinese would like to have two cars per household as the Americans do, then they would need 80 million barrels of oil per day, which is about 80 percent of the world production in 2011. Needless to say, the bigger size of parking lots would take 50 percent of the 31 million hectares currently used to produce the country's 132-million-ton harvest of rice, which is the basic food of these people.
- If the Chinese are to be more educated, then the consumption of paper would rise from 35 to 342 kilograms/per person (similar to the Americans), and they would need more paper than the world currently produces.

The business growth trap is very obvious in light of the provided examples. Its threat is very well seen in the big-picture perspective. Unfortunately, current business practices are oriented in small-picture perspectives. Also, political control of business is limited to a very short cycle, which neglects the decline of civilization on the small planet called Earth.

In 1972, an MIT research team led by Dennis Meadows published a book, *Limits to Growth*, predicting that growth on this planet will stop within the next one hundred years. They invoked five major trends of global concern: accelerating industrialization, rapid population growth, widespread malnutrition, depletion of nonrenewable resources, and a deteriorating environment. In the years following the publication of this book, people began to recycle wasted resources and thought more about sustainable growth. After the subsequent 36 years, a sixth trend of global concern must be added: unregulated turbo-capitalism (global economy), which threatens the well-being of Western civilization.

The Race for Resources and the Death Triangle of Civilization

“The race between population and resources leads to two related problems, the rate at which resources are being used (and used up), and the inequality in the distribution of resources,” (Cameron, 1993:404). The first threat can and perhaps will stop civilization sooner or later. The second threat will lead to internal and external wars of civilizations, which eventually will result in a more aggressive civilization at the expense of other civilizations.

Seen from space, Earth exhibits a striking difference from the other planets of the solar system: more than two-thirds of its surface is covered with water. Earth is the only planet in the solar system known to support life. Unlike the other planets, its crust is broken into plates that are in constant motion, borne along by currents of heat below. The Earth has a magnetic field generated by this heat, which is one of the sources of energy which drives civilization. The Earth is among four of the smallest plants in the Solar System. Its resources are finite.

From 4000 B.C. through 1800 A.D., our civilization grew three percent per 1,000 years, and the budgeting of strategic resources was not an issue (Maddison, 2001). Since the Industrial Revolution in the 19th century, civilization has been in accelerated growth and in the 21st century, it has entered the “growth trap” period. The growth trap is when accelerated growth is intensified by the growth of population and managerial/global turbo-capitalism, which looks for tremendous growth in executive benefits and replaces voters with lobbyists.

We used to think and act in terms of a local community, nation, region, or even a group of nations. But now we need to consider the broader – planetary – context if we want to sustain our social life. The planet is so large in relation to every individual but for the population it is becoming smaller and smaller. In the last 200 years the population has grown from 300 million to seven billion and is still growing. We have about 4.7 acres of available footprint but we use 5.4 acres in terms of calculated resources. “We are living beyond our ecological means. The planet is shrinking, because we are running out of resources. We are using the planet with such intensity that it is unable to restore itself,” (Steffen, 2008:16).

In terms of the two most important strategic resources of civilization, water and energy, the situation is as follows:

- **Water** – Over 97 percent of the Earth's water is in the oceans and has too much salt for the use of most land plants and animals. Of the 2.5 percent that is fresh water, about two-thirds is locked up in glaciers. This means that slightly less than one percent of the Earth's water is fresh and in liquid form. Irrigation systems are drying up the deltas of such major rivers as the Indus, Nile, Colorado, and some rivers in Europe. The U.N. set a goal to provide 13 gallons of safe water per day (within a few hundred meters of each family) to eight billion people in 2025. This goal is unrealistic, taking into account that according to the World Health Organization, the minimum need is five gallons of treated water a day per person, and it is difficult to provide this amount of water to everybody (Conkin, 2007:66).

- **Energy** – How long will our fossil fuels like oil, gas, and uranium last? Oil reserves should last about 40 years; gas, 51 years; uranium, 30-70 years; and coal, 200 years. Therefore, humans' knowledge and skills must replace these nonrenewable resources with ones that are either man-made (e.g., ethanol) or not subject to depletion (e.g., solar and wind energy). Otherwise, civilization will stop (Targowski, 2009:398).

There are many more threats to civilization, presented in Figure 1, which connects three dangerous bombs: the Population Bomb, the Ecological Bomb, and the Strategic Resources Depletion Bomb (Targowski, 2009:404).

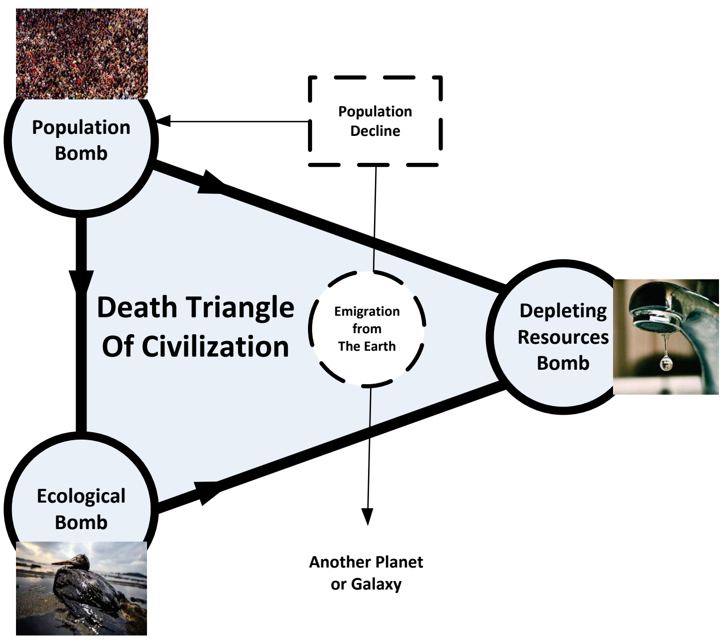

Figure 1. The Death Triangle of Civilization

The Death Triangle of Civilization will be controlling the global economy sooner than will China, supposedly the largest economic power in 2050, because the rise of China only accelerates the activation of that Triangle. In effect the whole world will enter such a complex, practically suicidal, situation that nobody will be able to manage it.

Can Western Knowledge Win Over Chinese Wisdom?

The present situation in the world civilization is not yet a confrontation between the Western and Chinese civilizations because the West still treats China as its "robot." It plans to utilize the cheap Chinese labor force as long as possible and to make a good profit. However, China is slowly getting out from under that subordination and beginning to surpass its master.

The Western civilization represented by the "1%" with the highest income recalls the last phase of Rome (476 A.D.), which dominated the world for nearly 1200 years. Similarly Western civilization dominated the world for nearly 1200 years since the rise of the Frankish Empire (800 A.D.). Table 2 compares the state of Rome I with the U.S. (Rome III).

Table 2. The Comparison of the Roman Empire and the U.S. in Times of Crisis

Criteria	**The Roman Empire** **5th Century A.D.**	**The United States** **The 2000s A.D.**
Rulers	Insensitive	Misleading
Politicians	Irrelevant	Self-serving
Elite	Passive	Detached
Military	Dispersed	Stretched-out
Work done by	Slaves & Servants	Computers Illegal immigrants working like slaves Offshore cheap labor
Ideas	Lack of ideas	Lack of ideas
Purpose of life	*Dolce vita*	The fun society
Mindset	Return to countryside and autarchy	Protectionist feelings and besieged
Viewed by others	Falling & attacked and beaten by weaker forces	Falling (Iraq & Afghanistan) & attacked by terrorists against whom one cannot decisively win

The comparison of Rome I and Rome III (the U.S.) gives the impression that the U.S. is in bad shape from the civilization point of view. It cannot lead Western civilization back to its previous prominent state.

The West is sure of its ability to create and disseminate knowledge, since it has been doing so very spectacularly for the last 500 years. In the Encyclopedia Britannica about 85 percent of the entries are about contributions made by Western civilization. Ricardo Duchesne in his book *The Uniqueness of Western Civilization* (2011) asks: what makes the West unique? He explains it is partly the singular emergence of democratic culture, including the capacity for self-criticism from which revisionism itself derives. It is partly the rationalization of so many spheres of life, from science to law. It is partly the culture of innovation and widespread competition. These are all classical explanations for the divergence of the West.

What Duchesne adds is an emphasis on the "continuous creativity," as he calls it, of the West, and the argument that the creativity of Western civilization derives from a longstanding matrix of aristocratic libertarianism. Another unique feature of Europeans was a relatively egalitarian (actually egalitarian-aristocratic) spirit. A king in Europe was usually a first among equals, at least among the aristocrats; at the very least no member of the nobility or aristocracy had to kowtow or prostrate themselves before a king. This is quite in contrast to despotic cultures almost anywhere else in the world. While some other warrior aristocracies (most notably Japan) had a similar "noblesse oblige" ethos, the egalitarianism was missing.

Of all these factors, the Western civilization lost the ability for self-correction by its elites, thus creating very strong economic inequality. Consequently, these two factors triggered the collapse of democratic values and the foundation of civil society. Such a society, while knowledgeable, cannot make good judgments and choices, which used to define its wisdom. Western civilization developed the belief that knowledge and technology can solve any crisis. In many cases this worked in the past. But when 9-11 billion people populate the Earth in 2050 and would like to live at the level of Westerners at the end of the 20th century, neither knowledge nor technology will solve the coming crisis.

Western society's loss of wisdom cannot compete with China's famous smartness, hard work, and wisdom to survive in very harsh conditions. This is contrary to some expectations that China must Westernize[22] like Japan in order to succeed, or that it will only be successful if it copies the American democratic model. In fact China learned much more from the failure of the Soviet Union and its fall in 1991, after seeing Russia's convulsions when transforming into the Western model.

The Chinese Communist Party saw that the Soviet Union was economically very inflexible at the citizen level. This led to its collapse in 1991. On the other hand, post-

[22] Chinese intellectual, Nobel Prize winner Liu Xiabo wrote that "I now realize that Western civilization, while it can be useful in reforming China in its present stage, cannot save humanity in an overall sense. I must 1). Use Western civilization as a tool to critique China. 2). Use my own creativity to critique the West." The New York Review of Books, February 9, 2012, p. 53.

Soviet Russia lost its grip on the economy and is in permanent turmoil. The lesson learned led China to two main rules: allow economic freedom at the bottom of society and simultaneously keep strong control at the top of the state by an authoritarian government. Perhaps this political system may be called modified communism or socialism. Needless to say, this is the future system of governing, in which the world will distribute limited strategic resources by coupons.

Then a strong government at the top will be required to supervise a life with limited resources. Perhaps it may even return to the level of Russian life under Leninism-Stalinism (1917-56). It will be a corrupt and ineffective system, of course, but people will be happy just to have something to eat and to keep them warm. Due to this system, China, which used to have a less comfortable civilization than the West, will be better off than the West during the time of the Death Triangle of Civilization's threats. Very probably the Chinese model will be adapted by the West so that it may address the coming critical times of the Triangle.

Table 3. The Comparison of Western and Chinese Civilizations

CRITERIA	WESTERN CIVILIZATION	CHINESE CIVILIZATION
State	Nation-states	Civilization-state spread through country and diaspora around the globe
Government	Democracy	Authoritarian Hierarchy
Culture	1200+ years old	5000 years old
Main values	Individualism Neglect of Seniors	Family Respect for Seniors
Hardship threshold	Low	High
Focus	Short and Instant	Long and Patient
Strongest knowledge	Scientific and Universal	Scientific and Conventional
Infrastructure	Complex	Simple and Complex
Interest	Extraverted	Introverted
Level of energy needed to support life activities	High	Low to Medium
Character	Arrogant	Submissive
Survival ability	Moderate	High

Source: Author's opinion, and Targowski (2009).

This comparison indicates that in the sense of enduring, Chinese civilization has better characteristics than Western civilization. This is proven by comparing 5000 to 1200 years, which means that the former has lasted four times longer than the latter. It is interesting that while Chinese civilization is still functioning, Western civilization is being transforming into Global civilization. This means that Western civilization is fading. The West in facing China's challenge does not show any strong vision, strategy, or will to correct its situation.

Toward the Wise Civilization and the Remaking of the Modern World in the 21st Century

In the 21st century we are facing the empirical fact that neither capitalism (particularly liberal and unregulated), nor socialism, nor communism are accomplished systems in the long-term. One must predict that a wise civilization (Targowski, 2011:185) will need a new political system in the 21st century that will be called Ecoism (or Eco-Superiority). This means that the ecosystem's long-term sustainability is superior to humankind's well-being in the short-term. This system is based on the following values:

- Eco-Justice, Eco-Freedom, and Eco-democracy
  To steer the development and operations of:
- Complementary Spirituality
- Integrated Society
- Deep Economy (Eco-Economy)
- Deep Communication
- Eco-Infrastructure

The values of Eco-Justice, Eco-Freedom, and Eco-Democracy mean that limits in terms of the well-being of the ecosystem must be given greater weight in traditionally perceived justice, freedom, and democracy. It is like in Deep Economy (Eco-Economy), where full economic cost cannot be limited only to business cost, but must include environmental and social costs as well.

Eco-Justice means that any crime and its consequences must also be evaluated from the ecosystem point of view.

Eco-Freedom means that humans are free in their choices and movements as long as they do not destroy the ecosystem. For example, deforestation should be forbidden, and the development of megacities should be controlled from an eco-policy point of view.

Eco-Democracy means that the balance of power must be preserved through free elections and a free press but that politicians and the press cannot act against the ecosystem, as they do today in the form of lobbyists' hidden support for politicians and the media. Consequently, the ecosystem will be *superior* to humans, who among themselves behave democratically but in facing the ecosystem are subordinate to it.

Complementary Spirituality - The level of spirituality and its complexity determines the possibility for a wise civilization. A low level or lack of spirituality in society puts a given civilization at risk. In the world's approximately 100 active major cultures, each one has its own kind of spirituality. To remove potential, if not certain, conflicts among them, one must find a common ground for them. This can be done by sharing selected values of each civilization and make of a set of complementary spiritual values. This will eventually lead to a Universal civilization as the potential wise civilization.

Integrated Society - The society of a wise civilization should be composed of people who are in solidarity with each other and are wise. In the age of globalization, most societies are multi-cultural, wherein each ethnicity has its own agenda and lives in an almost closed environment. To overcome this situation, they have to be able to integrate around a common culture, which will be called a *middle culture*.

Deep Communication - Current civilizations are driven by "shallow communication," particularly in mass media. They are very simplistic in delivering the news, focusing mostly on negative news about current events. The media rarely cover long-term issues with "deep background," which contains theoretical, global, and universal knowledge/wisdom about discussed issues.

Eco-Infrastructure - Contemporary civilizations have developed many supportive infrastructures (Targowski, 2009:15), which determine the well-being of humans. The most eco-driven infrastructures are urban, transportation, and information. The last two infrastructures created the foundation for the development of the Global civilization by the development of global transportation systems and the Internet. The eco-orientation of this infrastructure should be as follows:

- In the scope of the transportation infrastructure for a wise civilization, particularly for its North American part, one must expand metropolitan transit systems and intercity trains to reduce individual use of cars and save energy. The fuel consumption of cars should be regulated, and cars such as Hummers should not be produced.
- In the scope of the information infrastructure for the wise civilization, one must regulate the development of automation, according to the following laws (Targowski, 2009:273):
    - Law I. Do not develop service systems without human presence.
    - Law II. Do not develop service systems which harm society.
    - Law III. Do not develop service systems which endanger the human race.

Law I protects people against passivity; Law II protects society against structured unemployment; Law III protects the human race against bifurcation into two kinds of species.

Another set of laws for automation in manufacturing is provided by Targowski-Mordak (2011):

- Law I. Do not implement high automation technology before you are sure that the same goal cannot be achieved by other means.
- Law II. Do not implement automation technology with the aim to totally eliminate a human presence in a manufacturing process.
- Law III. Do not develop automation which harms society or endangers the human race.

In effect, the Ecoism (Eco-Superiority) political system satisfies all laws and rules of civilizations and adds new ones to expand human knowledge and wisdom, working for the sake of mankind and its environment.

Conclusions

One can draw the following conclusions:

1. The spectacular development of China in the 21st century has been triggered by Western civilization. It treats this country as its "robot" by economically colonizing its workforce, benefiting from cheap labor. It is a myth that so far China has improved its development through internal factors.
2. China is transforming in the 21st century from "a colonial robot" (low-level labor) into an economic superpower (high-level-labor, following the Japanese paths in the XX century), due to its wise top management, old culture, and increasing intellectual and infrastructural potential which is strengthening its internal developmental. As a result, China could surpass the U.S. in the 21st century in the size of its economy and eventually may become the hegemon of Asia and even the world. In this respect, China's ascendance is not a myth. However, if this premise should become a reality, it is assumed that the West will not be able to practice self-correction anymore, as it used to.
3. Today, it is doubtful whether the West can correct its service economy and return to the industrial or mixed economy because the financial elite still make huge profits through the strategy of outsourcing. This will continue until the "99%" movement transforms into a social revolution. This is the reality of Western civilization, which after transforming to the Global civilization has lost its Christian values and work ethics.
4. In the coming 10-15 years, economic cooperation between the West and China will transform into a conflict over strategic resources and particularly for oil. This may even reach a level of military confrontation, probably first *by proxy*. On the other hand, it is a myth that China is planning a military confrontation to establish a world order *a la* China. China will be content with achieving the status of the leader in Asia and the annexation of Taiwan, which is imminent.

It would be a waste of time and resources for the U.S. to try to maintain its leading role in Asia[23], because due to the shrinking of American financial might, this is impossible. The U.S. should keep its leadership in Europe, the Americas, and the Near East. This is a strategy which differs from the strategy offered by Z. Brzezinski (2012). It is too much for the declining U.S. to be a leader in another, faraway part of the world. Furthermore, competition from a richer and wiser China will be too much for the declining strategic abilities of the U.S., which so far are driven mostly by global corporations.

5. The clash over strategic resources and the well-being of citizens between the Western and Chinese civilizations will trigger the activation of the Death Triangle of Civilization. This is because a huge world population of 7-11 billion people will begin a fight for mere survival *a la* Darwinism. That clash may be very strong, or it may lead to wise cooperation to avoid the death of civilization. The latter is possible, since people usually behave better in a crisis than in good times.
   The reality of Western civilization is such that most of its population, particularly its elites, are too well-off and have lost the instinct for wisdom, despite developing rich knowledge.
6. It should be investigated further what is better from the civilizational point of view: to support less efficient Red China or more efficient White China? Which "China" will deplete sooner the strategic resources of our planet?
7. The development of a wise civilization is the only appropriate strategy in the 21st century. It is necessary to popularize it in schools, colleges, societies, and politics. It would be good to implement this strategy before our civilization declines too fast and disappears.
8. It is very probable that Western civilization will not outlive the knowledge which it created. Perhaps Chinese civilization will outlive the Triangle since is better at adapting to adverse conditions.
9. It would not be wrong to learn from the Chinese civilization what its wisdom is and how to use it for the sake of all. Should the West switch from 26 to a more effective 3000-5000 characters-oriented alphabet?

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[23] Some predict that within ten years, three of the world's five largest economies will be in Asia: China, Japan, and India (Time, January 30, 2012, p. 26). This is only if Western Civilization won't self-correct its economic strategy and the planet doubles its inventory of strategic resources.

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Annex 831

Robert Beckman, "International law, UNCLOS and the South China Sea", in *Beyond Territorial Disputes in the South China Sea* (R. Beckman et al., eds. 2013)

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2. International law, UNCLOS and the South China Sea

Robert Beckman

INTRODUCTION

This chapter will discuss the international legal framework governing the disputed islands in the South China Sea.[1] It will first briefly explain the territorial sovereignty disputes in the South China Sea between Brunei Darussalam, China, Malaysia, the Philippines, Viet Nam and Taiwan (the claimants) and the principles and rules of international law on the acquisition and loss of territorial sovereignty. It will then examine the significance of the 1982 United Nations Convention on the Law of the Sea[2] (UNCLOS) to the South China Sea disputes, including its provisions on the maritime zones which can be claimed by States from their mainland territory and from offshore geographic features, its provisions on maritime boundary delimitation and its provisions on dispute settlement. Finally, it will examine the evolving position of the claimants with regard to their maritime claims in the South China Sea. The objective of this chapter is to demonstrate that if the claimants comply in good faith with the relevant provisions of UNCLOS, it will clarify the maritime disputes and facilitate the establishment of a framework which will enable the claimants to co-operate in areas of overlapping maritime claims.

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1 On the South China disputes generally, see Robert W Smith, 'Maritime Delimitation in the South China Sea: Potentiality and Challenges', (2010) 41 Ocean Devel & Int'l L 214; See Clive Schofield and Ian Storey, *The South China Sea Dispute: Increasing Stakes, Rising Tensions*, Occasional Paper (Washington DC: The Jamestown Foundation, October 2009).

2 *United Nations Convention on the Law of the Sea*, Adopted in Montego Bay, Jamaica, on 10 December 1982, UNTS 1833, at 397 (entered into force 16 November 1994). As of 29 November 2012, 163 States and the European Union were parties to UNCLOS, online: United Nations http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm.

I. SOVEREIGNTY DISPUTES IN THE SOUTH CHINA SEA

The South China Sea has four groups of islands. The Spratly Islands are located on the east side of the South China Sea, west of the island of Palawan in the Philippines and northwest of the northern part of the island of Borneo, which consists of Brunei Darussalam and the East Malaysian states of Sabah and Sarawak. The Spratly Islands consist of more than 140 islets, rocks, reefs, shoals and sandbanks spread over an area of more than 410,000 square kilometers.[3] Some are totally or occasionally submerged while others are always dry. Less than 40 of the features are islands under Article 121(1) of UNCLOS, which defines an island as 'a naturally formed area of land, surrounded by water, which is above water at high tide'.[4] The total land area of the 13 largest islands is less than 1.7 square kilometres.[5] The remainder of the features are either completely submerged or are above water only at low tide. Because of the number of submerged reefs and low-tide elevations, the Spratly Islands are marked as 'dangerous ground' on navigation charts.[6] They lie east of the major international shipping routes.

All of the Spratly Islands are claimed by China, Taiwan, and Viet Nam. Many of the features of the Spratly Islands also fall within the Kalayaan Island Group (KIG) claimed by the Philippines. In addition, several features are claimed by Malaysia, and one reef lies within 200 nm of Brunei Darussalam.

More than 60 of the geographic features in the Spratlys are reportedly occupied by the claimants.[7] Itu Aba, the largest island and the only one with a natural water source, is occupied by Taiwan. The other 12 largest islands are occupied by either Viet Nam or the Philippines. Another report

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3 South China Sea Map, US Government Map, 803426A1 (G02284) 1-10, January 2010, online: CIL http://cil.nus.edu.sg/wp/wp-content/uploads/2011/06/75967_South-China-Sea-1.zip.

4 This compilation is based on the South China Sea Map, ibid; as well as information provided by David Hancox and Victor Prescott in Hancox and Prescott, *A Geographical Description of the Spratly Islands and an Account of Hydrographic Surveys Amongst Those Islands* (International Boundaries Research Unit, 1995) 1:6 *Maritime Briefing*.

5 This is based on an analysis of information provided in Hancox and Prescott, ibid.

6 Clive Schofield, 'Dangerous Ground – A Geopolitical Overview of the South China Sea' in S Bateman and R Emmers (eds), *The South China Sea: Towards a Cooperative Management Regime* (Routledge: London, 2009), at 17.

7 South China Sea Map, *supra* note 3.

indicates that a total of 44 features are occupied with installations and structures as follows: 25 by Viet Nam, eight by the Philippines, seven by China, three by Malaysia, and one by Taiwan.[8]

The Paracels are the second island group whose sovereignty is in dispute. They are located in the northeast corner of the South China Sea, approximately equidistant from the coast of Viet Nam and the Chinese island of Hainan. They are claimed by China, Taiwan, and Viet Nam. China forcibly ejected South Viet Namese troops from the Paracels in 1974,[9] and since then they have been occupied exclusively by China. China denies the existence of a territorial sovereignty dispute over the Paracels.[10] Nevertheless, the islands are a continuing source of tension between China and Viet Nam, especially with regard to the arrest of Viet Namese fishing vessels.[11]

The Paracels consist of about 35 islets, shoals, sandbanks and reefs with approximately 15,000 km² of ocean surface.[12] Woody Island is the location of Sansha City, a prefecture-level city established by China in June 2012 as its administrative centre for its claims in the South China Sea.[13]

Scarborough Shoal is another disputed feature in the South China Sea. It is located approximately 124 nm from Zambales Province in the Philippines,[14] and is claimed by China, the Philippines and Taiwan.

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8 Daniel J Dzurek, *The Spratly Islands: Who's On First?* (International Boundaries Research Unit: Durham, 1996), at 56–7.

9 Stein Tonnesson, 'Why are Disputes in the South China Sea so Intractable? A Historical Approach' (2002) 30:3 AJSS 570, at 574.

10 See for example, the response of the Chinese Foreign Ministry Spokesman to a question on Viet Nam's objections to Chinese military exercises around the Paracel Islands was to state 'it is known to all that China has undeniable sovereignty over the Xisha Islands and its adjacent islets. China and Viet Nam have no dispute over this issue', Foreign Ministry Spokesperson Qin Gang's Regular Press Conference (27 November 2007), online: China Ministry of Foreign Affairs http://www.fmprc.gov.cn/eng/xwfw/s2510/t385091.htm.

11 For example in March 2010, a Chinese patrol vessel seized a Viet Namese fishing boat and its 12-man crew around the Paracels; see Leszek Buszynski, 'The South China Sea: Oil, Maritime Claims and U.S – China Strategic Rivalry', (2012) 35:2 *The Washington Quarterly* 139, at 143.

12 South China Sea Map, *supra* note 3.

13 China's Ministry of Civil Affairs announced the establishment of Sansha on 21 June 2012. See China Establishes Sansha City, *Xinhuanet English News*, online: http://news.xinhuanet.com/english/china/2012-07/24/c_131734893.htm; confirmed by the Chinese Ministry of Foreign Affairs – see Foreign Ministry Spokesperson Hong Lei's Regular Press Conference on 25 June 2012, online: http://www.fmprc.gov.cn/eng/xwfw/s2510/2511/t945654.htm.

14 Republic of the Philippine, Ministry of Foreign Affairs, *Philippines Position on Bajo de Masinloc and the Waters within its Vicinity* (28 April 2012), at 1,

Scarborough Shoal is a large atoll with a lagoon of about 150 km² surrounded by reef.[15] Most of the reef is either completely submerged or above water only at low tide, but it contains several small rocks which are above water at high tide.[16] Scarborough Shoal was the scene of incidents between Chinese and Philippine vessels for several months in 2012.

Two geographic features in the northern part of the South China Sea are claimed by China and Taiwan, but not by other States. The first are the Pratas Islands, which are located in the northern part of the South China Sea, just over 200 miles southwest of Hong Kong. They are occupied by Taiwan. The second is Macclesfield Bank, a large atoll which is totally submerged even at low tide.[17] It is located in the northern part of the South China Sea, south of the Pratas Islands, east of the Paracels and west of Scarborough Shoal.

A. Principles on International Law on Acquisition and Loss of Territorial Sovereignty

The international law on the acquisition and loss of sovereignty over territory is governed by principles and rules of customary international law, as articulated by international courts and tribunals in the course of deciding sovereignty disputes which are referred to them for resolution.[18] Under customary international law, two of the most common modes of acquiring sovereignty over remote islands are by *occupation* and *prescription*. *Occupation* applies to territory that is *terra nullius*, that is, territory which is not under the sovereignty of any State and which is subject to acquisition by any State. Occupation requires proof of two elements: (1) the intention or will to act as the sovereign; and (2) the continuous and

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online: http://dfa.gov.ph/main/index.php/newsroom/dfa-releases/5216-philippine-position-on-bajo-de-masinloc-and-the-waters-within-its-vicinity.

15 Zou Keyuan, 'Scarborough Reef: A New Flashpoint in Sino-Philippine Relations?' (International Boundary Research Unit, 1999) *Boundary and Security Bulletin* 71, at 71.

16 See Keyuan, ibid; Philippine Position on Bajo de Masinloc, *supra* note 14, at 2.

17 See South China Sea Map 4508 of the United Kingdom Hydrographic Office, modified reproduction of INT Chart 508 (25 September 1987).

18 For a more detailed description of customary international law on the acquisition of territory, see David Harris, *Cases and Materials on International Law*, 7th edn (United Kingdom: Thomas Reuters, 2010) at 155–96. See generally, Robert Jennings and Alan Watts (eds), Oppenheim's International Law, 9th edn (Oxford: Oxford University Press, 1992), at 677–718; Ian Brownlie, *Principles of Public International Law*, 5th edn (Oxford: Oxford University Press, 1998), at 125–68.

peaceful display of sovereignty. The requirements for manifestations of territorial sovereignty for tiny, remote uninhabited islands are far less substantial than for land territory. *Prescription* applies to territory that was claimed by another State. It is described as the acquisition of territory through a continuous and undisturbed exercise of sovereignty during such a period as to usurp another State's sovereignty by its implied consent or acquiescence.

In actual practice, the distinction between occupation and prescription is often blurred, especially with respect to tiny, remote off-shore islands. In modern cases, such as the *Pedra Branca Case* between Malaysia and Singapore,[19] the International Court of Justice (ICJ) did not examine whether the historical requirements of occupation or prescription had been satisfied. Instead, the ICJ examined the acts undertaken by the two parties to the dispute which evidenced their belief that they had sovereignty over the features, and the reaction of these competing States to such displays of sovereignty.

An important factor in assessing a State's evidence of sovereignty is the reaction of other States, especially the reaction of another State which also claims sovereignty over the territory. If a second State claims sovereignty over the territory and it objects to or protests about the displays of sovereignty undertaken by the first State, this obviously weakens the claim of the first State. In addition, if a second State claiming sovereignty fails to object to acts of sovereignty of the first State of which it has notice, the second State may be deemed to have acquiesced to the sovereignty of the first State.

B. Resolution of the Sovereignty Dispute

The dispute over which claimant has the better claim to sovereignty over the islands cannot be resolved by an international court or tribunal unless all the claimants consent. Because the disputes are very sensitive and highly complex, it is unlikely that all of the claimants will ever agree to refer the sovereignty disputes to an international court or tribunal for resolution. All of the claimants except Brunei have attempted to bolster their sovereignty claims by occupying some of the islands and reefs and constructing air strips, research stations, tourist and military facilities on them. Taiwan occupies the largest island, Itu Aba. The other larger islands are occupied

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19 *Case Concerning Sovereignty over Pedra Branca/Pulau Batu Puteh, Middle Rocks and South Ledge (Malaysia/Singapore)*, (2008) ICJ Rep 12 ('*Pedra Branca Case*').

by Viet Nam and the Philippines.[20] Many claimants have also taken unilateral action to conduct seismic surveys to locate potential hydrocarbon resources. The claimants to the Spratly Islands are also very quick to officially protest any display of sovereignty by other States in order to protect their interests and make it clear that they have not acquiesced to the claim of another State. As a result, the disputes over the islands in the South China Sea are a major source of potential instability in the region.

II. THE IMPORTANCE OF UNCLOS

UNCLOS establishes a legal framework to govern all uses of the oceans. UNCLOS was adopted in 1982 after nine years of negotiations. It entered into force in 1994 and has been almost universally accepted.[21] China, Viet Nam, Malaysia, Philippines and Brunei are all parties.[22] Taiwan is not able to ratify UNCLOS because it is not recognized as a State by the United Nations, but it has taken steps to bring its domestic legislation into conformity with UNCLOS.[23]

UNCLOS is often described as a 'constitution for the oceans'[24] as it establishes the legal framework governing all uses of the oceans. It sets out the extent to which States can claim sovereignty over ocean spaces. It also sets out the rights and jurisdiction of States to explore and exploit the natural resources of the oceans, as well as the rights and freedoms of States to use the oceans.

UNCLOS has no provisions on how to determine sovereignty over offshore islands. Therefore, UNCLOS is not directly relevant to

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20 Schofield and Storey, *supra* note 1, at 10.

21 UNCLOS presently has 164 parties: See online: United Nations Treaty Collection http://treaties.un.org/pages/ViewDetailsIII.aspx?&src=TREATY&mtdsg_no=XXI~6&chapter=21&Temp=mtdsg3&lang=en#1.

22 The dates of ratification of the five claimant States are: Brunei Darussalam, 5 November 1996; China, 7 June 1996, Malaysia, 14 October 1996, Philippines, 8 May 1984, and Viet Nam, 25 July 1994. See online: UN Division for Ocean Affairs and Law of the Sea http://www.un.org/Depts/los/reference_files/status2010.pdf.

23 For the action taken by Taiwan to pass legislation claiming maritime zones as provided in UNCLOS, as well as a comparison of the positions of China and Taiwan, see Yann-Huei Song and Zou Keyuan, 'Maritime Legislation of Mainland China and Taiwan: Developments, Comparison, Implications, and Potential Challenges for the United States', (2000) 31 Ocean Devel & Int'l L 303, at 310–12.

24 Tommy TB Koh, 'A Constitution for the Oceans' (Statement by President Koh at the final session of the Conference at Montego Bay, 6 and 11 December 1982), reprinted in United Nations, *The Law of the Sea: United Nations Convention on the Law of the Sea* (1983) E.83.V.5.

resolving the dispute over which State has the better claim to sovereignty over the islands. However, UNCLOS has numerous provisions which are relevant to the South China Sea and which are legally binding on the claimants.

Once a State becomes a party to UNCLOS, it is under an obligation to bring its maritime claims and national laws into conformity with its rights and obligations under the Convention. Once UNCLOS enters into force for a State, its rights and obligations vis-à-vis other States Parties are governed by the provisions of the Convention. It is a fundamental principle of international law that a State cannot use its domestic law as an excuse not to conform to its obligations under an international treaty.[25] Therefore, in its relations with other States Parties, the provisions of UNCLOS prevail over any contrary provisions in the national laws of the State. As will be explained later, this principle also applies to any 'historic rights' to the resources of the oceans.

III. MARITIME ZONES UNDER UNCLOS

A. Maritime Zones from Land Territory

Under UNCLOS, States with sovereignty over land territory are permitted to claim maritime zones from such land territory. These maritime zones are measured from baselines. The normal baseline for measuring maritime zones is the low-water line along the coast.[26] Straight baselines may be employed if the coast is deeply indented or has a fringe of islands, provided that the baseline does not depart to an appreciable extent from the general direction of the coast.[27] The waters inside the baselines are known as internal waters.[28]

Special baseline rules apply to archipelagic States which consist entirely of island archipelagoes, such as Indonesia and the Philippines.[29] Archipelagic States are permitted to draw straight baselines connecting

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[25] *Vienna Convention on the Law of Treaties*, 22 May 1969, 1155 UNTS 331 (entered into force 27 January 1980), Article 27. Article 27 states that 'A party may not invoke the provisions of its internal law as justification for failure to perform a treaty.' The provisions of the Vienna Convention are generally regarded as binding on all States under customary international law.

[26] UNCLOS, *supra* note 2, Art 5.

[27] UNCLOS, *supra* note 2, Art 7.

[28] UNCLOS, *supra* note 2, Art 8.

[29] See Part IV of UNCLOS on Archipelagic States, *supra* note 2.

the outermost points of the outermost islands in their archipelago.[30] The waters inside the archipelagic baselines are called archipelagic waters. If a continental State has sovereignty over offshore island archipelagoes, the normal baselines rules apply to such archipelagoes because continental States do not fall within the definition of 'archipelagic States' under UNCLOS.[31]

UNCLOS provides that coastal States have sovereignty in the 12 nautical mile (nm) belt of sea adjacent to their coast called the territorial sea.[32] Archipelagic States also have sovereignty in their 'archipelagic waters'.[33] However, sovereignty in the territorial sea and in archipelagic waters is subject to the passage regimes in UNCLOS and to other rules of international law.[34]

UNCLOS made a revolutionary change in the law of the sea by establishing a new resource zone called the exclusive economic zone (EEZ)[35] which is adjacent to the territorial sea and which extends to 200 nm from the baselines from which the territorial sea is measured.[36] In their EEZ, coastal States have sovereign rights and jurisdiction for the purpose of exploring and exploiting the living and non-living natural resources of the waters superjacent to the seabed and of the seabed and its subsoil.[37] The EEZ regime in effect gives coastal States the vast majority of the oceans' fishing resources and hydrocarbon resources.

The other major resource zone in UNCLOS is the continental shelf.[38] The coastal State exercises sovereign rights over the continental shelf for the purpose of exploring it and exploiting its natural resources.[39] The continental shelf of a coastal State comprises the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the

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30 UNCLOS, *supra* note 2, Art 47.
31 For definition of 'archipelagic State', see UNCLOS, *supra* note 2, Art 46(b).
32 UNCLOS, *supra* note 2, Arts 2 and 3.
33 UNCLOS, *supra* note 2, Art 48.
34 Sovereignty over the territorial sea is exercised subject to the right of innocent passage of all vessels and to other rules of international law (Art 2(3) and Section 3 of Part II of UNCLOS) as well as the right of transit passage through straits used for international navigation as set out in Part III of UNCLOS. Sovereignty over archipelagic waters is subject to the right of both innocent passage and archipelagic sea lanes passage (Arts 52 and 53, UNCLOS).
35 See generally UNCLOS, *supra* note 2, Part V.
36 UNCLOS, *supra* note 2, Art 57.
37 UNCLOS, *supra* note 2, Art 56.
38 See generally UNCLOS, *supra* note 2, Part VI.
39 UNCLOS, *supra* note 2, Art 77.

continental margin, or to a distance of 200 nm from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin extends to less than this distance.[40]

In effect, this means that a coastal State has the sovereign right to explore and exploit the hydrocarbon resources off its coast out to the 200 nm limit under both the continental shelf regime and the EEZ regime. However, if a coastal State has a broad shelf off its coast, it has a right to claim a continental shelf out to 350 nm or even further by submitting technical information to a special body established under UNCLOS called the Commission on the Limits of the Continental Shelf (CLCS).[41]

When States become parties to UNCLOS, they agree that the sovereign right to explore and exploit the natural resources in and under the oceans off their coasts and islands will be governed by the provisions in UNCLOS. States Parties have in effect abandoned any traditional fishing rights or historic rights to natural resources, unless there are specific provisions in UNCLOS recognizing such rights.[42]

B. Offshore Features and their Maritime Zones

UNCLOS makes important distinctions between islands, rocks, low-tide elevations and artificial islands. The distinctions are significant because different maritime zones can be claimed from different features.

1. Islands

An island is defined in Article 121 of UNCLOS as a naturally formed area of land above water at high tide.[43] Islands are entitled to the same maritime zones as land territory, including a 12 nm territorial sea, a 200 nm EEZ and a continental shelf which could extend beyond 200 nm.[44]

2. Rocks

Rocks are also considered islands but Article 121(3) of UNCLOS provides that 'rocks which cannot sustain human habitation or economic life of

40 UNCLOS, *supra* note 2, Art 76(1).

41 UNCLOS, *supra* note 2, Arts 76(4) and 76(8).

42 An example of this is Art 51 of UNCLOS, which provides that an archipelagic State shall respect existing agreements with other States and shall recognize traditional fishing rights and other legitimate activities of the immediately adjacent neighbouring States in certain areas falling within archipelagic waters.

43 UNCLOS, *supra* note 2, Art 121(1).

44 UNCLOS, *supra* note 2, Art 121(2).

their own' shall have no EEZ or continental shelf. Rocks are only entitled to a 12 nm territorial sea.[45]

This phrase is deliberately vague because States at the UN Conference negotiating UNCLOS could not agree on more precise language.[46] The obvious intent was to provide that certain very small, uninhabitable features should not generate large resource zones. Article 121(3) has been the subject of a considerable amount of academic comment and debate,[47] but there has been no authoritative interpretation by any court or tribunal providing guidance on how it should be interpreted and applied.

The ICJ was invited to rule on this issue in the *Black Sea Case* between Romania and Ukraine.[48] Romania argued that Serpent's Island was a rock which cannot sustain human habitation or economic life of its own because it is a rocky formation in the geomorphologic sense and is devoid of natural water sources and virtually devoid of soil, vegetation and fauna. Further, Romania argued that human survival on the island is dependent on supplies, especially of water, from elsewhere and that the natural conditions there do not support the development of economic activities. It added that the presence of some individuals on the island, because they have to perform an official duty such as maintaining a lighthouse, does not amount to sustained human habitation. In response, Ukraine argued that Serpents' Island is indisputably an 'island' under Article 121(2) of UNCLOS, rather than a 'rock'. Ukraine contended that the evidence shows that Serpents' Island can readily sustain human habitation and that it is well established that it can sustain economic life of its own. In particular, the island has vegetation and a sufficient supply of fresh water.[49] Ukraine further asserted that Serpents' Island 'is an island with

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45 UNCLOS, *supra* note 2, Art 121(3).

46 For a brief history of the provision and State practice in the Pacific region, see Yuen-Huei Song, 'The Application of Article 121 of the Law of the Sea Convention to Selected Geographical Features Situated in the Pacific Ocean', (2010) 9 Chinese J Int'l L 663. For the detailed legislative history, see Office for Ocean Affairs and the Law of the Sea, *The Law of the Sea, Regime of Islands, Legislative History of Part VIII (Article 121) of the United Nations Convention on the Law of the Sea* (New York: UN, 1988).

47 See generally Jon M Van Dyke and Robert A Brooks, 'Uninhabited Islands: Their Impact on the Ownerships of the Oceans' Resources', (1983) 12 Ocean Devel & Int'l L 265; JI Charney, 'Rocks that Cannot Sustain Human Habitation,' (1999) 93 AJIL 863; B Kwiatkowska and AHA Soons, 'Entitlement to Maritime Areas of Rocks which Cannot Sustain Human Habitation or Economic Life of Their Own', (1990) 21 Netherlands YB Int'l L 139.

48 *Maritime Delimitation in the Black Sea (Romania v Ukraine)* (2009) ICJ Rep 61 ('*Black Sea Case*').

49 Ibid, at para 180.

appropriate buildings and accommodation for an active population'.[50] Unfortunately, the ICJ decided that it did not need to consider whether Serpents' Island falls under paragraph 2 or 3 of Article 121 of UNCLOS to determine the maritime boundary.[51] Nevertheless, the arguments put forward in that case provide guidance on how a case concerning the interpretation of Article 121(3) is likely to be argued.

One former member of the International Tribunal for the Law of the Sea, Judge Budislav Vukas of Croatia, made a Declaration in one of its cases on how Article 121(3) should be interpreted. He concluded his statement as follows:[52]

> 10. The purpose of this brief text is to explain my belief that the establishment of exclusive economic zones around rocks and other small islands serves no useful purpose and that it is contrary to international law.
>
> It is interesting to note that Ambassador Arvid Pardo – the main architect of the contemporary law of the sea – warned the international community of the danger of such a development back in 1971. In the United Nations Seabed Committee he stated:
>
> 'If a 200 mile limit of jurisdiction could be founded on the possession of uninhabited, remote or very small islands, the effectiveness of international administration of ocean space beyond national jurisdiction would be gravely impaired.'
>
> The annexed map showing Australia's exclusive economic zone around Heard Island and the McDonald Islands, provided by the Agent of the Respondent, confirms that Ambassador Pardo's fear has been borne out.

3. Low-tide elevations

A low-tide elevation is a feature which is above water at low-tide but submerged at high tide, so it is not an island.[53] Low-tide elevations are not entitled to any territorial sea of their own, but can be used as base points to measure the territorial sea if they are within 12 nm from the mainland or an island.[54] If a low-tide elevation is built up through land reclamation or if structures are built on it, it may either remain a low-tide elevation or become an artificial island. It does not become an island because it is not a 'naturally formed' area of land above water at high tide. Because it is a low-tide elevation or an artificial island, it is not entitled to any maritime

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50 Ibid, at para 184.

51 Ibid, at para. 187.

52 *The 'Volga' Case (Russian Federation v Australia)* (2002), Declaration of Vice-President Voukas, ITLOS, No 11, at para 10, online: ITLOS www.itlos.org/fileadmin/itlos/documents/cases/case_no_11/decl.Vukas.E.pdf.

53 UNCLOS, *supra* note 2, Art 13.

54 UNCLOS, *supra* note 2, Art 13.

zones of its own. In addition, as the ICJ pointed out in the *Pedra Branca* Case and the *Qatar/Bahrain* Case, it is not clear whether a State may lawfully claim sovereignty over a low-tide elevation situated more than 12 nm from the mainland coast or another island.[55]

4. Artificial islands, installations and structures

Artificial islands, installations and structures are not islands, and are not entitled to any maritime zones of their own but may be entitled to a 500 metre safety zone.[56] Within the territorial sea, they are subject to the sovereignty of the coastal state. In the EEZ and on the continental shelf,[57] a coastal state has the exclusive right to construct and to authorize and regulate the construction, operation and use of: (a) artificial islands; (b) installations and structures for economic purposes; and (c) installations and structures which may interfere with the exercise of the rights of the coastal state in the zone.[58] Coastal states have exclusive jurisdiction over such artificial islands, installations and structures, including jurisdiction with regard to customs, fiscal and health issues.

IV. MARITIME CLAIMS IN THE SOUTH CHINA SEA

The preceding Section described what maritime claims States are entitled to make under UNCLOS both from mainland territory and from offshore features. This Section examines the various maritime claims that the claimants have asserted in the South China Sea. In particular, it will discuss (A) maritime claims made from the mainland territory of the claimant States; (B) maritime claims from the offshore features in the South China Sea; (C) China's 'Nine-Dashed Line' Claim; (D) extended continental shelf claims

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55 *Pedra Branca Case*, *supra* note 19, at paras 295–296; *Maritime Delimitation and Territorial Questions between Qatar and Bahrain*, Merits, Judgment (2001) ICJ Reports 40 ('*Qatar/Bahrain*'), at paras 205–206.

56 UNCLOS, *supra* note 2, Art 60(8).

57 UNCLOS, *supra* note 2, Arts 60 and 80. The term 'artificial island' is not defined in UNCLOS. However, it generally refers to a feature which is above water at high tide because of land reclamation or other human activity. In other words, it fails to meet the definition of an 'island' under Article 121 because it is not a 'naturally formed' area of land, but rather is a man-made feature. Installations and structures are also not defined, but they would refer to things like buildings, lighthouses, research stations and oil platforms. Installations and structures are often built on low-tide elevations or submerged features.

58 UNCLOS, *supra* note 2, Art 60(1).

in the South China Sea and (E) the evolving position of the claimant States in relation to their South China Sea claims.

A. Maritime Claims from the Mainland Territory of the Claimant States

The first point to note before dealing with the maritime claims of the claimants is that there are potential disputes in the South China Sea over the baselines from which the maritime zones are measured from land territory or islands. The baselines deployed by Viet Nam have been criticized by the United States as inconsistent with UNCLOS.[59] China has declared straight baselines around the Paracel islands even though continental States like China are not permitted under UNCLOS to employ straight baselines around mid-ocean archipelagoes. China's use of straight baselines along its coast has been criticized by the United States as inconsistent with UNCLOS.[60] Taiwan's use of straight baselines has also been criticized by the United States as inconsistent with UNCLOS.[61] It is generally accepted that the archipelagic baselines declared by the Philippines in 2009 pursuant to its 2009 baselines legislation are consistent with UNCLOS.[62] Malaysia issued a map in 1979 setting out its continental shelf claim off the States of Sabah and Sarawak, but it did not publish the baselines from which the zone was measured. Malaysia passed a Baselines of Maritime Zones Act 2006, but it has yet to officially designate its baselines under the Act.

With regard to the maritime claims made from such baselines, all

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59 J Ashley Roach and Robert W Smith, *United States Responses to Excessive Maritime Claims*, 2nd edn (Boston: Martinus Nijhoff Publishers, 1996), at 101–3; US State Department, *Limits in the Seas* No. 99, Straight Baselines: Viet Nam, 12 December 1983 (www.law.fsu.edu/library/collection/limitsinseas/LS099.pdf).

60 See US Department of State, 'Straight Baseline Claim: China,' *Limits in the Seas*, No 117 (Washington, DC: Office of Ocean Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, US Department of State, 9 July 1996), online: US Department of State http://www.state.gov/documents/organization/57692.pdf.

61 See US Department of State, 'Taiwan's Maritime Claims,' *Limits in the Seas*, No 127 (Washington, DC: Office of Ocean Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, US Department of State, 15 November 2005), online: US Department of State www.state.gov/documents/organization/57674.pdf.

62 Republic Act No. 9522, An act to amend certain provisions of Republic Act No. 3046, as amended by Republic Act No. 5466, to Define the Archipelagic Baselines of the Philippines (enacted into Law on 10 March 2009), online: United Nations www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/PHL.htm.

the claimants (Brunei, China, Taiwan, Malaysia, Viet Nam and the Philippines), pursuant to UNCLOS, have claimed a territorial sea, an EEZ and continental shelf from their archipelagic baselines or baselines along their mainland coast[63] although the precise locations of the outer limits of some of their EEZ and continental shelf claims remain unclear. In 2009, Malaysia and Viet Nam submitted extended continental shelf claims to the CLCS which clarified the outer limit of the EEZ of these States in the South China Sea (this will be discussed further in Section D below). Although the Philippines has not issued a map indicating the outer limit of its EEZ claim in the South China Sea, it has clarified its archipelagic baselines in its 2009 baselines law, and it is easy to calculate where its EEZ boundary would be by measuring 200 nm from its archipelagic baselines.

B. Maritime Claims from Offshore Features in the South China Sea

The application of the provisions of UNCLOS to the offshore geographic features in the South China Sea raises several important issues. First, it is not clear how many geographic features there are in the South China Sea, and how many would be classified as islands, being naturally formed areas of land above water at high tide.[64] One analyst has noted that there may be

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63 Brunei Darussalam enacted the Territorial Waters of Brunei Act, 1982; China issued the Declaration on the Baselines of the Territorial Sea (15 May 1996), the Law on the Territorial Sea and the Contiguous Zone (25 February 1992), the Law on Exclusive Economic Zone and Continental Shelf (26 June 2008). Indonesia issued Law No 1/1973 concerning Continental Shelf (6 January 1973); Law No 5/1983 concerning Indonesia Exclusive Economic Zone (18 October 1983); Law No 6/1996 concerning Indonesian Water (8 August 1996); Government Regulations No 38/2002 on the Geographical List of Coordinates of the Indonesian Archipelagic Baselines (28 June 2002) and Government Regulations No 37/2008 amending Regulations No 38/2002 (19 May 2008). Malaysia enacted the Baselines of Maritime Zones Act 2006 – Act 660 (29 December 2006) and the Territorial Sea Act 2012 – Act 750 (18 June 2012). The Philippines passed the Act to Amend Certain Provisions of Republic Act No 3046, as Amended by Republic Act No 5446, to Define the Archipelagic Baselines of the Philippines and for other Purposes (10 March 2009). Viet Nam adopted the Law of the Sea of Viet Nam, Law No 18/2012/QH13 (21 June 2012), and issued the Statement on the Territorial Sea, the Contiguous Zone, the Exclusive Economic Zone and the Continental Shelf (12 May 1977) and the Statement on the Territorial Sea Baseline (12 November 1982). Taiwan enacted the Law on the Territorial Sea and Contiguous Zone of the Republic of China (21 January 1998) and the Law on the Exclusive Economic Zone and the Continental Shelf of the Republic of China (21 January 1998).

64 For descriptions of the geographic features in the Spratly Islands, see David

more than 170 geographic features in the South China Sea, but that only about 36 of them are islands above water at high tide.[65]

Second, it is also not clear how many of the islands in the Spratly Islands would be entitled to an EEZ and continental shelf because they are capable of sustaining human habitation or economic life of their own. The largest island, Itu Aba, which is occupied by Taiwan, is reportedly approximately 1400 metres long and 400 metres wide or about 0.46 square kilometres.[66] All of the largest islands in the Spratlys are within the Kalayaan Islands Group (KIG) claimed by the Philippines, except for Spratly Island,[67] which is occupied by Viet Nam.[68] One writer has addressed the issue of whether the islands in the Spratlys are rocks or islands and concluded that none of the islands would be capable of sustaining human habitation or economic life of their own.[69] However, the argument can certainly be made that the larger islands with land and vegetation are capable of sustaining human habitation or economic life of their own, even if some of them do not have a natural source of water. This is true of some of the islands in the Paracels as well as the Spratlys.

Third, another issue which could arise in the South China Sea is the status of features which are permanently submerged, even at low tide. The UNCLOS provisions imply that such features would be treated as part of the seabed and subsoil. If they were within the EEZ or on the continental shelf of a State, the State would have sovereign rights and jurisdiction to explore and exploit the natural resources. If they were outside the EEZ or continental shelf of any State, they would be part of the deep seabed, or 'the Area', and would be subject to the jurisdiction of the International Seabed Authority. This issue could arise with respect to several features in the South China Sea, including Macclesfield Bank, a sunken atoll which

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Hancox and Victor Prescott, *supra* note 4; Daniel J Dzurek, *supra* note 8; Mark J Valencia, Jon M Van Dyke and Noel A Ludwig, *Sharing the Resources in the South China Sea* (University of Hawaii Press, 1997), Appendix 1: Descriptions of the Spratly Features, at 225-35, online: Digital Gazetteer of the Spratly Islands http://community.middlebury.edu/~scs/macand/gazetteer.htm.

65 Dzurek, *supra* note 8, at 54.

66 Valencia, Van Dyke and Ludwig, *supra* note 64, at 230.

67 Although the group of islands is known as the 'Spratly Islands', there is also an individual island in the group known as 'Spratly Island'.

68 In addition to Itu Aba, the largest features in the Spratlys are four islands occupied by Viet Nam (Spratly Island, Namyit Island, Southwest Cay and Sin Cowe Island) and three occupied by the Philippines (Thitu Island, Loaita Island and Northwest Cay).

69 Marius Gjetnes, 'The Spratlys: Are They Rocks or Islands?' (2001) 32 Ocean Devel & Int'l L 191, at 201.

is reported to be completely submerged, even at low-tide.[70] China has traditionally claimed Macclesfield Bank.

It is pertinent to note that none of the claimants have officially stated which features they consider to be islands, rocks, low-tide elevations etc. Further, none of the claimants, with the exception of China, have confirmed whether and what maritime zones they believe the features are entitled to. China, in a Note Verbale submitted to the United Nations in 2011, stated that China's Nansha Islands (Spratly Islands) are fully entitled to a territorial sea, exclusive economic zone and continental shelf.[71] China has not, however, designated baselines around the Spratly Islands or officially claimed any maritime zones from any of the islands.

C. China's 'Nine-Dashed Lines' Map

It is undeniable that China has a historic claim to sovereignty over all of the islands, reefs and banks in the South China Sea, which it groups into four major archipelagic groups – Dongsha (Pratas), Xisa (Paracels), Zongsha (Macclesfield Bank) and Nansha (Spratlys) – as well as the Huangyan Island (Scarborough Reef). Articles summarizing China's historic claim make it clear that China has claimed the geographic features in these areas since ancient times. They do not purport to assert that China has a historic claim to all of the waters in the South China Sea.[72]

In recent years controversy has arisen over whether China's claim is not just to the features, but also to the waters inside the lines on its maps. This has raised questions and debate about the significance of the infamous 'nine-dashed lines' map of China and Taiwan and the nature of its claim. The Chinese nine-dashed lines first appeared in a Chinese map in 1914 by Chinese cartographer Hu Jin Jie.[73] In 1947, the Government of the

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[70] Alex G Oude Elferink, 'The Islands in the South China Sea: How Does Their Presence Limit the Extent of the High Seas and the Area and the Maritime Zones of the Mainland Coasts?' (2001) 32 Ocean Devel & Int'l L 169, at 177.

[71] Note from the Permanent Mission of the People's Republic of China to the Secretary-General of the United Nations, CML/8/2011, 14 April 2011, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2011_re_phl_e.pdf.

[72] For excellent summaries of the historic claim of China, see Jiangming Shen, 'International Law Rules and Historical Evidences Supporting China's Title to the South China Sea Islands' (1997–98) 21 Hastings Int'l & Comp L Rev 1; Jiangming Shen, 'China's Sovereignty over the South China Sea Islands: A Historical Perspective' (2002) 1 Chinese J Int'l L 94.

[73] Zou Keyuan 'The Chinese Traditional Maritime Boundary Line in the

Republic of China (presently Taiwan) published an official map of the archipelago of the South China Sea using 11 interrupted lines drawn in a 'u-shape' around most of the features of the Spratly Islands.[74] Two of these lines in the Tonkin Gulf area were later deleted and the line has come to be known as the 'interrupted lines' or 'nine-dashed lines'. The map was subsequently adopted by the People's Republic of China.

Questions arose in the 1990s on the status of China's nine-dashed lines. Some commentators took the view that China was using the nine-dashed line to claim all the waters as historic waters in which China would have historic rights.[75] Other commentators, however, are of the view that China only claims the islands and their adjacent waters inside the nine-dashed line.[76] Interestingly, this view was also expressed by Zhiguo Gao, China's judge on the International Tribunal for the Law of the Sea (ITLOS). In a 1994 article, Judge Gao opined that 'the boundary line on the Chinese map is merely a line that delineates ownership of islands rather than a maritime boundary in the conventional sense'.[77]

Some Chinese scholars have argued that among the 'historic rights' which China has enjoyed in the South China Sea is the right to fish in the waters of traditional fishing grounds in the South China Sea.[78] Chinese fishermen have traditionally fished in the South China Sea in waters now claimed as the EEZ of other claimant States in the South China Sea and possibly even the waters claimed as the EEZ of Indonesia. However, when China ratified UNCLOS in 1996, it in effect agreed that access to fishing resources in the oceans would be determined by the provisions of UNCLOS. Under UNCLOS, coastal States have the right to claim an EEZ of 200 nm from their baselines, as well as the sovereign right to explore and exploit the living resources in that EEZ. The UNCLOS provisions on the EEZ do not require the coastal State to allow foreign fisherman to continue to fish in their traditional fishing grounds within its EEZ. The only obligation of the coastal State with respect to economic dislocation is set out in Article 62 granting access to 'surplus' when a

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South China Sea and its Legal Consequences for the Resolution of the dispute over the Spratly Islands', (1999) 14:1 Int'l J Mar & Coast L 27, at 52.

74 Ibid.

75 Li Jinming and Li Dexia, 'The Dotted Line on the Chinese Map of the South China Sea: A Note', (2003) 34 Ocean Devel & Int'l L 287, at 291–2.

76 Zou Keyuan, *supra* note 73, at 52; Yann-huei Song and Peter Kien-hong Yu, 'China's 'Historic Waters' in the South China Sea: An Analysis from Taiwan, R.O.C.', (1994) 12 AA Rev 83, at 83–4.

77 Zhiguo Gao, 'The South China Sea: From Conflict to Cooperation?' (1994) 25 Ocean Devel & Int'l L 345, at 346.

78 Yann-huei Song and Zou Keyuan, *supra* note 23, at 118.

State's 'capacity to harvest' the fishing resources in its EEZ is less than the 'allowable catch' determined in order to promote optimal utilization of the fishing resources in its EEZ.[79] Article 62(3) provides that when giving access to any surplus, one of the factors which the coastal State shall take into account is 'the need to minimize economic dislocation in States whose nationals have habitually fished in the zone'. However, this is only one of several factors the coastal State must consider when granting access to any surplus, and the coastal State has discretion to decide whose nationals shall be given access to the surplus.

The concern with regards to China's claim to 'historic rights' outside its territorial sea is reinforced by the fact that its 1998 Law on the Exclusive Economic Zone and Continental Shelf contains a provision which seems to be intended to preserve its historic rights beyond its territorial sea. Article 14 of China's 1998 Law provides that the provisions of this Law 'shall not affect the historic rights enjoyed by the People's Republic of China'.[80] Therefore, China has included a position in its domestic legislation which could be intended to preserve certain 'historic rights' in the South China Sea. However, there is serious doubt whether a provision in China's domestic legislation could preserve the rights of Chinese nationals in areas outside China's national jurisdiction. Also, as stated earlier, when China ratified UNCLOS in 1996, it gave up whatever historic rights it had to the natural resources in areas that are now the EEZ or continental shelf of other States. China's legal relations with other Parties to UNCLOS are now governed by UNCLOS, and China cannot use its domestic law as an excuse not to fulfil its international obligations under UNCLOS.

Finally, it should be noted that under UNCLOS the waters in the South China Sea seaward of the outer limit of the 12 nm territorial sea measured from the land territory or from islands would be either EEZ or high seas. Article 58(1) provides that in the EEZ, all States enjoy the high seas freedoms of navigation and overflight and of the laying of submarine cables and pipelines, and other internationally lawful uses of the sea related to these freedoms, such as those associated with the operation of ships, aircraft and submarine cables and pipelines. This ensures that notwithstanding who has sovereignty over the islands and the territorial sea

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79 Article 61 sets out the requirements for determining the allowable catch and capacity to harvest.

80 *Economic Zone and Continental Shelf Act*, adopted at the third session of the Standing Committee of the Ninth National People's Congress of the People's Republic of China (26 June 1998), online: United Nations www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/CHN.htm.

adjacent to them, the freedom of all States to enjoy high seas freedoms in those waters cannot be impeded.

China has officially recognized that the high seas freedoms of navigation and overflight apply in the South China Sea. In response to concerns expressed by the US State Department in May 1995,[81] the PRC Foreign Ministry Spokesman Chen Jian stated that while safeguarding its sovereignty over the Nansha Islands, and its marine rights and interests, China will fulfil its duty of guaranteeing freedom of navigation and overflight in the South China Sea according to international law.[82] China reiterated this position as recently as 21 June 2011.[83]

D. Extended Continental Shelf Claims in the South China Sea

1. Rules and procedures concerning claims to continental shelf beyond 200 nm

As mentioned above, Article 76 of UNCLOS permits States to make continental shelf claims beyond 200 nm out to a maximum of 350 nm or even further,[84] by submitting technical information to the CLCS.[85] The deadline for submission of claims for most States Parties was 13 May 2009.[86]

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[81] The US State Department stated that it takes no position on the competing claims to sovereignty in the South China Sea, but that it would view with serious concern any maritime claim, or restriction on maritime activity, that was not consistent with international law, including UNCLOS; see: US Department of State, Daily Press Briefing 'Spratlys and the South China Sea' (10 May 1995), online: US Department of State http://dosfan.lib.uic.edu/ERC/briefing/daily_briefings/1995/9505/950510db.html.

[82] Statement of PRC Foreign Ministry Spokesman Chan Jian, 'News Briefing by Chinese Foreign Ministry', Beijing Review (8–14 May 1995), at 22, cited in Yann-huei Song and Zou Keyuan, *supra* note 23.

[83] China Foreign Ministry Spokesperson Hong Lei stated that 'China's position on the South China Sea is clear and consistent. China safeguards its sovereignty and maritime rights and interests in the South China Sea, which does not affect freedom of navigation in the South China Sea enjoyed by countries according to international law. In fact, freedom of navigation in the South China Sea is out of question'; see: China Foreign Ministry, Regular Press Conference (21 June 2011), online: www.fmprc.gov.cn/eng/xwfw/s2510/t833157.htm.

[84] UNCLOS, *supra* note 2, Art 76(4).

[85] UNCLOS, *supra* note 2, Art 76(8).

[86] Art 4 of Annex II required coastal states intending to establish the outer limits to their continental shelf beyond 200 nm to submit particulars of such limits to the CLCS within 10 years of the entry into force of UNCLOS. In 2008 states parties agreed to amend the requirement to allow states to meet the time period requirements by submitting preliminary information to the CLCS. See United Nations Convention on the Law of the Sea, Meeting of States Parties, Eighteenth

Article 76 provides that the Commission shall make recommendations to coastal States on matters related to the establishment of the outer limits of their continental shelf.[87] It also provides that the limits of the shelf established by a coastal State on the basis of these recommendations shall be final and binding.[88] However, it further provides that the provisions of Article 76 are without prejudice to the question of delimitation of the continental shelf between States with opposite or adjacent coasts.[89]

The effect of a submission to the Commission on 'existing maritime disputes' is dealt with specifically in the Rules of Procedure of the Commission.[90] Article 5(a) of Annex I provides that in cases where a land or maritime dispute exists, the Commission shall not consider and qualify a submission made by any of the States concerned in the dispute. However, the Commission may consider one or more submissions in the areas under dispute with prior consent given by all States that are parties to such a dispute.[91]

2. Submissions by ASEAN claimant States and related communications

In May 2009, Malaysia and Viet Nam made a joint submission to the Commission to extend their continental shelves beyond 200 nm into the South China Sea.[92] Viet Nam also made a separate

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Meeting, New York, 13–20 June 2008, SPLOS/183 (20 June 2008), online: http://www.un.org/Docs/journal/asp/ws.asp?m=SPLOS/183.

[87] UNCLOS, *supra* note 2, Art 76(8).

[88] UNCLOS, *supra* note 2, Art 76(8). This clause is not without ambiguity. It can be argued that the limits would be final and binding only on the coastal State extending its shelf on the basis of the recommendations.

[89] UNCLOS, *supra* note 2, Art 76(10).

[90] See Annex I of Rules of Procedure of the Commission on the Limits of the Continental Shelf, online: United Nations http://www.un.org/Depts/los/clcs_new/commission_rules.htm.

[91] Ibid.

[92] *Joint Submission to the Commission on the Limits of the Continental Shelf pursuant to Article 76, paragraph 8 of the United Nations Convention on the Law of the Sea 1982 in respect of the southern part of the South China Sea*, Executive Summary, 6 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm; Note from the Permanent Mission of the Republic of the Philippines to the United Nations to the Secretary-General of the United Nations, No. 000819, 4 August 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/clcs_33_2009_los_phl.pdf; Note from the Permanent Mission of Malaysia to the United Nations addressed to the Secretary General of the United Nations, HA 41/09, 21 August 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/mys_re_phl_2009re_mys_vnm_e.pdf. The Joint Submission of Malaysia and Viet Nam, as well as the

submission.[93] The submissions had one significant side effect. Maps included in the submissions clarified the 200 nm EEZ claims of Malaysia and Viet Nam. The submissions were also significant because Malaysia and Viet Nam claimed an EEZ only from the baselines along their mainland. They did not claim an EEZ from any of the islands they claimed in the Spratly Islands.

China immediately objected to these submissions through a Note Verbale dated 7 May 2009 to the UN Secretary-General in response to the Joint Submission of Malaysia and Viet Nam to the CLCS. China stated that the joint submission of Malaysia and Viet Nam 'seriously infringed China's sovereignty, sovereign rights and jurisdiction in the South China Sea'.[94] China referred to Article 5(a) of Annex I of the Rules of Procedure of the Commission, and requested the Commission not to consider the submissions of Malaysia and Viet Nam.[95] Given that a maritime dispute exists in the South China Sea, China's objection was a lawful response to the submissions, and the Commission will not be able to consider the submissions of Malaysia and Viet Nam.

In its Note Verbale of 4 August 2009 the Philippines also objected to the Joint Submission of Malaysia and Viet Nam because it lays claim to areas that are disputed. The Philippines stated that not only does the joint submission overlap with claims of the Philippines in the South China Sea, but also because there are conflicting claims to sovereignty over some of the islands and over the area known as North Borneo. This revived the historic claim of the Philippines to the Malaysian State of Sabah, which the Philippines refers to as North Borneo. The Philippines also pointed out

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Communications submitted to the UN Secretary-General by China, Malaysia, the Philippines, Viet Nam and Indonesia with regard to the Joint Submission of Malaysia and Viet Nam, are available online: CLCS www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm.

[93] *Partial Submission to the Commission on the Limits of the Continental Shelf pursuant to Article 76, paragraph 8 of the United Nations Convention on the Law of the Sea 1982 in respect of Viet Nam's extended continental shelf: North Area (VNM-N)*, Executive Summary, 7 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/vnm37_09/vnm2009n_executivesummary.pdf.

[94] See Note from the Permanent Mission of the People's Republic of China addressed to the Secretary General of the United Nations, CML/17/2009, 7 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm.

[95] Ibid.

that under its Rules of Procedure, the CLCS cannot consider a submission in cases where a land or maritime dispute exists.[96]

In its Note Verbale dated 7 May 2009 China included one sentence which has created considerable controversy. It reads as follows:[97]

> China has indisputable sovereignty over the islands in the South China Sea and the adjacent waters, and enjoys sovereign rights and jurisdiction over the relevant waters as well as the seabed and subsoil thereof (see attached map).

The attached map which was referred to was the nine-dashed line map. By attaching that map to a communication sent to the UN Secretary-General and asking that it be circulated to UN members, China had for the first time indicated that its claim in the South China Sea was based in part on the map. Because the wording of the note was ambiguous and the map was attached, it raised old suspicions in ASEAN countries about the nature of China's claim in the South China Sea. This resulted in a series of communications to the UN Secretary-General concerning the joint submission of Malaysia and Viet Nam.

Indonesia and the Philippines responded to China's Note Verbale by sending official communications to the UN Secretary-General stating that any claim to sovereign rights and jurisdiction in and under the waters inside the nine-dashed lines would be inconsistent with UNCLOS unless such claim to sovereign rights and jurisdiction was limited to maritime zones claimed from the islands.[98]

In its Note Verbale of 8 July 2010, Indonesia recalled China's position on the Japanese island of Okinitorishima, where China maintained that small uninhabited islands should be treated as rocks and should not be given a continental shelf or EEZ of their own, and stated that a similar practice should be followed in the South China Sea.[99]

In its Note Verbale of 5 April 2011, the Philippines emphasized the

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96 See Note from the Philippines dated 4 August 2009, *supra* note 92.

97 See Note from China dated 7 May 2009, *supra* note 94.

98 See Note from the Permanent Mission of Indonesian to the United Nations to the Secretary-General of the United Nations, 8 July 2010, No. 840/POL-703/VII/10, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/idn_2010re_mys_vnm_e.pdf; and Note from the Permanent Mission of the Republic of the Philippines to the United Nations to the Secretary-General of the United Nations, No. 000228, 5 Apr1 2011, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/phl_re_chn_2011.pdf.

99 Note from the Permanent Mission of Indonesian, dated 8 July 2010, *supra* note 98.

principle that the land dominates the sea, and stated that UNCLOS provides no legal basis for any claim to sovereign rights and jurisdiction over 'relevant' waters (and the seabed and subsoil thereof) within the nine-dashed lines outside of the claims to waters that are 'adjacent' to islands as defined in Article 121.[100] In its Note Verbale of 14 April 2011 in response to the Note of the Philippines, China made the following statement regarding its claims in the South China Sea:[101]

> Since 1930s, the Chinese Government has given publicity several times the geographical scope of China's Nansha Islands and the names of its components. China's Nansha Islands is therefore clearly defined. In addition, under the relevant provisions of the 1982 United Nations Convention on the Law of the Sea, as well as the Law of the People's Republic of China on the Territorial Sea and the Contiguous Zone (1992) and the Law on the Exclusive Economic Zone and the Continental Shelf of the People's Republic of China (1998), China's Nansha Islands is fully entitled to Territorial Sea, Exclusive Economic Zone (EEZ) and Continental Shelf.

China's statement dated 14 April 2011 suggests that its claim consists only of a claim to the islands, and that the islands are entitled not only to a territorial sea, but also to an EEZ and continental shelf of their own. There is no suggestion in the statement that China is claiming the waters inside the nine-dashed lines as historic waters, or that it is claiming any historic rights in the waters inside the nine-dashed lines. Like the Southeast Asian claimants, it seems to be bringing its claim to the Spratly Islands into conformity with UNCLOS. At the same time, however, China seems to be continuing its policy of 'deliberate ambiguity' with respect to the significance of the nine-dashed line map. Also, incidents in May and June of 2011, where Chinese vessels interfered in seismic surveys being carried out in the EEZ of Viet Nam and undertook seismic survey activities in the EEZ of the Philippines, indicate that some Chinese agencies appear to have a policy of enforcing China's 'sovereign rights and jurisdiction' in all ocean areas within the nine-dashed line, notwithstanding the language in its official notes to the United Nations. This has been a cause for serious concern in Southeast Asia and beyond.[102]

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100 See Note of 5 April 2011 of the Philippines, *supra* note 98.

101 See Note from the Permanent Mission of the People's Republic of China to the Secretary-General of the United Nations, CML/8/2011, 14 April 2011, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2011_re_phl_e.pdf.

102 See Carlyle A Thayer, 'China's New Wave of Aggressive Assertiveness in the South China Sea', paper presented at Conference on Maritime Security in the

Annex 831

E. Evolving Positions of the Claimants on their South China Sea

1. The ASEAN claimants

It is possible to discern a common strategy among the ASEAN claimants with regard to the Spratly Islands from their submissions and communications to the CLCS. First, the ASEAN claimant States are asserting that any claim to sovereign rights and jurisdiction in and under the waters in the South China Sea must be based on maritime zones claimed from land territory. They will not recognize any claim by China to sovereign rights and jurisdiction based on the fact that the maritime areas are inside the nine-dashed lines on China's map.

Second, by claiming an EEZ and an extended continental shelf from the baselines along their mainland coast or main archipelago, and not from any off-shore islands, the ASEAN claimants are taking the position that the sovereign right to explore and exploit the hydrocarbon resources in the South China Sea should be determined primarily by the EEZ and continental shelf measured from the baselines along the mainland of Viet Nam and Malaysia and the baselines of the main archipelago of the Philippines.

Third, the position of the ASEAN claimants is also likely to be that the majority of the features in the South China Sea are not islands because they are not naturally formed areas of land above water at high tide. Rather, they are either low-tide elevations or artificial islands and therefore have no maritime zones of their own, not even a 12 nm territorial sea. They are likely to maintain that all of the features which do meet the definition of 'islands' should be treated as 'rocks' within Article 121(3), and should not be entitled to an EEZ or continental shelf of their own because they are too small to sustain human habitation or economic life of their own.

Consequently, the position of the ASEAN claimants is likely to be that a significant portion of the sea space in the South China Sea is not in dispute, because it is within the EEZ or continental shelf of the ASEAN claimant States. The only areas in dispute would be the features themselves and the 12 nm territorial sea adjacent to the features.

If this indeed is the evolving position of Malaysia, Viet Nam and the Philippines, it would be in their common interests to further clarify their position. First, the three States should give official notice of the outer limit of their EEZ claim by publishing charts or lists of geographic coordinates,

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South China Sea, sponsored by the Center for Strategic and International Studies, Washington, DC (20–21 June 2011), online: http://dotchuoinon.files.wordpress.com/2011/06/thayer-csis-south-china-sea.pdf.

as required by UNCLOS.[103] In addition, if they have measured their 12 nm territorial sea and 200 nm EEZ from straight baselines along their coast, they should ensure that they have given official notice of such baselines by publishing charts or lists of geographic coordinates, as required by UNCLOS.[104] Second, they should identify the names and locations of the islands in the South China Sea over which they claim sovereignty. Third, if they believe that any of the islands they claim sovereignty over are entitled to an EEZ and continental shelf of their own, they should identify such islands and give notice of the EEZ claim from them by publishing official charts or lists of geographic coordinates of the limits of such claims, as required by UNCLOS.[105] If on the other hand, they believe that none of the islands over which they claim sovereignty is entitled to more than a 12 nm territorial sea, they should officially state that this is their position.[106]

2. Evolving position of China

China's actions from 2009 are evidence that it is pursuing its claims in the South China Sea along three tracks. First, it is claiming sovereignty over the islands and their adjacent waters, which presumably refers to the territorial sea. Second, it is asserting that the islands are entitled to an EEZ and continental shelf of their own. Third, it is at the same time asserting rights, jurisdiction and control over the resources in and under the waters inside the nine-dashed lines based on some form of historic rights.[107]

Evidence for the third assertion is found in China's objections to the announcement by the Philippines that it is issuing new contracts for oil exploration in Reed Bank, off the island of Palawan,[108] and by the issuance of new oil concession blocks by the Chinese national oil company (CNOOC) just inside the nine-dash lines, very close to the coast of Viet Nam and very far from any island claimed by China.[109] The CNOOC oil

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103 UNCLOS, *supra* note 2, Art 75.

104 UNCLOS, *supra* note 2, Art 16.

105 UNCLOS, *supra* note 2, Art 75.

106 If the Philippines and Malaysia can reach agreement on their adjacent EEZ boundary, most of the maritime space within the EEZs of Viet Nam, the Philippines and Malaysia will be clear. The only maritime areas in dispute will then be the 12 nm territorial sea surrounding the disputed islands, unless China claims an EEZ and continental shelf from some or all of the islands.

107 Hong Nong, 'Interpreting the U-shape Line in the South China Sea', *China US Focus* (15 May 2012), online: http://chinausfocus.com/print/?id=15964.

108 'China urges Philippines not to escalate tensions', *Global Times* (13 July 2012), online: http://www.globaltimes.cn/content/720964.shtml.

109 See for example, CNOOC, Press Release, 'Notification of Part of Open Blocks in Waters under Jurisdiction of the People's Republic of China Available for

blocks off the coast of Viet Nam are too far from any island over which China claims sovereignty for it to assert rights and jurisdiction based on the fact that the blocks are within the EEZ of Chinese islands. The Chinese action can be justified only on the basis that China has rights, jurisdiction and control over the natural resources in and under the waters inside the nine-dash line, notwithstanding the fact that those areas are within the EEZ of Viet Nam. This conclusion is supported by statements of the spokesperson of the China's Ministry of Foreign Affairs (MOFA) in September 2011 in response to questions relating to China's objections to joint exploration arrangements between Viet Nam and India in Vietnamese petroleum blocks off Viet Nam's coast.[110]

However, such a position is not consistent with UNCLOS (see above) and is likely to be vigorously challenged by the ASEAN claimants. Other interested States may also challenge the Chinese position as contrary to UNCLOS.[111] As explained above, challenging States would likely argue that whatever historic rights China may have had in the waters surrounding the features, its rights in those waters are now determined by UNCLOS.

The problem that China faces is that the ASEAN claimants and many other interested States are of the view that the only basis for China to legitimately claim a right to explore and exploit the natural resources in the South China Sea is from maritime zones measured from islands as provided in UNCLOS. The fact that China seems to be continuing a policy of deliberate ambiguity by refusing to clarify the nature of its claim and the significance of the nine-dashed line map has raised doubts and concerns about whether China is willing to abide in good faith with its rights and obligation under UNCLOS.

The best way for China to alleviate the doubts, fears and concerns of the ASEAN countries is for it to clarify its claim in a manner that is accepted by the ASEAN claimants and the international community as

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Foreign Cooperation in the Year of 2012' (23 June 2012), online: CNOOC http://en.cnooc.com.cn/data/html/news/2012-06-22/english/322127.html.

110 See Chinese Foreign Ministry, Regular Press Conference (15 September 2011), online: http://www.fmprc.gov.cn/eng/xwfw/s2510/2511/t860126.htm.

111 In a Press Statement issued regarding the South China Sea, US Secretary of State Hillary Clinton stated: 'We also call on all parties to clarify their claims in the South China Sea in terms consistent with customary international law, including as reflected in the Law of the Sea Convention. Consistent with international law, claims to maritime space in the South China Sea should be derived solely from legitimate claims to land features'; see: US Department of State, Press Release (22 July 2011), online: http://www.state.gov/secretary/rm/2011/07/168989.htm.

consistent with UNCLOS. If China fails to clarify its claim, conflicts will continue to arise over which areas are in dispute in the South China Sea, and the doubts, fears and concerns of the ASEAN countries about China's intentions will continue.

V. DELIMITATION OF MARITIME BOUNDARIES

A. UNCLOS Provisions on Maritime Boundary Delimitation

Although the maritime claims of the claimants in the South China Sea have not been clarified, there is no doubt that many of the claims will overlap. UNCLOS sets out principles for the delimitation of maritime boundaries between such opposite and adjacent States where the maritime zones overlap and it is appropriate to briefly examine the provisions on maritime delimitation.

Article 15 sets out the rules for the delimitation of the territorial sea boundary, providing that failing agreement between opposite and adjacent States to the contrary, the boundary should be a median line, every point of which is equidistant from the nearest points on baselines. However, a departure from the median line may be justified on the grounds of historic title or other special circumstances. Article 15 on the delimitation of territorial sea boundaries would apply in the South China Sea if it were decided that different claimant States had sovereignty over different islands, and there was a distance of less than 24 nm between the islands.

Articles 74 and 83 respectively govern the delimitation of the EEZ and continental shelf boundaries between opposite or adjacent States. The wording of both articles is near identical and provides that the general principle is that delimitation shall be effected by agreement on the basis of international law in order to achieve an equitable solution. These articles were among the last to be agreed upon during the negotiation of UNCLOS because of a division between States which preferred an 'equidistance-special circumstances' rule and States which preferred a rule to delimit on the basis of 'principles of equity'. The end result was a compromise on a text which is vague and which does not contain the language preferred by either group. The requirement that the delimitation is to achieve an 'equitable solution' places emphasis on the objective of the delimitation, thus differing from the use of equitable principles as a method or procedure for delimitation.

B. Practice of Courts and Tribunals on Maritime Boundary Delimitation

Scholars who have studied boundary delimitation cases have concluded that the delimitation provisions in Articles 74 and 83 are identical to the rules of customary international law that have been developed by courts and tribunals on the delimitation of continental shelf and EEZ boundaries.[112]

Courts have referred to the method called for in Articles 74 and 83 (and in customary international law) as the equitable principles-relevant circumstances method.[113] Also, they have stated that this method is very similar to the 'equidistance-special circumstances' rule that is called for in Article 15 of UNCLOS regarding the delimitation of territorial sea boundaries.[114]

In the 2009 *Black Sea Case*, the ICJ articulated a three-stage test. First, the Court will establish a provisional delimitation line, using methods that are geometrically objective and also appropriate for the geography of the area in which the delimitation is to take place. So far as delimitation between adjacent coasts is concerned, an equidistance line will be drawn unless there are compelling reasons that make this unfeasible in a particular case. So far as opposite coasts are concerned, the provisional delimitation line will consist of a median line between the two coasts. At the second stage, the Court will consider whether there are factors calling for the adjustment or shifting of the provisional equidistance line in order to achieve an equitable result. During this stage the Court will consider factors such as the configuration of the coasts concerned and the presence of islands. Finally, at the third stage, the Court will verify that the line does not, as it stands, lead to an inequitable result by reason of any marked disproportion between the ratio of the respective coastal lengths and the ratio between the relevant maritime area of each State by reference to the delimitation line. This final check for an equitable outcome entails a confirmation that no great disproportionality of the delimited

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[112] ED Brown, *Sea-Bed Energy and Minerals: The International Legal Regime, Vol 1, The Continental Shelf*, (Kluwer/Martinus Nijhoff, 1992), at 360; AG Oude Elferink, 'The Impact of the Law of the Sea Convention on the Delimitation of Maritime Boundaries,' in D Vidas and W Ostreng (eds), *Order for Oceans at the Turn of the Century* (The Fridtjof Nansen Institute, 1999), at 462.

[113] See for example, *Case Concerning the Land and Maritime Boundary between Cameroon and Nigeria (Cameroon v. Nigeria; Equatorial Guinea intervening)* [2002] ICJ Rep 303, at para 288.

[114] Ibid.

maritime areas can be evident by comparison to the ratio of coastal lengths.[115]

C. Effect of Small Offshore Islands on Delimitation of Maritime Boundaries

Although, as noted above, there has been no authoritative ruling on how Article 121(3) is to be interpreted, international courts and tribunals have on a number of occasions been faced with the question of how islands should affect the delimitation of maritime boundaries. Even if an island is large enough to have an EEZ of its own, this does not mean it would be given full effect in a maritime delimitation. It is not simply a question of drawing an equidistance line between the island and the mainland territory. If there are overlapping maritime claims between an EEZ measured from a small, remote island and an EEZ measured from the mainland or from an archipelagic State, the practice of courts and tribunals is to give a significantly reduced effect to the island when delimiting the maritime boundary.[116]

If the practice of international courts and tribunals is followed, the larger islands in the Spratlys and Paracels would be given significantly less effect in the direction of the mainland coasts of the claimant States. However, many of the larger islands are located near the 200 nm EEZ limits of the ASEAN claimant States. The EEZ of these islands could extend into the areas beyond the outer limits of the 200 nm EEZ of the claimant States and thus reduce or completely eliminate the pocket of high seas in the middle of the South China Sea.

D. Provisional Arrangements of a Practical Nature under Articles 74 (3) and 83 (3)

Unless the fundamental and intractable disagreements on sovereignty over the islands can be resolved, it will not be possible to negotiate any boundary agreements in the South China Sea. UNCLOS purports to provide a solution to this in Articles 74(3) and 83(3). It provides that if delimitation cannot be effected by agreement:

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115 *Black Sea Case*, *supra* note 48, at paras 115–122.

116 Robert Beckman and Clive Schofield, 'Moving Beyond Disputes over Island Sovereignty: ICJ Decision Sets Stage for Maritime Boundary Delimitation in the Singapore Strait', (2009) 40(1) Ocean Devel & Int'l L 1, at 13–16.

> [T]he States concerned, in a spirit of understanding and cooperation, shall make every effort to enter into provisional arrangements of a practical nature and during the transitional period, not to jeopardize or hamper the reaching of final agreement. Such arrangements shall be without prejudice to the final delimitation.

This provision is designed to 'promote interim regimes and practical measures that could pave the way for provisional utilization of disputed areas pending delimitation' and 'constitutes an implicit acknowledgement of the importance of avoiding the suspension of economic development in a disputed maritime area'.[117]

The obligation to make every effort to enter into provisional arrangements of a practical nature was considered by an Arbitral Tribunal constituted under Annex VII of UNCLOS in a case between Guyana and Suriname. While it was acknowledged that the language 'every effort' leaves 'some room for interpretation by the States concerned, or by any dispute settlement body', the Tribunal stated that it imposes on the Parties 'a duty to negotiate in good faith'. This requires the parties to take 'a conciliatory approach to negotiations, pursuant to which they would be prepared to make concessions in the pursuit of a provisional arrangement'.[118]

The obligation to negotiate in good faith appears to include an obligation to consult with each other if carrying out unilateral activities in the disputed area and to continue to negotiate even after such unilateral activities take place. In the *Guyana v. Suriname Arbitration*, it was found that the Parties had breached their obligation to negotiate provisional arrangements of a practical nature pending maritime delimitation of its territorial sea, EEZ and continental shelf boundary. This stemmed from an incident in 2000 where an oil rig and drill ship engaged in seismic testing under a Guyanese concession was ordered to leave the disputed area by two Surinamese vessels. It was found that Guyana had violated its obligation under Article 83(3) as it should have, in a spirit of co-operation, informed Suriname of its exploratory plans, given Suriname official and detailed notice of the planned activities, offered to share the results of the exploration, given Suriname an opportunity to observe the activities, and offered to share all the financial benefits received from the exploratory activi-

117 Guyana/Suriname Arbitration, UN Law of the Sea Annex VII Arb Trib, award on 17 September 2007, at para 460, online: Permanent Court of Arbitration http://www.pca-cpa.org/showpage.asp?pag_id=1147.

118 Guyana v. Suriname, *supra* note 117, at para 461.

ties.[119] Similarly, the Tribunal found that when Suriname became aware of Guyana's exploratory efforts in disputed waters, 'instead of attempting to engage it in a dialogue which may have lead to a satisfactory solution for both Parties, Suriname resorted to self-help in threatening the oil rig and drill ship in violation of [UNCLOS]'.[120]

The second part of the obligation provides that during this transitional period States are obliged not to jeopardize or hamper the reaching of a final agreement on delimitation. It is said that a court or tribunal's interpretation of this obligation must reflect the delicate balance between preventing unilateral activities that affect the other party's rights in a permanent manner but at the same time, not stifling the parties' ability to pursue economic development in a disputed area during a time-consuming boundary dispute.[121]

International courts and tribunals have found that 'any activity which represents an irreparable prejudice to the final delimitation agreement' is a breach of this obligation and that 'a distinction is to be made between activities of the kind that lead to a permanent physical change, such as exploitation of oil and gas reserves, and those that do not, such as seismic exploration'.[122] In the *Guyana v. Suriname Arbitration* it was found that allowing exploratory drilling in disputed waters was a breach of the obligation to make every effort not to hamper or jeopardize the reaching of a final agreement as this could result in a physical change to the marine environment and engender a 'perceived change to the status quo'.[123] This was in contrast to seismic testing, which did not cause a physical change to the marine environment. The key aspect of provisional arrangements of a practical nature is that they are 'without prejudice' to the final delimitation.' The effect of such a feature is that:[124]

1. Nothing in the arrangement can be interpreted as a unilateral renunciation of the claim of any party or as mutual recognition of any other party's claim.

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119 *Guyana v. Suriname*, *supra* note 117, at para 478.

120 *Guyana v. Suriname*, *supra* note 117, at para 476.

121 *Guyana v. Suriname*, *supra* note 117, at para 470.

122 *Guyana v. Suriname*, *supra* note 117, at para 467.

123 *Guyana v. Suriname*, *supra* note 117, at para 480.

124 As succinctly summarized by Judge Gao Zhiguo in Gao Zhiguo, 'Legal Aspects of Joint Development in International Law', in: M Kusuma-Atmadja, TA Mensah, BH Oxman (eds), *Sustainable Development and Preservation of the Oceans: The Challenges of UNCLOS and Agenda 21* (Honolulu: Law of the Sea Institute, 1997), at 639.

2. The arrangement itself does not create any legal basis for any party to claim title over the area and its resources.
3. The States concerned cannot claim any acquired rights from the interim arrangement.
4. Final delimitation does not have to take into account either any such preceding arrangement or any activities undertaken pursuant to such arrangement.

Essentially, parties are preserving their claims either to sovereignty over disputed territory or to sovereign rights over the waters surrounding such territory, and at the same time, temporarily shelving the issues of the sovereignty disputes and the final boundary delimitation.[125]

E. Maritime Boundary Disputes in the South China Sea

Until China clarifies its claim, it is not possible to identify the overlapping claim areas in the South China Sea. China has not claimed an EEZ from any of the islands in the South China Sea. If it were to do so, and it issued a map indicating the EEZ claimed from the islands, there would then be overlapping claim areas between the EEZ claimed from the islands and the EEZ and continental shelf claimed by the ASEAN claimants from their mainland coast or archipelagic baselines.

However, since the islands in question are also claimed by one or more of the ASEAN claimant States, and the ASEAN claimants appear not to be claiming an EEZ from such islands, there is likely to be a dispute between China and the ASEAN claimant States on the interpretation and application of Article 121 on the regime of islands, rather than a maritime delimitation dispute. Furthermore, given the fact that two or more other States also claim sovereignty over the islands, it would not be possible for the claimant States to even discuss boundary delimitation at this point in time.

There are also likely to be overlapping maritime boundary claims between Malaysia and the Philippines on their adjacent EEZ boundary. However, given the fact that the Philippines claims sovereignty over the East Malaysian State of Sabah, it may be impossible for them to agree on a maritime boundary until they first resolve this sovereignty dispute.

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[125] Hazel Fox et al, *Joint development of Offshore Oil and Gas: A Model Agreement for States with Explanatory Commentary* (Great Britain: British Institute of International and Comparative Law, 1989), at 378.

VI. PROVISIONS ON REGIONAL CO-OPERATION

Part IX of UNCLOS on semi-enclosed seas is applicable to the South China Sea because it is a sea 'consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States'.[126] Article 123 imposes a general obligation on States bordering a semi-enclosed sea to co-operate with each other in the exercise of their rights and in the performance of their obligations under the Convention. In particular, these States are obliged to endeavour, directly or through an appropriate regional organization, to coordinate their activities in three areas: (a) the management, conservation, exploration and exploitation of the living resources; (b) the protection and preservation of the marine environment; and (c) marine scientific research.

VII. UNCLOS SYSTEM OF DISPUTE SETTLEMENT

The dispute settlement regime in UNCLOS is the most complex system ever included in any global convention.[127] It was part of the 'package deal' agreed to at the start of the nine-year negotiations leading to the adoption of UNCLOS in 1982. Under the package deal, States agreed to accept the Convention in its entirety, with no right to make reservations, and that as a general principle, all disputes concerning the interpretation or application of any provision in the Convention would be subject to compulsory binding dispute settlement.[128] In other words, when States become parties to UNCLOS, they consent in advance to the system of compulsory binding dispute settlement in the Convention.

A. The Choices for Arbitration or Adjudication

The 'default' rule in UNCLOS is that if there is a dispute between two States concerning the interpretation or application of any provision in the Convention, it is subject to the system of compulsory binding dispute

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[126] UNCLOS, *supra* note 2, Art 122.

[127] On the UNCLOS dispute settlement system generally, see Natalie Klein, *Dispute Settlement in the UN Convention on the Law of the Sea* (Cambridge University Press, 2005).

[128] Tommy Koh and S Jayakumar, 'Negotiating Process of the Third United Nations Conference on the Law of the Sea', in: Myron H Nordquist (ed.), *United Nations Convention on the Law of the Sea* 1982: A Commentary, Vol 1 (Martinus Nijhoff, 1985), at 29–134.

settlement in section 2 of Part XV. States are obligated to first exchange views to try to resolve the dispute by following the procedures set out in section 1 of Part XV.[129] However, where no settlement has been reached by recourse to section 1, the dispute may be unilaterally submitted *at the request of any party to the dispute* to the court or tribunal having jurisdiction under this section.[130]

The Court or tribunal which has jurisdiction to hear a dispute depends in part on whether the parties to the dispute exercise their right to select a procedure for resolving disputes to which they are parties.[131] Under Article 287, a State is free to choose, by means of a written declaration, one or more of four procedures for the settlement of disputes concerning the interpretation or application of the Convention. States have a choice between two methods of adjudication and two methods of arbitration. The choices are: adjudication before the ICJ; adjudication before ITLOS; arbitration under Annex VII of UNCLOS; or special arbitration under Annex VIII of UNCLOS. The choice of procedure may be made when signing, ratifying or acceding to UNCLOS, or at any time thereafter.[132]

If two States Parties to a dispute have elected the same procedure, the dispute will be referred to that procedure. If the States Parties to the dispute have not elected the same procedure, or if one of them has not made a choice of procedure, the dispute will go to arbitration under Annex VII, unless the parties otherwise agree.[133] For example, in 2010, Bangladesh invoked the dispute settlement system in UNCLOS against both India and Myanmar concerning the UNCLOS provisions on maritime boundary delimitation.[134] None of the three States concerned had made a choice of procedure under Article 287. Therefore, the dispute between Bangladesh and India as well as the dispute between Bangladesh and Myanmar would normally go to arbitration under Annex VII. However, Bangladesh and Myanmar subsequently agreed to take their dispute to ITLOS rather than to arbitration.[135] Consequently, Bangladesh will be going to arbitration

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129 UNCLOS, *supra* note 2, Art 238.
130 UNCLOS, *supra* note 2, Art 286.
131 UNCLOS, *supra* note 2, Art 288.
132 UNCLOS, *supra* note 2, Art 287.
133 UNCLOS, *supra* note 2, Art 287(5).
134 On 8 October 2009, the People's Republic of Bangladesh instituted arbitral proceedings concerning the delimitation of the maritime boundary between Bangladesh and the Republic of India pursuant to Article 287 and Annex VII, Article 1 of UNCLOS. The Permanent Court of Arbitration acts as Registry in this arbitration, online: www.pca-cpa.org/showpage.asp?pag_id=1376.
135 *Dispute Concerning Delimitation of the Maritime Boundary between*

under Annex VII in its dispute with India and to ITLOS in its dispute with Myanmar.

None of the States which claim sovereignty over features in the South China Sea have made an election under Article 287.[136] Therefore, if the compulsory binding dispute settlement system in section 2 of Part XV were invoked in a dispute between two claimant States relating to the South China Sea, the dispute in question would automatically go to arbitration under Annex VII of UNCLOS.[137]

B. Applicable Law and Finality of Decisions

The court or tribunal resolving the dispute has jurisdiction because the dispute concerns the interpretation or application of a provision in UNCLOS. However, in resolving the dispute, the court or tribunal is not restricted to applying the provisions of UNCLOS. Article 293 of UNCLOS provides that a court or tribunal having jurisdiction shall apply the Convention as well as other rules of international law not incompatible with the Convention. Whether the dispute goes to one of the two methods of adjudication or to one of the two methods of arbitration, the decision rendered by a court or tribunal having jurisdiction is final, and must be complied with by all the parties to the dispute.[138]

C. Request for Provisional Measures

A State party to a dispute which is referred to dispute settlement under section 2 may also request provisional measures to either (1) preserve the respective rights of the parties; or (2) prevent serious harm to the marine

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Bangladesh and Myanmar in the Bay of Bengal (2012) Judgment, ITLOS Case No 16 (*Bangladesh/Myanmar*), online: ITLOS http://www.itlos.org/fileadmin/itlos/documents/cases/case_no_16/C16_Judgment_14_03_2012_rev.pdf. The dispute had initially been submitted to an arbitral tribunal to be constituted under Annex VII UNCLOS through a notification dated 8 October 2009, made by the People's Republic of Bangladesh to the Union of Myanmar. However, on 14 December 2009, proceedings were instituted before ITLOS after both States submitted declarations to ITLOS accepting its jurisdiction to hear the case; see ITLOS, Press Release, 140 (16 November 2009), online: ITLOS http://www.itlos.org/fileadmin/itlos/documents/press_releases_english/PR.140-E.pdf.

136 The up-to date official texts of declarations and statements which contain the choice of procedure under Article 287 of the UNCLOS are available online: UN Treaties Collection http://treaties.un.org/Pages/ParticipationStatus.aspx.

137 UNCLOS, *supra* note 2, Art 287(5).

138 UNCLOS, *supra* note 2, Art 296.

environment.[139] The only prerequisite is that ITLOS must first determine that, prima facie, the arbitral tribunal to be constituted would have jurisdiction to hear the case.

Such provisional measures are legally binding.[140] Even if a dispute is being referred to an arbitration tribunal, a State party may request provisional measures from ITLOS pending the establishment of the arbitral tribunal.[141]

D. Limitations and Exceptions to Compulsory Binding Dispute Settlement

Section 3 of Part XV provides for exceptions and limitations to the system of compulsory binding dispute settlement in Section 2. Specifically, Article 297 excludes two types of disputes from the compulsory binding dispute settlement system in section 2: (i) disputes with respect to discretionary decisions on fisheries in their EEZ; and (ii) disputes with respect to discretionary decisions on permits for marine scientific research in their EEZ.

Section 3 of Part XV also gives States the right to 'opt out' of the compulsory binding dispute settlement system in section 2 for certain categories of disputes. Article 298 provides that States Parties have the option to formally declare to the UN Secretary-General that they do not accept Section 2 for the following categories of disputes:[142]

> (a) disputes concerning the interpretation or application of articles 15, 74 and 83 relating to sea boundary delimitations, or those involving historic bays or titles . . .
> (b) disputes concerning military activities, including military activities by government vessels and aircraft engaged in non-commercial service, and disputes concerning law enforcement activities in regard to the exercise of sovereign rights or jurisdiction excluded from the jurisdiction of a court or tribunal under article 297, paragraph 2 or 3;
> (c) disputes in respect of which the Security Council of the United Nations is exercising the functions assigned to it by the Charter of the United Nations, unless the Security Council decides to remove the matter from its agenda or calls upon the parties to settle it by the means provided for in this Convention.

Several States in Asia, including Australia, China, Korea and Thailand, have exercised their right to exclude these categories of disputes from

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139 UNCLOS, *supra* note 2, Art 290(1).
140 UNCLOS, *supra* note 2, Art 290(1).
141 UNCLOS, *supra* note 2, Art 290(5).
142 UNCLOS, *supra* note 2, Art 298(1).

the system of compulsory binding dispute settlement in section 2 of Part XV.[143] Significantly, on 25 August 2006, China submitted a declaration under Article 298 providing that:[144]

> The Government of the People's Republic of China does not accept any of the procedures provided for in Section 2 of Part XV of the Convention with respect to all the categories of disputes referred to in paragraph 1 (a) (b) and (c) of Article 298 of the Convention.

E. Effect of China's Declaration under Article 298

China has exercised its right under Article 298 to opt out of the compulsory binding dispute settlement regime in section 2 of Part XV for disputes referred to in paragraph 1(a), (b) and (c) of Article 298 of UNCLOS. The question is what types of legal disputes relating to activities in the South China are excluded by this declaration.

First, the declaration excludes disputes concerning the interpretation or application of Articles 15, 74 and 83 on maritime boundary delimitation. Therefore, if Viet Nam and China cannot agree to their EEZ boundary near the Paracel Islands, neither State would be able to invoke the compulsory dispute settlement system in UNCLOS. The issue then is whether the EEZ boundary could be referred to non-binding conciliation under Annex V. Article 298(1)(a) provides as follows:[145]

> (i) disputes concerning the interpretation or application of articles 15, 74 and 83 relating to sea boundary delimitations, or those involving historic bays or titles, provided that a State having made such a declaration shall, when such a dispute arises subsequent to the entry into force of this Convention and where no agreement within a reasonable period of time is reached in negotiations between the parties, at the request of any party to the dispute, accept submission of the matter to conciliation under Annex V, section 2; and provided further that any dispute that necessarily involves the concurrent consideration of any unsettled dispute concerning sovereignty or other

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143 The up-to date official texts of declarations and statements which contain optional exceptions to the applicability of Part XV, Section 2, under Article 298 of UNCLOS, online: UN Treaties Collection http://treaties.un.org/Pages/ParticipationStatus.aspx.

144 Declaration under Article 298 by the Government of the People's Republic of China (25 August 2006), online: UN Division for Ocean Affairs and the Law of the Sea http://www.un.org/Depts/los/convention_agreements/convention_declarations.htm#China after ratification.

145 UNCLOS, *supra* note 2, Art 298(1).

> rights over continental or insular land territory shall be excluded from such submission;

Even if the dispute with China on the delimitation provisions arose after UNCLOS entered into force on 16 November 1994, the dispute on the China-Viet Nam EEZ boundary near the Paracel Islands would necessarily involve consideration of an unsettled sovereignty dispute over the Paracel Islands, which is 'insular land territory'. Therefore, the last proviso in the paragraph would apply, and the dispute would be excluded from submission to conciliation. This same reasoning would apply to disputes concerning delimitation of maritime boundaries in the Spratly Islands.

China's declaration excludes all disputes relating to the interpretation or application of Articles 74 and 83, including a dispute on whether a claimant State has breached its obligation under Articles 74(3) and 83(3) to make every effort to enter into provisional arrangements of a practical nature, or a dispute on whether a claimant State has breached its obligation not to take unilateral action in areas of overlapping claims that would jeopardize or hamper the reaching of the final agreement on the maritime boundary. However, if a claimant State were to take unilateral action in a disputed area such as drilling for gas or oil, other claimants may be able to invoke the dispute settlement system in UNCLOS by arguing that such unilateral action is an abuse of rights under Article 300 of UNCLOS.

Second, the declaration excludes disputes concerning the interpretation of the provisions of UNCLOS involving historic bays and titles.[146] Therefore, a dispute on the interpretation of Article 10(6) on historic bays would be excluded. Similarly, a dispute on whether the equidistance line should not be followed in territorial sea boundary delimitation under Article 15 because the 'historic title' of one of the parties would be excluded. UNCLOS contains no other provisions on historic title. Article 15 mentions historic title, but not historic rights, and there are no provisions in UNCLOS on historic rights. Therefore, if China were to argue that it has the right under international law to exercise historic rights in the waters inside the nine-dashed lines, a dispute could arise over whether such rights are consistent with UNCLOS, and such dispute would not be excluded by the declaration.

Third, the declaration excludes disputes relating to military activities. Therefore, any dispute on whether a State has a right under Article 58

[146] On historic title generally, see Clive R Symmons, *Historic Waters in the Law of the Sea* (Martinus Nijhoff, 2008).

of UNCLOS to conduct military activities such as military surveys or military exercises in the EEZ of China would be excluded from the compulsory binding dispute settlement system in UNCLOS. Any dispute concerning military activities by China in the maritime zones of another State would also be excluded.

Fourth, the declaration excludes disputes relating to law enforcement activities in regard to the exercise of sovereign rights or jurisdiction excluded from the jurisdiction of a court or tribunal under Article 297, paragraph 2 or 3. This in effect excludes only a narrow category of law enforcement activities, that is, those relating to the enforcement of fisheries activities and marine scientific research activities which are excluded from the compulsory binding dispute settlement system under Article 297(2) and (3). Disputes relating to other types of law enforcement activities, such as disputes concerning interference with seismic surveys or disputes concerning the arrest of foreign fishing vessels in areas of overlapping claims would not be excluded by the declaration.

Fifth, the declaration excludes disputes in respect of which the Security Council of the United Nations is exercising the functions assigned to it by the Charter of the United Nations, unless the Security Council decides to remove the matter from its agenda or calls upon the parties to settle it by the means provided for in UNCLOS. The purpose of this exception is to avoid a conflict between a dispute settlement procedure initiated under Part XV of UNCLOS and action that the United Nations Security Council might be taking in the exercise of its responsibility to maintain international peace and security under Chapter VII of the United Nations Charter. For example, if armed conflict were to break out between claimant States over the disputed islands in the South China Sea, the matter may be referred to the Security Council. In such case, one of the parties to the dispute could not invoke the dispute settlement procedures in UNCLOS on the issue of whether the use of military force by a claimant State was a violation of UNCLOS.

Finally, it should also be noted that the exceptions in Article 298 are not 'self-judging'. A party to a dispute cannot determine whether the exceptions do or do not apply in a given case. Article 288(4) makes it clear that in the event of dispute on whether a court or tribunal has jurisdiction, the matter shall be settled by a decision of that court or tribunal.

F. Disputes Subject to Compulsory Binding Dispute Settlement

Except for the limited categories of disputes which are excluded, all other disputes between States Parties to UNCLOS on the interpretation or application of a provision in UNCLOS are subject to the compulsory binding dispute settlement system in UNCLOS. With respect to provisions discussed in this chapter, disputes on the following issues would be subject to dispute settlement by an international court or tribunal:

1. A dispute on whether a State's straight baselines along its coast are in conformity with Article 7 of UNCLOS.
2. A dispute on whether straight baselines can be drawn from a mid-ocean archipelago such as the Spratlys or Paracels.
3. A dispute on whether a feature is an island under Article 121 or a low-tide elevation under Article 13.
4. A dispute on whether a feature is an island under Article 121 or an artificial island under Article 60.
5. A dispute on whether an island is a rock which cannot sustain human habitation or economic life of its own under Article 121(3).
6. A dispute on whether a State has unlawfully interfered with the sovereign rights and jurisdiction of another State in its EEZ under Articles 56 and 77.
7. A dispute on whether a State's domestic laws and regulations on survey activities in its EEZ or on its continental shelf are consistent with UNCLOS.

VIII. ITLOS ADVISORY OPINIONS

There is no provision in UNCLOS or in the Statute of ITLOS which permits States Parties or institutions created by UNCLOS to request an advisory opinion from ITLOS on legal questions. However, the Rules of the Tribunal, adopted in 1996 by the Tribunal pursuant to Article 16 of its Statute, give the Tribunal the authority to give advisory opinions in certain circumstances. The Tribunal's advisory jurisdiction is based on Article 21 of the Statute of the Tribunal, which states that the jurisdiction of the Tribunal comprises all disputes and all applications submitted to it and all matters specifically provided for in any other agreement which confers jurisdiction on the Tribunal.

Article 138 of the Rules of the Tribunal reads as follows:[147]

> 1. The Tribunal may give an advisory opinion on a legal question if an international agreement related to the purposes of the Convention specifically

[147] ITLOS, *Rules of the Tribunal*, ITLOS/8, as amended on 17 March 2009, online: ITLOS http://www.itlos.org/fileadmin/itlos/documents/basic_texts/Itlos_8_E_17_03_09.pdf.

provides for the submission to the Tribunal of a request for an advisory opinion.

2. A request for an advisory opinion shall be transmitted to the Tribunal by whatever body is authorized by or in accordance with the agreement to make the request to the Tribunal.
3. The Tribunal shall apply mutatis mutandis articles 130 to 137.

The status and legal basis of Article 138 (1) has been the subject of analysis by government officials and judges of the tribunal.[148] Although some concern has been raised on whether the Tribunal exceeded its powers in providing for advisory jurisdiction in Article 138(1) of the Rules of the Tribunal, commentators have concluded that there has largely been a positive reaction to the rule empowering ITLOS to give advisory opinions in certain circumstances.[149]

If a body were to request an advisory opinion pursuant to Article 138(1), it would be difficult for any State to challenge the authority of the Tribunal to give an Advisory Opinion. In any case, even if such a challenge could be made, Article 288(4) of UNCLOS provides in the event of a dispute as to whether a court or tribunal has jurisdiction, the matter shall be settled by decision of that court or tribunal. Therefore, it would be up to the Tribunal itself to determine whether it has the authority it has vested in itself under its Rules.

Under Article 138(1), the Tribunal can give an advisory opinion on a legal question if an international agreement related to the purposes of the Convention specifically provides for the submission to the Tribunal of a request for an advisory opinion. Three requirements must be met. First, there must be an agreement between States that is related to the purposes of the UNCLOS. This could be a multilateral agreement, a regional agreement or even a bilateral agreement, so long as the agreement is related to the purposes of the Convention.

Second, the agreement must specifically provide for the submission of a request for an advisory opinion from the Tribunal. The international agreement should state who can request an advisory opinion and set out the procedure for making such request. The agreement could provide that the States Parties to the agreement can make the request when there is a consensus to do so. The agreement could also establish a body and

[148] See Ki-Jun You, 'Advisory Opinions of the International Tribunal for the Law of the Sea: Article 138 of the Rules of the Tribunal, Revisited' (2008) 39 Ocean Devel & Int'l L 360; Tafsir Malick Ndiaye, 'The Advisory Function of the International Tribunal for the Law of the Sea' (2010) 9 Chinese J Int'l L 565.

[149] Ki-Jun You, *supra*, note 148 at 364.

authorize that body to request an advisory opinion if it believes an opinion would assist it in carrying out its functions and objectives.

Third, the advisory opinion must be on a legal question. This presumably would be a legal question relating to the Convention. The Tribunal is likely to follow the jurisprudence of the International Court of Justice in determining whether there is a legal question.[150]

Would it be possible for some or all of the claimant States in the South China Sea to request an advisory opinion on legal issues relating to the interpretation and application of UNCLOS? It could be possible if two or more claimant States entered into an agreement relating to the purposes of the Convention, such as an agreement to co-operate to prevent pollution of the marine environment in the South China Sea through ocean dumping. That agreement could establish a body to institute rules and standards to prevent pollution of the marine environment in the South China Sea through ocean dumping. It could also authorize that body to request an advisory opinion from ITLOS on legal questions relating to their functions and purposes. For example, the body created under the international agreement could request an advisory opinion on whether there are any international rules and standards on the decommissioning and abandonment of offshore platforms which are legally binding on States Parties to UNCLOS who are not parties to the 1972 London Convention or its 1996 Protocol.[151]

It may also be possible for claimant States to enter into an international agreement which would enable them to request an advisory opinion on more controversial legal issues such as how to interpret Article 121(3) on rocks which cannot sustain human habitation or economic life of their own. The claimant States could enter into an international agreement to co-operate to clarify the status of the features in the Spratly Islands. The agreement could establish a technical body to review the features to determine which are completely submerged at low tide, which are low tide elevations, which meet the definition of islands in Article 121(1), and which may be rocks as defined in Article 121(3). The treaty could then authorize the technical body to request an advisory opinion from ITLOS on legal questions relating to their functions and responsibilities.

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150 On this issue, see *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, ICJ Reports 1996 (I) 226, at para 13.

151 *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*, 1046 UNTS 120; *1996 Protocol to the 1972 Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, 2006 ATS 11.

One question which could arise is whether States not parties to the agreement would have the right to present arguments to the Tribunal on a legal question if they believe that they have an interest in the issue. A more difficult question would be whether a claimant State which is not a party to the agreement could intervene to argue that the Tribunal should not give an advisory opinion on a particular legal question because the opinion might irreparably prejudice their rights in an ongoing territorial sovereignty dispute.

CONCLUSION

Although UNCLOS is of no assistance in resolving the territorial sovereignty claims to islands in the South China Sea, it contains important rules and principles that govern the validity of claims with respect to the South China Sea itself, including marine features and areas, and has important provisions regarding the management and resolution of disputes that may arise in that respect.

If all of the claimants would bring their maritime claims into conformity with the provisions in UNCLOS, it would clarify the areas of overlapping maritime claims. This would set the stage for negotiations between the concerned claimant States to attempt to reach provisional arrangements for joint development agreements and other co-operative arrangements in the areas of overlapping maritime claims.

China could clarify its position regarding its claim in the South China Sea without abandoning the nine-dashed line map. All China needs do is make it clear, as implied by its language in its Notes Verbale and in its historic documents, that it is claiming sovereignty over the islands and their adjacent waters inside the nine-dashed line, as well as sovereign rights and jurisdiction in the EEZ and continental shelf measured from the islands. It could also issue a map of its EEZ in the South China Sea based on an approximate median line between the islands and the baselines employed by the ASEAN claimants from their mainland or main archipelago. This would then clarify which areas of the South China Sea are in dispute, and which are not in dispute. This would set the stage for serious discussion on setting aside the sovereignty disputes and jointly developing the resources in the areas in dispute.

Such a clarification would send an important signal to the ASEAN States that China is willing to comply with its rights and obligations under UNCLOS in good faith. This would be a major confidence-building measure and would lay the groundwork necessary to enable China to work with the ASEAN States to implement the 2002 ASEAN-China

Declaration on the Conduct of Parties in the South China Sea.[152] It would also be a significant step towards setting aside the sovereignty disputes and jointly developing the resources, which was suggested by the late Deng Xiaoping.[153] Finally, all these actions would be without prejudice to China's claims to sovereignty over the islands and to the final delimitation of the maritime boundaries.

China seems to have little choice in the long run except to clarify its claims and bring them into conformity with UNCLOS. As a party to UNCLOS it is bound by its provisions. If it fails to clarify its claim and asserts rights in the South China Sea close to the coasts of the ASEAN claimants and a considerable distance from any disputed island, the ASEAN claimants may feel they have little choice but to seek the assistance of an international court or tribunal in clarifying the areas in dispute. They could do this by either invoking the compulsory binding dispute settlement system in section 2 of Part XV of UNCLOS or entering into an agreement which will give them the right to seek an advisory opinion from ITLOS.

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[152] *2002 Declaration on the Conduct of Parties in the South China Sea*, signed at the 8th ASEAN Summit on 4 November 2002 in Phnom Penh, Cambodia by the Foreign Ministers of ASEAN and the People's Republic of China, online: CIL Documents Database http://cil.nus.edu.sg/2002/2002-declaration-on-the-conduct-of-parties-in-the-south-china-sea-signed-on-4-november-2002-in-phnom-penh-cambodia-by-the-foreign-ministers/.

[153] This concept was first openly advanced by Deng on 11 May 1979 in relation to China's dispute with Japan over Senkaku/Diao Yu Dao Islands; see 'Set Aside Dispute and Pursue Joint Development', 17 November 2000, online: Ministry of Foreign Affairs of the People's Republic of China http://www.fmprc.gov.cn/eng/ziliao/3602/3604/t18023.htm.

Annex 832

Clive Schofield, “What’s at Stake in the South China Sea?: Geographical and Geopolitical Considerations”, *in Beyond Territorial Disputes in the South China Sea* (R. Beckman et al., eds. 2013)

Beyond Territorial Disputes in the South China Sea

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1. What's at stake in the South China Sea? Geographical and geopolitical considerations

Clive Schofield

I. INTRODUCTION

The South China Sea ranks among the most geographically and geopolitically complex ocean spaces in the world. It certainly appears to have been one of its most vigorously contested, featuring multiple, longstanding and competing territorial and maritime jurisdictional claims. The objective of this chapter is to provide the geographical and geopolitical background to the frequently conflicting national maritime claims made by the South China Sea littoral States. This exercise is designed to provide the necessary contextual backdrop to considerations of the application of maritime joint development mechanisms and/or other provisional arrangements of a practical nature in the South China Sea.

With this in mind, key characteristics of the coastal geography of the South China Sea are outlined, notably the implications of its semi-enclosed nature and the baselines that have been defined along its coasts. The insular features of the South China Sea, many of which are subject to conflicting sovereignty claims, are then examined with particular reference to their potential maritime claims and role in the delimitation of maritime boundaries. The chapter then outlines the maritime jurisdictional claims of the South China Sea coastal States, including existing maritime boundary agreements and maritime joint development zones, as well as unilateral and historical maritime claims.

Accordingly, a spatial picture of the maritime geography of the South China Sea including the locations and extents of claims to maritime jurisdiction is built up. The chapter then proceeds to highlight the main geopolitical factors that arguably serve as key drivers for the South China Sea disputes. These include longstanding yet still powerful sovereignty imperatives, significant and growing marine resource interests and energy security concerns, crucial navigational and maritime trade considerations and evolving military and strategic factors.

II. GEOGRAPHICAL CONSIDERATIONS AND CLAIMS TO MARITIME SPACE

A. Geographical Context

The South China Sea is a large ocean space located between the southern coast of China and Taiwan to the north, the mainland and peninsular coasts of Southeast Asia to the west and the archipelagic island groups of the Philippines, Borneo and Indonesia to the east and south. This semi-enclosed sea is bordered by the six claimants to the disputed South China Sea islands (Brunei Darussalam (Brunei), the People's Republic of China (China), Malaysia, the Philippines, Taiwan, and Viet Nam) and two non-claimants (Indonesia and Singapore). Additionally, Cambodia and Thailand are located along the South China Sea's Gulf of Thailand extension.

The limits of the South China Sea have been defined as extending southwards from the Strait of Taiwan to around the 3° South parallel of latitude.[1] It has, however, been suggested that the 1° North parallel of latitude may be a more appropriate southern limit.[2] If the latter definition is taken, the total surface area of the South China Sea (including the Gulf of Thailand) has been calculated at approximately three million square kilometres (equivalent to around 874,660 square nautical miles (nm)).[3] The coastal geography of the South China Sea is both characterised and complicated by the presence of a profusion of predominantly small islands, islets, rocks and reefs. These coastal fronts are directly related to the maritime claims of the claimants.

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[1] According to the International Hydrographic Organization, the southernmost defining point of the South China Sea is Lucipara Point on the east coast of Sumatra. See: International Hydrographic Organization, *Limits of Oceans and Seas*, Special Publication No 23, 3rd edn (Monte Carlo: IHO, 1953), at 30.

[2] Hasjim Djalal, 'South China Sea Island Disputes', in MH Nordquist and JN Moore (eds), *Security Flashpoints: Oil, Islands, Sea Access and Military Confrontation* (The Hague: Martinus Nijhoff Publishers, 1998), 109–33, at 109.

[3] Ibid. Technically the correct abbreviation for a nautical mile is 'M', while 'nm' denotes nanometres. However, 'nm' is widely used by many authorities (for example the UN Office of Ocean Affairs and the Law of the Sea) and appears to cause less confusion than 'M', which is often assumed to be an abbreviation for metres.

B. Baseline Claims

National claims to maritime jurisdiction are fundamentally dependent on, first, possession of land territory with a coast and, second, the geography of the coast concerned. Indeed, it has been observed: '. . . the land dominates the sea and it dominates it by the intermediary of the coastal front'.[4] More precisely, a coastal State's maritime claims are measured from baselines defined along its coasts. In the absence of any other claim, 'normal' baselines will be used coincident with the low-water line along the coast. However, relevant international law as represented by the United Nations Convention on the Law of the Sea (UNCLOS)[5] provides for several types of straight line baselines to be drawn as an alternative to normal baselines. It is worth noting at this point that UNCLOS provides the fundamental legal framework governing maritime jurisdictional claims, which has gained widespread acceptance by the majority of the States in the world, including the South China Sea States (see below).[6]

Several of the South China Sea claimants have taken the view that their coastlines are complex enough to justify the application of straight baselines along large parts of their coastal fronts. Article 7 of UNCLOS allows coastal States to depart from normal, low-water line, baselines along selected parts of their coastlines. The intention of Article 7 is, essentially, to deal with particularly complex coastal geography where the configuration of the coastline is such that using 'highly irregular'[7] normal baselines

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[4] Prosper Weil, *The Law of Maritime Delimitation – Reflections* (Cambridge: Grotius, 1989), at 50.

[5] United Nations, *United Nations Convention on the Law of the Sea*, Publication No E97.V10, (United Nations, New York, 1983). See 1833 UNTS 3, opened for signature 10 December 1982, Montego Bay, Jamaica (entered into force 16 November 1994) ('UNCLOS' or 'the Convention'), online: United Nations http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm.

[6] At the time of writing there were 164 parties to UNCLOS, comprising 163 States plus the European Community. See United Nations, *Status of the United Nations Convention on the Law of the Sea, of the Agreement relating to the implementation of Part XI of the Convention and of the Agreement for the implementation of the Convention relating to the conservation and management of straddling fish stocks and highly migratory fish stocks*, New York, updated on 29 November 2012, online: United Nations http://www.un.crg/Depts/los/reference_files/status2010.pdf.

[7] See International Hydrographic Organization (with the International Oceanographic Commission and the International Association of Geodesy), *A Manual on Technical Aspects of the United Nations Convention on the Law*

would result in similarly irregular maritime limits, such as a complex mosaic of enclaves or pockets of non-territorial sea areas within a State's territorial sea.[8] In accordance with Article 7 of UNCLOS straight baselines may be drawn 'where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity'. Rather than apply straight baselines to selected parts of their coastlines, however, both China and Viet Nam have opted to front the vast majority of their mainland coastlines with systems of straight baselines.

This liberal interpretation of the admittedly rather loosely phrased terms of Article 7 of UNCLOS runs counter to the view of the International Court of Justice, as expressed in its decision in the *Qatar/Bahrain Case*, where it stated unequivocally that the method of straight baselines in accordance with UNCLOS 'must be applied restrictively'.[9] It is highly questionable whether the coastlines in question are sufficiently deeply indented, cut into, or feature a suitable fringe of islands sufficiently close to the coast to justify their being fronted by a system of straight baselines. Further, the Western terminus of the system in the Gulf of Thailand is at 'Point O', out to sea and joining the Cambodian baseline system (see below). Accordingly, these extensive claimed systems of straight baselines have been viewed as excessive by other States and been subject to international protests, notably from the United States.[10]

Viet Nam made a claim to straight baselines in 1977,[11] with the claim being implemented in 1982.[12] Viet Nam's claimed straight baselines start in the north and extend for a distance of approximately 850 nm to

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of the Sea, 1982, Special Publication no 51, 4th edn, (Monaco: International Hydrographic Bureau, 2006), Chapter 4, at 6.

[8] United Nations, *Baselines: An Examination of the Relevant Provisions of the United Nations Convention on the Law of the Sea* (New York: Office for Ocean Affairs and the Law of the Sea, United Nations, 1989).

[9] *Maritime Delimitation and Territorial Questions between Qatar and Bahrain*, Merits, Judgment (2001) ICJ Reports 40 ('Qatar/Bahrain'), at para 212, online: International Court of Justice http://www.icj-cij.org/docket/files/87/7027.pdf.

[10] See generally, J Ashley Roach and Robert Smith, *United States Responses to Excessive Maritime Claims* (The Hague: Martinus Nijhoff Publishers, 1996).

[11] The straight baselines were claimed through Viet Nam's *Statement on the Territorial Sea, the Contiguous Zone, the Exclusive Economic Zone and the Continental Shelf* of 12 May 1977, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/VNM_1977_Statement.pdf.

[12] Declaration on Baseline of Territorial Waters of 12 November 1982, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/VNM_1982_Statement.pdf

enclose the entire Vietnamese coast south of the Gulf of Tonkin.[13] The islands used as basepoints for Viet Nam's claimed straight baselines are small, scattered and largely distant from the mainland coast, such that of the nine turning points defined five are more than 50 nm offshore. Viet Nam's straight baselines claims have, consequently, been subject to critical appraisal by the US Department of State[14] and have been subject to US[15] and Thai protests.[16]

China enacted enabling legislation on baselines in 1992[17] and partially defined the baselines in 1996.[18] The 1996 claim defines straight baselines along the majority of its mainland coast. A detailed analysis of this baseline system was undertaken by the US Department of State. The analysis was highly critical of China's baseline claim on the basis that China's coastline does not meet the criteria laid out in Article 7 of UNCLOS for the application of straight baselines.[19] It is worth noting with respect to China's straight baselines claims that this designation is only partial. While China defined straight baselines around the Paracel Islands[20]

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[13] US Department of State, 'Straight Baselines: Viet Nam', *Limits in the Seas*, No 99, (Washington DC: Bureau of Intelligence and Research, 12 December 1983), at 5.

[14] Ibid. In particular the US analysis highlighted that the longest distance between basepoints is 161.8 nm, (the average being 84.6 nm), that island basepoints averaged 39.4 nm offshore with a maximum of 80.7 nm offshore and that the internal waters claimed total approximately 27,000 nm^2 (93,000 km^2).

[15] The US protest note stated that 'there is no basis in international law for the system of straight baselines provided in the declaration of November 12, 1982'; see Roach and Smith, *supra* note 10, at 102.

[16] The Thai protest note, dated 9 December 1985, stated that between points 0 and A7, Viet Nam's claimed straight baselines were 'at variance with the well-established rules of international law', referring to both the 1958 and 1982 Conventions, and concluded that: 'the Government of Thailand reserves all its rights under international law in relation to the sea areas in question and the airspace above them'; see *UN Law of the Sea Bulletin* 7 (April 1986), at 111.

[17] See Law on the Territorial Sea and Contiguous Zone, 25 February 1992, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/CHN_1992_Law.pdf.

[18] See Declaration of the Government of the People's Republic of China on the baselines of the territorial sea, 15 May 1996, online United Nations: http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/CHN_1996_Declaration.pdf.

[19] See US Department of State, 'Straight Baseline Claim: China,' *Limits in the Seas*, No 117 (Washington, DC: Office of Ocean Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, US Department of State, 9 July 1996), online: US Department of State http://www.state.gov/documents/organization/57692.pdf.

[20] Chen Degong, 'China and the Law of the Sea', *Occasional Paper*, Canberra,

(a feature of the Chinese claim that has also been the subject of criticism),[21] no straight baselines were defined around the disputed Spratly Islands, though such baselines could be designated in the future.

For its part Taiwan has defined its own system of straight baselines. This system of straight baselines is extensive and applies not only to Taiwan's main islands but also to Pratas Island and the Macclesfield Bank. While at first glance Taiwan's baselines claim gives the appearance of archipelagic baselines, they are, in fact, straight baselines, taking into account Taiwan's claim to represent China as a whole. Taiwan's claimed straight baselines, defined all the way around Taiwan's main islands, are similarly excessive in character.[22]

Malaysia has not publicised the location of its claimed straight baselines. Their existence can be inferred from an examination of official maps, notably the 1979 map (often referred to as the 'Malaysian Map') issued by the Malaysian Directorate of National Mapping on 21 December 1979 in order to illustrate Malaysia's agreed maritime boundaries and the limits of Malaysia's unilateral territorial sea and continental shelf claims.[23] Although no baselines are shown on these maps, the fact that in certain areas the outer limit of the Malaysian territorial sea claim is marked with straight lines leads to the conclusion that Malaysia has necessarily constructed a system of straight baselines. Malaysia subsequently enacted legislation in 2006 that provides for the declaration of the coordinates of the basepoints for defining its baselines, though such coordinates have yet to be defined, or at least published.[24] Further, the joint submission of

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Northeast Asia Program, Research School of Pacific and Asian Studies, Australian National University, December 1996, at 23.

[21] US Department of State, *supra* note 19, at 8.

[22] A comprehensive and critical analysis of this claim is provided by the US Department of State; see: US Department of State, 'Taiwan's Maritime Claims,' *Limits in the Seas*, No. 127 (Washington DC: Bureau of Intelligence and Research, 15 November 2005).

[23] The *Peta Menunjukkan Sempadan Perairan dan Pelantar Benua Malaysia* or 'Map Showing the Territorial Waters and Continental Shelf Boundaries of Malaysia,' often referred to as the *Peta Baru* ('New Map'), published by the Malaysian Directorate of National Mapping in two sheets. The location of these baselines may then be determined by drawing lines parallel to the outer limit of the Malaysian territorial sea claim but 12 nm landward of the straight line limits of the Malaysian territorial sea claim. See Clive Schofield and May Tan-Mullins, 'Claims, Conflicts and Cooperation in the Gulf of Thailand', (2008) 22 Ocean YB 75, at 86–7; and Mark J Valencia, 'Validity of Malaysia's Baselines and Territorial Sea Claim in the Northern Malacca Strait', (2003) 27 *Marine Policy* 367, at 367–73.

[24] Vivian L Forbes, 'The Territorial Sea Datum of Malaysia', (2007) 14:4 *MIMA Bulletin* 3, at 7–8.

Malaysia and Viet Nam with respect to extended continental shelf rights revealed the location of some of Malaysia's straight baselines, specifically those fronting the coast of the Malaysian provinces of Sarawak and Sabah on the South China Sea, through illustrating them on maps included in the joint submission.[25]

The straight baseline claims of Cambodia and, to a somewhat lesser extent, Thailand in the Gulf of Thailand are also questionable. Cambodia's present straight baselines, claimed in 1982,[26] join up with those of Viet Nam at a 'floating' point and join up small and disparate islets. While Thailand's 1970-vintage straight baselines in the Gulf of Thailand were relatively conservative,[27] its 1992 designation of an additional area (Area 4) of straight baselines was considerably less so,[28] and has excited international protests.[29]

The South China Sea is also host to two archipelagic States: Indonesia and the Philippines. Both have defined archipelagic baselines which are compliant with Article 47 of UNCLOS. Indonesia claimed archipelagic baselines from 1960 and has revised and refined its claims on several occasions since, notably through legislation in 1996 and regulations in 2002

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25 *Joint Submission to the Commission on the Limits of the Continental Shelf pursuant to Article 76, paragraph 8 of the United Nations Convention on the Law of the Sea 1982 in respect of the southern part of the South China Sea, Executive Summary*, 6 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm.

26 Cambodia's claim was made through a Council of State Decree dated 13 July 1982. In this legislation Cambodia's baselines were defined as being 'straight baselines, linking the points of the coast and the furthest points of Kampuchea's [Cambodia's] furthest islands', online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/KHM_1982_Decree.pdf.

27 Areas 1 and 2 of Thailand's straight baselines claim lie in the Gulf of Thailand. The other area (Area 3) is located on Thailand's western coast on the Andaman Sea. The announcement of the Prime Minister's Office concerning straight baselines and internal waters of Thailand was published in the Official Gazette, Special Volume 87, Chapter 52, 12 June 1970, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/THA_1970_Announcement.pdf.

28 United Nations, *UN Law of the Sea Bulletin* 25 (June 1994), at 82–84, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/THA_1992_Announcement.pdf.

29 For example, the US Department of State analysis of this extension to Thailand's claimed straight baselines stated categorically that 'clearly this is an excessive maritime claim'. See US Department of State, Straight Baseline Claim: Thailand, *Limits in the Seas*, No 122 (Washington, DC: Bureau of Oceans and International Environmental and Scientific Affairs, 8 September 2000), at 9.

and 2008.[30] Indonesia subsequently deposited documents detailing the location of its archipelagic baselines, including the coordinates of and a map illustrating the 195 turning points involved, with the United Nations Secretary-General on 11 March 2009.[31] These archipelagic baselines encompass the outermost rocks and reefs of the Natuna Islands group in the southwest of the South China Sea.

For a considerable period the Philippines claim to baselines was at variance with the terms of UNCLOS. The baselines claimed by the Philippines in 1961 and revised in 1968 not only included a baselines segment (141 nm long) in excess of the maximum length permitted under Article 47(2) of UNCLOS (125 nm), but were framed as straight baselines with internal rather than archipelagic waters claimed within them. In 2009, however, the Philippines revised its baselines and brought them into line with UNCLOS.[32] The Philippines now claims archipelagic baselines around its main archipelago and applies the 'regime of islands' to outlying islands claimed, such as Scarborough Reef (or Shoal) and those Spratly Islands claimed by the Philippines as part of its Kalayaan Island Group (KIG) claim. The inclusion of the disputed South China Sea islands in the Philippines legislation and reconfirmation of the Philippines sovereignty claims to these features led to protests from China on the grounds that this represented a violation of Chinese sovereignty.[33] Further, the maritime claims of the Philippines remain problematic on account of its historically-inspired claim to the Philippines Treaty Limits (see below).

C. A 'Labyrinth of Detached Shoals': The Islands of the South China Sea

As noted, a key feature of the maritime geography of the South China Sea is the presence of a myriad of predominantly small islands, islets, rocks, cays, shoals and drying reefs. The main island groups of the South China Sea are as follows:

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30 See Clive Schofield and Andi Arsana, 'Closing the Loop: Indonesia's Revised Archipelagic Baselines System', Commentary (2009) 1 Aus J Mar & Ocean Aff 2, at 57–62.

31 For maritime zone notification and a complete list of the coordinates, see online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/IDN.htm.

32 Republic Act No 9522, 10 March 2009.

33 'China lodges stern protest over Philippine bill,' *Xinhua News Agency* (18 February 2009), online: http://www.chinadaily.com.cn/china/2009-02/18/content_7489838.htm.

1. The Paracel Islands, located to the northeast which comprise around 130 islands, predominantly divided between the Crescent and Amphritite groups which are occupied by China but also claimed by Viet Nam.[34]
2. The Pratas Islands, located to the northeast of the South China Sea and comprising three islands made up of coral atolls and reef flats which are occupied by Taiwan.[35]
3. Scarborough Reef, to the northeast, which has been described as 'step-to on all sides and consists of a narrow belt of coral', which is predominantly submerged at high tide but surmounted by a 'tallest rock' 3 m high. This feature is disputed between China and the Philippines.[36] A feature often associated with Scarborough Reef, especially by China, is Macclesfield Bank. This is an entirely submerged feature described as a 'below-water atoll' with a least depth of water over it of 9.1 m.[37]
4. The Natuna Islands, located in the southwest of the South China Sea, are an extensive group of islands under uncontested Indonesian sovereignty.[38]
5. The Spratly Islands (see below).

With respect to the Spratly Islands, one notable early description of this complex and numerous group of insular features dating from 1889 aptly refers to a 'labyrinth of detached shoals'.[39] It can further be observed that traditionally the islands of the South China Sea have generally been ignored. Predominantly consisting of very small, uninhabited islets of little apparent intrinsic worth, they have long been regarded as little more than hazards to navigation. For example, British Admiralty navigational charts routinely marked (and still mark) the area occupied by the Spratly Islands, appropriately enough, as 'Dangerous Ground'.[40] Arguably it is only since

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34 See United Kingdom Hydrographic Office (UKHO), *China Sea Pilot*, Vol 1, 8th edn, Admiralty Sailing Directions (Taunton: UKHO, 2010), at 75–8.

35 Ibid, at 78.

36 See United Kingdom Hydrographic Office, *China Sea Pilot*, Vol 2, 9th edn, Admiralty Sailing Directions (Taunton: UKHO, 2010), at 74.

37 See UKHO, *China Sea Pilot*, Vol 1, *supra* note 34, at 68–9.

38 Comprising an extensive group of islands in the southwestern South China Sea. See UKHO, *China Sea Pilot*, Vol 2, *supra* note 36, at 78–86.

39 AG Findlay, *Indian Archipelago and China Directory*, 3rd edn (Richard Holmes Laurie: London, 1889), at vi, quoted in David Hancox and JR Victor Prescott, *Secret Hydrographic Surveys in the Spratly Islands* (The Maritime Institute of Malaysia, Kuala Lumpur: 1997), at 1.

40 Clive Schofield, 'Dangerous Ground – A Geopolitical Overview of the South China Sea' in S Bateman and R Emmers (eds), *The South China*

the expansion of national maritime claims offshore and growing awareness of the valuable marine resources that may be contained within these maritime spaces that disputes have surfaced.

It is generally well known the sovereignty disputes over islands in the South China Sea relate to the Paracel Islands group in the northwest (disputed between China and Viet Nam), the Scarborough Reef (or Shoal) in the northeast (between China and the Philippines), and the Spratly Islands group (claimed in whole or in part by Brunei, China/Taiwan, Malaysia, the Philippines and Viet Nam).[41] What is often less well understood is the geographical characteristics of these island groups. For example there exists great uncertainty, on the part of media commentators and also in academic literature, as to the answer to the deceptively simple-sounding question: 'how many Spratly Islands are there?' On the face of it this seems surprising, given the concerted focus on disputes involving these islands, and on the South China Sea area, over a considerable period of time.

A key source of uncertainty relates to the lack of clarity over what type of insular feature is under discussion. 'Islands' of the South China Sea range from relatively large features, with their own water sources and vegetation which have been developed, for example, to host military garrisons and runways, to much smaller islets, rocks, low-tide elevations and reefs as well as entirely sub-surface features on which structures may have been built. These features are scattered over a considerable area of ocean – estimated to be of the order of 240,000 km^2.[42] An additional source of confusion in this context is the fact that many of the features in question boast multiple names in a variety of languages.[43] This complexity of insular features, coupled with uncertainties as to what to count and even how to refer to features, has led different commentators to arrive at radically different figures with respect to, for example, the number of 'islands' that make up the Spratly Islands. At one end of the spectrum it has been suggested that there are as many as 400[44] or even 500 islands in the Spratly Islands

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Sea: Towards a Cooperative Management Regime (Routledge: London, 2009), at 7–25.

41 The littoral States give one or both of these island groups names in their respective vernaculars: for the sake of consistency and clarity English language toponyms will be used.

42 See Daniel J Dzurek, *The Spratly Islands: Who's On First?* (International Boundaries Research Unit: Durham, 1996), at 1.

43 See Schofield, *supra* note 40, at 9–10.

44 See Craig Snyder, 'The South China Sea Dispute: Prospects for Preventative Diplomacy', USIP Special Report, No 18 (United States Institute of Peace: Washington DC, August 1996), online: USIP http://www.usip.org/publications/south-china-sea-dispute-prospects-preventive-diplomacy.

group.[45] Other commentators suggest figures in the range of 150–180. For example, Dzurek has suggested that there are 'more than 170 features with English names in the Spratly Islands'.[46]

With respect to types of insular feature, UNCLOS provides for several options. In brief these include islands and rocks, low-tide elevations, reefs and artificial islands. The Regime of Islands is provided for in a single article of UNCLOS, this being Article 121 which covers both islands and a sub-category of islands termed 'rocks'. The provisions of Article 121 have excited considerable debate over the years.[47] Article 121(1) of UNCLOS is relatively uncontroversial, defining an island as 'a naturally formed area of land, surrounded by water, which is above water at high tide', as is the subsequent paragraph of the Article which states that the maritime claims made from islands should be determined in the same manner as for 'other land territory'. However, UNCLOS Article 121(3) provides for a sub-category of islands, 'rocks', that are incapable of supporting human habitation or an economic life of their own. Such features 'shall have no exclusive economic zone or continental shelf' – an enormous disadvantage in terms of capacity to generate claims to maritime jurisdiction. Going to theoretical extremes, if an island had no maritime neighbours within 400 nm, it could generate 125,664^2 nm (431,014 km^2) of territorial sea, exclusive economic zone (EEZ) and continental shelf rights as compared to the capacity of a 'rock' to generate a territorial sea claim of 452^2 nm (1,550 km^2).[48]

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[45] See for example, Glen Hearns and Peter Tyedmers, 'Poseidon's Trident: biological Diversity Preservation, Resource Conservation and Conflict Avoidance in the South China Sea', in Gerald H Blake *et al* (eds), *The Peaceful Management of Transboundary Resources* (Graham and Trotman: London, 1995), at 290.

[46] See Dzurek, *supra note* 42, at 1.

[47] See for example, Jonathan I Charney, 'Rocks that cannot Sustain Human Habitation', (1999) 93 AJIL 4, at 863–78; Alexander GO Elferink, 'Clarifying Article 121(3) of the Law of the Sea Convention: the Limits Set by the Nature of International Legal Processes', (1998) 6 *Boundary & Security Bulletin* 2, at 58–68; Barbara Kwaitkowska and Alfred HA Soons, 'Entitlement to Maritime Areas of Rocks which cannot Sustain Human Habitation or Economic Life of their Own', (1990) Netherlands YB of Int'l L XXI, at 139–81; JR Victor Prescott and Clive H Schofield, *The Maritime Political Boundaries of the World* (Leiden/Boston: Martinus Nijhoff Publishers, 2005), at 61–75; Jon M Van Dyke and RA Brooks, 'Uninhabited Islands: Their Impact on the Ownership of the Oceans' Resources', (1983) Ocean Devel & Int'l L 12, at 265–84; and Jon M Van Dyke, J Morgan and J Gurish, 'The Exclusive Economic Zone of the Northwestern Hawaiian Islands: When Do Uninhabited Islands Generate an EEZ?', (1988) 25 San Diego L Rev 3, at 425–94.

[48] For the purposes of these theoretical calculations it is assumed that the insular features in question have no land area.

To date, however, no reliable way of distinguishing between these types of insular feature has emerged, despite the fact that to do so is critical for determining their capacity to generate claims to maritime jurisdiction. In short, despite exhaustive analysis, for instance of the drafting history of Article 121 of UNCLOS, together with detailed analysis of past State practice and the jurisprudence of international courts and tribunals, Article 121 remains a conundrum and open to considerably varied interpretations.

Many of the features making up the disputed South China Sea islands, especially low-lying reef-type features, can be categorised as low-tide elevations, defined in Article 13 of UNCLOS as a 'naturally-formed area of land which is surrounded by water at low-tide but submerged at high-tide'. Such features are considered to be distinct from islands as a result of their being in an inundated state at high tide. Consequently, low tide elevations are not capable of generating claims to maritime space in their own right. Instead, they may be used as territorial sea basepoints, but only if the low-tide elevation in question falls wholly or partially within the breadth of the territorial sea measured from the normal baseline of a State's mainland or island coasts.[49] A low-tide elevation's value for maritime jurisdictional claims is, therefore, geographically restricted to coastal locations. Such features have been termed 'parasitic basepoints' as their zone-generative capacity is reliant on their proximity to a mainland or island baseline.[50]

As far as features such as banks and shoals that are never above low water are concerned, such features have no capacity to generate claims to maritime jurisdiction under UNCLOS. It should also be noted that despite submerged reef platforms having been used to build artificial structures, UNCLOS Article 60(8) states unambiguously that: 'Artificial islands, installation and structures do not possess the status of islands. They have no territorial sea of their own, and their presence does not affect the delimitation of the territorial sea, the exclusive economic zone or the continental shelf'.[51]

Overall it would seem that the vast majority of features making up the disputed 'islands' of the South China Sea and the Spratly 'Islands' in particular are not islands capable of generating extended claims to maritime jurisdiction in accordance with the first two paragraphs of Article 121

49 UNCLOS, Article 13(1).

50 Clive R Symmons, 'Some Problems Relating to the Definition of "Insular Formations" in International Law: Islands and Low-Tide Elevations' (1995) 1 *Maritime Briefing* 5, at 7.

51 UNCLOS, Article 60(5) does, however, provide that safety zones of not more than 500 metres may be declared around such artificial islands or installations.

of UNCLOS. Indeed, it has been suggested that only 48 features among the Spratly Islands group are known to rise above high-tide and thus be subject to the regime of islands.[52] While some of these above high-tide features among the Spratlys are relatively substantial features – the largest, Itu Aba, being 1.4km long and 370m wide with an area of approximately 50 hectares – and may conceivably be considered as 'full' islands from which EEZ and continental shelf rights could be advanced, it would seem likely that many of the other features that make up the disputed islands of the South China Sea, even if above water at high-tide, could well be reasonably classified as mere 'rocks' within the meaning of Article 121(3). It is also worth observing that none of the disputed islands boasts an indigenous population or longstanding history of habitation, only what are essentially garrisons of government personnel, and this can be regarded as a pertinent factor when considering the question of whether a feature is capable of sustaining 'human habitation' in accordance with UNCLOS Article 121(3). Accordingly, the vast majority of the disputed features generally termed Spratly 'Islands' are no more than low-tide elevations, or even submerged features with limited or no capacity to generate claims to maritime jurisdiction.

If features among the Spratly Islands are categorised as mere 'rocks' consistent with the terms of Article 121(3) of UNCLOS, and thus deemed incapable of supporting human habitation or an economic life of their own, their capacity to generate claims to maritime jurisdiction would be severely restricted. The debate over whether features are 'full' islands versus mere 'rocks' is, however, arguably something of a distraction. The disputed features, even the largest among them, are clearly small and have short coastal fronts. The lengths of the coastal fronts involved, and in particular the existence of a significant disparity in the lengths of relevant coasts, has proved to be an influential factor in maritime boundary delimitations in the past.[53] Further, a review of the treatment of islands in the delimitation of maritime boundaries suggests that such features would consequently have a significantly reduced influence on the course of any

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[52] Prescott and Hancox provide the figure of 48. However, some commentators offer lower figures, *supra* note 39. For example, Dzurek offers the number 36, *supra* note 42, at 1.

[53] In the context of maritime boundaries delimited through International Court of Justice rulings, the *Libya/Malta* and *Jan Mayen* cases provide relevant examples. See generally *Continental Shelf (Libyan Arab Jamahiriya/Malta)* (1985) ICJ Rep 13 (*Libya/Malta*) and *Maritime Delimitation in the Area between Greenland and Jan Mayen (Denmark v Norway)* (1993) ICJ Rep 38 (*Jan Mayen Case*).

maritime boundary defined between, for example, the disputed islands and the surrounding mainland or main island coasts. Such a conclusion has been reinforced by recent rulings on the part of the International Court of Justice (ICJ) and International Tribunal on the Law of the Sea (ITLOS) on the delimitation of maritime boundaries where islands have been a key consideration. In both the *Black Sea Case* before the ICJ of 2009 and *Bay of Bengal Case* before ITLOS which concluded in 2012, islands were discounted as basepoints even before a provisional delimitation line based on equidistance was constructed.[54]

This, in turn, suggests that the potential maritime claims to be made from the disputed islands of the South China Sea, often illustrated by reference to maps giving these features full-effect in the generation of strict equidistance lines, is misleading. For example, an equidistance line constructed around the Spratly Islands and according them full-effect encompasses an area of approximately 165,000 nm^2.[55] However, debates over island status and the capacity of insular features to generate claims to maritime space, let alone their potential role in the delimitation of maritime boundaries, tend to be obscured by the claims to sovereignty over the territory of the islands themselves. Such sovereignty claims also manifest themselves in a physical sense as illustrated by the fact that all of the claimants, with the exception of Brunei, have sought to back up their territorial and maritime claims by occupying features among the disputed South China Sea islands. The resolution of these island sovereignty disputes can be regarded as an essential precursor to the settlement of overlapping maritime claims and the delimitation of maritime boundaries. Nonetheless, as subsequent chapters in this volume demonstrate, even highly complex and contentious disputes can be side-stepped through the application of maritime joint development arrangements and, further, this can be achieved in a manner that does not undermine the parties' existing sovereignty and jurisdictional claims.

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54 In the *Black Sea Case* between Romania and Ukraine the island in question was Ukraine's Serpents' Island and in the *Bay of Bengal Case* between Bangladesh and Myanmar it was St. Martin's Island belonging to Bangladesh. See *Maritime Delimitation in the Black Sea* (*Romania v Ukraine*) (2009) ICJ Rep 61 (*Black Sea Case*), online: ICJ http://www.icj-cij.org/docket/files/132/14987.pdf, at para149; and *Dispute Concerning Delimitation of the Maritime Boundary between Bangladesh and Myanmar in the Bay of Bengal* (2012) Judgment, ITLOS Case No 16 (*Bangladesh/Myanmar*), at para 233, online: ITLOS http://www.itlos.org/fileadmin/itlos/documents/cases/case_no_16/1-C16_Judgment_14_02_2012.pdf.

55 Prescott and Schofield, *supra* note 47, at 457.

D. Converging Claims to Maritime Jurisdiction

As previously noted, UNCLOS provides the generally accepted international legal framework governing maritime jurisdiction. Among the States bordering the South China Sea, Brunei, China, Indonesia, Malaysia, the Philippines, Singapore and Viet Nam have all signed and ratified UNCLOS. Of the Gulf of Thailand States, Cambodia has signed the Convention but has yet to ratify it. For its part Thailand signed the Convention in 1982 but only finally acceded to it in May 2011.[56] Additionally, non-UN member Taiwan is not a party to the Convention.

A key achievement of UNCLOS was agreement on spatial limits for national claims to maritime jurisdiction, which are largely defined as extending to a set distance from baselines along the coast.[57] The South China Sea claimants have proved to be enthusiastic in advancing such maritime claims. To a large degree these claims are broadly consistent with the terms of UNCLOS; comprising claims to 12 nm-breadth territorial seas, contiguous zones to 24 nm, EEZs to 200 nm and continental shelf rights. These claims, however, frequently only represent a general claim to jurisdiction to a specified distance measured from claimed baselines, rather than specifying the coordinates of a particular claim. There are, however, exceptions to this rule, both in terms of specifying the limits of unilateral maritime claims and with respect to their consistency with the terms of UNCLOS (see below).

The semi-enclosed nature of the South China Sea means that it is surrounded by numerous bordering States and entities. This feature of the South China Sea means that the maritime entitlements of the claimants tend to converge and overlap with one another. If 200 nm claims from the mainland and main island coastlines are defined, a substantial high seas pocket exists in the central part of the South China Sea. This 'doughnut hole' is reduced in area but not eliminated once 200 nm limits are constructed from straight and archipelagic baselines as compared with claims from normal, low-water line baselines along the coast. However, this potential high seas pocket disappears entirely if extended claims to maritime jurisdiction (that is, to EEZ and continental shelf rights) are made from the disputed islands of the South China Sea. As noted many of the 'islands' of the South China Sea, for instance among the Spratly Islands,

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56 See United Nations, *supra* note 6.

57 The notable exception to this general rule is provided by the definition of the outer limits of the continental shelf where it extends seawards of the 200 nm limit. Article 76 of UNCLOS provides a complex series of criteria in this respect which include geophysical factors as well as distance measurements.

could be classified as either 'rocks' within the meaning of Article 121(3) of UNCLOS, or low-tide elevations, or even sub-surface features and as such are incapable of generating claims to EEZ and continental shelf rights (and, indeed, any maritime claims in the case of features permanently below the low-water level). Indeed, there are indications that some of the South China Sea littoral States regard all of the Spratly Islands as no more than 'rocks', meaning that a high seas doughnut hole would exist in the South China Sea (see below). Other claimants appear to take a different view. It can be observed that even if only a few of the larger features among the disputed islands are capable of generating extended maritime claims, this potential South China Sea high seas pocket would disappear, or at the least be radically curtailed in area.[58]

E. Existing Agreements

Despite its well-earned reputation as an arena for disputes and conflict, agreements on maritime boundary delimitation are not entirely absent from the South China Sea. Indeed, though progress has tended to have been incremental and partial in character, several boundary treaties have been concluded, including some in recent times. Examples include the Thailand and Malaysia territorial sea delimitation of 1979[59] and partial continental shelf delimitation of the same date,[60] the Thailand-Viet Nam EEZ agreement of 1997,[61] China and Viet Nam's 2000 agreement

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[58] For example, if EEZs are defined from Woody Island in the Paracel Islands group, from Itu Aba, Spratly Island and Thitu Island in the Spratly Islands and also from Scarborough Shoal, the high seas pocket is almost entirely eliminated. It is worth noting, however, that these features are not of comparable size as Scarborough Shoal in particular is significantly smaller.

[59] *Treaty between the Kingdom of Thailand and [the Republic of] Malaysia Relating to the Delimitation of the Territorial Seas of the Two Countries* of 24 October 1979. See Jonathan I Charney and Lewis M Alexander (eds), *International Maritime Boundaries*, Vols I & II (Dordrecht: Martinus Nijhoff, 1993), at 1,096–1,098, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/TREATIES/THA-MYS1979TS.PDF.

[60] *Memorandum of Understanding between Malaysia and the Kingdom of Thailand on the Delimitation of the Continental Shelf Boundary between the Two Countries in the Gulf of Thailand* was signed on 24 October 1979. See Charney and Alexander, *supra* note 59 at 1,105–1,107.

[61] *Agreement between the Government of the Kingdom of Thailand and the Government of the Socialist Republic of Viet Nam on the Delimitation of the Maritime Boundaries between the Two Countries in the Gulf of Thailand*. See JI Charney and RW Smith (eds), *International Maritime Boundaries*, Vol IV

on maritime boundary delimitation through the Gulf of Tonkin/Beibu Gulf,[62] the Indonesia-Viet Nam continental shelf boundary of 2003[63] and Indonesia and Singapore's territorial sea boundary agreements of 1973 and 2009.[64] Brunei and Malaysia also appear to have clarified their maritime boundary issues through a 16 March 2009 Exchange of Letters.[65]

The South China Sea also features multiple provisional arrangements of a practical nature in lieu or in addition to maritime boundary agreements. Such joint development mechanisms have been established

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(Dordrecht: Martinus Nijhoff, 2002), at 2,692–2,694, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/TREATIES/THA-VNM1997MB.PDF.

62 *Agreement between the Socialist Republic of Viet Nam and the People's Republic of China on the Delimitation of the Territorial Sea, Exclusive Economic Zone and Continental Shelf between the Two Countries in the Tonkin Gulf*, 25 December 2000 (entry into force 30 June 2004). See David A Colson and Robert W Smith (eds), 'People's Republic of China-Viet Nam', *International Maritime Boundaries*, Vol V (Leiden, Martinus Nijhoff, 2005), at 3,745–3,758. See also Nguyen Hong Thao, 'Maritime Delimitation and Fishery Cooperation in the Tonkin Gulf', (2005) 36 *Ocean Development and International Law*, at 25–44.

63 *Agreement between the Government of the Socialist Republic of Viet Nam and the Government of the Republic of Indonesia concerning the delimitation of the continental shelf boundary*, 26 June 2003 (entry into force 29 May 2007). See David A Colson and Robert W Smith (eds), *International Maritime Boundaries*, Vol VI (Leiden, Martinus Nijhoff, 2005), at 4,301–4,315.

64 *Agreement Stipulating the Territorial Sea Boundary Lines between Indonesia and the Republic of Singapore in the Strait of Singapore*, 25 March 1973 (entry into force 29 August 1974). See The Geographer, 'Territorial Sea Boundary: Indonesia-Singapore', *Limits in the Seas*, No 60, 11 November 1974. See, also, Ministry of Foreign Affairs, Indonesia, 'The Signing of The Treaty Between The Republic of Indonesia and The Republic of Singapore Relating to The Delimitation of The Territorial Seas in the Western Part of the Strait of Singapore', Press Release Jakarta, 10 March 2009, online: Indonesia Ministry of Foreign Affairs http://www.deplu.go.id/_layouts/mobile/PortalDetail-PressReleaseLike.aspx?l=en&ItemId=c148acb8-88c6-4e24-9dd3-352ec9cd90c2.

65 The territorial sea boundaries between Brunei and Malaysia were defined in 1958 out to the 100 fathom isobath through two British Orders in Council. See Charney and Alexander, *supra* note 59, at 915–928. Brunei's submission of preliminary information to the United Nations Commission on the Limits of the Continental Shelf further states that maritime boundaries between Brunei and Malaysia have been delimited by virtue of the 1958 Orders in Council and 'an Exchange of Letters dated 16 March 2009' which served to delimit territorial sea, EEZ and continental shelf rights 'to a distance of 200 nautical miles'. See Brunei-Darussalam's Preliminary Submission concerning the Outer Limits of its Continental Shelf, 12 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/commission_preliminary.htm.

between Malaysia and Thailand concerning seabed energy resources (agreed in principle in 1979,[66] implemented from 1990), between Malaysia and Viet Nam, also related to seabed hydrocarbon exploration and development in 1992,[67] and between China and Viet Nam in 2000 concerning joint fishing activities as part of their above-mentioned maritime boundary treaty.[68] Cambodia and Thailand also agreed in principle to pursue an accord on maritime joint development for part of their overlapping claims area in 2001, although little progress has subsequently been achieved.[69] These joint arrangements will be considered in more detail elsewhere in this volume but reference to them is included here as part of the overall jurisdictional scenario in the South China Sea. It is notable, however, that both the maritime boundary agreements and joint arrangements that have been concluded have been exclusively on a bilateral basis and largely towards the periphery of the South China Sea.

F. Historic Claims

While it is the case that most, if not all, of the claims to sovereignty over disputed territory, that is, islands, in the South China Sea owe something to history, there also exist claims to maritime space that are, apparently at least, based on historical factors. In particular Cambodia and Viet Nam have, since 1982, claimed an oblong area of 'joint historic waters' projecting from their coasts (but within their claimed straight baselines, in the Gulf of Thailand)[70] – a claim that has given rise to international

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[66] *Memorandum of Understanding between the Kingdom of Thailand and [the Republic of] Malaysia on the Establishment of a Joint Authority for the Exploitation of the Resources of the Sea-Bed in a Defined Area of the Continental Shelf of the Two Countries in the Gulf of Thailand*, done on 21 February 1979. See Charney and Alexander, *supra* note 59, at 1107–1123, online: United Nations http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/TREATIES/THA-MYS1979CS.PDF.

[67] *Memorandum of Understanding between Malaysia and the Socialist Republic of Viet Nam for the Exploration and Exploitation of Petroleum in a Defined Area of the Continental Shelf Involving the Two Countries* was signed on 5 June 1992 and entered into force on 4 June 1993. See Charney and Alexander, *supra* note 59, at 2335–2344.

[68] *Agreement on Fishery Co-operation in the Tonkin Gulf between the Government of the People's Republic of China and the Government of the Socialist Republic of Viet Nam*, 25 December 2000. See Nguyen Hong Thao, *supra* note 62, at 25–44.

[69] Indeed in late 2009 it was reported that Thailand intended to unilaterally abrogate the 2001 Memorandum of Understanding.

[70] *Agreement on Historic Waters of Viet Nam and Kampuchea*, 7 July 1982.

protests.[71] The Philippines has also long claimed rights within its 'Treaty Limits' – the 'box' formed by several nineteenth and early twentieth century era treaties.[72] In particular, the Philippines claims territorial sea rights within the Treaty Limits box, and thus out to 285 nm at its furthest extent from the Philippines baselines.[73] This claim, and the Treaty Limits assertion generally, appear to be manifestly at variance to the terms of UNCLOS.

The Philippines has also defined an irregular pentagonal box in the South China Sea, terming the islands within this box, the 'Kalayaan Island Group' (KIG). However, the KIG box does not appear to represent a claim to historic waters but instead provides an indication of a claim to sovereignty to all the territories (that is, islands) within this area. This interpretation, supported by the above-mentioned 2009 baselines revision, leaves the South China Sea islands claimed by the Philippines outside the Philippine's archipelagic baselines, instead dealing with them under the 'regime of islands', and in a manner consistent with UNCLOS.

China's (in)famous dashed line claim is of particular note here. This dashed line claim (if it can be termed as such) remains shrouded in uncertainty. An 11-dashed line first appeared on a map issued in 1947 by the Republic of China authorities but was subsequently adopted by the PRC in 1949, albeit with two dashes removed from the early 1950s.[74] These dashed lines are sometimes joined up by commentators to form a so-called 'U-shaped line' although it should be stressed that official Chinese sources consistently show a discontinuous line. What is also consistent is a lack

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See Jonathan I Charney and Lewis M Alexander (eds), *International Maritime Boundaries*, vol III (Dordrecht: Martinus Nijhoff, 1998), at 2,364–2,365.

71 Notably on the part of Thailand and the United States. See United Nations, *Law of the Sea Bulletin* 7 (April 1986), at 111; and United Nations, *Law of the Sea Bulletin* 10 (November 1987), at 23.

72 Specifically, the Treaty of Peace between the United States and Spain (Treaty of Paris) of 10 December 1898, the *Treaty between Spain and the United States for the Cession of Outlying Islands for the Philippines* of 7 November 1900 (Cessation Treaty), and the *Convention between the United States and Great Britain Delimiting the Philippine Archipelago and the State of Borneo* of 2 January 1930 (Treaty of Washington).

73 Prescott and Schofield, *supra* note 47, at 452.

74 See for example, Li Jinming and Li Dexia, 'The Dotted Line on the Chinese Map of the South China Sea: A Note', (2003) 34 Ocean Devel & Int'l L 287; Zou Keyuan, 'The Chinese Traditional Maritime Boundary Line in the South China Sea and Its Legal Consequences for the Resolution of the Dispute over the Spratly Islands', (1997) 14 Int'l J Mar & Coast L 52; Kuan-Hsiung Wang, 'The ROC's Maritime Claims and Practices with Special Reference to the South China Sea', (2010) 41 Ocean Devel & Int'l L, at 237–52.

of clarity as to what this dashed line actually signifies. It remains unclear whether the dashed line is a claim to sovereignty over the territory (that is, the disputed islands) within it, whether it is indicative of a unilateral claim to a maritime boundary or whether it represents a claim to the maritime spaces within the dashes, either as historic waters or another type of maritime zone. The significance of China's inclusion of the nine-dashed line in its protest notes with respect to the extended continental shelf submissions of Viet Nam alone, and Malaysia and Viet Nam jointly, similarly remains unclear. Nevertheless, several Chinese enforcement actions in the South China Sea in recent times strongly suggest that the nine-dashed line remains the basis for Chinese claims. These have included fisheries incidents in Indonesian claimed waters in the southwestern South China Sea,[75] as well as incidents related to oil exploration activities on the part of both the Philippines and Viet Nam.[76] Further, in mid-2012 the China National Offshore Oil Corporation (CNOOC) designated a series of oil exploration blocks in close proximity to the Viet Namese coastline, yet just within the nine-dashed line which was also illustrated on the map showing the CNOOC blocks.[77] These activities appear to be only justifiable on the basis of a claim to the limits of the nine-dashed line.

G. Unilateral Maritime Claims

While, as noted above, many of the South China Sea claimants, in common with many coastal States worldwide, simply make ambit claims to broad maritime jurisdictional zones, several of the claimants have been more specific regarding the spatial limits of at least some of their maritime

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[75] Andi Arsana and Clive Schofield, 'Indonesia's "Invisible" Border with China', in *Beijing's Power and China's Borders: Twenty Neighbors in Asia*, edited by Bruce A Elleman, Stephen Kotkin and Clive H Schofield (New York, NY: ME Sharpe Publishers, 2012), at 67–70.

[76] Regarding incidents between China and the Philippines see, for example, Jerome Aning and Norman Bordadora, 'China snubs PH protest: Aquino to send "Spratlys expert" to Beijing', *Philippine Daily Inquirer*, 3 May 2011. See also L Bautista and CH Schofield, 'Philippine-China border relations' in S. Kotkin *et al*, supra note 75, at 244.. Concerning incidents between China and Viet Nam see, for example, Daniel Ten Kate, 'South China Sea Oil Rush Risks Clashes as U.S. Emboldens Viet Nam on Claims', *Bloomberg*, 27 May 2011, online: http://www.bloomberg.com/news/2011-05-26/s-china-sea-oil-rush-risks-clashes-as-u-s-emboldens-vietnam.html.

[77] See China National Offshore Oil Corporation (CNOOC), 'Notification of Part of Open Blocks in Waters under Jurisdiction of the People's Republic of China Available for Foreign Cooperation in the Year of 2012', 23 June 2012 http://en.cnooc.com.cn/data/html/news/2012-06-23/english/322127.html.

claims. In the Gulf of Thailand, all of the littoral States defined unilateral continental shelf claims in the 1970s, which substantially overlap with one another.[78] In the South China Sea 'proper', as previously mentioned, Malaysia issued a map in 1979 that shows the limits of Malaysia's unilateral territorial sea and continental shelf claims.[79] In 1988 Brunei similarly defined a rectangular maritime claim extending into the South China Sea by publishing a series of maps.[80] In 2010 Indonesia also employed cartographic means to clarify its 'forward position' in terms of its maritime claims.[81]

H. Extended Continental Shelf Submissions

In 2009, in common with many coastal States around the world, Viet Nam alone[82] and Malaysia and Viet Nam jointly[83] made submissions to the UN Commission on the Limits of the Continental Shelf (CLCS).[84] These submissions are significant because they relate to areas seaward of the 200 nm limit from these States' mainland coasts. The implication of these submissions is that, as far as Malaysia and Viet Nam are concerned, the disputed islands of the South China Sea are, at best, no more than 'rocks' within the meaning of UNCLOS Article 121(3). This is fundamental because, as noted above, if the disputed islands are in fact islands capable

[78] For analysis of these claims see Clive Schofield and May Tan-Mullins, *supra* note 23, at 75–116

[79] The *Peta Baru* ('New Map'), *supra* note 23.

[80] Maps Showing Continental Shelf of Brunei Darussalam (1988); and Maps Showing Fishery Limits of Brunei Darussalam (1988). Also of note is the Map Showing Territorial Waters of Brunei Darussalam (1987). See also Renate Haller-Trost, 'The Brunei-Malaysia Dispute over Territorial and Maritime Claims in International Law', (1994) 1 *Maritime Briefing* 3, International Boundaries Research Unit, at 4–5.

[81] Bakosurtanal, *Map of the Republic of Indonesia* (Cibinong, 2010).

[82] *Submission to the Commission on the Limits of the Continental Shelf pursuant to Article 76, paragraph 8 of the United Nations Convention on the Law of the Sea 1982, Partial Submission in Respect of Viet Nam's Extended Continental Shelf: North Area (VNM-N)*, Executive Summary, 7 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn 2009re mys vnm e.pdf .

[83] *Joint Submission to the Commission on the Limits of the Continental Shelf pursuant to Article 76, paragraph 8 of the United Nations Convention on the Law of the Sea 1982 in respect of the southern part of the South China Sea*, Executive Summary, 6 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm.

[84] See online: United Nations Commission on the Limits of the Continental Shelf http://www.un.org/Depts/los/clcs_new/clcs_home.htm.

of generating EEZ rights, then no area of extended continental shelf exists in the South China Sea.[85]

These submissions became a point of contention between the South China Sea claimants with both of the above-mentioned submissions prompting near-identical protest notes from China which stated in a diplomatic note directed to the Secretary General of the United Nations dated the day after Malaysia and Viet Nam's joint submission was made, that China has 'indisputable sovereignty over the islands in the South China Sea', and that, consequently, Malaysia and Viet Nam's joint submission 'seriously infringed China's sovereignty'.[86] These protest notes in turn led to counter assertions on the part of Malaysia and Viet Nam stating that their submissions 'constitute legitimate undertakings' in the implementation of its obligations as Parties to UNCLOS.[87] Subsequently, communications have also been directed to the United Nations Secretary General by Indonesia[88] and the Philippines,[89] both protesting China's nine-dashed line, with the latter note leading to a robust response on the part of China.[90]

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[85] Sam Bateman and Clive Schofield, 'Outer Shelf Claims in the South China Sea: New Dimension to Old Disputes' (Singapore: RSIS Commentary, 1 July 2009).

[86] See Note from the Permanent Mission of the People's Republic of China addressed to the Secretary General of the United Nations, CML/17/2009, 7 May 2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm; see also, an English language translation of China's reaction to Viet Nam's submission at http://www.un.org/depts/los/clcs_new/submissions_files/vnm37_09/chn_2009re_vnm.pdf.

[87] See Note from the Permanent Mission of Malaysia to the United Nations addressed to the Secretary General of the United Nations, HA 24/09, and, Note from the Permanent Mission of the Socialist Republic of Viet Nam to the United Nations addressed to the Secretary General of the United Nations, 86/HC-2009, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm; and, http://www.un.org/depts/los/clcs_new/submissions_files/vnm37_09/vnm_re_chn_2009re_vnm.pdf.

[88] See Note from the Permanent Mission of Indonesian to the United Nations to the Secretary-General of the United Nations, 8 July 2010, No. 840/POL-703/VII/10, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/idn_2010re_mys_vnm_e.pdf.

[89] See Note from the Permanent Mission of the Republic of the Philippines to the United Nations to the Secretary-General of the United Nations, No. 000228, 5 April 2011, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/phl_re_chn_2011.pdf.

[90] See Note from the Permanent Mission of the People's Republic of China to the Secretary-General of the United Nations, CML/8/2011, 14 April 2011, online: United Nations http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2011_re_phl_e.pdf.

It is worth noting here that the CLCS is a scientific and technical role rather than legal one in the sense of adjudicating between competing submissions. Indeed, the CLCS lacks the mandate to address areas subject to a sovereignty dispute or subject to overlapping maritime claims. Furthermore, the Commission's recommendations are also specifically without prejudice to the delimitation of maritime boundaries with Article 76(10) of UNCLOS providing that '[t]he provisions of this article are without prejudice to the question of delimitation of the continental shelf between States with opposite or adjacent coasts'.[91]

The extended continental shelf submissions process, and the reactions to the submissions made, is, however, of note in that these documents arguably assist in the interpretation of existing maritime claims in the South China Sea. While attention was focussed on China's inclusion of its nine-dashed line map with its protest notes, the language used in the Chinese protests is potentially instructive. In particular, China's note verbale in response to the above-mentioned submissions of Malaysia and Viet Nam stated that China has 'sovereignty' over waters 'adjacent' to the disputed South China Sea islands and 'sovereign rights' over 'relevant waters as well as the seabed and subsoil thereof'. This language is, arguably, consistent with claims to territorial sea, EEZ and continental shelf rights made from the disputed islands, as opposed to a claim to historic waters or similar within the nine-dashed line, as has been speculated.[92] Further, in its response to the protest made by the Philippines, China was explicit in stating that 'China's Nansha [Spratly] Islands is fully entitled to Territorial Sea, EEZ, and Continental Shelf'.[93] Unfortunately it is not possible to be definitive on this point as China's claim remains less than explicit. Moreover, China's recent enforcement actions and activities such as the issuing of oil concession blocks in the South China Sea, as alluded to above, would seem to run counter to any suggestion that Chinese maritime claims in the South China Sea are increasingly in keeping with UNCLOS.

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[91] See also Annex II of UNCLOS and the Rules of Procedure of the Commission on the Limits of the Continental Shelf. The current version of the Rules is contained in Doc CLCS/40/Rev 1 of 17 April 2008, online: United Nations http://www.un.org/Depts/los/clcs_new/commission_documents.htm#Rules%20of%20Procedure.

[92] Robert Beckman, 'South China Sea: Worsening Dispute or Growing Clarity in Claims?' (Singapore, RSIS Commentary, 16 August 2010).

[93] See Note from the Permanent Mission of the People's Republic of China to the Secretary-General of the United Nations, *supra* note 90.

III. GEOPOLITICAL CONSIDERATIONS

A. Sovereignty

Sovereignty remains a critical element of the South China Sea disputes. Such disputes involve sovereignty over territory (that is, islands) and also sovereignty and sovereign rights over maritime spaces. Although traditional Westphalian conceptions of bounded territorial States have been subject to concerted criticism and challenge prompted, for instance, by deepening globalisation, the territorial State has by no means withered away. On the one hand, globalisation has clearly led to increasingly unfettered flows of capital, ideas, information and to a large extent labour, across and within the boundaries of States, thereby arguably eroding the importance of international boundaries and undermining the significance and authority of territorial States themselves. This, in turn has led to the emergence of a developing literature challenging traditional assumptions concerning the role and relevance of bordered State sovereignties. There are, however, powerful countervailing forces favouring inertia in the international legal order and which serve to underpin territorial States. Further, while globalisation may be changing or diluting the significance of sovereignty and boundaries in some areas, in others they have been reinforced. For example security and environmental concerns have been deployed as a rationale for the reassertion of the role of territorial States and their international boundaries as barriers and filters against hostile 'other' influences and threats.

For all the merits of the contemporary discourse and critique of territorial States, such entities remain as the key actors and fundamental building blocks of the international legal system. Indeed, it remains deeply unclear whether the international legal order, with the concept of the territorial State at its heart, is indeed under terminal threat, not least for want of a viable alternative system. Certainly sovereignty as a concept appears to be alive and well, indeed enthusiastically embraced, in East and Southeast Asia, including its associated maritime spaces. In this context it is important to note that the law of the sea gives States a primary role (unsurprisingly since UNCLOS was the creation of States). Crucially, claims to maritime jurisdiction may only be made by States.[94]

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94 This conclusion is implicit from the terms and language of the Convention and in particular its emphasis on the role of States. For example, in the preamble to UNCLOS reference is made to the desirability of establishing 'a legal order for the seas and oceans' through the Convention 'with due regard to the sovereignty of all States'. Further, among the few definitions of terms pro-

Territorial States are, as the name suggests, dependent, at least in part, on the possession of a 'defined territory'.[95] The fundamental linkage between States and their constituent territories in international legal terms, coupled with the powerful influences of nationalism, patriotism and the demands of domestic and international politics, means that States tend to have great attachment to territory. Consequently, such entities tend to vigorously defend any apparent threat to their constituent territories as a threat to part of a State's territory, however small, can be construed, especially to a domestic audience politically, as an assault on the territorial integrity of a given State and thus a threat to its legitimacy. This holds true no matter how small or apparently intrinsically worthless (for instance tiny, remote and uninhabited islets) such fragments of territory may appear from a detached, external perspective.

Disputed sovereignty, especially over land territory (disputed islands) remains a root cause, or at least explanation, for the South China Sea islands disputes, especially when coupled with the influences of historical competition and animosity. Compromising on sovereignty is especially challenging for territorial States, seemingly regardless of the remote, uninhabited and apparently desolate nature of the territory (islands) in question. It can be observed that this is especially the case where the legitimacy of the governments of the States involved is closely tied to nationalism and patriotism which, in turn, provides a strong imperative for the protection of perceived infringements of national sovereignty.

It is noticeable, however, that many sovereignty disputes over such far-flung islands, including those of the South China Sea, have only manifested themselves in the post-World War II period, as extended claims to maritime jurisdiction became more prevalent. This has tended to add maritime jurisdictional and thus marine resource access issues as significantly complicating factors in sovereignty disputes. However, although sovereignty disputes are difficult to overcome, it is nonetheless possible to

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vided in Article 1 of UNCLOS, 'States Parties' is defined as 'States which have consented to be bound by this Convention and for which this Convention is in force'. Moreover, regarding claims to maritime zones of jurisdiction, States are given an exclusive role. For example, Article 2 of UNCLOS dealing with the territorial sea provides that '[t]he sovereignty of a coastal State extends . . .'. Similar language prevails in respect of the other types of maritime zones covered by UNCLOS.

95 Article 1 of the Montevideo Convention on the Rights and Duties of States, provides that States should possess a 'defined territory', a permanent population, a government and the capacity to enter into international relations with other States. See the Montevideo Convention on the Rights and Duties of States opened for signature 26 December 1933, 165 LNTS 19 (entered into force 26 December 1934).

do so, for instance through the delimitation of international boundaries or through innovative joint arrangements of a provisional and practical nature that are, moreover, 'sovereignty neutral' and therefore do not imperil existing sovereignty claims.

B. South China Sea Oil Dreams . . . or Illusions?

A long-standing assumption with respect to the broad areas of overlapping maritime claims in the South China Sea is that they are host to substantial reserves of seabed energy resources. Indeed, the words 'potentially oil rich' are often seen in close proximity to 'South China Sea' or 'Spratly Islands'. Many such estimates are speculative, poorly supported and are thus frequently highly misleading. Nonetheless, persistent perceptions that the South China Sea represents a major potential source of seabed energy resources and even a 'second Persian Gulf'[96] is often suggested as a key driver in the South China Sea disputes. Recent incidents involving oil and gas surveying and exploration activities tend to reinforce the view that access to valuable oil and gas resources underlying contested waters is an important contributing factor to the South China Sea disputes.

Certainly the potential presence of substantial and, critically, close-to-hand reserves of, particularly, oil, would be extremely attractive to the South China Sea claimants in the face of their generally increasing energy security concerns. States in Northeast Asia such as South Korea and Japan have long been highly energy import dependent – Japan for instance importing 90 per cent of its oil requirements by sea. China became a net oil importer in 1993 and is predicted to be importing 60 per cent or more of its energy needs by 2020. In Southeast Asia, domestic production is generally plateauing or declining. This means that currently or recently exporting States such as Indonesia, Malaysia and Viet Nam already are, or are highly likely to become, oil importers in the near future. This trend is compounded by predictions that oil demand in these States is likely to continue to rise. Indeed, International Energy Agency (IEA) figures suggest that growth in demand in Southeast Asia and China coupled with maturing production there will mean that net oil imports are likely to quadruple by 2030. In consequence imports would meet 74 per cent of Southeast Asia's oil demands, compared with 25 per cent in

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[96] Daniel Ten Kate, 'South China Sea Oil Rush Risks Clashes as US Emboldens Viet Nam on Claim', Tuoi Tre News, 30 May 2011, online: *Tuoi Tre News* http://www.tuoitrenews.vn/cmlink/tuoitrenews/politics/china-s-power-thirst-underpins-sovereignty-breach-1.32681.

2008.[97] This, in turn, tends to underscore the importance of sea lanes security (see below).

These present and increasing energy security considerations go a long way to explaining not only the expansive maritime claims of the claimants, but also the general intransigence of these claimants with regard to their maritime claims – to compromise on maritime claims may be perceived as running the risk of 'missing out' on a particular claimant's perceived rightful share of the potential (though potentially illusory) oil bonanza. Suggestions that the Spratlys are host to enormous reserves of oil and gas should be viewed with caution, however. While parts of the South China Sea are prospective and have long attracted interest from the oil industry as well as the governments of coastal States, in light of the longstanding disputes in these regions, the actual presence and size of the seabed energy resources present within these contested areas have proved impossible to verify. Many estimates as to the oil and gas resource potential of the South China Sea tend to be highly speculative in character, precisely because of the lack of ground-truthing to information derived from exploration activities.

South China Sea oil and gas resource estimates also tend to vary wildly. While this is partially attributable to their essentially speculative nature, a key reason for the broad disparities that exist between different estimates is a failure to distinguish between undiscovered oil and gas *resources* and recoverable *reserves*. The industry 'rule of thumb' for frontier provinces suggests that only 10 per cent of estimated in situ resources can be recovered (though this figure can vary and is in any case a function of oil price and extraction technologies).[98] For example, characteristically optimistic Chinese estimates for the oil and gas potential of the South China Sea tend to deal in resources rather than reserves. A further source of uncertainty relates to geographical definition. Some estimates quoted for the South China Sea in fact relate to Southeast Asia as a whole and thus includes resources located in undisputed waters or outside the South China Sea entirely.

Moreover, many reports are less than rigorous in identifying the type of resource under discussion and in particular whether conventional or unconventional oil and gas resources are subject to appraisal. Conventional crude oil is defined as oil that is less dense than water which

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97 International Energy Agency (IEA) (2009) *World Energy Outlook 2009* (Paris: OECD/IEA).

98 This figure may be of the order of 30% in more established provinces, however.

generally flows from the ground under pressure, and remains liquid at surface temperature and pressure.[99] Unconventional crude oil includes resources such as oil shale, tar sands and deepwater oil resources. With regard to the latter type of oil resources, significant technological advances are increasingly allowing exploration and development in deep (that is, according to some definitions, water depths in excess of 1000 feet) and ultra-deep (over 5000 feet) waters.[100] Such waters include parts of the South China Sea and exploration efforts are underway there as illustrated by China's recent domestic construction of semi-submersible, deepwater drilling rig capable of drilling in up to 3000 meters of water and the deployment of this rig in the northern South China Sea.[101]

In this context it is also worth noting that it has been suggested that the South China Sea is predominantly a gas-prone province. This is good news in that recovery rates from gas fields tend to be significantly higher than for oil fields (75 per cent vs. 10 per cent). That said, gas is a substantially less attractive resource than is oil in large part because of high dependence on oil as a key liquid fuel energy carrier, coupled with the significant limitations that exist in relation to the use of gas as a substitute for petroleum-derived fuels. In particular, although it is feasible to use gas in the transport sector, the global economy is to an extent 'locked in' to technologies that demand oil-derived fuels.[102] Further, estimates for South China Sea gas reserves suffer from uncertainties of a similar magnitude as is the case for oil and for analogous reasons (principally because of lack of exploration opportunities as a consequence of overlapping maritime claims). A further important consideration is that many of the more optimistic assessments of the gas resource potential of the South China Sea fail to distinguish between conventional and unconventional gas resources. That is, many optimistic estimates include gas hydrates. While gas hydrates offer con-

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[99] Conventional crude oil also includes lease condensate (a mixture of heavy hydrocarbons associated with gas production, which condenses to form a liquid at surface conditions) and liquefied petroleum gas (LPG) a mixture of light hydrocarbons associated with crude oil production and refining that is gaseous at surface conditions).

[100] The figures of 1000 ft (305 m) for deepwater and 5000 ft (1,524 m) for ultra-deepwater are used by the United States government. See, for example, Richard McLaughlin, 'Hydrocarbon Development in the Ultra-Deepwater Boundary Region of the Gulf of Mexico: Time to Reexamine a Comprehensive U.S.-Mexico Cooperation Agreement', (2008) 39 Ocean Devel & Int'l L 1, at 1.

[101] See for example, Daniel Ten Kate, *supra* note 96.

[102] For example, as a result of long vehicle fleet turnover times. See Nick A Owen and Clive H Schofield, 'Disputed South China Sea Hydrocarbons in Perspective', (2012) 36 *Marine Policy* 809, at 811.

siderable potential as a future energy resource, at present their commercial development is well beyond the horizon. This is essentially because they rank as the most technically challenging, and therefore expensive, of unconventional gas resources. As a consequence of their position at the base of the hierarchy of gas resources, gas hydrates are only likely to be developed after less technically challenging and expensive gas resources are exploited. Given the enormous combined volume of other unconventional gas resources, development of gas hydrates is presently beyond any foreseeable timescale. Consequently, the inclusion of gas hydrates in gas resource estimates for the South China Sea significantly and unrealistically inflates such estimates and renders them highly suspect from the point of view of near to medium term energy security considerations.[103]

The potential oil and gas resources of the South China Sea should also be placed in a regional and global context. The States of East and Southeast Asia face immediate and increasingly pressing energy security worries, especially as demand is anticipated to continue trending sharply upwards. However, even if the South China Sea disputes were to be resolved tomorrow (a tall order indeed), and exploration activities could begin in earnest, South China Sea energy resources, should they in fact exist, would provide no instant solution. This is because it is usual for approximately 10 years to elapse between the discovery of a field and 'first oil' being delivered. Production from such a field would then need to build up over time such that the South China Sea resources would be unlikely to peak for a decade and a half following resolution (or shelving) of the territorial and maritime disputes in question. In any case, it also appears unlikely that South China Sea reserves are likely to significantly address existing and predicted energy demands, even taking into account the more optimistic resource estimates mentioned above. This suggests that the oil and gas resources of the South China Sea do not represent some kind of silver bullet for regional energy security concerns.

C. Critical Sea Lanes

The South China Sea is host to a series of Sea Lines of Communication (SLOCs) of regional and global significance. These SLOCs connect constricting 'chokepoints' that provide entry to and egress from the South China Sea. Of particular note in the southern part of the South China Sea are the Straits of Malacca and Singapore at the southwestern entrance to the South China Sea and the Karimata Strait providing access to the Java

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[103] Ibid, at 813.

Sea and Indonesia's archipelagic waters and thus the Straits of Sunda. In the northern South China Sea the Taiwan Strait between Taiwan and mainland China and the Bashi and Balintang Channels located between Taiwan and the Philippines main island of Luzon are significant. The South China Sea can also be accessed to the east via the Mindoro Strait and Cape Verde Passage (connecting to the Sulu Sea within the archipelagic waters of the Philippines). Moreover the South China Sea can be entered via the Straits of Lombok and Makassar and then the Balabac Strait between the Philippines archipelago and Borneo.[104] This route is particularly important because it is a favoured route for very large crude carriers (VLCCs) when fully laden and is also significant for LNG exports from Australia to China.

The SLOCs connecting these key chokepoints do not represent a single sea lane but rather a network of routes used for navigation. The precise route used by a particular ship is commonly influenced by its point of departure and intended destination, allied to weather considerations influenced by the time of year the voyage take place.[105] What is worth noting, however, is that despite the fact that the disputed islands of the South China Sea are often referred to as being located on or straddling these SLOCs, in fact the island groups in question have long been regarded primarily as hazards to navigation – as shown by terminology such as 'Dangerous Ground' as mentioned above. Consequently, much maritime traffic, for instance travelling between the Malacca and Singapore Straits and ports in East and Northeast Asia, tends to sail well to the west of the disputed Spratly Islands. Similarly, the Palawan Passage route skirts the east of the Spratlys archipelago.[106]

Secure SLOCs and freedom of navigation are essential to the smooth functioning of the global economy as maritime transport continues to provide the 'backbone' of international trade with in excess of 80 per cent of global trade by volume being transported by sea.[107] If anything this

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104 See for example, Chris Rahman and Martin Tsamenyi, 'A Strategic Perspective on Security and Naval Issues in the South China Sea', 41 Ocean Devel & Int'l L 315, at 316–17.

105 Ibid, at 317.

106 Chris Rahman and Martin Tsamenyi, *supra* note 104, at 316–18.

107 United Nations Conference on Trade and Development, *Review of Maritime Transport 2008* (Geneva, 2008), at 8. Other estimates provide an even greater figure. For example the Rio Ocean Declaration of 2012 states that 'The international shipping sector transports 90% of global trade, making it a cornerstone of sustainable development.' See Rio Ocean Declaration, online: UNESCO http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/pdf_Rio_Ocean_Declaration_2012.pdf.

dependence on seaborne trade is accentuated for the generally resource-poor but export-oriented States of East and Southeast Asia and in this context the SLOCs that traverse the South China Sea are unquestionably crucial. As noted above, there is also a strong, and increasing, energy security dimension to sea lane security in the region. As already mentioned, oil and gas import dependence appears set to rise sharply in the future and the vast majority of these resources will be carried by sea. The IEA's prediction, mentioned above, of quadrupling net oil imports by 2030 implies substantially increased tanker traffic in the future, thus emphasizing the significance of the SLOCs. A further consideration is that these waterways are not solely used for commercial traffic. The South China Sea and its SLOCs represents the shortest route between the Pacific and Indian Oceans and is therefore used as a transit route by, for example, naval vessels attached to the United States Pacific Command. SLOC security therefore remains a crucial and shared concern for all regional and indeed extra-regional States and is only likely to become more vital in the future.

D. The Real Prize? Sustainable Marine Living Resources and the Environment

The semi-enclosed, tropical environment of the South China Sea and Gulf of Thailand hosts marine environments of extraordinary richness in biodiversity terms. These environments support fisheries of significance in global, and certainly regional, terms. Indeed, it has been suggested that the South China Sea alone accounts for as much as one tenth of global fish catches.[108] Other sources have suggested that South China Sea fisheries provide catches of the order of five million tonnes per annum.[109] These marine living resources are fundamental to the food security of coastal populations numbered in the hundreds of millions. Access to the waters of the South China Sea and Gulf of Thailand in order to exploit these abundant living resources therefore represents an enduring maritime concern of the littoral States. It follows that the preservation and protection of the marine environment supporting living resources that are so crucial from a

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[108] See UNEP/GEF *Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand* project website at www.unepscs.org. See also Schofield, *supra* note 40, at 17–18.

[109] United Nations Environment Programme (UNEP), *Global International Waters Assessment. South China Sea: Regional Assessment 54* (Kalmar, Sweden: University of Kalmar, 2005), 40–1. See also, Rahman and Tsamenyi, *supra* note 104, at 319.

food security perspective should be top policy priority for the governments concerned. This is especially the case in reference to the vulnerable coral reef ecosystems of the disputed South China Sea islands, which provide important nursery and breeding grounds that are crucial to sustaining the fishery as a whole. In fact, however, the marine environment, biological diversity and living resources in question are under serious threat.[110] It remains decidedly unclear whether this factor is accorded the priority it deserves in practice, at least partially because of rival claims to sovereignty and also arguably misleading perceptions and priorities attached to hydrocarbon resource exploration and development.

E. The Evolving Military and Strategic Context

As is well known, all of the claimants to the Spratly Islands save for Brunei have backed up their claims to sovereignty with island occupations. While the terms of the 2002 Declaration on the Conduct of Parties in the South China Sea (DoC) tended to forestall further island occupations, existing facilities have been maintained and in some cases substantially improved. In this context reports in mid-2011 that Chinese vessels had been observed 'unloading construction materials' on a previously unoccupied feature, Amy Douglas reef, raised significant concerns.[111] Should China or any other claimant go ahead and construct a new facility and occupy a previously unoccupied feature, this would represent a clear breach of the DoC, which calls on parties to 'exercise self-restraint in the conduct of activities that would complicate or escalate disputes and affect peace and stability including, among others, refraining from action of inhabiting on the presently uninhabited islands, reefs, shoals, cays, and other features'.[112] While the military worth of these garrisons, save perhaps as listening posts, is

110 It has been suggested that over 80% of reefs are at great risk and will collapse within 20 years unless unsustainable practices are abated; 70% of mangrove cover has been lost in the last 70 years and at current rates of habitat loss the remainder will be lost by 2030; 20–60% of seagrass beds have similarly disappeared over the last 50 years and those still in existence are also threatened with destruction. Ibid.

111 Greg Torode, 'China's Pledges Fail to Convince Security Forum', *South China Morning Post*, 6 June 2011, online: South China Morning Post http://www.scmp.com/portal/site/SCMP/menuitem.2c913216495213d5df646910cba0a0a0/?vgnextoid=fac1828573060310VgnVCM100000360a0a0aRCRD&vgnextfmt=teaser&ss=China&s=News.

112 See for example, Nguyen Hong Thao, 'The 2002 Declaration on the Conduct of Parties in the South China Sea: A Note', (2003) 34 Ocean Devel & Int'l L, at 279–85.

questionable,[113] fresh occupations of features could have a destabilising impact, would be likely to have a negative influence on the fragile environment of the disputed islands and should be set in the overall strategic context of the South China Sea.

An important allied consideration in the overall geopolitics, and geopolitical competition, affecting the South China Sea disputes is the evolving military and strategic balance in the South China Sea. It is abundantly clear that the People's Liberation Army (PLA) of China is undergoing a rapid process of modernisation efforts, backed by the largest defence budget in Asia – second only to the United States globally. While it is the case that other South China Sea claimants are also actively pursuing force modernisation initiatives, the pace and scope of the transformation of the PLA-Navy significantly outstrips their combined efforts. This shift in the regional balance of power and, particularly, the growing asymmetry in military terms between China on the one hand and the other South China Sea claimants on the other, affect the strategic and geopolitical context of the South China Sea disputes.[114] Arguably, if this trend is maintained, as seems likely, China may have greater scope to uphold what it perceives to be its legitimate territorial and maritime claims, including through increasingly assertive and even coercive means. Indeed, it has been suggested that the South China Sea disputes, and thus the need to effectively protect and reinforce sovereignty and jurisdictional claims, are themselves significant drivers for regional naval modernisation efforts.[115] Even if this proves not to be the case, the fact remains that all of the South China Sea claimants are engaged in efforts to enhance their militaries, often with territorial and maritime disputes invoked as the justification for arms purchases. These developments, coupled with the failure of the parties to the DoC to implement the conflict management and avoidance mechanisms envisaged within that document, mean that the South China Sea is an increasingly armed environment. This, in turn, raises the stakes and the risks of confrontational incidents. It should also be recalled that the waters of the South China Sea are not solely the preserve or of interest to the

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113 Although it has been suggested that facilities in the Spratly Islands could conceivably be used as bases to disrupt shipping, it has also been acknowledged that their small size renders them highly vulnerable to attack and of 'minimal strategic value in any significant conflict'. See Rahman and Tsamenyi, *supra* note 104, at 320.

114 See Clive Schofield and Ian Storey, *The South China Sea Dispute: Increasing Stakes, Rising Tensions*, Occasional Paper (Washington DC: The Jamestown Foundation, October 2009), at 23–4.

115 Rahman and Tsamenyi, *supra* note 104, at 319.

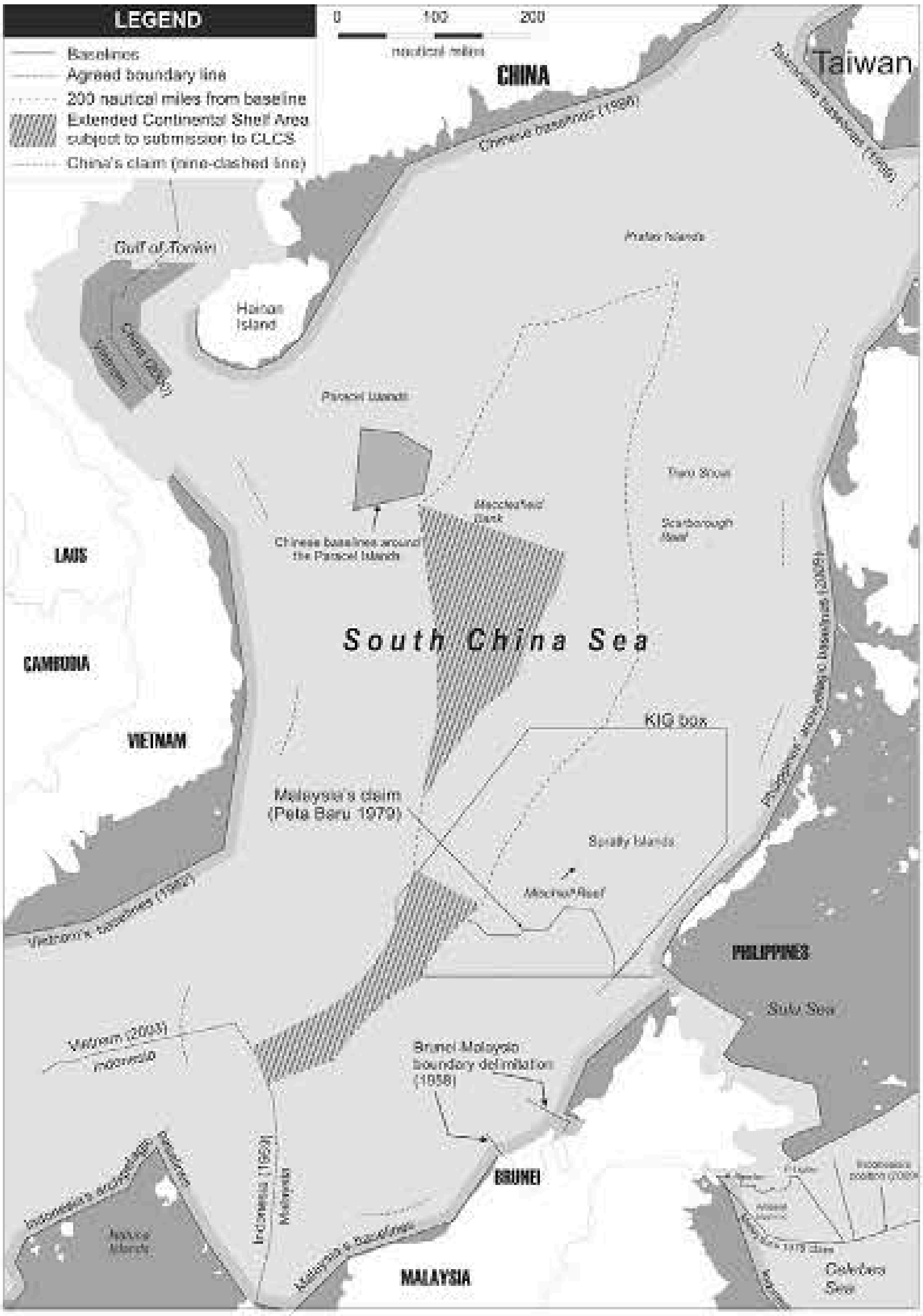
littoral States and Taiwan. A number of extra-regional States, notably the United States, but also India, Japan and Korea, have legitimate concerns in the South China Sea and the interest and presence of these States in the South China Sea appears likely to grow in the future, potentially adding complexity to the geopolitical and operational picture.[116]

IV. CONCLUDING THOUGHTS

The South China Sea is complex in terms of its coastal geography. The semi-enclosed nature of the South China Sea, coupled with the multiple States bordering it mean that maritime entitlements converge and overlap. Further, the eastern and southern margins of the South China Sea are formed by islands and archipelagoes and the South China Sea itself is host to a profusion of insular features of one type or another, many of which are subject to competing claims to sovereignty. These territorial disputes, coupled with uncertainties over what type of insular feature is under discussion and therefore what capacity a particular Spratly 'Island' may have to generate claims to maritime jurisdiction or influence a maritime boundary delimitation line, considerably complicate the jurisdictional picture in the South China Sea. Add excessive claims to baselines and expansive and historically-inspired unilateral maritime claims and the level of complexity increases considerably, leading to substantial, though not entirely certain, areas of overlapping maritime claims and, indeed, overlaps of overlaps where the same maritime space is subject to the claims of multiple States. That said, it is worth observing that some progress, especially peripherally, has been made. A number of maritime boundary agreements and interim joint arrangements of a practical nature have been reached. There may also be some hints of increased clarity in existing and heretofore worryingly opaque jurisdictional claims. Overall though the geographical and maritime jurisdictional picture in the South China Sea is one of continued and daunting complexity and uncertainty.

With respect to the geopolitical drivers of the South China Sea disputes, sovereignty continues to have a corrosive influence that is extremely difficult to overcome. States are, by their nature, territorial and there is ample evidence of this type of behaviour among the South China Sea littoral States and Taiwan. The South China Sea territorial disputes over islands cannot, however, be divorced from disputes over their associated maritime spaces and the valuable marine resources within these areas.

[116] Ibid, at 329; see, also, Schofield and Storey, *supra* note 114, at 38–41.



Source: Andi Arsana and Clive Schofield, Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia

Figure 1.1 South China Sea

Here a reordering of priorities is surely advisable. The waterways of the South China Sea certainly remain critical for all of the parties involved, especially from the point of view of trade and energy flows and this is likely to remain a shared concern. However, while there continues to be a strong perception that the South China Sea is host to substantial seabed energy resources, it is suggested that, even should substantial oil and gas reserves exist, they are unlikely to solve escalating regional energy security concerns. Arguably of more urgent importance is ensuring the protection of the South China Sea's marine environment with a view to ensuring the sustainability of South China Sea's fish stocks upon which millions depend for their primary protein needs. The geopolitical outlook for the South China Sea, in particular based on recent confrontational trends and set against a backdrop of increasing militarization of the area, is one that emphasises competition over co-operation. This, however, only re-emphasises the pressing need for efforts to overcome the jurisdictional and geopolitical impasse. Maritime joint development zones and provisional arrangements of a practical nature provide an important and enticing potential opportunity in this regard.

Annex 833

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Defining EEZ Claims from Islands: A Potential South China Sea Change

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Abstract

In the face of seemingly intractable territorial and maritime disputes in the South China Sea, the article examines how the 1982 United Nations Convention on the Law of the Sea (LOSC), sets out what maritime claims States can make in the South China Sea and how it establishes a framework that will enable States to either negotiate maritime boundary agreements or negotiate joint development arrangements (JDAs) in areas of overlapping maritime claims. It provides an avenue whereby the maritime claims of the claimants can be brought into line with international law, potentially allowing for meaningful discussions on cooperation and maritime joint development based on areas of overlapping maritime claims defined on the basis of the LOSC.

Keywords

South China Sea islands – EEZ maritime disputes – maritime claims – maritime boundary delimitation – joint development

Introduction

The South China Sea territorial and maritime disputes are commonly viewed as "intractable" and joint development of maritime areas subject to overlapping jurisdictional claims is often offered as a potential way forward. An enduring

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obstacle to the establishment of joint management mechanisms has, however, been the question of precisely where such joint zones should be located. This issue has been made especially problematic because of the lack of clarity in the maritime claims of the parties. This article seeks to address this central, problematic issue and offers a potentially "game-changing" route towards a clearer definition of the areas of overlapping claims—something that has the potential to contribute substantially to de-escalating these disputes and is an essential precursor to the realisation of maritime joint development in the South China Sea.[1] This article examines how the 1982 United Nations Convention on the Law of the Sea (LOSC)[2] sets out what maritime claims States can make in the South China Sea and how it establishes a framework that will enable States to either negotiate maritime boundary agreements or negotiate joint development arrangements (JDAs) in areas of overlapping maritime claims.

The analysis is based on the view that the States claiming sovereignty over the islands in the South China Sea (the Claimants) will not be able to resolve the territorial sovereignty disputes through negotiations for the foreseeable future. It is also considered that they will not be willing to give their consent to refer the sovereignty disputes to an international court or arbitral tribunal and ask that court or tribunal to determine which State has the better claim to sovereignty. Consequently, we have not attempted to analyse the merits of the sovereignty claims to the disputed islands. Nor have we attempted to analyse the legal issues in a wider geopolitical context. The proposals made here offer avenues whereby the maritime claims of the South China Sea Claimants can be brought into conformity with the LOSC. It is recognised that for this to be achieved, political will on the part of the Claimants is essential. We are, however, firmly of the view that the parties to the South China Sea disputes have shared interests in relations that are grounded on trust, mutual respect, cooperation and the rule of international law. Moreover, we believe that the changes that we advocate can be effected at relatively limited cost but potentially substantial benefits to all of the South China Sea littoral States.

This article is organised as follows. First, the sovereignty and maritime claims in the South China Sea are summarised. Second, the prospect of identifying

1 The authors would like to thank Ms. Youna Lyons, Senior Research Fellow at the NUS Centre for International Law, for her assistance in identifying and classifying the features in the Spratly Islands and the Paracel Islands. The authors are also indebted to I Made Andi Arsana of the Dept. of Geodetic and Geomatic Engineering, Faculty of Engineering, Gadjah Mada University, Indonesia, for his assistance in the preparation of the maps accompanying this article.

2 United Nations Convention on the Law of the Sea (LOSC) (Montego Bay, 10 December 1982, in force 16 November 1994) 1833 *UNTS* 397.

the areas of overlapping maritime claims and negotiating JDAs in the areas surrounding the Spratly Islands is examined. Third, an analysis of issues and opportunities related to specific sectors of the South China Sea is provided. Finally, some general conclusions are drawn on the role of the LOSC in defining the areas of overlapping claims in the South China Sea.

Maritime Claims in the South China Sea

Sovereignty Claims to Offshore Geographic Features

The fundamental legal dispute in the South China Sea is about which State has the better claim to sovereignty over the disputed offshore islands. The LOSC has no provisions on how to determine competing claims to sovereignty over islands or other land territory. That issue is governed by the rules and principles of customary international law on the acquisition and loss of territory.[3] The LOSC provides a broad framework with respect to international law of the sea issues. Of particular relevance to the present discussion, the LOSC sets out the freedoms, rights and obligations of States on the high seas and in the various maritime zones measured from land territory and islands. The LOSC assumes that sovereignty over the land territory and islands has been established. Therefore, the LOSC is of no assistance in resolving the territorial sovereignty disputes in the South China Sea. Determining which coastal State (or States) has (or have) sovereignty over the disputed islands of the South China Sea is, however, directly relevant to claims to maritime jurisdiction in keeping with the long-standing legal maxim that "the land dominates the sea".[4]

China, Malaysia, the Philippines, Taiwan and Vietnam have sovereignty claims to some or all of the islands in the Spratly Islands[5] and Brunei may also claim sovereignty over one reef in the Spratly Islands. China, Taiwan

3 James Crawford, *Brownlie's Principles of Public International Law* (8th ed., Oxford University Press, Oxford, 2012) 215–244.

4 This point was emphasised by the International Court of Justice (ICJ) in its first case concerning jurisdiction beyond the territorial sea, the *North Sea Continental Shelf Cases* (*Germany v. Netherlands, Germany v. Denmark*) (1969) I.C.J. Reports 3, especially para. 19.

5 The Chinese name for the group of islands known as the Spratlys is Nansha and the Vietnamese name is Trường Sa. There are multiple names in Chinese, Vietnamese, Filipino and Malay for most of the individual features in the Spratlys. For the sake of simplicity and consistency, we have used only the English language versions. For a list of the names of the features in the Spratly Islands in the various languages, see the Gazetteer to the map published by the US State Department in 2010. It is available on the CIL web site at http://cil.nus.edu.sg/wp/wp-content/uploads/2011/06/75967_gazetteer.pdf; accessed 5 April 2014.

and Vietnam also claim sovereignty over the Paracel Islands.[6] None of the Claimants have clarified which geographic features they claim are islands as defined in Article 121 of the LOSC and subject to appropriation. Nor have they issued charts or geographic coordinates of any straight baselines relating to the islands from which they measure the territorial sea as required by Article 16 of the LOSC. Where normal baselines apply to these islands, the Claimants have likewise not publicised charts illustrating the location of the low-water line they officially recognise in accordance with Article 5 of the LOSC. They also have not clarified which geographic features are low-tide elevations that can be used as basepoints because they are wholly or partially within 12 nautical miles (nm) of an island.[7]

China has defined straight baselines around the Paracel Islands, but these baselines are not consistent with the LOSC and have excited international protests.[8] Although at first glance these baselines have the appearance of being archipelagic baselines, under the LOSC only 'archipelagic States' are permitted to draw such baselines around mid-ocean archipelagos.[9]

There is also uncertainty regarding the current status of an historic claim of the Philippines to an excessive claim to a territorial sea. The long-standing position of the Philippines was that its "international treaty limits" were established under three international treaties, namely the 1898 Treaty of Paris,[10] the

6 The Chinese name for the Paracel Islands is Xisha and the Vietnamese name is Hoàng Sa, and there are also names for the individual islands in English, Chinese and Vietnamese. For the sake of simplicity and consistency, we have used only the English language versions. For a list of the names of the features in the Paracel Islands in the various languages, see the Gazetteer to the map published by the US State Department in 2010. *Ibid*.

7 This is permitted under Art. 13(2) of the LOSC. It is recognised that "M" is the technically correct abbreviation for nautical miles. However, "nm" is frequently used in the literature and will be employed as the abbreviation for nautical miles in this article.

8 Declaration of the Government of the People's Republic of China on the Baselines of the Territorial Sea of the People's Republic China, 15 May 1996, available at http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/DEPOSIT/chn_mzn7_1996.pdf; J. Ashley Roach and Robert Smith, *Excessive Maritime Claims* (3rd ed., Martinus Nijhoff Publishers, Leiden, 2012) 98; See also, United States Department of State, Bureau of Oceans and Environmental and Scientific Affairs, 'Limits in the Sea No. 117—Straight Baseline Claim: China', available at http://www.state.gov/documents/organization/57692.pdf; accessed 5 April 2014.

9 China is not an "archipelagic State"; see LOSC Arts. 46 and 47(1).

10 The Treaty of Paris between Spain and the United States, signed at Paris, 10 December 1898, TS No. 343.

Cession Treaty of 1900[11] and the 1930 Treaty of Washington.[12] Under Section 1 of the 1935 Philippines Constitution, the territory of Philippines is described as consisting of the territory established by these treaties, with all waters from the baselines of the Philippines to the so-called "international treaty limits" being considered as the territorial sea of the Philippines.[13] Consequently, at the furthest extent of the "box" formed by the treaty limits outlined above, the Philippines claimed territorial sea rights extending 285 nm from the straight baselines it claimed in the 1960s.[14] Perhaps unsurprisingly, the international community, including the United States as a party to the 1898 Treaty of Paris, did not accept the position of the Philippines on the status of the waters inside the rectangular box established by the treaties.[15] In response to an objection by Australia, the Philippines submitted a statement to the UN Secretary-General, dated 26 October 1988, that it would harmonise its domestic legislation with the LOSC.[16] This harmonisation took more than 20 years. In 2009, the Philippines passed a new baselines law which brought its claim into conformity with the LOSC.[17] As a result, the Philippines seems in practice to be bringing its maritime claims into strict conformity with the provisions of the LOSC. However, it has still not amended its Constitution or formally abandoned its historic maritime claim.

11 The Treaty between Spain and the United States for the Cession of Outlying Islands for the Philippines, signed at Washington, 7 November 1900, TS No. 345.

12 Convention between the United States and Great Britain Delimiting the Philippine Archipelago and the State of Borneo, signed at Washington, 2 January 1930, TS No. 856.

13 Republic Act No. 3046 of 17 June 1961. An Act to Define the Baselines of the Territorial Sea of the Philippines, available at http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/PHL_1961_Act.pdf; accessed 5 April 2014.

14 See *ibid.* Republic Act No. 3046 of 17 June 1961, subsequently amended them through Republic Act No. 5446 of 18 September 1968. An Act to Amend Section One of the Republic Act Numbered Thirty Hundred and Forty-Six, Entitled "An Act to Define the Baselines of the Territorial Sea of the Philippines", available at http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/PHL_1968_Act.pdf; accessed 5 April 2014; See also Victor Prescott and Clive Schofield, *The Maritime Political Boundaries of the World* (Martinus Nijhoff Publishers, Leiden/Boston, 2005) 452.

15 Roach and Smith (n 8), at 146–148.

16 *Ibid.*, at p. 222.

17 Republic Act No. 9522: An Act to Amend Certain Provisions of Republic Act No. 3046, as Amended by Republic Act No. 5446, to Define the Archipelagic Baselines of the Philippines, and for Other Purposes Approved by the President on 10 March 2009 (2009) 70 *Law of the Sea Bulletin* 32–35.

Maritime Claims from Mainland Territory

All of the States bordering the South China Sea claim an exclusive economic zone (EEZ) measured from the baselines along their mainland coasts, or in the case of the Philippines and Indonesia, from archipelagic baselines.[18] It is generally agreed that the archipelagic baselines employed by Indonesia and the Philippines around their main archipelago are consistent with the LOSC (see Fig. 1).[19]

Although some of the straight baselines used by China, Malaysia, Taiwan and Vietnam may be of questionable legality,[20] and may have a substantial impact on the areas subject to the regimes of internal waters and territorial sea, they will have only moderate impact on the outer limit of the 200-nm EEZ claims measured from those baselines. For example, the islands that Vietnam's straight baselines link can generate maritime claims in their own right. This means that the expansion of the potential scope of Vietnam's EEZ is increased to a far more limited extent than might otherwise be presumed (see Fig. 2).

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18 Brunei Darussalam—Territorial Waters of Brunei Act, 1982. Indonesia—Law No. 1/1973 Concerning Continental Shelf (6 January 1973); Law No. 5/1983 on the Indonesian Exclusive Economic Zone (18 October 1983); Law No. 6/1996 regarding Indonesian Water (8 August 1996); Government Regulations No. 38/2002 on the Geographical List of Coordinates of the Indonesian Archipelagic Baselines (28 June 2002) and Government Regulations No. 37/2008 amending Regulations No. 38/2002 (19 May 2008). Malaysia—Exclusive Economic Zone Act, 1984; Act No. 311 An Act Pertaining to the Exclusive Economic Zone and Certain Aspects of the Continental Shelf of Malaysia and to Provide for the Regulations of Activities in the Zone and on the Continental Shelf and for Matters Connected Therewith, the Baselines of Maritime Zones Act 2006—Act 660 (29 December 2006) and the Territorial Sea Act 2012—Act 750 (18 June 2012). People's Republic of China—Law on the Territorial Sea and the Contiguous Zone of 25 February 1992; Exclusive Economic Zone and Continental Shelf Act, 26 June 1998. Philippines—Presidential Decree No. 1599 of 11 June 1978 Establishing an Exclusive Economic Zone and for other Purposes; Republic Act No. 9522 (n 17). Vietnam—Statement on the Territorial Sea, the Contiguous Zone, the Exclusive Economic Zone and the Continental Shelf of 12 May 1977; Statement on the Territorial Sea Baseline of 12 November 1982, all available at the United Nations, Division for Ocean Affairs and the Law of the Sea (UNDOALOS) National Legislation Database—Asian and South Pacific States: http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/asia.htm; Vietnam—The Law of the Sea of Viet Nam, 21 June 2012, Art. 15, available at http://vietnamnews.vn/politics-laws/228456/the-law-of-the-sea-of-viet-nam.html; Republic of China—Law on the Territorial Sea and Contiguous Zone, 21 January 1998; Law on the Exclusive Economic Zone and the Continental Shelf, 21 January 1998, available at http://www.moi.gov.tw/english/english_law/law.aspx?pages=12; accessed 5 April 2014.

19 Roach and Smith (n 8), at pp. 209 and 213.

20 *Ibid.*, at pp. 76–82.

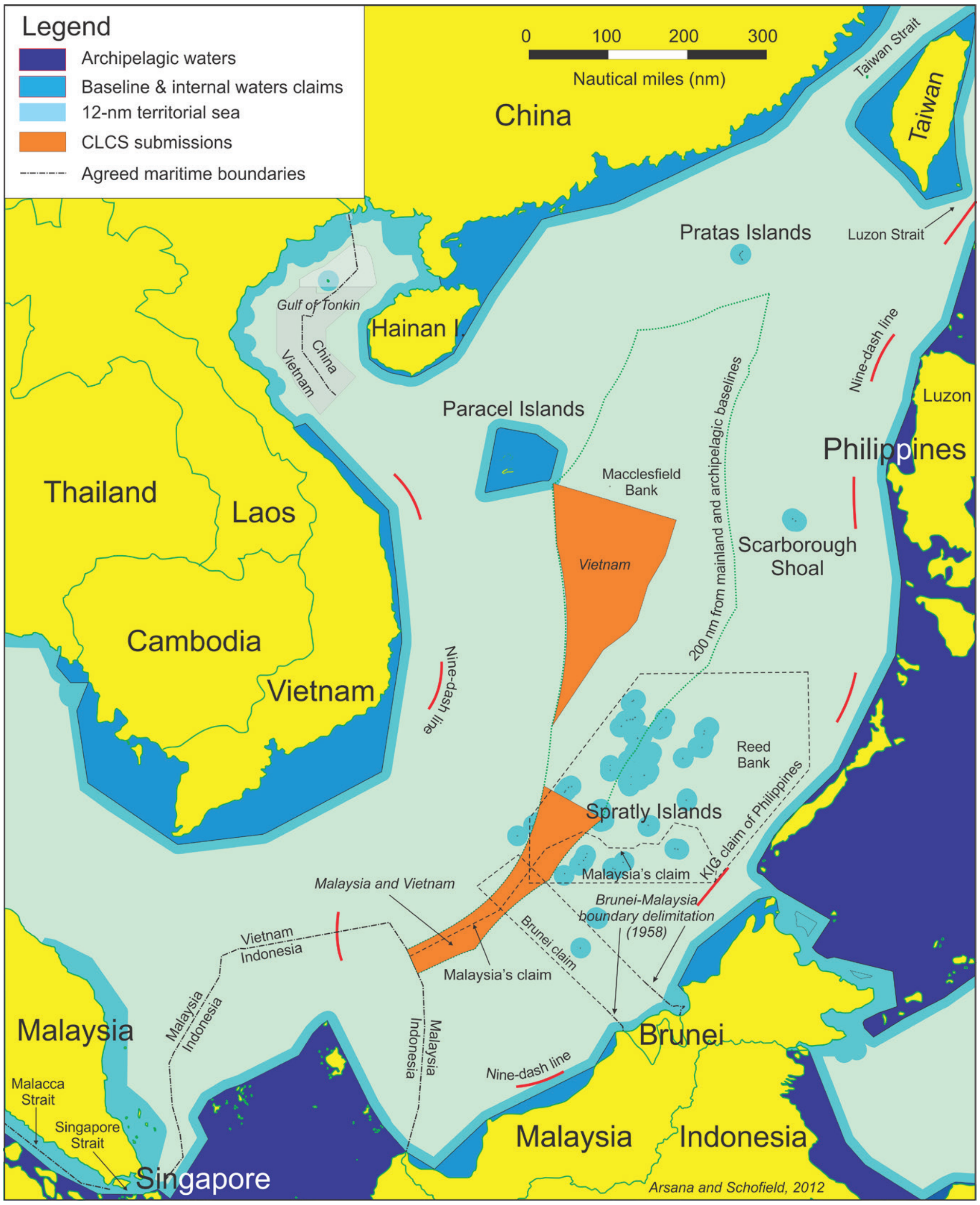

FIGURE 1 *Baselines and maritime claims in the South China Sea*
SOURCE: ADAPTED FROM A MAP INCLUDED IN THE JANUARY 2013 ISSUE OF THE *AMERICAN JOURNAL OF INTERNATIONAL LAW* PREPARED BY CLIVE SCHOFIELD AND ANDI ARSANA OF THE AUSTRALIAN NATIONAL CENTRE FOR OCEAN RESOURCES AND SECURITY (ANCORS), UNIVERSITY OF WOLLONGONG, AUSTRALIA.

Therefore, the questionable use of straight baselines, while an important issue of concern, especially with respect to potential implications for freedom of navigation, is relatively unimportant with respect to identifying areas of overlapping maritime claims in the central part of the South China Sea.

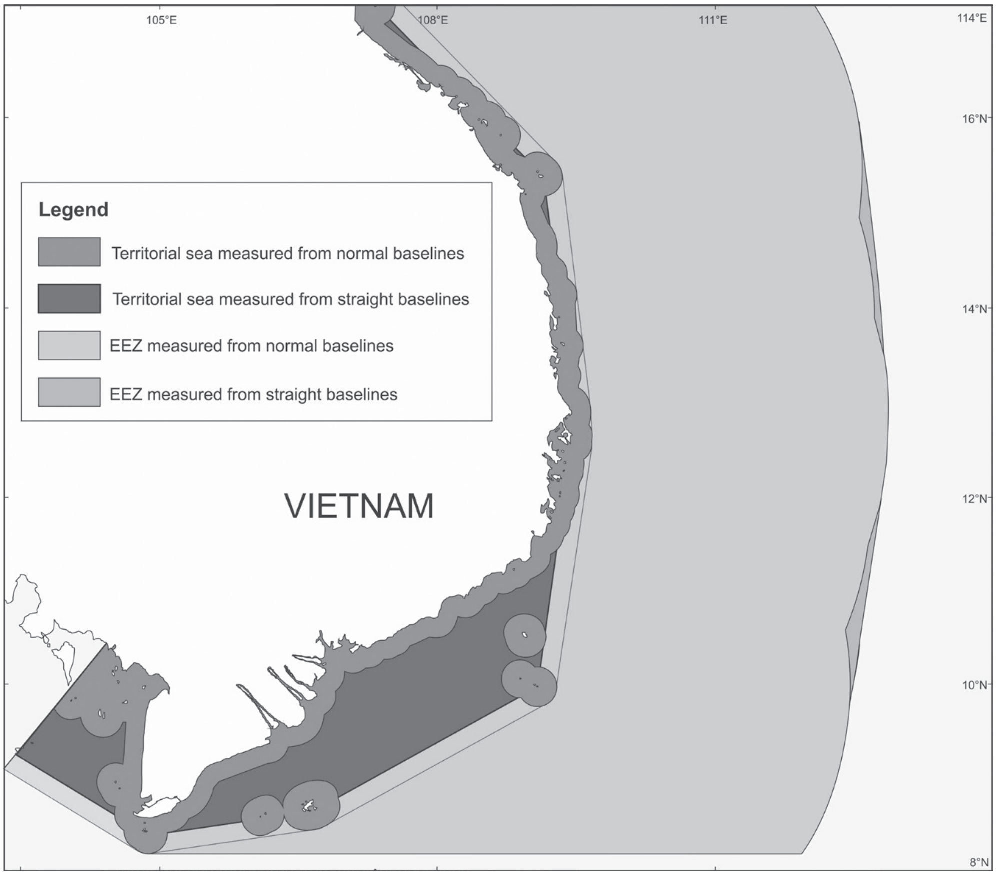

FIGURE 2 *The impact of Vietnam's claimed straight baselines on its maritime claims*[21]

None of the States bordering the South China Sea have issued official charts or lists of geographic coordinates showing the outer limit lines of their EEZ claims as required by Article 75 of the LOSC. However, the outer limits of the EEZ claims of Malaysia and Vietnam are shown on the maps contained in their submissions to the Commission on the Limits of the Continental Shelf (CLCS).[22] Brunei, China, the Philippines and Taiwan have not issued charts or

21 Adapted from Fig. 2.11 in Clive Schofield, 'Defining the "Boundary" between Land and Sea: Territorial Sea Baselines in the South China Sea', in S. Jayakumar, Tommy Koh and Robert Beckman (eds), *The South China Sea Disputes and Law of the Sea* (Edward Elgar Publishing, UK, forthcoming, 2014).

22 Commission on the Limits of the Continental Shelf (CLCS) Outer Limits of the Continental Shelf beyond 200 Nautical Miles from the Baselines: Submissions to the Commission: Joint Submission by Malaysia and Socialist Republic of Viet Nam, Executive Summary (6 May 2009), available at http://www.un.org/Depts/los/clcs_new/submissions_files/submission_mysvnm_33_2009.htm; accessed 5 April 2014.

coordinates indicating the outer limit of their EEZ claims. It is interesting that the Joint Submission of Malaysia and Vietnam shows a 200-nm EEZ limit for the Philippines.[23]

Several of the States bordering the South China Sea are adjacent to each other and agreements will be required to clarify their adjacent EEZ boundaries. Brunei seems to have settled its adjacent boundaries with Malaysia through an exchange of letters,[24] and China and Vietnam have reached a partial boundary agreement in the Gulf of Tonkin.[25] Additionally, Indonesia has delimited its continental shelf boundaries in the south-western part of the South China Sea with both Malaysia and Vietnam (see Fig. 1).[26] The adjacent boundary between Malaysia and the Philippines is an especially difficult problem because of the historic sovereignty claim of the Philippines to the Malaysian State of Sabah.[27]

In May 2009, Malaysia and Vietnam made a Joint Submission to the CLCS claiming a continental shelf beyond 200 nm.[28] Vietnam made a separate submission for an extended continental shelf further to the north, opposite

23 *Ibid.*

24 Brunei Darussalam's Preliminary Submission concerning the Outer Limits of its Continental Shelf, 12 May 2009, para. 10, available at http://www.un.org/depts/los/clcs_new/submissions_files/preliminary/brn2009preliminaryinformation.pdf; accessed 5 April 2014.

25 Agreement between the People's Republic of China and the Socialist Republic of Viet Nam on the Delimitation of the Territorial Seas, Exclusive Economic Zones and Continental Shelves of the Two Countries in Beibu Bay/Bac Bo Gulf (with maps) (Beijing, 25 December 2000, in force 30 June 2004), 2336 *UNTS* 179.

26 Indonesia and Malaysia signed an agreement related to seabed boundary delimitation in the Strait of Malacca and South China Sea, on 27 October 1969. See Choon-ho Park, 'Indonesia-Malaysia (Continental Shelf)' in Jonathan I. Charney and Lewis M. Alexander (eds), *International Maritime Boundaries* (Martinus Nijhoff Publishers, Dordrecht/Boston, 1993) 1025–1027. The terminal points of the two lateral seabed boundary segments defined by Indonesia and Malaysia in the south-western South China Sea were subsequently connected to each other through a continental shelf boundary line agreed between Indonesia and Vietnam which was signed on 26 June 2003. See Agreement between the Government of the Socialist Republic of Viet Nam and the Government of the Republic of Indonesia concerning the delimitation of the continental shelf boundary (26 June 2003, in force 29 May 2007), in David A. Colson and Robert W. Smith (eds), *International Maritime Boundaries* (Volume VI, Martinus Nijhoff Publishers, Leiden, 2011), 4,301–4,315.

27 Official Gazette, No. 2587 Appendix XVI, Republic of the Philippines Department of Foreign Affairs, 2 February 1966, available at http://www.gov.ph/1966/02/07/philippine-claim-to-north-borneo-sabah-vol-ii-appendix-xvi/; accessed 5 April 2014.

28 CLCS, Joint Submission by Malaysia and the Socialist Republic of Viet Nam (n 22).

the Philippines.[29] Brunei, China and the Philippines have either made partial submissions or submitted preliminary information indicating that they also intend to make submissions claiming an extended continental shelf in the South China Sea.[30] China and the Philippines have objected to the Joint Submission of Malaysia and Vietnam, as well as to the separate submission of Vietnam.[31]

If Brunei, China and the Philippines make extended continental shelf claims in the South China Sea, they are likely to overlap with the claims of Malaysia and Vietnam. In addition, Malaysia and Vietnam are likely to object to their claims. Therefore, even if no maritime zones (such as the EEZ and continental shelf) are claimed from the disputed offshore islands, there will be substantial areas of overlapping continental shelf claims between opposite States and adjacent States in the South China Sea.

EEZ and Continental Shelf Claims from Offshore Geographic Features

The offshore geographic features in the South China Sea that meet the definition of an island in Article 121(1) are entitled in principle to an EEZ and continental shelf of their own.[32] However, Article 121(3) provides that if they are rocks which cannot sustain human habitation or economic life of their own,

29 CLCS Outer Limits of the Continental Shelf beyond 200 Nautical Miles from the Baselines: Submission to the Commission: Submission by the Socialist Republic of Viet Nam, Executive Summary (7 May 2009), available at http://www.un.org/Depts/los/clcs_new/submissions_files/submission_vnm_37_2009.htm; accessed 5 April 2014.

30 Brunei Darussalam's Preliminary Submission (n 24); Preliminary Information Indicative of the Outer Limits of the Continental Shelf Beyond 200 Nautical Miles of the People's Republic of China, 11 May 2009, available at http://www.un.org/depts/los/clcs_new/submissions_files/preliminary/chn2009preliminaryinformation_english.pdf; CLCS Outer Limits of the Continental Shelf beyond 200 Nautical Miles from the Baselines: Submissions to the Commission: Submission by the Republic of the Philippines, 19 July 2012, available at http://www.un.org/Depts/los/clcs_new/submissions_files/submission_phl_22_2009.htm; CLCS Outer Limits of the Continental Shelf beyond 200 Nautical Miles from the Baselines: Submissions to the Commission: Submission by the People's Republic of China, 14 December 2012, available at http://www.un.org/Depts/los/clcs_new/submissions_files/submission_chn_63_2012.htm; accessed 6 April 2014.

31 Communications Received with regard to the Joint Submission made by Malaysia and Viet Nam to the CLCS (n 22), China (7 May 2009 and 14 April 2011) and the Philippines (4 August 2009 and 5 April 2011); Communications Received with regard to the Submission made by Viet Nam to the CLCS (n 29), China (7 May 2009 and 14 April 2011) and the Philippines (4 August 2009 and 5 April 2011).

32 LOSC Art. 121(2).

they are not entitled to an EEZ and continental shelf. If it is not a rock within the meaning of Article 121(3), an island is automatically entitled to a continental shelf. If a State intends to claim an EEZ from an island or from other land territory, it must make a formal claim. As a practical matter, the simplest option would be for a Claimant to claim an EEZ from an island, as that would give it sovereign rights for the purpose of exploring and exploiting the natural resources of both the seabed and subsoil and the superjacent waters.[33]

For example, under its national legislation China claims an EEZ from the Paracel Islands,[34] but it has not clarified the outer limits of its EEZ claim. China has stated that the Spratly Islands are entitled to an EEZ and continental shelf,[35] but it has not indicated the baselines from which its maritime zones are measured or the outer limit of its EEZ or continental shelf claim from the Spratlys.

Indeed, none of the other Claimants have indicated whether they are claiming an EEZ or continental shelf from any of the islands in the Spratly Islands, and Vietnam has not indicated whether it is claiming an EEZ or continental shelf from the Paracel Islands. The fact that Malaysia and Vietnam included EEZ claims only from their respective mainland coasts in their submissions to the CLCS implies that they are not intending to claim an EEZ or continental shelf from any of the disputed islands over which they claim sovereignty. However, they would arguably not be precluded from claiming an EEZ from the islands at some point in the future if they decide that it is in their interests to do so. If EEZ and/or continental shelf claims are made from any of the disputed islands, they will overlap substantially with the EEZ claims and extended continental claims from the mainland territory and archipelagic baselines of the States bordering the South China Sea.

Historic Title or Historic Rights inside the Nine-Dashed Line

When China attached its nine-dashed line map to its *Note Verbale* of 6 May 2009 to the UN Secretary-General, questions arose as to the significance of the map to China's maritime claims in the South China Sea. The *Note Verbale* states that "China has indisputable sovereignty over the islands in the South China Sea and the adjacent waters, and enjoys sovereign rights and jurisdiction over

33 LOSC Art. 56(1).

34 China—Law on the Territorial Sea and the Contiguous Zone (n 18), Art. 2; Exclusive Economic Zone and Continental Shelf Act (n 18), Art. 2.

35 Communications Received with regard to the Joint Submission made by Malaysia-Viet Nam (n 22), China (14 April 2011); Communications Received with regard to the Submission made by Viet Nam (n 29), China (14 April 2011).

the relevant waters (see attached map)".[36] Under the LOSC, a State has sovereignty over islands and the 12-nm territorial sea adjacent to them. It also has sovereign rights and jurisdiction to explore and exploit the natural resources in the EEZ measured from the islands and to any continental shelf claimed from the islands. Therefore, if the term 'adjacent waters' is meant to signify areas of territorial sea while the phrase 'relevant waters' is intended to refer to an EEZ claimed from the islands, China's statement as to its claims would be consistent with the LOSC.

The question has arisen as to whether China is claiming rights and jurisdiction only in the EEZ measured from the islands or whether it is claiming rights and jurisdiction in all the waters inside the nine-dashed line. With respect to jurisdiction, some national legislation of China states that it applies not only in China's maritime zones, but also in all other sea areas under the jurisdiction of the PRC.[37] Some commentators have suggested that the "other sea areas under

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36 Communications Received with regard to the Joint Submission made by Malaysia-Viet Nam (n 22), China (7 May 2009); Communications Received with regard to the Submission made by Viet Nam (n 29), China (7 May 2009).

37 Regulations of the People's Republic of China on the Control over Dumping Wastes into the Sea Waters, 6 March 1985, Art. 3: "The present Regulations shall apply to (1) The dumping of wastes or other matter into the internal sea and the territorial sea, onto the continental shelf and into other sea areas under the jurisdiction of the People's Republic of China; . . . (3) The shipping of wastes or other matter in the internal sea, territorial sea and other sea areas under the jurisdiction of the People's Republic of China for the purpose of dumping." Available at http://www.asianlii.org/cn/legis/cen/laws/rotprocotcodwitsw934/; Marine Environment Protection Law of the People's Republic of China, 25 December 1999, Art. 2: "This law shall apply to the internal waters, territorial seas and the contiguous zones, exclusive economic zones and continental shelves of the People's Republic of China and all other sea areas under the jurisdiction of the People's Republic of China." Available at http://www.asianlii.org/cn/legis/cen/laws/meplotproc607/; Fisheries Law of the People's Republic of China, Art. 2: "All productive activities of fisheries, . . . in the inland waters, tidal flats, territorial waters and exclusive economic zones of the People's Republic of China and in all other sea areas under the jurisdiction of the People's Republic of China shall be conducted in accordance with this Law." Available at http://www.china.org.cn/china/LegislationsForm2001-2010/2011-02/14/content_21917138.htm; Surveying and Mapping Law of the People's Republic of China, 29 August 2002, Art 2: "All surveying and mapping activities conducted in the domain of People's Republic of China and other sea areas under the jurisdiction of the People's Republic of China shall comply with this Law." Available at http://www.asianlii.org/cn/legis/cen/laws/samlotproc506/; accessed 6 April 2014.

the jurisdiction of the PRC" could refer to the all of the sea areas inside the nine-dashed line.[38]

China issued a second *Note Verbale* on 11 April 2011. Some writers have argued that the language used in this second *Note Verbale* suggests that China is also claiming historic rights to resources in all the areas inside the nine-dashed line.[39] However, the *Note Verbale* does not use the phrase 'historic rights'. Also, there appears to be no other official statement from the Chinese Government claiming that it has historic rights in the waters inside the nine-dashed line. The only reference to historic rights in any official document is that in Article 14 of China's national legislation on the EEZ, which states that "[t]he provisions of this Act shall not affect the historical rights of the People's Republic of China".[40] However, that Act gives no indication as to where China may have historical rights.

Nevertheless, some commentators from China and Taiwan have asserted that China claims historic rights and jurisdiction in the waters inside the nine-dashed line.[41] Some academics have opined that in practice China has been asserting not only historic rights to fish in the waters inside the nine-dashed line, but also historic rights to other maritime activities, including the right to explore and exploit oil and gas resources.[42]

The Philippines and Vietnam have taken the position that under the LOSC, States can only claim sovereign rights to explore and exploit natural resources in and under the water if they claim maritime zones from land territory, including islands.[43] They do not recognise the legitimacy of any other claim to historic rights to resources in and under the waters inside the nine-dashed line.

38 Nong Hong, 'Interpreting the U-Shape Line in the South China Sea', 15 May 2012, available at http://www.chinausfocus.com/peace-security/interpreting-the-u-shape-line-in-the-south-china-sea/; accessed 6 April 2014.

39 Zhiguo Gao and Bingbing Jia, 'The Nine-Dash Line in the South China Sea: History, Status, and Implications' (2013) 107(1) *The American Journal of International Law* (*AJIL*) 98–124, at p. 108.

40 China—Exclusive Economic Zone and Continental Shelf Act (n 18), Art. 14.

41 Yann-Huei Song, *United States and Territorial Disputes in the South China Sea: A Study of Ocean Law and Politics* (School of Law of the University of Maryland, Baltimore, 2001) 73. Keyuan Zou, 'Historic Rights in International Law and in China's Practice' (2001) 32(2) *Ocean Development and International Law* (*ODIL*) 149–168, at pp. 160–163; Gao and Jia (n 39), at pp. 123–124.

42 Hong (n 38); Gao and Jia (n 39), at pp. 108 and 124; Keyuan Zou, 'China's U-Shaped Line in the South China Sea Revisited' (2012) 43(1) *ODIL* 18–34, at p. 22.

43 See, for example, Republic of the Philippines Department of Foreign Affairs Manila, SFA Statement on the UNCLOS Arbitral Proceedings against China, 22 January 2013,

They presumably take a similar position with respect to the assertion of claims to jurisdiction over activities in the waters inside the nine-dashed line that are not consistent with the jurisdiction of coastal States in the EEZ as provided in Article 56 of the LOSC.

It can be argued that the decision in the *Eritrea/Yemen Arbitration* supports the view that historic fishing rights of a third State in waters under the jurisdiction of a coastal State were not necessarily extinguished by the LOSC and continue to be governed by customary international law.[44] However, it is unlikely that the ASEAN Claimants would recognise China's claim to historic fishing rights within the areas they consider to be part of their EEZs. They would in all probability maintain that they have sovereign rights to exploit the living resources in their EEZ, and that they need only to take into account "the need to minimise economic dislocation in States whose nationals have habitually fished in the zone" when granting access to any surplus in their EEZ.[45]

Furthermore, Clive Symmons maintains that a claim to historic rights must meet the same general requirements as a claim to historic waters. That is, there must have been a formal claim, a continuous and effective exercise of the rights being claimed, and international acquiescence in the claim.[46] It would be very difficult for China to prove that these requirements have been met in the South China Sea, as it would need to show that it formally claimed historic fishing rights in the EEZ of the other Claimants and that those States acquiesced in China's claim. It would be even more difficult for China to assert historic rights to explore and exploit for hydrocarbon resources in the EEZs of other States.

China's claim to historic rights in all the waters inside the nine-dashed line could possibly be considered and ruled upon in the pending arbitration case between the Philippines and China.[47] Otherwise, the only other prospect for resolving this issue would be for the Claimants to enter into JDAs which spell out the right of the Claimants, including China, to exercise rights to resources in the areas subject to the JDAs. Such JDAs might be possible if they sidestep

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Notification and Statement of Claim on West Philippine Sea, available at https://www.dfa.gov.ph/index.php/2013-06-27-21-50-36/unclos; accessed 6 April 2014.

44 Permanent Court of Arbitration (PCA): *Eritrea v. Yemen*, Award of the Arbitral Tribunal in the Second Stage of the Proceedings—Maritime Delimitation (17 December 1999), at paras 109–11; available at http://www.pca-cpa.org/showpage.asp?pag_id=1160; accessed 6 April 2014.

45 LOSC Art. 62(3).

46 Clive R. Symmons, *Historic Waters in the Law of the Sea: A Modern Re-Appraisal* (Martinus Nijhoff Publishers, Leiden/Boston, 2008) 111–245.

47 PCA: *The Republic of the Philippines v. The People's Republic of China*, available at http://www.pca-cpa.org/showpage.asp?pag_id=1529; accessed 6 April 2014.

the difficult legal issues by not specifically mentioning either the nine-dashed line or the historic rights of China.

Potential Impact of the Philippines v. China Arbitration

The Arbitral Tribunal in the *Philippines v. China case*[48] will decide whether it has jurisdiction to hear the case, notwithstanding the declaration of China under Article 298 excluding disputes concerning the interpretation or application of Articles 15, 74 and 83 of the LOSC relating to sea boundary delimitations, or disputes involving historic bays or titles.[49] If it does decide that it has jurisdiction, the Arbitral Tribunal could rule on several issues that would clarify how LOSC provisions apply to the complex legal disputes in the South China Sea.

First, the Arbitral Tribunal may rule on the Philippines' assertion that claims to rights and jurisdiction in maritime space can only be made from land territory, including islands. In the course of doing so, it may also confirm that reefs or rocks that are totally submerged are part of the seabed and cannot be subject to appropriation.

Second, the Arbitral Tribunal may also consider whether China has rights and jurisdiction in the waters surrounding disputed islands within the EEZ of the Philippines. In the course of addressing this issue, the Arbitral Tribunal may consider the issue of whether China has historic rights in such areas, even though historic rights are governed by customary international law rather than the LOSC. Article 321 of the LOSC provides that a tribunal having jurisdiction under section 2 of Part XV shall apply the LOSC and "other rules of international law" compatible with the LOSC. Thus, even though the topic of historic rights is governed for the most part by customary international law rather than by the LOSC, the Arbitral Tribunal could decide how the concept of historic rights relates to the LOSC, and under what circumstances historic fishing rights in the EEZ of another State must be recognised or taken into account.

Third, the Arbitral Tribunal may decide whether the islands occupied by China are rocks under Article 121(3) that are not entitled to an EEZ and continental shelf of their own. In the course of deciding this question, it could also provide valuable guidance on whether any of the larger islands in the South China Sea would in principle be entitled to an EEZ and continental shelf of their own.

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48 Philippines—Notification and Statement of Claims on West Philippine Sea (n 43).

49 China—Declaration made after Ratification (25 August 2006), available at http://www.un.org/Depts/los/convention_agreements/convention_declarations.htm#China Upon ratification; accessed 6 April 2014.

Fourth, the Arbitral Tribunal may address the legal issues relating to the occupation of low-tide elevations, including rights and jurisdiction in the waters surrounding them.

Although attempting to discern the possible or likely outcomes of the Arbitral Tribunal's deliberations would inevitably be highly speculative, if some or all of these issues are addressed, the Arbitral Tribunal could clarify some of the complex legal issues that are relevant to resolving the maritime disputes in the South China Sea. However, any award of the Arbitral Tribunal will not address the two most fundamental legal issues which underlie the disputes in the South China Sea. First, the Arbitral Tribunal cannot consider which State has the better claim to sovereignty over any of the disputed islands because it can only consider disputes concerning the interpretation or application of the LOSC, and there are no provisions in the LOSC on how to decide issues of sovereignty. Second, the Arbitral Tribunal cannot decide how to delimit any EEZ boundaries between China and its neighbours, including the EEZ boundary between the main archipelago of the Philippines and the disputed offshore islands. This is because the declaration made by China under Article 298 excludes the disputes on the interpretation or application of Article 74 concerning the delimitation of overlapping EEZ boundaries.

Clarifying Areas of Overlapping Maritime Claims around the Spratly Islands

Maritime Claims from the Spratly Islands

None of the ASEAN Claimants have clarified whether they are claiming an EEZ from any of the Spratly Islands over which they claim sovereignty. This is not surprising, as it is arguably in their interests to maintain that all of the islands in the Spratlys are rocks within Article 121(3) that have no entitlement to an EEZ and continental shelf of their own. This would serve to limit the "areas in dispute" in the waters surrounding the Spratly Islands to the 12-nm belt of territorial sea around those features which meet the definition of an island, that is, the naturally formed areas of land surrounded by and above water at high tide.[50] The result would be that the areas of overlapping claims associated with the islands would be limited to the 12-nm territorial sea surrounding the disputed islands. From the perspective of the ASEAN Claimants, this would be advantageous as it would leave them free to pursue marine resource development activities in offshore areas proximate to their coasts in the South China

50 LOSC Art. 121(1).

Sea. However, Claimants would still need to delimit their adjacent maritime boundaries. This scenario would leave a substantial high seas "pocket" in the central part of the South China Sea located beyond 200 nm from the surrounding mainland and main island coasts (see Figs. 1 and 8).

From its *Notes Verbales* of 7 May 2009 and 11 April 2011, it seems that China is making two types of claims to maritime space in the South China Sea.[51] First, it claims 'sovereignty' over the islands (and perhaps over other geographic features) in the four archipelagos in the South China Sea, as well as to the 'waters adjacent to the islands', which most likely refers to the 12-nm territorial seas adjacent to the islands. Second, it claims 'sovereign rights and jurisdiction' over the 'relevant waters' as well as the seabed and subsoil thereof. Given that the statement of 11 April 2011 also asserts that the Spratly Islands are fully entitled to a territorial sea, EEZ and continental shelf, we can probably assume that China is claiming sovereign rights and jurisdiction to the natural resources in the EEZ (and continental shelf) measured from the islands.

As noted above, if the reference to 'adjacent waters' is read to refer to the territorial sea and the reference to 'relevant waters' is read to refer to the EEZ, China's claims would be consistent with the LOSC and international law. However, China has not indicated which of the islands it believes are entitled to an EEZ, and it has not amended its national legislation to declare baselines around them, as it has for the Paracel Islands.[52] Therefore, the extent of its EEZ claim from the islands, and the area of overlapping claims, is uncertain.

A Game-Changing Option for China?

China could potentially trigger a paradigm shift in its disputes in the South China Sea if it were to formally declare an EEZ from the largest islands in the Spratly Islands.[53] To make its EEZ claim clear, China could identify which islands in the Spratlys it believes are in principle entitled to an EEZ of their own. It could define the baselines for these islands, taking into account the provisions in the LOSC for baselines of islands on atolls and fringing reefs, as

51 Communications Received with regard to the Joint Submission made by Malaysia-Viet Nam (n 22), China (7 May 2009 and 14 April 2011); Communications Received with regard to the Submission made by Viet Nam (n 29), China (7 May 2009 and 14 April 2011).

52 China—Declaration on the Baselines of the Territorial Sea (n 8).

53 For an appraisal of hydrographic issues relating to the South China Sea islands, see David Hancox and Victor Prescott, 'A Geographical Description of the Spratly Islands and an Account of Hydrographic Surveys Amongst those Islands' (1995) 1(6) *International Boundaries Research Unit (IBRU) Maritime Briefing* 1–88.

well as the existence of any low-tide elevations situated within 12 nm from islands on the reefs.[54]

Since most of the islands in the Spratlys are very small and are located in relatively close proximity to each other, China could limit its EEZ claim to the largest islands and/or those which are vegetated, without having an overly dramatic impact on the scope of its claims to maritime jurisdiction based on claimed sovereignty over the disputed islands of the South China Sea. For purposes of illustration, we have identified what appear to be the 12 largest islands based on past studies (see Fig. 3). They are all very small and the total land area of the 12 islands is less than two square kilometres. Despite their limited size, however, all 12 have vegetation and in some cases roads and structures have been built on them.

When Article 121 of the LOSC was drafted, numerous proposals were made regarding the tricky issue of distinguishing between islands capable of generating continental shelf and EEZ claims and mere "rocks" which cannot. Many of these proposals focused on criteria related to size and the presence of vegetation and/or water sources.[55] Ultimately, no consensus was reached then and subsequently no definitive position has been determined through State practice or by virtue of an authoritative ruling from an international judicial body. Nonetheless, it is suggested that island size, coupled with the presence of vegetation, are useful, if not necessarily definitive, indicators of islands that may, in principle, be capable of generating continental shelf and EEZ rights.

Accordingly, it can be argued in good faith that the islands we have identified are not "rocks which cannot sustain human habitation or economic life of their own" within the meaning of Article 121(3). As a result, they would, in principle, be entitled to a territorial sea, EEZ and continental shelf of their own. Furthermore, the largest features among the Paracel Islands group have been identified and would similarly be entitled to generate EEZ and continental shelf rights in keeping with Article 121(2) of the LOSC (see below). Further, Pratas Island can be viewed as being of an analogous character.

Of the 12 largest islands in the Spratlys, Taiwan occupies Itu Aba (Taiping Island), the largest island and the only one reported to have a source of fresh

54 LOSC Arts. 6 and 13.

55 Such proposals were advanced, for example, by the delegations of Malta and Ireland during the Third Conference on the Law of the Sea (UNCLOS III). See S.N. Nandan and S. Rosenne (eds) *United Nations Convention on the Law of the Sea 1982: A Commentary* (Volume III, Kluwer Law International, Dordrecht, 1995) 321–339. On the legislative history of Article 121, see also UNDOALOS, *Régime of Islands: Legislative History of Part VIII (Article 121) of the United Nations Convention on the Law of the Sea* (United Nations, New York, 1988).

water. The Philippines currently occupies five features, all of which are located within what it terms the Kalayaan Island Group (KIG): Northeast Cay, Thitu Island, West York Island, Loaita Island and Nanshan Island. Vietnam occupies the remaining six: Southwest Cay, Sand Cay, Namyit Island, Sin Cowe Island, Amboyna Cay and Spratly Island. All of those islands occupied by Vietnam are within the KIG, except for Spratly Island, which is located towards the south-western fringes of the Spratly Islands group. Although China does not currently occupy any of the 12 islands, as it claims sovereignty over all of them, it is likely to take the view that it has a right to claim an EEZ from them.

If China were to claim an EEZ from these 12 islands, it should issue charts indicating the geographic limits of its EEZ claim. In indicating the geographic limits it could give full effect to the islands toward the open sea and draw an equidistance or median line between the islands and the coasts of Brunei, Malaysia, the Philippines and Vietnam.[56] Even though the jurisprudence of international courts and tribunals provides that the maritime zones from small offshore islands should be given reduced effect or even 'enclaved' when delimiting maritime boundaries between large mainland territory and a small island, it is now well established that the starting point for courts and tribunals is almost always the equidistance line.[57] Since the equidistance line is the first step in determining the boundary in the case of overlapping claims between offshore islands and mainland territory, a claim to the equidistance line would

56 An equidistance line is a geometrically exact expression of the concept of a "mid-line", consistently at an equal distance from opposing basepoints. In the technical law of the sea literature, the term "median line" is sometimes used when referring to an equidistance line between two opposite States and the term "equidistance line" is used for an equidistance line between two adjacent States. However, as is observed in the International Hydrographic Organization's TALOS Manual, "In practice, however, the concept of adjacent and opposition are often difficult to define and apply, but the method used to determine an equidistance line is the same whatever the relationship of the coasts of the States." Consequently, the term 'equidistance line' is preferred in this Chapter. See International Hydrographic Organization (with the Intergovernmental Oceanographic Commission and the International Association of Geodesy), *A Manual on Technical Aspects of the United Nations Convention on the Law of the Sea—1982*, Special Publication No.51, (4th ed., International Hydrographic Bureau, Monaco, 2006) (*TALOS Manual*) Chapter 6, 3–4, available at http://www.gc.noaa.gov/documents/gcil_iho_tech_aspects_los.pdf; accessed 6 April 2014.

57 ICJ: *Case Concerning the Continental Shelf* (*Libyan Arab Jamahiriya v. Malta*), Judgment of 3 June 1985 (1985) I.C.J. Reports 13; *Maritime Delimitation and Territorial Questions between Qatar and Bahrain* (*Qatar v. Bahrain*), Merits, Judgment of 16 March 2001 (2001) I.C.J. Reports 40; *Territorial and Maritime Dispute* (*Nicaragua v. Colombia*), Judgment of 19 November 2012 (2012) I.C.J. Reports 624.

be a good faith claim that is consistent with the LOSC and international law. Any claim to an EEZ from an island beyond the equidistance line could be viewed as an abuse of right under Article 300 of the LOSC. At the same time, China could make an EEZ claim from Pratas Island, which is currently occupied by Taiwan but also claimed by China, and from the Paracel Islands, which are currently occupied by China but also claimed by Vietnam.

Fig. 3 is intended to demonstrate the effect of an EEZ claim from the 12 largest islands in the Spratlys, as well as from the largest islands in the Paracels and from Pratas Island. It gives full effect to the islands in the direction of the open sea, making most of the area in the middle of the South China Sea subject to the EEZ regime rather than the high seas regime. The map also shows the theoretical equidistance line between the 12 islands in the Spratlys and the coasts of Brunei, Malaysia, the Philippines and Vietnam. Moreover, the map illustrates full effect lines into the central part of the South China Sea as well as theoretical equidistance lines for the largest of the features among the Paracel Islands and for Pratas Island.[58]

For the purposes of this exercise, normal rather than claimed straight or archipelagic baselines have been used for the surrounding mainland and main island coastlines. This approach is consistent with past international judicial practice which has tended to ignore claimed straight baselines when determining the basepoints from which to construct equidistance lines.[59] The area of overlapping claims would include a significant portion of the above-mentioned KIG claim area of the Philippines (illustrated on Fig. 1). It would also include some areas where the Governments of some of the littoral States have

58 The names of the islands in the Paracel Island group that we believe would be entitled in principle to an EEZ and continental shelf of their own are annotated on Fig. 8 and listed in the next section of this paper, together with an analysis of the practical effect of such an EEZ claim. Note that Fig. 3 is designed to illustrate the location of the larger islands in the Spratly and Paracel Islands. These are shown with shaded territorial sea areas around them. Note also that there are numerous other smaller features in these island groups that are entitled to generate territorial sea areas. These smaller features are not illustrated on Fig. 3 in order to highlight the location of the larger islands used to construct equidistance lines. See, however, Fig. 9. See also the Appendix to this paper, which contains an explanatory note summarizing the rationale for the maritime zones drawn from the islands illustrated in the figures accompanying this article.

59 It remains open to question how an international court or tribunal might treat archipelagic baselines defined in accordance with Art. 47 of the LOSC when constructing equidistance lines, as this issue has yet to arise before an international judicial body.

granted concessions for the exploration of hydrocarbon resources.[60] One notable impact of this approach is that a relatively small high seas pocket would exist in the north-eastern part of the South China Sea (see Fig. 3).

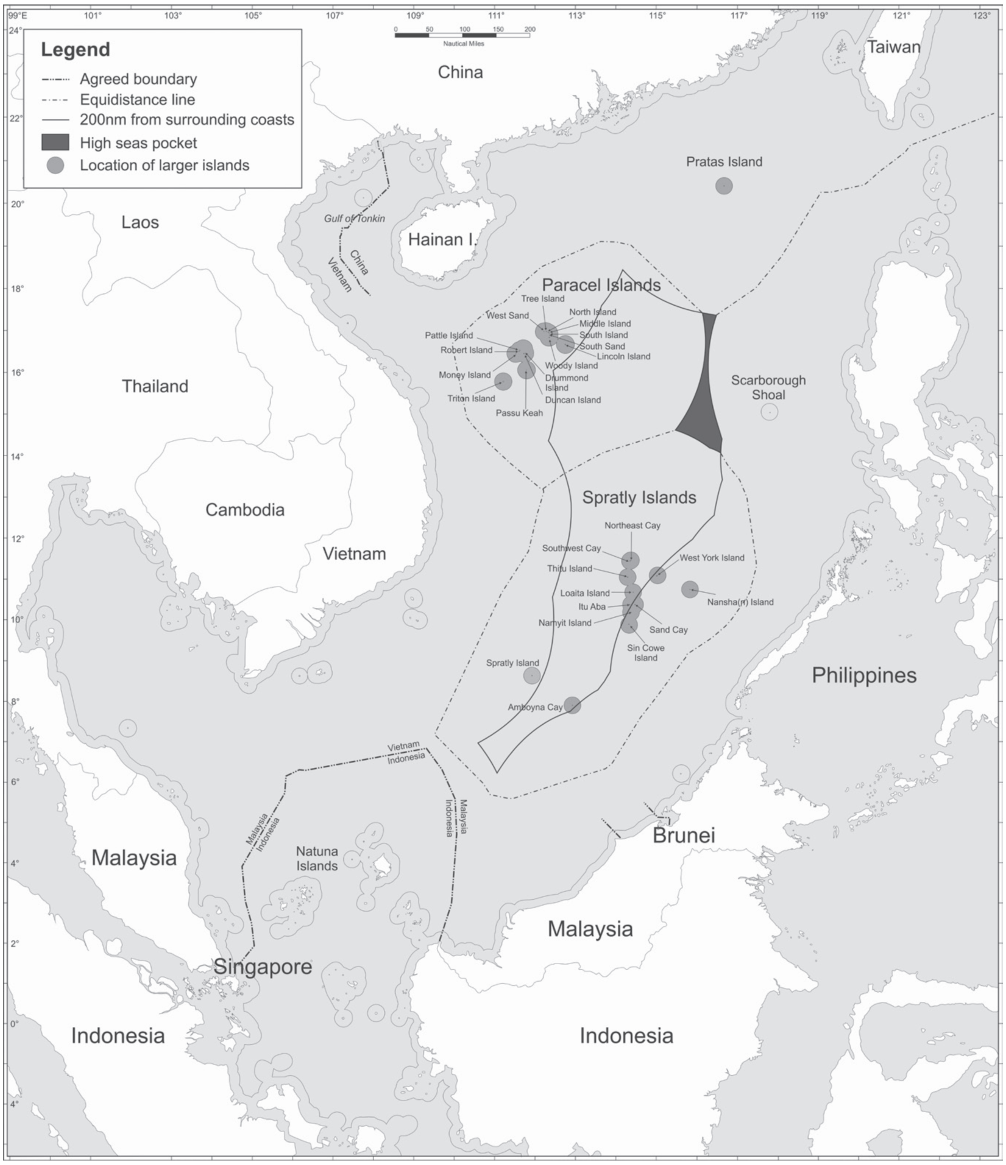

FIGURE 3 *Theoretical equidistance lines and remaining high seas pocket generated from larger islands in the South China Sea*

60 For example, the Philippines, with respect to the Reed Bank area located to the north-east of the Spratly Islands group, Malaysia and Brunei, concerning areas off their territories on the Island of Borneo, and Vietnam, in relation to the Vanguard Bank to the south-west of the Spratly Islands.

There would be several advantages to China if it made such a claim. First, its claim would be in conformity with the LOSC. Second, it would result in a large area of overlapping EEZ claims that would be subject to the provisions in Articles 74 and 83. The Claimants would be under an obligation to make every effort to enter into "provisional arrangements of a practical nature" such as JDAs.[61] Furthermore, they would be under an obligation not to take any unilateral actions that would jeopardise or hamper the reaching of a final agreement on the maritime boundaries.[62] In short, this action would bring China's maritime claims into line with both the LOSC and the claims made by the other Claimant States. Consequently, all of the Claimants would be negotiating on the same basis in international law and, in the authors' view, this could result in a de-escalation of the South China Sea disputes and arguably clear the way for them to begin negotiations on the area of overlapping claims.

A further advantage to China if it followed this course of action is that the ASEAN Claimants may not have the option of invoking the compulsory procedures entailing binding decisions in section 2 of Part XV of the LOSC on the settlement of disputes. China's declaration of 26 August 2006 excludes any disputes on the interpretation or application of Articles 74 and 83 from the compulsory procedures entailing binding decisions in section 2 of Part XV.[63]

As alluded to above, if China were to claim an EEZ from the largest 12 islands in the Spratlys, the Philippines or Vietnam may challenge the claim. They could maintain that all of the islands in the Spratlys are rocks within Article 121(3) and not entitled to an EEZ or continental shelf of their own. This would be a very difficult argument to make, unless a very strict reading of Article 121(3) were to be taken. Alternatively, the Philippines and Vietnam could respond by also claiming an EEZ from some or all of the same islands if they also claim sovereignty over them. If they were to make such a claim, they are likely to argue that islands can be given full effect in the direction of the open ocean, but that they should be given a substantially reduced or partial effect in the direction of their mainland territory or main archipelago and even "enclaved" or "semi-enclaved" (see Fig. 4). They could cite the jurisprudence of the International Court of Justice (ICJ) in support of their position on the

61 LOSC Arts. 74(3) and 83(3).

62 *Ibid.*

63 China—Declaration made after Ratification (n 49). The texts of the declarations of all States Parties to the LOSC are available on the United Nations Treaties Database (Status as at 05 April 2014) at https://treaties.un.org/pages/ViewDetailsIII.aspx?&src=TREATY&mtdsg_no=XXI~6&chapter=21&Temp=mtdsg3&lang=en; accessed 6 April 2014.

latter point.[64] The result would be negotiations between China and ASEAN Claimants as to how to define the area of overlapping claims between the islands and the coasts of the ASEAN countries.

If China claimed an EEZ from the largest islands, it would benefit the ASEAN Claimants as well as China. The ASEAN Claimants would benefit because it would be clear that, at the least, the waters on "their" side of the equidistance line would not be areas of overlapping claims. Therefore, they would have undisputed sovereign rights to explore and exploit the natural resources in these areas.

Clarifying the Areas of Overlapping Maritime Claims

If China were to make an EEZ claim from the largest disputed islands as described above, it would set the stage for negotiations to more precisely define the areas of overlapping claims. In some areas between the islands and the mainland coasts, the Claimants directly concerned may agree to follow the jurisprudence of international courts and tribunals and give these small, isolated islands a reduced or partial effect, rather than full effect. The impact of according the larger islands of the Paracel and Spratly Island groups half and quarter effect is illustrated in Fig. 4.

In the areas of overlapping claims, the Claimants could then attempt to negotiate JDAs and other cooperative arrangements as called for in the 2002 Declaration on the Conduct of Parties in the South China Sea.[65] Such cooperative arrangements would be interim arrangements of a practical nature and they would be without prejudice to the sovereignty disputes over the islands or to a final agreement on the maritime boundaries.

If the Claimants were to enter into negotiations to cooperate in the areas of overlapping claims, they could sidestep most of the difficult legal issues, such as which State has the better claim to sovereignty over the islands, whether an extended continental shelf claim from the mainland takes precedence over or "trumps" an EEZ claim from an island, and whether a State has the right to legally occupy a low-tide elevation.

If it took this approach, China would not need to formally abandon its nine-dashed line map or even issue a formal clarification of the nine-dashed line.

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64 ICJ: *Case Concerning the Continental Shelf* (*Libyan Arab Jamahiriya v. Malta*); *Maritime Delimitation and Territorial Questions between Qatar and Bahrain* (*Qatar v. Bahrain*); *Territorial and Maritime Dispute* (*Nicaragua v. Colombia*) (n 57).

65 Declaration on the Conduct of Parties in the South China Sea (Phnom Penh, 4 November 2002), available at http://www.asean.org/asean/external-relations/china/item/declaration-on-the-conduct-of-parties-in-the-south-china-sea; accessed 6 April 2014.

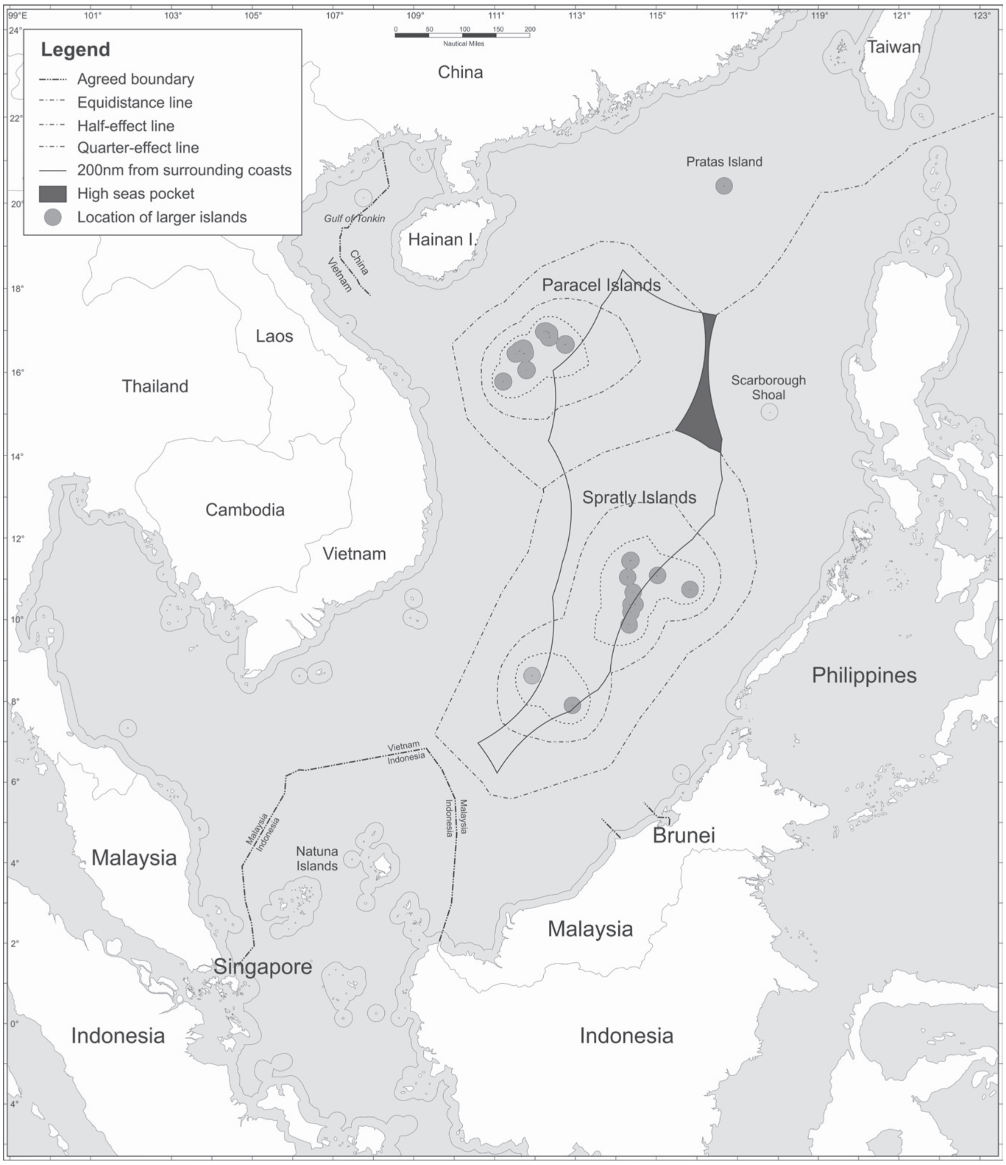

FIGURE 4 *Partial effect for the larger Paracel and Spratly Islands*

China could instead simply agree to begin negotiations on cooperative arrangements in the areas of overlapping claims resulting from its EEZ claims from the disputed islands. The result would be that the ASEAN Claimants would, in principle, have sovereign rights over those maritime areas off their coasts up to the equidistance line with the largest disputed islands—something that presently appears to be contested. China could, however, still take the position that its "historic fishing rights" should be taken into account in any JDAs in the areas of overlapping claims. In addition, China could request that the ASEAN Claimants give access to its nationals to any surplus in the areas of their EEZ that are not subject to overlapping claims. The rationale for the latter request is Article 62 of the LOSC, which provides that when giving access to any surplus in their EEZ, coastal States should take into account the need to minimise economic dislocation in States whose nationals habitually fished in the zone.

If China adopted this pragmatic position, it would be similar to that of the Philippines with respect to its historic claim to a territorial sea based on the 1898 Treaty of Paris. Like the Philippines, China could take measures to bring its claims into conformity with the LOSC without formally abandoning its historic claim.

Clarifying Areas of Overlapping Maritime Claims in the Other Areas in the South China Sea

Gulf of Tonkin and Areas Surrounding the Paracel Islands

This section of the South China Sea includes Hainan Island and the southern coast of mainland China, the northern section of the coast of Vietnam, the Gulf of Tonkin between China and Vietnam, and the Paracel Islands. The sovereignty and maritime disputes in this area are essentially between China and Vietnam, although Taiwan has a claim similar to that of China.

Sovereignty Dispute

The Paracel Islands are located approximately equidistant from the coastlines of Vietnam and the Chinese island of Hainan. China, Taiwan and Vietnam all claim sovereignty over the Paracel Islands. China forcibly ejected South Vietnamese troops from the Paracels in 1974, and they are now occupied exclusively by China.[66] Vietnam continues to claim sovereignty over the islands, but China denies the existence of a sovereignty dispute.[67] Vietnamese fishermen continue to enter the waters surrounding the Paracels, and the arrest of Vietnamese fishermen by China is a continual source of friction and tension

66 King C. Chen, *China's War with Vietnam, 1970: Issues, Decisions, and implications* (Hoover Institution Press, Stanford, 1987) 42–48; Cable News Network (CNN), 'China and Vietnam: A Timeline of Conflict', 28 January 2011, available at http://edition.cnn.com/2011/WORLD/asiapcf/06/27/china.vietnam.timeline/; accessed 6 April 2014.

67 Foreign Ministry Spokesperson Hong Lei's Regular Press Conference on 21 June 2012, available at http://www.fmprc.gov.cn/mfa_eng/xwfw_665399/s2510_665401/2511_665403/t945296.shtml; accessed 6 April 2014. Vietnam—The Law of the Sea of Viet Nam (n 18), Art 1.

between China and Vietnam, as is the issue of exploration for seabed energy resources.[68]

Questions will remain as to the rights and obligations of the two Claimants in the waters surrounding the Paracels, including their rights in what would be internal waters or territorial sea of the islands. This is not an issue of overlapping claims between opposite or adjacent States, but an issue of rights and jurisdiction in the waters surrounding islands over which both States claim sovereignty. Two principles of general international law that would clearly be applicable are the obligation to refrain from the threat or use of force and the obligation to resolve any disputes in a peaceful manner.[69]

Maritime Claims

Vietnam has claimed an EEZ from the baselines along its coast.[70] Vietnam has not issued any official charts or geographic coordinates indicating the outer limit lines of its EEZ, but the map accompanying its submission to the CLCS in May 2009 does indicate the outer limit of its EEZ claim.[71] In May 2009, Vietnam made a separate submission to the CLCS claiming an extended continental shelf in the area off its east coast, southwest of the Paracel Islands.[72] China has objected to Vietnam's extended shelf claim, and has asked the CLCS not to consider it because of the existence of land or maritime disputes in the area.[73] One of the bases of China's objection is that Vietnam's claim may overlap with China's claims in the same area.

China has claimed an EEZ measured seawards from its territorial sea baselines, including its claimed straight baselines fronting its mainland coast, as well as the straight baselines that it has defined around the Paracel Islands.[74]

68 China Detains Vietnamese Fishermen in Disputed Water, 22 March 2012, available at http://www.reuters.com/article/2012/03/22/china-vietnam-idUSL3E8EM3YJ20120322; Vietnam Lodges China Protest over Claims of Attack on Fishermen, available at http://www.bloomberg.com/news/2013-07-18/vietnam-lodges-china-protest-over-claims-of-attack-on-fishermen.html; accessed 6 April 2014. See also, for example, 'Vietnam and China ships "collide in the South China Sea" ', BBC News, 7 May 2014, available at http://www.bbc.com/news/world-asia-27293314, accessed 23 May 2014.

69 Charter of the United Nations (San Francisco, 26 June 1945, in force 24 October 1945), Art. 2(3)–(4), available at https://treaties.un.org/doc/publication/ctc/uncharter.pdf; accessed 6 April 2014.

70 Vietnam—The Law of the Sea of Viet Nam (n 18), Art. 15.

71 CLCS, Joint Submission—Malaysia-Viet Nam, Executive Summary (n 22).

72 CLCS, Submission—Viet Nam (n 29).

73 Communications Received with regard to the Joint Submission made by Malaysia-Viet Nam (n 22), China (7 May 2009 and 14 April 2011); Communications Received with regard to the Submission made by Viet Nam (n 29), China (7 May 2009 and 14 April 2011).

74 China—Exclusive Economic Zone and Continental Shelf Act (n 18), Art 2.

However, it has not issued any charts or geographic coordinates showing the limits of its EEZ claim in this area. China has submitted preliminary information to the CLCS suggesting that it may make a further submission regarding extended continental shelf limits and such a submission may well involve this area.[75] China's claim could conceivably overlap with the extended continental shelf claim of Vietnam.

Woody Island, the largest island in the Paracels, hosts the Chinese administrative centre known as Sansha City, as well as military facilities, and is about the same size as the 12 largest islands in the Spratly Islands combined.[76] Therefore, a strong argument can be made that Woody Island is entitled to an EEZ and continental shelf of its own. Also, the information available suggests that several other islands in the Paracels are large enough to be entitled, in principle, to an EEZ and continental shelf of their own.[77]

If an EEZ is claimed from the largest islands in the Paracels, it would extend east into the area beyond the outer limits of the EEZ claims measured from the mainland coasts of Vietnam and China. The EEZ generated from the Paracels would include Macclesfield Bank, but would not extend as far as Scarborough Shoal. An EEZ from the Paracels would also overlap with the EEZ claimed from the largest islands in the Spratlys. The result would be that most of the area in the middle of the South China Sea north of the Spratlys would be an area of overlapping claims.

The impact of an EEZ claim from the largest islands in the Paracels in the north-western part of the South China Sea is indicated in Fig. 5. In preparing this figure, the EEZ from the Paracels was measured from the largest islands, not from the straight baselines employed by China around the islands. This is because the straight baselines employed by China around the Paracel Islands are not in conformity with the LOSC.[78] However, the area of EEZ that can be claimed from the Paracels is not significantly reduced if the EEZ

75 CLCS, Preliminary Information—China (n 30), paragraph 10 "China reserves its right to make submissions on the outer limits of the continental shelf that extends beyond 200 nautical miles in the East China Sea and in other sea areas"; also Submission—China (n 30).

76 China Raises Administrative Status of South China Sea Islands, 21 June 2012, available at http://news.xinhuanet.com/english/china/2012-06/21/c_131668568.htm; accessed 7 April 2014.

77 The following islands in the Paracels may be large enough to generate an EEZ of their own: Woody Island and Rocky Islet, Lincoln Island, Triton Island, Pattle Island, Duncan Island, West Sand, Money Island, Robert Island, North Island, Drummond Island, Tree Island, South Island, Middle Island, Passuh Keah and South Sand. See Explanatory Note in the Appendix to this paper.

78 See China's straight baselines claims and other States' responses (n 8).

is measured from the largest islands rather than from the straight baselines connecting them.

Fig. 5 illustrates 12-nm territorial seas for the Paracel Islands themselves, together with theoretical equidistance lines between the Paracel Islands on the one hand and the mainland coasts of both China and Vietnam on the other.

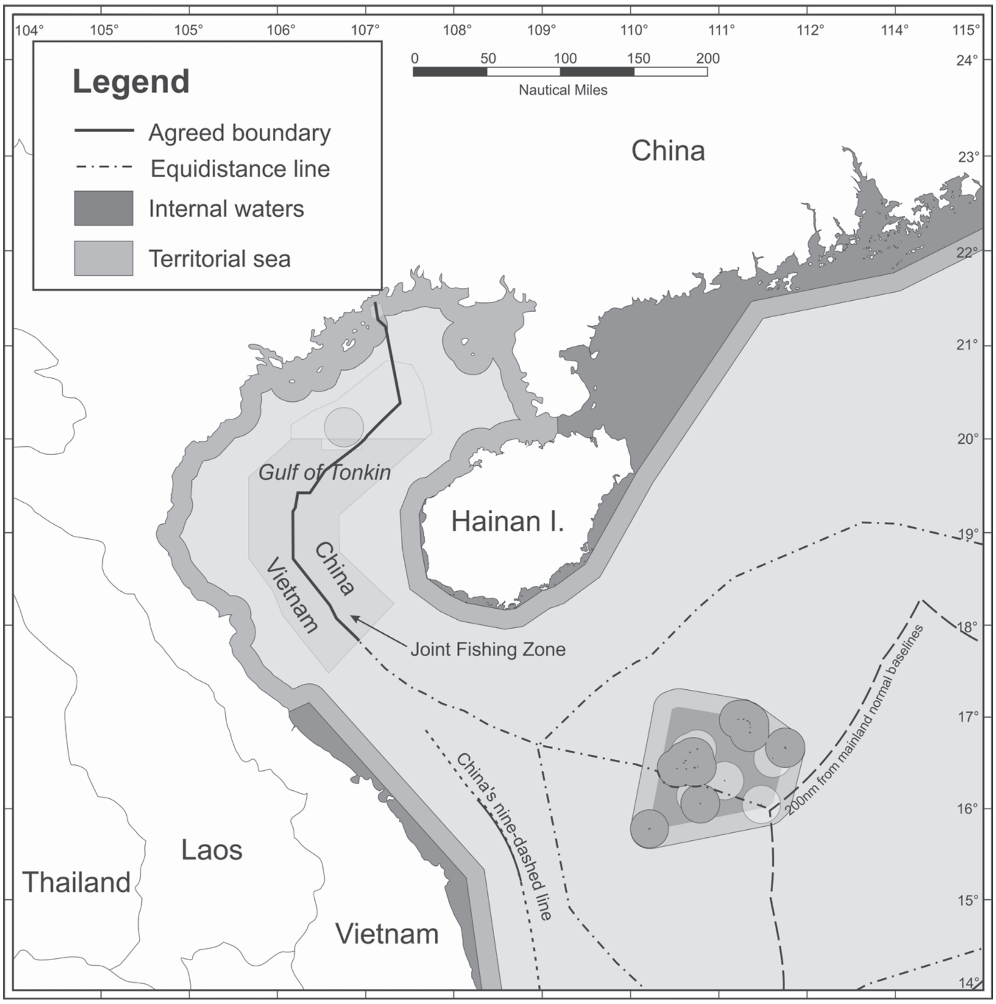

FIGURE 5 *Overlapping maritime claims in the North-western South China Sea*[79]

79 The continuous, that is, "joined up", version of the nine-dashed line illustrated in the maps accompanying this chapter was formed by plotting the dashed line segments extracted from a map attached in the Chinese note to the Secretary-General of the United Nations in its response to Malaysia-Vietnam's extended continental shelf submission and then interpolating a line to connect these dashes. There is therefore some inherent uncertainty in the precise location of these lines. Available at http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2009re_mys_vnm_e.pdf; accessed 7 April 2014. It is worth emphasising that China has never officially issued coordinates for the nine-dashed line nor depicted this line as a continuous one.

Once again, for the purposes of this exercise the straight baselines of both China and Vietnam have not been taken into account due to their excessive character and normal baselines have been used to generate theoretical equidistance lines. This provides an indication of what can be viewed as the maximum maritime area that could be realistically associated with these disputed islands under the LOSC and thus a plausible area of overlapping claims, as both China and Vietnam claim sovereignty over the Paracel Islands. Additionally, a theoretical equidistance line between China and Vietnam ignoring the Paracel Islands is illustrated by proceeding seawards from the mouth of the Gulf of Tonkin into the north-western part of the South China Sea and out to the 200-nm limit from normal baselines along mainland coasts (including Hainan Island), allowing 12-nm territorial sea semi-enclaves around features among the Paracel Islands, as appropriate.

Because the EEZ generated from the largest islands in the Paracel group into the potential central high seas "pocket" beyond 200 nm from surrounding mainland coasts would include Macclesfield Bank, this would solve a difficult legal problem for China. China has claimed sovereignty over Macclesfield Bank, even though it is a submerged reef that is not subject to a sovereignty claim.[80] However, if Macclesfield Bank lies within the EEZ claimed from the largest islands in the Paracels, China would have a basis to claim sovereign rights to explore and exploit the natural resources in and under the water in Macclesfield Bank. In such a case, it would not be necessary for China to pursue its sovereignty claim over Macclesfield Bank, which is clearly a problematic one to sustain in international law terms.

Maritime Boundaries

China and Vietnam have reached agreement on a maritime boundary in the section of the Gulf of Tonkin extending seaward from their land boundary.[81]

80 People's Republic of China—Law on the Territorial Sea and the Contiguous Zone (n 18), Article 2: "The land territory of the People's Republic of China includes the mainland of the People's Republic of China and its offshore islands; Taiwan and all islands appertaining thereto including the Diaoyu Islands; the Penghu Islands; the Dongsha Islands; the Xisha Islands; the Zhongsha Islands and the Nansha Islands; as well as all the other islands belonging to the People's Republic of China." This English translation is available in Office of Policy, Law and Regulation, State Oceanic Administration, *Collection of the Sea Laws and Regulations of the People's Republic of China* (Ocean Press, 1998), 186. The English names of the four groups of islands in the South China Sea are Pratas Island (Dongsha Islands), Paracel Islands (Xisha Islands), Macclesfield Bank (Zhongsha Islands), and Spratly Islands (Nansha Islands).

81 Agreement between China and Viet Nam on the Maritime Delimitation in Beibu Bay/Bac Bo Gulf (n 25).

Additionally, they reached an accord concerning fishing activities in specified areas straddling the agreed boundary line.[82] Negotiations are continuing to extend the existing boundary south-eastwards, and in October 2013 the two States agreed to undertake joint seismic surveys in this area.[83] The current boundary could be extended for a short distance without too much difficulty (see Fig. 5). However, it will be extremely difficult for the two States to extend this boundary too much farther because it will then intrude into the maritime zones of the disputed Paracel Islands.

The ocean space between the Paracels and the Vietnamese coast is likely to be a continual source of friction. China is likely to maintain that as the islands in the Paracels are entitled to an EEZ of their own, the waters between the islands and the Vietnamese coast are an area of overlapping EEZ claims between opposite States. Vietnam is likely to maintain that as it has sovereignty over the Paracels, all the waters between its coast and the Paracels are either its territorial sea or its EEZ.

Vietnam officially protested China's use of straight baselines around the Paracels.[84] However, it has not taken any official position on whether the Paracel Islands are entitled to an EEZ and continental shelf of their own. Given the size of Woody Island, it may be in Vietnam's own interests to recognise that the largest islands in the Paracels are entitled to an EEZ of their own.

In addition to overlapping EEZ claims, complex issues arise because of the outer continental shelf claim by Vietnam north-west of the Spratlys.[85] Vietnam's claim to an extended continental shelf in this area will overlap with the EEZ claim of China from the Paracel Islands. China has indicated this in its diplomatic notes regarding Vietnam's claim.[86] This raises the issue of whether an extended shelf claim will "trump" an EEZ claim from offshore islands in the

82 *Agreement on Fishery Co-operation in the Tonkin Gulf between the Government of the People's Republic of China and the Government of the Socialist Republic of Vietnam* (Beijing, 25 December 2000, in force 30 June 2004), in Nguyen Hong Thao, 'Maritime Delimitation and Fishery Cooperation in the Tonkin Gulf' (2005) 36(1) *ODIL* 25–44, at pp. 35–41.

83 Teddy Ng, 'China, Vietnam to set up Group to Explore Disputed South China Sea', 14 October 2013, available at http://www.scmp.com/news/china/article/1331106/china-vietnam-set-group-explore-disputed-south-china-sea; accessed 7 April 2014.

84 Daniel J. Dzurek, 'The People's Republic of China Straight Baseline Claim' (1996) 4(2) *IBRU Boundary and Security Bulletin Summer* 77–89, at p. 80.

85 CLCS, Submission—Viet Nam (n 29).

86 In its *Note Verbale* of 7 May 2009 objecting to a separate Submission of Viet Nam (n 29), China stated that "the above Submission by the Socialist Republic of Viet Nam has seriously infringed China's sovereignty, sovereign rights and jurisdiction in the South China Sea".

same area with regard to rights and jurisdiction over the seabed and subsoil. The decision of the International Tribunal for the Law of the Sea (ITLOS) in the *Bangladesh/Myanmar* case suggests that this is a possibility in some cases.[87] If so, there may ultimately have to be separate EEZ and outer continental shelf boundary agreements in the area, although the prospects of this being realised in the foreseeable future are dim in light of the parties' irreconcilable positions on sovereignty over the Paracel Islands.

Prospects for Joint Development in Areas of Overlapping Claims

China and Vietnam seem to have only two options if they want an alternative other than continued uncertainty and friction. First, they can decide to take the issue of which State has the better claim of sovereignty over the Paracel Islands to an international court or tribunal, and once the sovereignty issue is resolved, they can attempt to negotiate an EEZ boundary agreement. It seems unlikely that China would even consider this option, given the fact that it controls the Paracels, has invested heavily in them and does not even acknowledge the existence of a sovereignty dispute over them.[88] It is also uncertain whether Vietnam would seriously entertain this option, given its own oft-repeated uncompromising position, analogous to China's, regarding sovereignty over the Paracels.[89]

The second option would be to agree, either formally or informally, to set aside the sovereignty dispute over the Paracels and to try to reach an agreement on a combination of maritime boundaries and JDAs in areas of overlapping maritime claims. For example, the existing maritime boundary agreement between China and Vietnam in the Gulf of Tonkin could be extended from the terminus of their existing agreement in a south-eastward direction until a potential tripoint between the mainland coasts (including Hainan Island) and a full effect equidistance line involving the Paracel Islands, without undue

87 International Tribunal for the Law of the Sea (ITLOS): *Dispute Concerning the Maritime Boundary between Bangladesh and Myanmar in the Bay of Bengal* (*Bangladesh/Myanmar*), Judgment of 14 March 2012, paras 463–474, available at http://www.itlos.org/fileadmin/itlos/documents/cases/case_no_16/C16_Judgment_14_03_2012_rev.pdf; accessed 7 April 2014.

88 Foreign Ministry Spokesperson Hong Lei's Regular Press Conference on 21 June 21 2012 (n 67).

89 See, for example, Note from the Permanent Mission of the Socialist Republic of Viet Nam to the United Nations addressed to the Secretary General of the United Nations, 86/HC-2009, 18 August 2009, available at http://www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/vnm_re_phl_2009re_mys_vnm_e.pdf; accessed 7 April 2014.

difficulty (see Fig. 5). Additionally, without either China or Vietnam formally giving up their respective sovereignty claims to the Paracels, JDAs could be reached in the areas of overlapping claims between the disputed islands and the mainland coasts of the parties.

Under such a scenario, it is conceivable that each side might have a greater share in the joint zone on "their" side of the theoretical line ignoring the influence of the Paracel Islands. Moreover, Vietnam and China could agree to jointly develop the resources in areas to the south-east of the Paracels, including Macclesfield Bank.[90] It is recognised that the compromises and concessions require significant reserves of political will. Accordingly, the potential scenarios outlined here are likely to prove difficult to realise in practice. The above suggestions are not, however, intended as a proposed solution, but as examples of the sort of options available to the two States in a negotiating context where the primary objective is to achieve a mutually beneficial solution in an area that will otherwise be a protracted source of tension and potential conflict.

Area between the Philippines and Taiwan and China

The north-east section of the South China Sea is bordered by China and Taiwan in the north and the Philippines in the east. There is one significant offshore atoll in the area, Pratas Island. The Pratas Island consists of a number of features located on an atoll that is 2.8 km long and 0.865 km wide, located about 140 nm off the coast of China and about 240 nm west of Taiwan.[91] Pratas Island is claimed by China and Taiwan, and occupied by Taiwan. Given the size of Pratas Island, it can be argued in good faith that it is not a rock within the meaning of Article 121(3) of the LOSC, but an island entitled, in principle, to an EEZ and continental shelf of its own.

Areas of Overlapping Maritime Claims

The Philippines claims an EEZ from its archipelagic baselines.[92] This produces an area of overlapping EEZ claims between opposite States which would be

90 If the Philippines claimed an extended continental shelf beyond 200 nm from its archipelago, some of its extended continental shelf area might overlap with the EEZ generated from the Paracel Islands, which may include Macclesfield Bank.

91 Tungsha Atolls (Pratas), available at http://island.giee.ntnu.edu.tw/islandengweb/007.htm; Marine National Park Headquarters, Introduction to Dongsha Atoll National Park, available at http://marine.cpami.gov.tw/english/index.php?option=com_efpublication&view=pdetailen&id=4&Itemid=79; accessed 7 April 2014.

92 Philippines—Presidential Decree No. 1599 of 11 June 1978 Establishing an Exclusive Economic Zone and for other Purposes (n 18), Section 1.

governed by Article 74 of the LOSC. The Philippines has submitted a claim to the CLCS for an extended continental shelf in Benham Rise, off its east coast, and has indicated that it intends to claim an extended shelf in other areas,[93] which may include the area in the direction of Pratas Island and China's southern coast. China's future claim to an extended continental shelf in this area is likely to overlap with the future extended continental shelf claim of the Philippines.

Taiwan claims an EEZ from the straight baselines around its main island. It also claims an EEZ from the Pratas Island, using a combination of normal baselines and straight baselines.[94] This area of overlapping claims includes the Luzon Strait between Taiwan and the Philippines, which is a major route for international navigation. Taiwan is not a party to the LOSC. Therefore, it is not eligible to submit an extended continental shelf claim to the CLCS.

The overlapping EEZ claims in the area of Luzon Strait involve Taiwan and the Philippines, because Taiwan has effective control of Taiwan Island and Pratas Island. To define the possible EEZ boundary in this sector of the South China Sea, an equidistance line can be drawn between Taiwan and Pratas Island on one side, and the nearest Philippine islands on the other side (see Fig. 6). If the equidistance lines were drawn from basepoints on the largest islands rather than from the straight baselines, it would avoid any problems relating to the legality of the baselines employed by Taiwan. In this context it can be observed that the Philippines would be likely to push for recognition of its archipelagic baselines. However, although this would likely be a point of discussion, the influence of the archipelagic baselines of the Philippines on the construction of the theoretical equidistance line is marginal, because an equidistance line constructed from basepoints on the islands would be the almost the same as one constructed from the archipelagic baselines.

The fact that the Taiwan's use of straight baselines may not be in compliance with the LOSC is not likely to have a significant effect on securing an agreement on the EEZ boundary (or a provisional fisheries enforcement line) between Taiwan and the Philippines, because the baselines need not be taken into account in the negotiations of the EEZ boundary. As Bautista and Schofield have noted, if a theoretical equidistance line is constructed between the Philippines and Taiwan, it would proceed from an eastern tripoint where

93 CLCS, Submission—Philippines (n 30).

94 Republic of China—Law on the Territorial Sea and the Contiguous Zone (n 18), Art 4; Law on the Exclusive Economic Zone and the Continental Shelf (n 18), Art 2; Territorial Sea Baseline, Outer Limits of the Territorial Sea and Contiguous Zone Amended, 26 November 2009, available at http://navy.mnd.gov.tw/english/Publish.aspx?cnid=844&p=38637&Level=1; accessed 7 April 2014.

the claims of Taiwan and the Philippines meet those generated from Japan's Sakishima Islands group, then proceed through the Bashi Channel in the Luzon Strait into the South China Sea "proper" (see Fig. 6).[95]

Further to the south-west, a theoretical equidistance line between China and the Philippines relies on basepoints located on Pratas Island on one side and the western coast of the major Philippine island of Luzon on the other. In light of the small size and thus restricted coastal front of Pratas Island in comparison to Luzon, if maritime boundary delimitation negotiations were ever initiated with China/Taiwan, the Philippines would be highly likely to argue that Pratas Island be accorded a substantially reduced effect, if not entirely ignored and "enclaved" within their territorial sea areas. Further, if a theoretical equidistance line is generated between the mainland coast of China and the Philippines, baseline issues and particularly the questionable straight baselines of China fronting its mainland coast would likely prove to be key points of discussion. The Philippines would be likely to insist that any equidistance line be measured from China's coast, that is, from its normal baselines, rather than from its straight baselines (see Fig. 6). The maritime area lying between an equidistance line according full weight to the Paracel Islands and one giving them nil effect and, moreover, ignoring the potential influence of China's claimed straight baselines, represents a theoretical area of overlapping maritime claims. As illustrated in Fig. 6, Pratas Island also has a potential impact on the scope of the above-mentioned high seas pocket in the northern-central part of the South China Sea.

Prospects for Joint Development in Areas of Overlapping Claims

Special legal problems arise in reaching an agreement on the EEZ boundary in this area because of the legal status of Taiwan. The position of the Governments of both China and Taiwan is that there is one China and Taiwan is part of China. The Republic of China Government on Taiwan is recognised by a small number of States as the legitimate government of China. The People's Republic of China Government in Beijing represents China in the United Nations. Taiwan was not invited to participate in the negotiation and signing of the LOSC and it was unable to become a party to it.[96] The Philippines, like the other

95 See Lowell Bautista and Clive Schofield, 'Philippine-China Border Relations: Cautious Engagement Amidst Tensions', in Bruce Elleman, Stephen Kotkin and Clive H. Schofield (eds) *Beijing's Power and China's Borders: Twenty Neighbors in Asia* (M.E. Sharpe Publishers, Armonk/New York, 2012) 235–250, at pp. 237–238. See also, Prescott and Schofield (n 14), at p. 434.

96 Ministry of Foreign Affairs Republic of China (Taiwan), 'Declaration of the Republic of China on the Outer Limits of Its Continental Shelf' (12 May 2009), available at http://

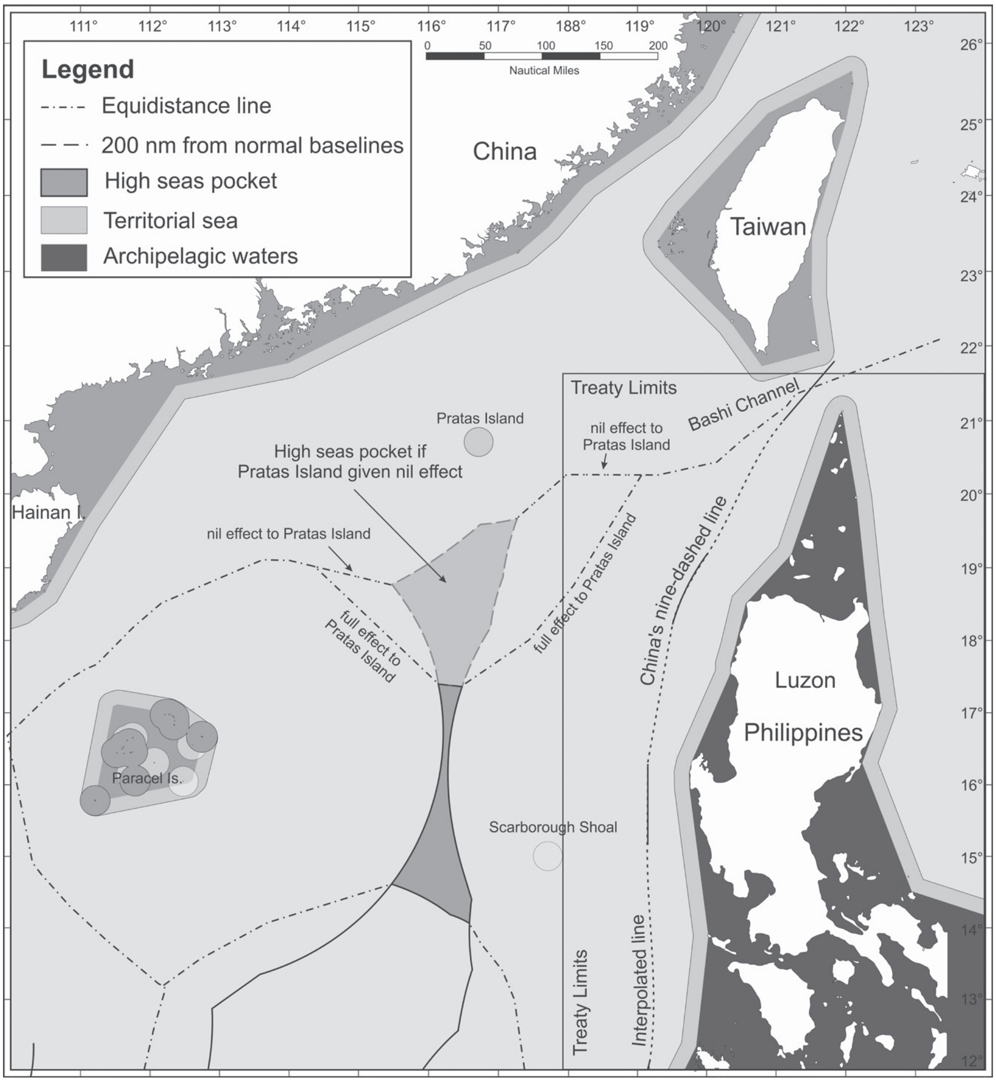

FIGURE 6 *Overlapping maritime claims in the North-eastern South China Sea*

ASEAN member States, follows a 'One China Policy' under which it officially recognises that Taiwan is part of China.[97] This makes it extremely difficult, if not impossible, for the Philippines to negotiate an EEZ boundary with Taiwan in this area. China is likely to object if the Philippines and Taiwan enter into

www.mofa.gov.tw/EnOfficial/ArticleDetail/DetailDefault/ad125edc-048e-45de-93bc-11427232687b?arfid=7b3b4d7a-8ee7-43a9-97f8-7f3d313ad781&opno=84ba3639-be42-4966-b873-78a267de8cf1; accessed 7 April 2014.

97 Taipei Economic and Cultural Office in the Philippines, Taiwan-Philippine Relations, available at http://www.roc-taiwan.org/PH/ct.asp?xItem=57628&CtNode=4705&mp=272&xp1; accessed 7 April 2014.

formal maritime boundary negotiations because it would be contrary to the 'One China Policy'.

On the other hand, the Taipei authorities, not the Beijing authorities, are in effective control not only of Pratas Island, but arguably also of the waters in this area, both in the vicinity of Taiwan itself, but also proximate to Pratas Island; and Taiwanese fishing vessels fish in these waters. Therefore, for an agreement to be effective, Taiwan would have to be a party to it, or at least not challenge it. In this context, it is perhaps noteworthy that Taiwan was able to conclude a joint fisheries agreement with Japan in April 2013 in respect of parts of the southern East China Sea—suggesting the possibility of an analogous arrangement being applied to parts of the north-eastern South China Sea.[98]

It has been reported that following an incident in 2013, in which the Philippines coast guard fired on a Taiwanese fishing vessel and killed a Taiwanese fisherman, the Taiwan authorities have requested the Philippines authorities to enter into some kind of provisional arrangement with respect to fishing in these waters in order to prevent potential conflicts in the area of overlapping EEZ claims.[99] Any arrangement must be consistent with the 'One China Policy' so that it does not raise an objection from China. The dispute

98 The agreement does, however, exclude the 12-nm territorial waters of the disputed Senkaku/Diaoyutai Islands and its conclusion is without prejudice to the parties' positions concerning that dispute. See Shih Hsiu-chuan, 'Taiwan, Japan ink fisheries agreement', *Taipei Times*, 11 April 2013. Available at http://www.taipeitimes.com/News/front/archives/2013/04/11/2003559323/2; accessed 7 April 2014.

99 Philippines and Taiwan have agreed to: refrain from using force in enforcing fisheries laws and regulations, inform each other of their respective maritime law enforcement procedures; establish a mechanism for prompt notification when an enforcement operation is underway against any fishing vessel of the other party, and set up a mechanism for the prompt release of detained fishing vessels and their crews. See the Press Release of the Ministry of Foreign Affairs of the Republic of China (Taiwan), 8 August 2013, available at http://www.mofa.gov.tw/EnOfficial/ArticleDetail/DetailDefault/eb8081fd-8616-4263-8b96-f443c63b3294?arfid=12e3ae93-5bcb-43a6-90cb-05ff0268cafc&opno=3874e0ce-d467-4f72-b271-a5af8d47ab33; See also Camille Diola, 'Taiwan Ready to Revive Fishery Talks with Philippines', 8 August 2013, available at http://www.philstar.com/headlines/2013/08/08/1066891/taiwan-ready-revive-fishery-talks-philippines; Elaine Hou, 'Taiwan, Philippines to Set Up Working Group for Fishery Issues', 22 October 2012, available at http://focustaiwan.tw/news/aipl/201310220048.aspx; Kelvin Huang and James Lee, 'Foreign Ministry Reports Progress in Taiwan-Philippines Fishery Talks', 28 October 2013, available at http://focustaiwan.tw/news/aipl/201310280016.aspx; accessed 7 April 2014.

settlement procedures in Part XV will not be relevant to any dispute between the Philippines and Taiwan because Taiwan is not a party to the LOSC.

A further potential complication in this area is the fact that the theoretical equidistance lines outlined above and illustrated in Fig. 6 cut through the Philippines Treaty Limits area or rectangular "box". This may lead to complications in pursuing negotiations, particularly towards maritime boundary delimitation, on the Philippines domestic front.[100]

In conclusion, this area of the South China Sea presents issues of boundary delimitation and fisheries cooperation between China, Taiwan and the Philippines which are complicated in particular by the status of Taiwan. Nonetheless, it is conceivable that joint arrangements and other provisional arrangements of a practical nature could be agreed upon, for example in relation to fisheries resources, as has already occurred in parts of the East China Sea, if the governments concerned recognise their common interests and can agree on practical steps to cooperate in this area.

Scarborough Shoal Area

Scarborough Shoal (or Reef) is located approximately 124 nm from the Philippines, well within the EEZ claimed by the Philippines from its main archipelago.[101] Scarborough Shoal is a large atoll with a lagoon of about 150 km² surrounded by a reef.[102] Most of the reef is either completely submerged or above water only at low tide, but it contains four to six small rocks which are permanently above water at high tide.[103] Some Chinese writers have claimed that it is part of Macclesfield Bank,[104] but given the distance from Macclesfield

100 See discussion in text at footnotes *supra* 9–16; Also see Bautista and Schofield (n 95), at pp. 238 and 242–243.

101 Republic of the Philippine, Official Gazette, 'Philippines Position on Bajo de Masinloc (Scarborough Shoal) and the Waters within its Vicinity' Department of Foreign Affairs (18 April 2012), available at http://www.gov.ph/2012/04/18/philippine-position-on-bajo-de-masinloc-and-the-waters-within-its-vicinity/; accessed 7 April 2014.

102 Keyuan Zou, 'Scarborough Reef: A New Flashpoint in Sino-Philippine Relations?' (1999) 7(2) *IBRU Boundary and Security Bulletin* 71–81, at p. 71.

103 *Ibid.*; Philippines Position on Bajo de Masincloc (n 101). The relevant British Admiralty Sailing Directions (Pilot) describe Scarborough Reef as being "step-to on all sides and consists of a narrow belt of coral enclosing a lagoon of clear blue water"; South Rock, at 3m high, is the "tallest rock" located at the south-east extremity of the reef. See United Kingdom Hydrographic Office, *Admiralty Sailing Directions: China Sea Pilot* (Volume 2, 9th ed., UKHO, Taunton, 2010) 74.

104 Zou (n 102), at p. 71; Keyuan Zou, 'The Chinese Traditional Maritime Boundary Line in the South China Sea and Its Legal Consequences for the Resolution of the Dispute over the Spratly Islands' (1999) 14(1) *International Journal of Marine and Coastal Law* (IJMCL) 27–55,

Bank and the depth of the waters in the area between them, it is difficult to argue that it is geographically part of Macclesfield Bank.

The rocks in the Scarborough Shoal are very small and contain no vegetation. Consequently, they appear to be a classic case of "rocks which cannot sustain human habitation or economic life of their own". Following an incident in 2012, in which a naval vessel of the Philippines arrested Chinese fishing vessels in the lagoon, China has allegedly taken 'effective control' of the atoll.[105] It reportedly has coast guard vessels in the area and allegedly does not allow vessels from the Philippines to enter the lagoon.[106]

Areas of Overlapping Maritime Claims

The Philippines has claimed an EEZ from the archipelagic baselines surrounding its main archipelago.[107] Although it has yet to issue charts or geographic coordinates setting out the outer limit lines of its EEZ, an EEZ claim from its archipelagic baselines would be consistent with the LOSC, and would include the waters around Scarborough Shoal.

China, Taiwan and the Philippines all claim sovereignty over Scarborough Shoal and over the 12-nm territorial sea surrounding it.[108] The disputes concerning Scarborough Shoal are essentially disputes between the Philippines

at p. 28; Embassy of the People's Republic of China in the Republic of the Philippines, 'Huangyan Dao Shi Wen (Ten Basic Questions regarding the Scarborough Shoal)', 16 June 2012, available at http://www.fmprc.gov.cn/ce/ceph/chn/zgxw/t941671.htm; accessed 7 April 2014.

105 M. Taylor Fravel, 'China's Island Strategy: "Redefine the Status Quo"', 1 November 2012, available at http://thediplomat.com/china-power/chinas-island-strategy-redefine-the-status-quo/; Foreign Ministry Spokesperson Hua Chunying's Regular Press Conference on 1 July 2013, available at http://www.fmprc.gov.cn/mfa_eng/xwfw_665399/s2510_665401/2511_665403/t1055206.shtml; accessed 7 April 2014.

106 Jojo Malig, 'China Claims Control of Scarborough Waters', 24 May 2012, available at http://www.abs-cbnnews.com/-depth/05/24/12/china-claims-control-scarborough-waters; Tarra Quismundo, 'China's Surveillance Ships back at Scarborough Shoal', 8 January 2013, available at http://globalnation.inquirer.net/80007/chinas-surveillance-ships-back-at-scarborough-shoal; accessed 7 April 2014.

107 Philippines—Presidential Decree No. 1599 of 11 June 1978 Establishing an Exclusive Economic Zone and for other Purposes (n 18), Section 1.

108 Philippines—Republic Act No. 9522 (n 17), Section 2(2); Foreign Ministry Spokesperson Hua Chunying's Remarks on the Philippines' Efforts in Pushing for the Establishment of the Arbitral Tribunal in Relation to the Disputes between China and the Philippines in the South China Sea, 26 April 2013, available at http://www.fmprc.gov.cn/mfa_eng/xwfw_665399/s2510_665401/2535_665405/t1035577.shtml; accessed 7 April 2014.

and China, with Taiwan taking a position analogous to that of China. Because the rocks on the shoal are islands as defined in Article 121 of the LOSC (that is, naturally formed areas of land surrounded by and above water at high tide), these rocks are subject to a claim of sovereignty.

None of the Claimants have designated baselines for measuring the territorial sea from the Scarborough Shoal. If the rocks above water at high tide are situated on an atoll, the baseline for measuring the territorial sea may be the seaward low-water line of the reef.[109] Because this is a very large atoll, using the seaward low-water line of the reef as the baseline could significantly increase the area of territorial sea surrounding the shoal. Also, the waters inside the lagoon enclosed by straight baselines would be internal waters. Alternatively, if there are drying rocks on the atoll that are within 12 nm of any of the rocks that meet the definition of an island, the drying rocks would be low-tide elevations that can be used as basepoints in determining the baselines from which the territorial sea would be measured.[110]

Two major issues concerning Scarborough Shoal are not governed by the LOSC, but by general principles of international law. First, which State has the better claim to sovereignty over the islands? Second, what are the rights and obligations of the Claimants in the waters surrounding the disputed islands?

Relevance of LOSC Dispute Settlement Procedures

The most contentious issue with respect to Scarborough Shoal, other than the sovereignty dispute, is the legal status of the islands and their entitlement to maritime zones. The Philippines' legislation on baselines states that Scarborough Shoal is governed by the regime of islands in Article 121 of the LOSC, without stating how Article 121 would apply.[111] However, the position of the Philippines in its arbitration case with China is that Scarborough Shoal is not entitled to an EEZ or continental shelf of its own because the small rocks fall within Article 121(3) of the LOSC, which provides that "rocks which cannot sustain human habitation or economic life of their own" shall have no EEZ or continental shelf.[112] This issue is important to the Philippines because Scarborough Shoal is situated in the EEZ which the Philippines claims from its archipelagic baselines. If the rocks are entitled only to a 12-nm territorial

109 LOSC Art. 6.
110 LOSC Art. 13.
111 Philippines—Republic Act No. 9522 (n 17), Section 2(2).
112 Philippines—Notification and Statement of Claims on West Philippine Sea (n 43).

sea, then the only 'disputed waters' where China could claim any rights would be the 12-nm territorial sea surrounding the islands. The waters seaward of the outer limit of Scarborough Shoal's territorial sea would be the EEZ of the Philippines, where it has sovereign rights to explore and exploit the natural resources (see Fig. 6).

On the other hand, if the Arbitral Tribunal were to hold that the islands in the Scarborough Shoal are in principle entitled to an EEZ of their own, an issue of overlapping EEZ would arise. It would then be a case of delimitation of the EEZ boundaries between opposite States, which is governed by Article 74. Given that China has exercised its right under Article 298 to opt out of the compulsory procedures entailing binding decisions for disputes on the interpretation or application of Article 74, this issue would have to be resolved in bilateral negotiations.

Conclusion on Scarborough Shoal

The area around Scarborough Shoal provokes a bilateral problem between China and the Philippines. Some of the issues concerning the waters in and around the shoal could be resolved by the Arbitral Tribunal in the pending case between the Philippines and China if it decides that it has jurisdiction to hear the case. On the other hand, it might be possible for the two States to settle the case before an Award is issued by the Arbitral Tribunal. The issues concerning Scarborough Shoal are fairly straightforward compared to many areas in the South China Sea. If China and the Philippines could establish the necessary trust and political will, it might be possible for them to reach an amicable arrangement with respect to fishing in and around Scarborough Shoal, provided such arrangements, like all provisional arrangements, are without prejudice to the underlying sovereignty disputes and a final agreement delimiting the maritime boundaries.[113]

Indonesia's EEZ Boundaries off the Natuna Islands

There are no disputed islands in the south-western-most section of the South China Sea. Indonesia has undisputed sovereignty over the Natuna Islands.

Area of Overlapping Maritime Claims

Indonesia has agreements delimiting its continental shelf boundaries in this area with Malaysia to both the east and west and with Vietnam to the north.[114]

113 LOSC Arts. 74(3) and 83(3).

114 Agreement between the Government of Malaysia and the Government of Indonesia on the Delimitation of the Continental Shelves between the two Countries (27 October

Indonesia negotiated these agreements in 1969 and 2003, respectively. Although the area encompassed by China's nine-dashed line map cuts across these agreed continental shelf boundaries, as illustrated on Fig. 7, no available record indicates that China has objected to Indonesia's boundary agreements with Malaysia and Vietnam.[115] This raises the issue of whether, because of its silence, China is precluded from asserting any rights to resources on the continental shelf in this area, even though the area is partially inside China's nine-dashed line.

Indonesia's claim to an EEZ in this area extends beyond the limits of its continental shelf boundary agreements with Malaysia and Vietnam.[116] This indicates that Indonesia is not prepared to use the continental shelf boundaries to delimit its EEZ boundaries with Malaysia and Vietnam. Therefore, Indonesia must negotiate bilateral agreements with its neighbours setting out the EEZ boundaries (see Fig. 7).

1969); Agreement between the Government of the Socialist Republic of Vietnam and the Government of the Republic of Indonesia Concerning the Delimitation of the Continental Shelf Boundary (26 June 2003, in force 29 May 2007), available at http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/IDN.htm; accessed 7 April 2014.

115 For example, Oegroseno, referring to the continental shelf boundary agreed between Indonesia and Malaysia in 1969 (n 114), states unequivocally that "[n]ot a single country has challenged the validity of this 45 year-old treaty that divides rather significantly certain segments of the SCS [South China Sea]". See Arif Havas Oegroseno, 'Indonesia, South China Sea and the 11/10/9-dashed lines', Jakarta Post, 9 April 2014. Available at http://www.thejakartapost.com/news/2014/04/09/indonesia-south-china-sea-and-11109-dashed-lines.html; accessed 15 April 2014.

116 Indonesia—Act No. 5 of 1983 on the Indonesian Exclusive Economic Zone, 18 October 1983, Art 2, available at http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/IDN_1983_Act.pdf; that Indonesia's EEZ claim extends beyond its agreed continental shelf boundaries with neighbouring States is confirmed by reference to official Indonesian government mapping, notably its National Map which is issued on an annual basis and which clearly illustrates an Indonesian EEZ limit that is further seaward than Indonesia's agreed continental shelf boundary lines. See, for example, Bakosurtanal, The National Map of the Unitary States of Indonesia [*Peta Negara Kesatuan Republik Indonesia*] (generally referred to as *Peta NKRI*), 2013, Cibinong, Indonesia. The same limits are also reflected in depictions of Indonesia's fisheries management zone or Wilayah Pengelolaan Perikanan (WPP), in keeping with the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) Regulation Number 1 of 2009 on Fisheries Management Areas, available at http://infohukum.kkp.go.id/files_permen/PER%2001%20MEN%202009.pdf (in Indonesian) accessed 7 April 2014.

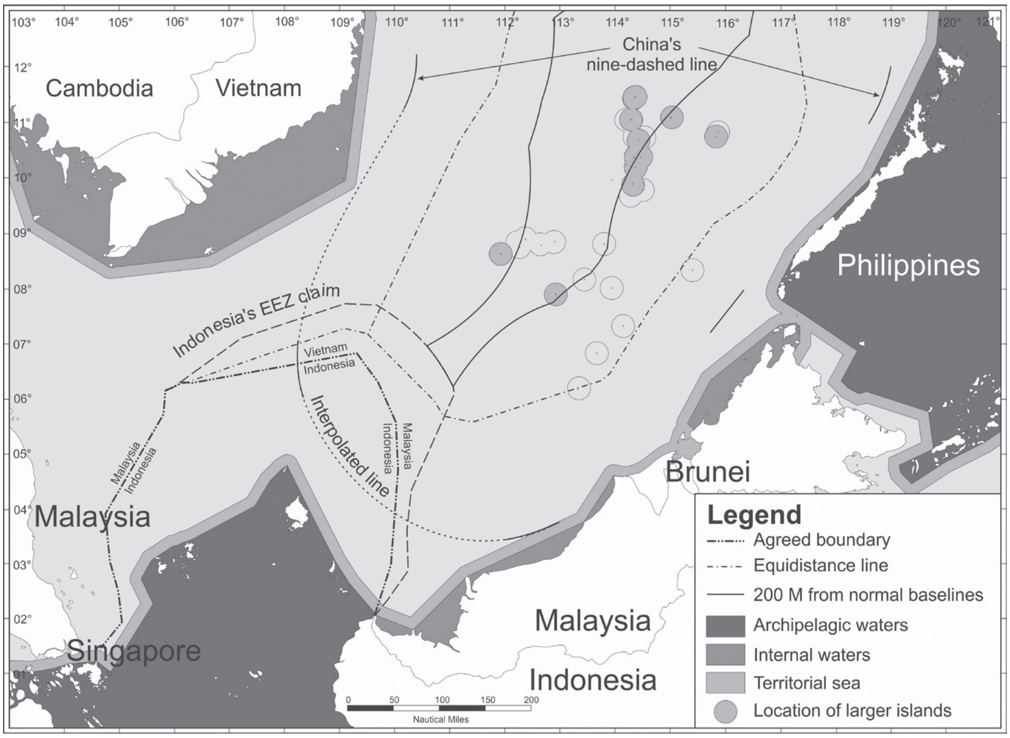

FIGURE 7 *Maritime boundaries and overlapping maritime claims in the South-western South China Sea*

Indonesia has been resistant to any suggestion that it must negotiate a maritime boundary agreement with China because its maritime zones overlap with those claimed by China.[117] However, if China were to claim an EEZ from the largest islands in the Spratlys and draw a full-effect equidistance line from the larger Spratly Islands, it would create an overlap with the north-eastern part of Indonesia's EEZ claim. In such a case, Indonesia is likely to take the view that the small isolated and largely uninhabited Spratly Islands should be accorded a reduced effect so that the claims from the Spratly Islands would not overlap with Indonesia's EEZ claim from the Natuna Islands.[118]

Conclusions

The major obstacle which must be overcome before JDAs can be seriously considered is to reach agreement on the areas of overlapping claims where JDAs

117 See in particular, Oegroseno (n 115).

118 See I. Made Andi Arsana and Clive Schofield, 'Indonesia's "Invisible" Border with China', in Elleman, Kotkin and Schofield (n 95) 60–79, at pp. 67–70.

and other cooperative provisional arrangements can take place. At the present time, there is substantial uncertainty with respect to the areas of overlapping EEZ claims between the mainland coasts and the islands. This is because none of the Claimants have indicated which islands, if any, they believe are entitled to an EEZ and continental shelf of their own. Furthermore, none of the Claimants have indicated the baselines on the islands over which they claim sovereignty or issued charts or geographic coordinates showing the outer limit of the EEZ claims from the islands.

Agreement on areas for joint development is not possible if China maintains that the area for joint development must include all of the ocean space within the nine-dashed line. On the other hand, agreement on areas for joint development is also not possible if the ASEAN Claimants insist that none of the disputed islands in the South China Sea are entitled to an EEZ and continental shelf of their own.

There are several advantages to pursuing discussions to agree on areas of overlapping claims where joint development can take place. First, the arrangements in areas of overlapping claims would be without prejudice to sovereignty claims over the islands or final boundary delimitation agreements between the islands and the mainland coasts. Second, the difficult issues regarding the status of the extended continental shelf claims and their overlap with EEZ claims from the islands could be avoided. Third, the Claimants could remain on the features they presently occupy, again without prejudice to a final settlement of the disputes. Fourth, it would not be necessary to determine the status of each and every geographic feature if Claimants could agree on which of the larger islands in the Spratlys and Paracels are entitled in principle to an EEZ and continental shelf of their own.

China could trigger a paradigm shift in its disputes in the South China Sea if it were to formally declare an EEZ from the largest islands in the Spratly Islands and Paracel Islands and issue charts indicating the outer limit of its EEZ claims from the islands. If China made such an EEZ claim, it would set the stage for serious negotiations on setting aside the disputes, defining the areas of overlapping claims, and pursuing negotiations for JDAs and other "provisional arrangements of a practical nature" under Article 74(3) of the LOSC. In our view, such a move would go a long way towards both clarifying claims and de-escalating the South China Sea disputes.

The advantage for China in making such a claim is that it would be consistent with the LOSC. In addition, it would leave a large area of overlapping EEZ claims that would be subject to the provisions in Article 74. The States concerned would be under an obligation to comply with Article 74(3) and to make every effort to enter into "provisional arrangements of a practical nature", such as JDAs. Furthermore, they would be under an obligation not to take any unilateral actions which would jeopardise or hamper the reaching of a final agreement on the maritime boundaries. In other words, the unilateral claim by China would define the area of overlapping claims and establish a legal basis consistent with the LOSC for joint development in the area of overlapping claims. Another advantage for China if it followed this course of action is that the ASEAN Claimants would not have the option of invoking the compulsory procedures entailing binding decisions in section 2 of Part XV of the LOSC on the settlement of disputes.

The ASEAN Claimants would also benefit if China were to exercise this option. This is because it would clarify which areas of their EEZs were not subject to overlapping claims. They could then exercise their sovereign rights and jurisdiction in these areas without fear of any interference and without any prospect of their right to the natural resources in these areas of their EEZs being called into question.

If China defined its EEZ claim from the Paracel Islands, it would complicate its bilateral negotiations for defining its boundary with Vietnam. However, it would clarify the issues which China and Vietnam must address in this area. Clarifying the dimensions of areas of overlapping maritime claims involving the disputed islands represents an essential first step towards discussion on potential joint development areas. As illustrated by boundary delimitation and joint fishing arrangements between China and Vietnam in the Gulf of Tonkin, a solution may not be impossible.

The issues in the remaining areas in the other sectors in the South China Sea are far less complex. The Scarborough Shoal area is a territorial sovereignty dispute between China and the Philippines which could be set aside by provisional arrangements to jointly develop the fisheries resources in the waters in and surrounding the shoal. The area between the Philippines and Taiwan is a boundary delimitation dispute complicated by the role of Pratas Island, baselines issues and the legal status of Taiwan; however, it could be resolved through provisional arrangements between the three parties with respect to, for example, the joint development of the fisheries resources. The area off Indonesia's Natuna Island is such a distance from any disputed islands that the degree of overlapping claims is constrained and is arguably of limited interest to China. However, if an equidistance line were constructed between Indonesia's Natuna Islands and the largest islands in the Spratlys, some overlap would appear to exist, and this may have to be addressed. Nevertheless, a much higher priority for Indonesia will be to negotiate its EEZ boundary agreements with Vietnam and Malaysia in this area.

In summary, despite its limitations, the LOSC provides a legal framework which the Claimants could utilise if they have the political will and trust

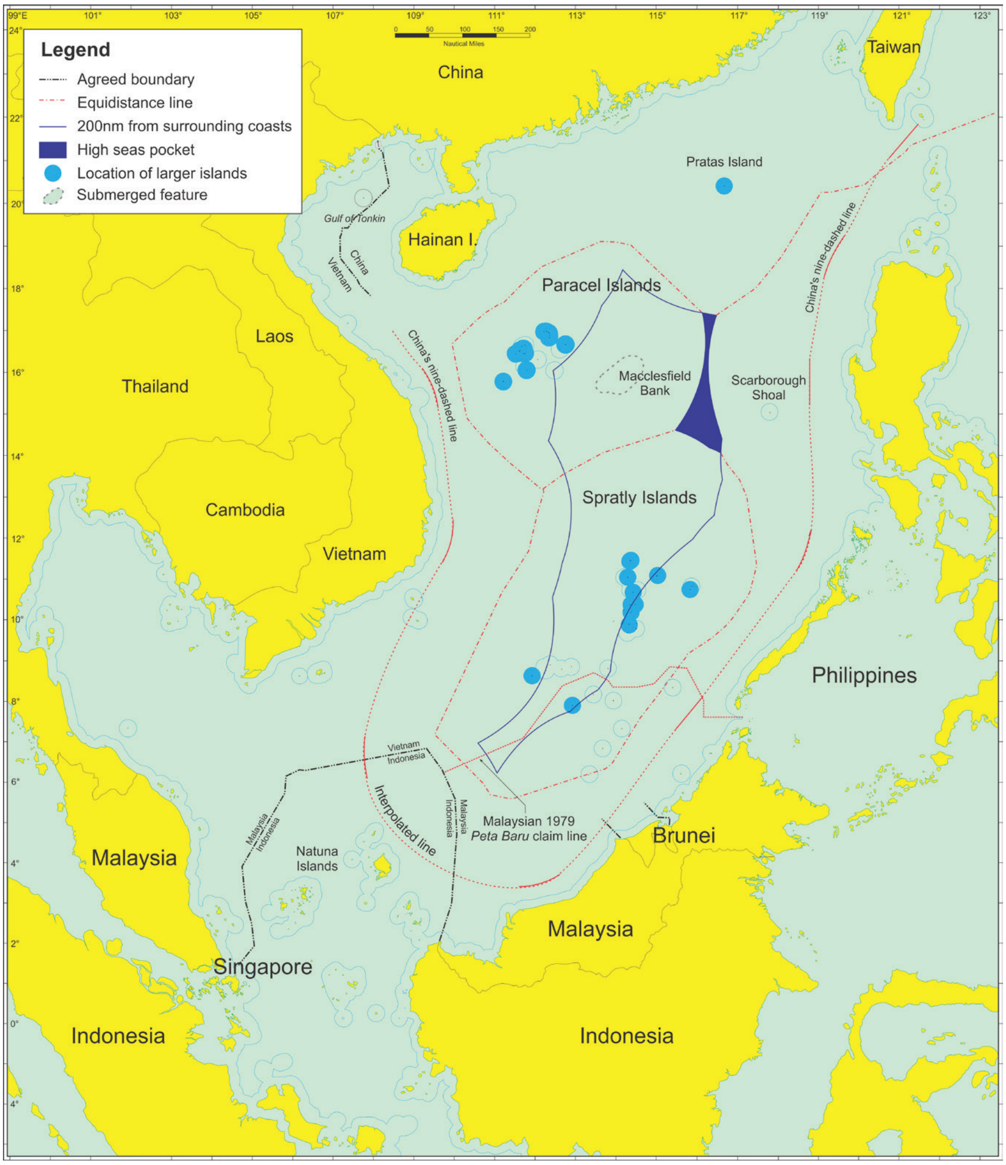

FIGURE 8 *Existing maritime claims and EEZ claim from largest islands (with equidistance lines) and 12-nm territorial sea arcs from rocks*

necessary to set aside the disputes on territorial sovereignty and maritime claims and begin serious negotiations on JDAs and other provisional arrangements of a practical nature in the areas of overlapping maritime claims. The LOSC also provides a framework whereby all of the Claimants, including China, can pursue their national interests in the South China Sea in a manner that is consistent with international law. The proposals advanced here offer an avenue whereby China's maritime claims can be brought into conformity with the LOSC at relatively limited cost but potentially substantial benefit to itself and to the other South China Sea Claimants. This would potentially provide a platform for constructive discussions on cooperation and joint development in the areas of overlapping claims defined on the basis of the LOSC, which would be to the benefit of all parties to the South China Sea disputes.

Appendix: Explanatory Note on Figures

Fig. 1 is a version of the map prepared by Clive Schofield and Andi Arsana of the Australian National Centre for Ocean Resources and Security (ANCORS) for the agora on the South China Sea in the American Journal of International Law (AJIL), Vol. 107, No. 1, January 2013, page 96. It was based on the map issued by the Geographer's Office of the U.S. Department of State in January 2010, No. 803425AI(G02257) 1–10. However, the authors determined that several features near Vanguard Bank which had 12-nm territorial sea arcs around them on the US map were in fact submerged. Therefore, these features were not included in the map for the AJIL. Subsequent analysis has led to the conclusion that other features are not above high-tide features and this is reflected in the other figures included in this article (see below).

Fig. 2 is adapted from Fig. 2.11 in Clive Schofield, 'Defining the "Boundary" between Land and Sea: Territorial Sea Baselines in the South China Sea', in S Jayakumar, Tommy Koh and Robert Beckman, eds, *The South China Sea Disputes and the Law of the Sea* (Edward Elgar Publishing, forthcoming, UK, 2014). It illustrates that the impact of straight baseline claims is significantly more pronounced with respect to "additional" areas of internal waters and territorial sea generated than in terms of expanding the limits of the EEZ.

Fig. 3 illustrates the effect if an EEZ were claimed from the largest islands in the South China Sea. In drawing hypothetical EEZ claims from the islands *in the direction of the open sea* in the central part of the South China Sea, the islands were given full effect by drawing 200-nm arcs from the islands. As indicated on the map, the result is that all of the South China Sea would be subject to EEZ claims, except for a relatively small high seas pocket in the north-eastern part of the South China Sea.

With respect to maritime spaces lying between the larger islands of the South China Sea and the surrounding mainland and main island coasts, overlapping maritime claims would result as there is predominantly less than 400 nm between them. Consequently, *in the direction of mainland coasts* of the States bordering the South China Sea, theoretical equidistance lines were constructed between the islands and the surrounding mainland and main island coasts. The reason for this is that even if the islands are in principle entitled to an EEZ of 200 nm, the maximum extent of the EEZ that could be accorded to the islands would be that within a strict equidistance line drawn between the islands and the mainland coast.

The 28 islands used for this exercise are 12 islands in the Spratly Islands group, 15 islands in the Paracel Islands group, and Pratas Island. These features were selected based on analysis of satellite imagery and information in the sailing directions issued by the United States and the United Kingdom and relevant literature.[119] Evidence suggests that these features meet the definition of an island in Article 121, that is, they are naturally formed areas of land surrounded by and above water at high tide. The islands that were selected are the largest and/or are vegetated. Therefore, it can be maintained that they are not "rocks which cannot sustain human habitation or economic life of its own that are not entitled to an EEZ and continental shelf. Accordingly, it can be argued that these features are capable, in principle, of generating an EEZ of their own".

The insular features in the Spratly Islands group used to construct theoretical equidistance lines and 200-nm arcs were as follows (from largest to smallest in estimated area): Itu Aba, Thitu Island, West York Island, Northeast Cay, Southwest Cay, Spratly Island, Namyit Island, Nansha(n) Island, Sand Cay, Loaita Island, Sin Cowe Island and Amboyna Cay.

The islands in the Paracel Islands group used for the same exercise were as follows: Woody Island and Rocky Islet, Lincoln Island, Triton Island, Pattle Island, Duncan Island, West Sand, Money Island, Robert Island, North Island, Drummond Island, Tree Island, South Island, Middle Island, Passuh Keah and South Sand. These features are the largest in the Paracel Islands group and all but West Sand appear to be vegetated. Given the relatively large size of West Sand, coupled with its connection to the reef on which Tree Island (which is vegetated) lies, West Sand was included as a basepoint for the purposes of the present exercise.[120] However, given its proximity to Tree Island, another of the larger Paracel Islands which is also vegetated, its influence on the theoretical equidistance line is minimal.

119 Hancox and Prescott (n 53); UKHO, *Admiralty Sailing Directions China Sea Pilot* (Volume 1, 8th ed., UKHO, Taunton, 2010) 75–78; Mark J. Valencia, Jon M. Van Dyke and Noel A. Ludwig, *Sharing the Resources of the South China Sea* (Martinus Nijhoff Publishers, Boston, 1997) 226–235; UKHO, *China Sea Pilot*, Vol. 2 (n 103), at pp. 64–73; and United States National Geospatial-Intelligence Agency, Sailing Directions (ENROUTE) PUB.161, *South China Sea and the Gulf of Thailand* (13th ed., National Geospatial-Intelligence Agency, Bethesda, 2011) 5–14.

120 The relevant British Admiralty Sailing Directions (Pilot) note that West Sand is a "sandy cay" located near the west end of the reef on which Tree Island lies. See UKHO, *China Sea Pilot*, Vol. 1 (n 119), at p. 77.

These features are annotated on Fig. 3. Also, note that for the purposes of this exercise, normal baselines were applied not only for the islands themselves, but also with respect to the surrounding mainland and main island coastlines.

Fig. 4 illustrates full, half and one-quarter weighting or effect accorded to the larger islands in the Spratly and Paracel Island groups identified in Fig. 3.

Figs. 5, 6 and 7 are larger-scale maps detailing maritime claims, including EEZ claims from larger islands, in the north-western, north-eastern and southern parts of the South China Sea. These maps, together with Figs. 8 and 9, illustrate the location of the larger islands of the Spratly Islands and Paracel Islands groups used for the construction of theoretical equidistance lines by showing shaded territorial sea areas around them. Unshaded 12-nm arcs are shown with respect to smaller features which may meet the definition of an island under the LOSC, but which in our view are too small and barren to be inhabitable and entitled to an EEZ of their own (see below). Unshaded 12-nm territorial sea limits are also shown around mainland and main island coasts.

Fig. 8 shows the hypothetical EEZ claims from the islands and the equidistance lines. As noted above, the islands used to generate the EEZ claims are shown with shaded 12-nm territorial sea circles around them, and unshaded 12-nm territorial sea arcs are shown around other features which may meet the definition of an island under the LOSC, but which were not used to claim an EEZ because they are too small and barren to be inhabitable and entitled to an EEZ of their own. The number of features in the latter category is very uncertain because past studies and past maps are not consistent. Although the 2010 US State Department map has 12-nm territorial sea arcs around more than 50 other features in the Spratly Islands, our analysis of the previous studies and sailing directions indicates that 34 of those features are either clearly below water at high tide or the sources are inconsistent as to whether they are above water at high tide. Consequently, we have adopted a consciously conservative approach and exercised prudence and caution, drawing 12-nm arcs only around the 16 small features (in addition to the 12 larger islands identified above) in the Spratly Islands, which the previous studies consistently refer to as being above water at high tide. For similar reasons, we have drawn 12-nm arcs around Scarborough Shoal as there is consistent evidence that 4–6 small rocks on the reef are above water at high tide.

The features which we identified as rocks entitled to a 12-nm territorial sea of their own include Scarborough Shoal, as well as the following 16 features in the Spratly Islands: Loaita Cay, Lankiam Cay, Sandy Cay, Collins Reef, Len Dao, Barque Canada Reef, Commodore Reef, Louisa Reef, Mariveles Reef, Pearson Reef, Royal Charlotte Reef, Swallow Reef, Central Reef, Cuarteron Reef, East Reef and West Reef. The following features in the Paracel Islands also meet this definition: Antelope Reef, Bombay Reef, Discovery Reef, Middle Sand, North Sand, Observation Bank, Pyramid Rock, Quanfu Dao and Vuladdore Reef.

These territorial sea limits associated with these features are shown on Fig. 8 and all features mentioned above are annotated on **Fig. 9** below. In light of the complex tidal regime of the South China Sea, coupled with uncertainties

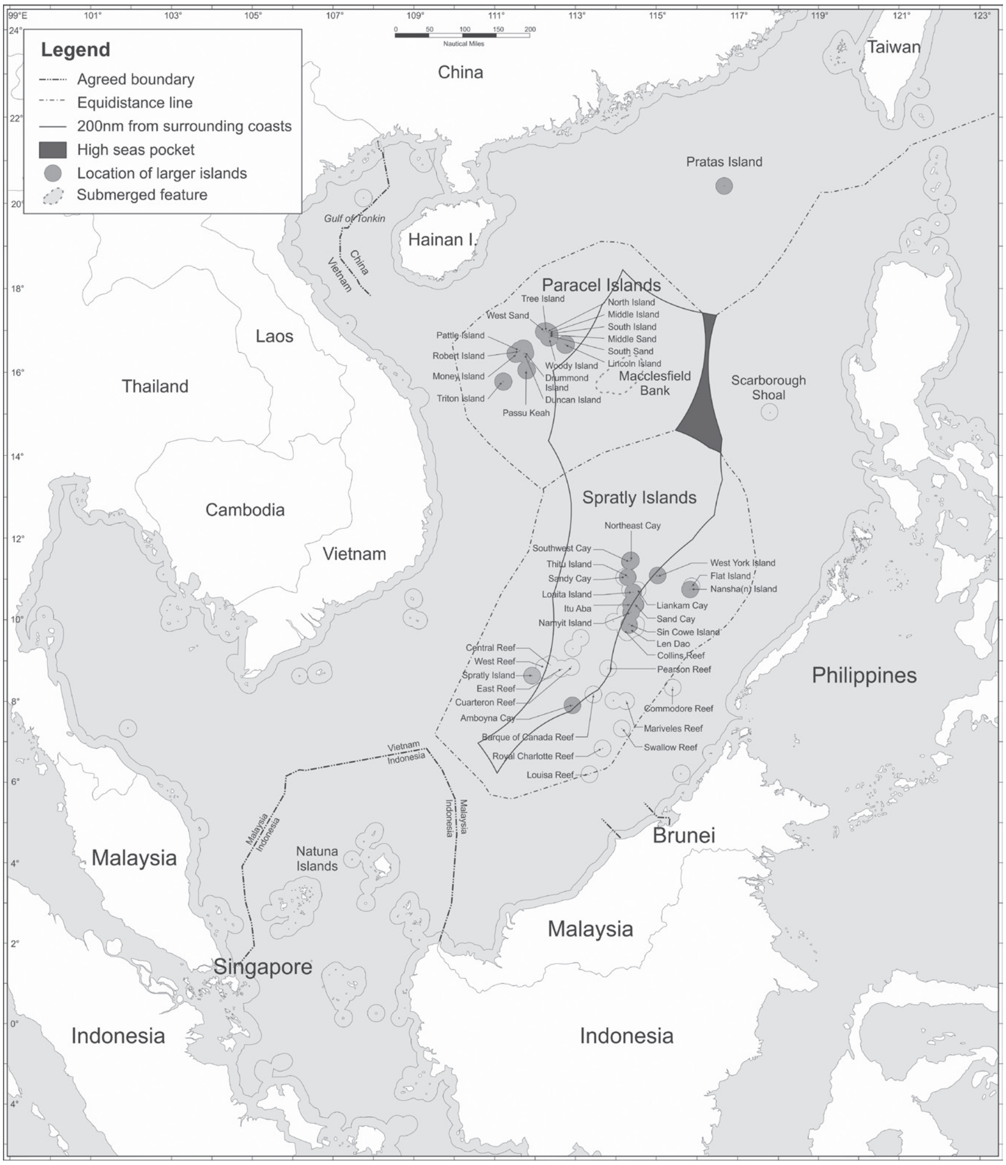

FIGURE 9 *Annotated map of South China Sea Islands*

and inconsistencies with respect to hydrographic surveying in the region, it is acknowledged that a number of additional very small features may exist in the Paracel and Spratly Islands which are, in fact, above the high water. Such features can most plausibly be categorised as 'rocks' within the meaning of Article 121(3) of the LOSC and therefore would be capable of generating 12-nm territorial sea limits.[121] However, even if such additional insular features do exist in the South China Sea, it is the authors' view that they would not qualify as islands capable of generating EEZ and continental shelf rights and therefore would not have a meaningful impact on the central arguments advanced in this article.

Fig. 8 also shows the nine-dashed line that is indicated on Chinese maps of the South China Sea. The dashes on the Chinese map are indicated in bold and are also connected by interpolated lines to illustrate what China's claim is if it claims rights and jurisdiction over all of the maritime space inside the nine-dashed line.[122] It should be noted that there is inherent uncertainty related to both the location of the nine-dashed line and the interpolated intervening lines shown "joining" the nine dashes up. No official coordinates of the dashed line have been published. The dashed line segments illustrated were extracted from a map attached in the Chinese note to the Secretary-General of the United Nations in its response to Malaysia-Vietnam's extended continental shelf submission and the intervening lines interpolated between them. This map therefore allows one to visualise the difference between the area inside the nine-dashed line and the area of overlapping claims that would result if an EEZ claim were made from the largest islands in the South China Sea.

121 In this context it is worth noting that, based on its past jurisprudence, the ICJ indicated in clear terms in 2012 that even the smallest island generates a 12-nm territorial sea. See *Territorial and Maritime Dispute* (*Nicaragua v. Colombia*) (n 57), at para. 37.

122 Communications Received with regard to the Joint Submission made by Malaysia and Viet Nam (n 22), China (7 May 2009).

Annex 834

Yann-huei Song, "Legal Status of Taiping Island under the United Nations Convention on the Law of the Sea: Taiwan's View", *Korean Journal of International and Comparative Law*, Vol. 3, No. 2 (2015)

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Legal Status of Taiping Island under the United Nations Convention on the Law of the Sea

Taiwan's View

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Abstract

The government of the Philippines argues in the South China Sea arbitration case that all features in the Spratly archipelago are incapable of sustaining human habitation or economic life of their own. Even the largest feature in the Spratlys, that is, Taiping Island (Itu Aba), is a "rock" and accordingly, cannot generate maritime entitlement to a 200 nautical mile Exclusive Economic Zone (EEZ) under UNCLOS.

Is Taiping Island an "island" or a "rock" under the UNCLOS? Is Taiping Island capable of sustaining human habitation or economic life of its own? Is Taiping Island entitled to generate a 200-nm EEZ or a continental shelf? The purpose of this article is to answer these questions from the perspective of Taiwan. It is Taiwan's position that Taiping Island is "a full-fledged island" and therefore can generate a 200-nm EEZ in accordance with Article 121 of UNCLOS.

Keywords

Taiping Island – Taiwan – Article 121 – UNCLOS – arbitration – South China Sea

I Introduction

In its memorial[1] and supplemental information[2] submitted to the arbitral tribunal constituted under Annex VII to the 1982 United Nation Convention on

1 The Memorial consists of eleven volumes (4,000 pages), which have not yet been made available to the public.

 | DOI 10.1163/22134484-12340055

the Law of the Sea (hereinafter "UNCLOS" or "the Convention")[3] between The Republic of the Philippines (Applicant) and The People's Republic of China (Respondent) [hereinafter "the South China Sea Arbitration Case"][4] on March 30, 2014 and March 16, 2015, respectively, the Philippines argue that all features in the Spratly archipelago are incapable of sustaining human habitation or economic life of their own. Even the largest feature in the Spratlys – Taiping Island (Itu Aba) – is a "rock." Accordingly, Taiping Island cannot generate maritime entitlement to a 200 nautical miles ("nm") Exclusive Economic Zone ("EEZ") or a continental shelf under UNCLOS.

The Philippines' claim is based on the following arguments: (1) Taiping Island is a very small atoll consisting of a tropical reef covered with sandy coral and shell that covers a mere 0.43 km^2; (2) the island has no permanent civilian population; (3) the wells on the island contain chloride salts, and the underground water is salty and unusable for drinking; (4) although the island is partially covered by scrub brush and trees, its soil is poor and no meaningful amount of agricultural produce is cultivated on the feature; (5) general goods are shipped from outside regularly by civil merchantmen, and without this outside support, the island would be incapable of supporting the small human community that Taiwan maintains there; and (6) neither the military nor the civilian personnel on the island are engaged in activities of production, distribution or exchange in a manner that can sustain the existence and development of stable habitation.[5] These arguments were reiterated by Professor Philippe Sands, one of the Philippines' counsels for the South China Sea Arbitration Case, at a hearing on jurisdiction and admissibility that was held at the Permanent Court

2 The supplemental information consists of twelve volumes (3,000 pages). This information has also not yet been made available to the public.

3 United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 3, *reprinted in* 21 I.L.M. 1262 (1982) and *The Law of the Sea: Official Texts of the United Nations Convention on the Law of the Sea and of the Agreements relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea with Index and excerpts from the Final Act of the Third United Nations Conference on the Law of the Sea*, U.N. Sales No. E.97.V.10 (2001). As of Jan. 7, 2015, the Convention had 167 parties. *See* U.N. Division for Ocean Affairs and Law of the Sea, Chronological lists of ratifications of, accessions and successions to the Convention, *available at* http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm# The United Nations Convention on the Law of the Sea (last updated January 7, 2015).

4 For an introduction to the case, visit the official website of the Permanent Court of Arbitration at http://www.pca-cpa.org/showpage65f2.html?pag_id=1529 (last visited July 25, 2015).

5 *See* Arbitration under Annex VII of the United Nations Convention on the Law of the Sea (Republic of the Philippines v. People's Republic of China), Memorial of the Philippines, Vol. I, Mar. 30, 2014, paras. 5.96–5.97 (on file with author).

of Arbitration ("PCA"), Peace Palace, The Hague, the Netherlands on July 7, 2015. The counsel stated that Taiping Island "is similar in nature to Colombia's Serrana Cay" and that in the *Niaragua v. Colombia* case,[6] the international court granted Serrana Cay no more than a 12-nm territorial sea.[7]

Is Taiping Island an "island" or a "rock" under UNCLOS? Is Taiping Island capable of sustaining human habitation or economic life of its own? Is Taiping Island entitled the right to generate a 200-nm EEZ or a continental shelf? Is the Philippines' argument well founded in fact and law? The purpose of this article is to answer these questions in particular from Taiwan's view on the said land feature. Following brief introductory remarks, Part II of this article provides information about Taiping Island and discusses recent development work conducted by the Republic of China (hereinafter "ROC" or "Taiwan") on Taiping Island. This is followed by an examination of Article 121 of UNCLOS and its application to Taiping Island for the purpose of clarifying its legal status in Part III. Part IV addresses the issue concerning the legal status of Taiping Island in the South China Sea arbitration case. Part V discusses Taiwan's response to the arbitral case, focusing in particular on those actions taken to defend its position that Taiping Island is indeed an "island" under Article 121 of the Convention. The article ends with brief remarks in Part VI.

II Information about Taiping Island and Taiwan's Development Work

Taiping Island, known in English as Itu Aba Island, in Chinese as Tàipíng Dǎo (literally: "peace island"), in Tagalog as Ligao, and in Vietnamese as Đảo Ba Bình, is the largest of the naturally occurring Spratly Islands in the South China Sea.[8]

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6 Territorial and Maritime Dispute (Nicaragua v. Colombia), Counter Memorial of the Republic of Colombia, Vol. I (Nov. 11, 2008), *available at* http://www.icj-cij.org/docket/files/124/16969.pdf (last visited July 25, 2015).

7 *See* Final Transcript Day 1, Hearing on Jurisdiction and Admissibility, Between the Republic of the Philippines and the People's Republic of China, at 88, *available at* http://www.pcacases.com/web/sendAttach/1399 (last visited Sept. 4, 2015).

8 Monique Chemillier-Gerndreau, *Sovereignty over the Paracel and Spratly Islands* 20-21, 43-44, 116, 126, 131-132, 165, 207, 225, 250 (Kluwer Law International, 2000), *available at* https://www.free-ebooks.net/ebook/Sovereignty-over-the-Paracel-and-Spratly-Islands (last visited Oct. 18, 2015); Kwang-Tsao Shao & Hsing-Juh Lin (Eds.), *A Frontier in the South China Sea: Biodiversity of Taiping Island, Nansha Islands* (Construction and Planning Agency, Ministry of the Interior, 2014); GEOGRAPHICAL NAMES, TAIPING DAO: SPRATLY ISLANDS, http://www.geographic.org/geographic_names/name.php?uni=-1912246&fid=4587&c=spratly_islands

Taiping Island is named in honor of a Nationalist Chinese Navy warship – the ROCS *Taiping*, which sailed to the island on December 12, 1946 after the end of World War II. Under Article 2(f) of the 1951 San Francisco Treaty of Peace with Japan[9] and Article 2 of the 1952 Treaty of Peace between the Republic of China and Japan,[10] Japan renounced all rights, titles and claims to the Spratly Islands and to the Paracel Islands in the South China Sea. Between June and September 1956, the Republic of China Navy dispatched the naval task forces *Li-Wei*, *Wei-Yuan*, and *Ning-Yuan* to conduct three separate patrols in the Spratly area.[11] On June 7, 1956, sovereignty markers were erected on Taiping Island.[12] Since 1956, the island has continuously been administered by the Republic of China (Taiwan). Since February 1990, Taiping Island has been incorporated into the administration of Qijin District, Kaohsiung City of Taiwan.[13]

Information about Taiping Island's geographical situation, flora and fauna, potential economic resources, facilities in support of human habitation and

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(last visited July 25, 2015). For a satellite view, visit TAIPING DAO, SPRATLY ISLANDS, SATELLITE VIEWS NET, http://www.satelliteviews.net/cgi-bin/w.cgi?c=pg&UF=-1322892&UN=-1912246&DG=ISL (last visited July 25, 2015). *See also*, Ministry of Foreign Affairs, Republic of China (Taiwan), *Our Island: The Atlas of Taiping Island of the Republic of China (Taiwan), Vol. 1*, http://www.mofa.gov.tw/UplOad/RelFile/661/150648/a1fe8e7f-aeeb-4953-8921-ef2607294072.pdf. For more video clips and photographs courtesy of the ROC Ministry of the Interior, Ministry of National Defense, Ministry of Economic Affairs, Coast Guard Administration, Public Television Service, and TJ Kuo Underwater Imagery, July 7, 2015, see https://www.youtube.com/watch?v=faPvJ_ioHtQ (in Chinese) (last visited Oct. 18, 2015).

9 Treaty of Peace with Japan, Sept. 8, 1951, 1356 U.N.T.S. 45, *available at* http://www.taiwandocuments.org/sanfrancisco01.htm (last visited July 25, 2015). Neither the Republic of China ("ROC") nor the People's Republic of China ("PRC") was invited to the San Francisco Peace Conference, and neither was a party to the San Francisco Treaty. The Republic of China concluded a separate Treaty of Peace with Japan in 1952.

10 Treaty of Peace Between the Republic of China and Japan, Apr. 28, 1952, 138 U.N.T.S. 38, *available at* http://www.taiwandocuments.org/taipei01.htm (last visited July 25, 2015).

11 Chung-ping Chen & Guan-long Lun, *Study on Military Secure National Sovereignty in South China Sea – In Case of Li-wai, Wai-Yan and Nin-Yan Naval Task Forces*, 65 Whampoa – An Interdisciplinary Journal 185–200, 188 (2013), *available at* http://www2.cma.edu.tw/u_edu/journal/ (click on the fourth item in the menu options; then follow the link to "第 六十五期 Vol. 65") (in Chinese) (last visited Sept. 4, 2015). This study is based on the ROC Ministry of Defense's Nationalist Army Archives No. 541.5/4022.

12 *Id.*

13 *See* Ministry of Foreign Affairs, Republic of China (Taiwan), *Statement on the South China Sea*, No. 001, July 7, 2015, *available at* http://www.mofa.gov.tw/en/News_Content.aspx?n=1EADDCFD4C6EC567&s=EDEBCA08C7F51C98 (last visited Sept. 4, 2015).

economic activities can be found in the atlas and video clips that are made available to the public by the ROC Ministry of Foreign Affairs at its official website.[14] The information aims to support Taiwan's view that under UNCLOS, Taiping Island is an "island" not a "rock," and that therefore under Article 121 of the Convention, it has the right to generate a 200-nm EEZ.

At present, the total population of Taiping Island is close to 200 with no civilians. All of the people living on Taiping Island are from Taiwan's Coast Guard Administration and a number of soldiers from the Navy and Air Force, who are stationed there for safeguarding sovereignty, national defense, security, environmental protection, law enforcement, and other purposes. These stationed personnel have been cultivating vegetables and fruits (mostly papaya, coconut, and some wax apple) and rearing livestock. In the past, sand paintings were made by the stationed personnel as gifts for visitors or for sale. Later it was banned because of environmental concern over sand beach loss.

Since 2011, Taiping Island has become an attractive visiting site for college students, teachers and researchers who apply to participate in a study camp organized by Taiwan's Ministry of National Defense to enhance awareness among young people on the importance of maritime strategy and security in the South China Sea.[15] Between May and July 2015, three rounds of the *Nansha* study camp were held.[16] It is not clear if the new administration after Taiwan's 2016 presidential election will decide to invite college students and scholars to visit Taiping Island under the name of the *Nansha* Study Camp.

On February 7, 2014, Taiwan began development work on Taiping Island. This development project comes in two parts and includes the construction of two new piers and improvements to the 1200-meter long runway built in 2008.[17] The project also includes a 212 meter long access road, navigation guidance and other auxiliary facilities, rain water drainage improvement, landing light

14 *See* Our Island: The Atlas of Taiping Island of the Republic of China (Taiwan), and additional video clips and photographs, *supra* note 8.

15 Elaine Ho, *Ma hails National Taiwan Ocean University's Nansha visit*, TAIWAN TODAY, July 19, 2011, *available at* http://taiwantoday.tw/ct.asp?xItem=171887&ctNode=420 (last visited Sept. 4, 2015).

16 *See* Ministry of National Defense, ROC, *Scholars Visited Taiping Island to Witness Results of Economic Strategy and Recognize Organization of Camp*, July 23, 2015, https://www.mnd.gov.tw/english/Publish.aspx?cnid=436&p=66390 (last visited Sept. 4, 2015).

17 The Beginning of Transportation Basic Repairing and Improving Works on Spratly Taiping Island, Mar. 2014, Taiwan Area National Freeway Bureau, MOTC, http://www.freeway.gov.tw/Upload/Html/201431387/page01.html (in Chinese) (last visited July 25, 2015).

repairs, and a refueling facility. In December 2014, it was also reported that a lighthouse is to be built on the island.[18]

The Taiping development project was announced by President Ma Ying-jeou in early September 2012. The Taiwan Area National Expressway Engineering Bureau under the Ministry of Transportation is responsible for the project, which will cost NT$3.3 billion (around US$ 110 million) and is required by contract to be completed by the end of 2015.[19] The watertight chambers needed for constructing the piers were completed in Taiwan's Tainan City in early November 2014. Because the contractor for the project could not find a Taiwanese ship able to transport the caissons, it turned to Shanghai Zhenhua Port Machinery Company, a Chinese state-run company, for help. The plan to use the company's vessel *Zhenhua 7* worried some Taiwanese legislators, in particular those from the opposition Democratic Progressive Party (DPP), due to national security concerns.

Zhenhua 7 is a flag-of-convenience (FOC) ship and is registered in Libya. Because the vessel is owned by a Chinese state-run company, with Chinese crew members, however, it raised questions concerning the interpretation and application of Taiwan's Act Governing Relations between the People of the Taiwan Area and the Mainland Area.[20] Under the Act, no Chinese vessels may enter restricted or prohibited waters in Taiwan's territory unless permitted by the relevant authorities. The prohibited waters are 4,000 meters seaward measured from Taiping Island's coast and the restricted waters are 6,000 meters from the coast.

The development work at Taiping Island was brought to a halt between November 2014 and the first half of January 2015, because of these national security concerns. After consultations between the concerned legislators and

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18 *Lighthouse to be Built on Itu Aba Island*, LIBETY TIMES NET, Dec. 21, 2014, *available at* http://news.ltn.com.tw/news/focus/breakingnews/1186385 (last visited July 25, 2015).

19 *Introduction to Transportation Basic Repairing and Improving Works on Spratly Taiping Island* (*Part I*), June 2014, Taiwan Area National Freeway Bureau, MOTC, http://www.freeway.gov.tw/Upload/Html/201461994/page03.html (in Chinese) (last visited July 25,2015); *Introduction to Transportation Basic Repairing and Improving Works on Spratly Taiping Island* (*Part II*), July 2014, Taiwan Area National Freeway Bureau, MOTC, http://www.freeway.gov.tw/Upload/Html/201471595/page03.html (in Chinese) (last visited July 25, 2015).

20 The Act Governing Relations between People of the Taiwan Area and Mainland Area was promulgated on July 31, 1992. It was enacted in accordance with Article 10 of the Amendment to the ROC Constitution that was promulgated on May 1, 1991. For an English translation of the text, visit the website of the Mainland Affairs Council, Republic of China (Taiwan), at http://www.mac.gov.tw/ct.asp?xItem=90541&ctNode=5914&mp=3 (last visited July 25, 2015).

the government agencies, permission was given for the *Zhenhua 7* to complete its transport, but with a number of attached conditions, including inspections on board and monitoring by Taiwan's Coast Guard vessels during the entire shipping process. The vessel arrived at Taiping Island on January 25. After unloading the caissons, it left on January 28. It was reported in June 2015 that the development work on Taiping Island for new piers should be completed in October 2015.[21]

The construction of piers and reinforced runways are considered useful in support of Taiwan's argument that Taiping Island is an island that can generate a 200-nm EEZ and continental shelf in accordance with Article 121 of UNCLOS. This position is relevant to the ongoing legal arbitration between Manila and Beijing. Part IV will discuss the role played by Taiping Island in the South China Sea arbitration case and Taiwan's response to the arbitral proceedings. Before proceeding to that discussion, Part III examines the application of Article 121 of UNCLOS to Taiping Island.

III Article 121 of UNCLOS and Legal Status of Taiping Island

Article 121 has the following three paragraphs:

1. An island is a naturally formed area of land, surrounded by water, which is above water at high tide.
2. Except as provided for in paragraph 3, the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf of an island are determined in accordance with the provisions of this Convention applicable to other land territory.
3. Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf.[22]

This article includes two categories of islands: (1) the islands that are capable of sustaining human habitation or economic life of their own, and therefore, just like other land territory, can have territorial sea, contiguous zone, EEZ, and continental shelf; and (2) the islands that are incapable of sustaining human habitation or economic life of their own, and therefore are treated as "rocks."

21 *Taiwanese Officials: New Piers Construction Work on Spratly Taiping Island Could Complete Sooner by October*, CHINA NEWS SERVICE, June 30, 2015, *available at* http://big5.chinanews.com/tw/2015/06-30/7374225.shtml (in Chinese) (last visited July 25, 2015).

22 *Supra* note 3, art. 121.

The islands belonging to the second category have no right to generate an EEZ or continental shelf, but they can have a territorial sea and contiguous zone. The land feature that is able to sustain human habitation or has an economic life of its own and can generate an EEZ or continental shelf has been called a "full-fledged island" by Ashley Roach.[23]

How should Article 121, in particular its third paragraph, be interpreted and applied to Taiping Island? According to Jon M. Van Dyke and Robert A. Brooks, it should be interpreted according to Article 31 of the 1969 Vienna Convention on the Law of Treaties,[24] which provides that "[a] treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose."[25] Because the purposes for establishing coastal EEZs cannot justify claims to EEZs around uninhabited islands situated far away from their coasts, Van Dyke and Brooks have argued that it is not consistent with the main purpose of adopting UNCLOS for remote rocks or reefs to generate extended maritime zones. Accordingly, only if stable communities of people live on the island and use the surrounding ocean areas, can islands generate ocean space, such as an EEZ or a continental shelf.[26] Van Dyke and Dale Bennett have argued that from a historical perspective, if a rock or reef cannot sustain human habitation permanently for at least fifty people, it cannot claim an EEZ or continental shelf.[27] Other international legal scholars, including Northcut Ely,[28] Arvid Pardo,[29]

23 J. Ashley Roach, *China's Shifting Sands in the Spratlys*, 19(15) ASIL Insights (July 15, 2015), http://www.asil.org/insights/volume/19/issue/15/chinas-shifting-sands-spratlys (last visited July 26, 2015).

24 Jon M. Van Dyke & Robert A. Brooks, *Uninhabited Islands: Their Impact on the Ownership of the Oceans' Resources*, 12 Ocean Development & Int'l Law 265, 286 (1983).

25 The Vienna Convention on the Law of Treaties, May 23, 1969, 1155 U.N.T.S. 331.

26 Van Dyke & Brooks, *supra* note 24, at 286.

27 Jon Van Dyke & Dale Bennett, *Islands and the Delimitation of Ocean Space in the South China Sea*, 10 Ocean Yearbook 54, 79 (1993).

28 Ely stated that "If an island is too small or insignificant to have attracted its owner's national resources, in terms of population and investments, it is too small to serve as a baseline." Van Dyke & Brooks, *supra* note 24, at 286 (citing Northcut Ely, *Seabed Boundaries Between Coastal States: The Effect to be Given Islets as 'Special Circumstances'*, 6 Int'l Lawyer 219–236 (1972)).

29 Ambassador Pardo argued that the "equity and reasonableness" that justify the allocation of ocean resources to a coastal state simply do not apply where "no population exists." Van Dyke & Brooks, *supra* note 24 (citing Arvid Pardo, *An International Regime for the Deep Sea-Bed: Developing Law or Developing Anarchy*? 5 Texas Int'l Law Forum 204–217 (1970)).

B. Gidel,[30] and Robert D. Hodgson[31] have expressed similar views. There is no doubt that Taiping Island is capable of sustaining human habitation permanently for more than 150 people.

Jonathan I. Charney advocated a broader interpretation of whether rocks have rights to EEZs or continental shelves under Article 121(3).[32] He argued that a rock or reef is a kind of island, and that Article 121(3) would not be needed in the Convention if they were not. Article 121(3) uses "or" between "human habitation" and "economic life of their own," and therefore it is only necessary to prove that an island or rock can sustain human habitation or economic activity of its own to be able to claim an EEZ or continental shelf.[33]

After examining the *travaux preparatoires* of UNCLOS III,[34] Charney reasoned that the habitation referred to in Article 121(3) need not be permanent nature, and the economic activity need not be capable of sustaining a person throughout the year. The economic activity could include industry or exploration of the living or mineral resources in the territorial sea of the island or rock.[35] Charney was of the opinion that this economic activity can be a future condition based on future technological advances.

Charney suggested that a feature is not subject to Article 121(3) if it has mineral resources such as oil or gas, or other resources such as a newly harvestable fishery, or was the location for a profitable business such as a casino, which could sustain an economy sufficient to support that activity through the

30 Gibel tried to define "habitability" more precisely than others had by stating that to be an "island" a land formation had to have "natural conditions" that permitted a "stable residence of organized groups of human beings." Van Dyke & Brooks, *supra* note 24, at 287 (citing B. Gidel, 3 *Le Droit International Publication de la Mer* 684 (1934)).

31 Hodgson stated specifically that the word "rocks" in Article 121(3) should be defined in terms of whether a land formation is habitable. Van Dyke & Brooks, *supra* note 24 (citing Robert D. Hodgson, *Islands, Normal and Special Circumstances*, in John King Gamble, Jr. & Giulio Pontecorve (Eds.), *Law of the Sea: The Emerging Regime of the Oceans* (1974); and Robert D. Hodgson & Robert W. Smith, *The Informal Single Negotiation Text (Committee II): A Geographical Perspective*, 12 Ocean Development & Int'l Law 225 (1976)).

32 Jonathan I. Charney, *Note and Comment: Rocks That Cannot Sustain Human Habitation*, 93 American Journal of Int'l Law 868 (1999).

33 *Id.*

34 However it was argued that *travaux preparatoires* of UNCLOS III does not exist. John E. Noyes cited the conversation between John Nortom Moore and Myron H. Nordquist about the absence of a *travaux preparatoires* in his article 'Memorializing UNCLOS III, Interpreting the Law of the Sea Convention, and the Virginia Commentary', in Michael W. Lodge & Myron H. Nordquist (Eds.), *Peaceful Order in the World's Oceans: Essays in Honor of Satya N. Nandan* 218 (Brill/Nijhoff, 2014).

35 Jonathan I. Charney, *supra* note 32, at 869.

purchase of necessities from external sources. He maintained that Article 121(3) should be interpreted as permitting a finding of an economic life as long as the feature could generate revenues sufficient to purchase the missing necessities. Charney concluded that changes in circumstances might help features such as reefs or rocks that are subject to the application of Article 121(3) to obtain the legal status of an island and therefore have the right to generate EEZs and continental shelves.[36]

Jonathan L. Hafetz argued that marine conservation constitutes an economic use within the meaning of Article 121(3), as conservation activities bring net economic benefits and sustainable development through the establishment of marine protected areas ("MPAs"):

> A State that establishes a marine park or protected area around a pristine coral reef should not be penalized by being forced to forego the expansion of its maritime jurisdiction that it would likely have gained from pursuing a more traditional form of economic development. Instead such States should be given an incentive to preserve the marine environment where such preservation is also economically beneficial and thus consistent with the "economic life" criterion of Article 121(3).[37]

Although the number of the features located in the Spratly archipelago and qualified as islands under Article 121 of the UNCLOS varies, Mark J. Valencia, Jon M. Van Dyke, and Noel A. Ludwig suggest that between 25 and 35 of the 80–90 distinct features in the Spratly area are above water at high tide, and therefore they qualify as "islands" under Article 121.[38] Taiping Island is the largest among these land features. Based on a number of writings on the Spratly Islands, Gregory B. Poling suggests that there are 30 features in the Spratly archipelago that are classified as "islands" which include Taiping Island, Cuarteron Reef, Fiery Cross Reef, Gaven Reef, Johnson South Reef, Thitu Island, and West York Island.[39]

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36 *Id.* at 876.

37 Jonathan L. Hafetz, *Fostering Protection of the Marine Environment and Economic Development: Article 121(3) of the Third Law of the Sea Convention*, 15 American University Int'l Law Review 583, 626–27 (2000).

38 Mark J. Valencia, Jon M. Van Dyke & Noel A. Ludwig, *Sharing the Resources of the South China Sea* 41 (University of Hawaii Press, 1999).

39 Gregory B. Poling, *The South China Sea in Focus: Clarifying the Limits of Maritime Dispute*, CSIS, at 28, http://csis.org/files/publication/130717_Poling_SouthChinaSea_Web.pdf (last visited July 31, 2015).

Robert Beckman and Clive H. Schofield suggest that because they all have vegetation, and in some cases roads and structures that have been built on them, the following features, from largest to smallest in the estimated area of the Spratlys, are "islands" and therefore entitled to an EEZ and continental shelf under UNCLOS: Taiping Island, Thitu Island, West York Island, Northeast Cay, Southwest Cay, Spratly Island, Namyit Island, Nansha(n) Island, Sand Cay, Loaita Island, Sin Cowe Island, and Amboyna Cay.[40] In January 2010, the U.S. government released a South China Sea Map and Gazetteer, in which Taiping Island, along with other smaller features, are labelled as "islands." More recently, BBC correspondent Bill Hayton wrote in his book, entitled *The South China Sea: The Struggle for Power in Asia*, that Taiping Island is "clearly able to support at least minimal human habitation."[41]

Based on the writings of highly qualified scholars in the field of the law of the sea, it can be argued that Taiping Island is not considered a "rock" as referred to in paragraph 3 of Article 121 of the Convention and therefore it is possible for the island to claim a 200-nm EEZ or continental shelf.

IV Taiping Island and the South China Sea Arbitration Case

In the Notification and Statement of Claims, submitted to the Chinese Embassy in Manila by the Philippines' Department of Foreign Affairs on January 22, 2013, the government of the Philippines claims that Mischief Reef, McKennan Reef, Gaven Reef, and Subi Reef are submerged features that are not above sea level at high tide and therefore are not islands under UNCLOS.[42] In addition, Scarborough Shoal, Johnson Reef, Cuarteron Reef, and Fiery Cross Reef are submerged features that are below sea level at high tide, except that each has small protrusions that remain above water at high tide, which qualify as "rocks" under Article 121, paragraph 3 of the Convention, and can therefore generate no more than a 12-nm territorial sea.[43] These land features are occupied by the PRC. Although the Philippines adopts a "One China" Policy which

40 Robert C. Beckman & Clive H. Schofield, *Defining EEZ Claims from Islands: A Potential South China Sea Change*, 29 Int'l Journal of Marine & Coastal Law 193, 210 (2014).

41 Bill Hayton, *The South China Sea: The Struggle for Power in Asia* 111 (Yale University Press, 2014).

42 Republic of the Philippines, Dep't of Foreign Affairs, *Notification and Statement of Claims*, para. 31, Jan. 22, 2013, *available at* http://dfa.gov.ph/newsroom/unclos/216-sfa-statement-on-the-unclos-arbitral-proceedings-against-china (last visited July 31, 2015).

43 *Id.*

considers Taiwan a province of the PRC, Taiping Island is not included in the list of the Philippines' claims.

In March 2014, the Philippines submitted its Memorial to the Arbitral Tribunal, in which the Philippines requested the Tribunal to adjudge and declare, *inter alia*, that

- Scarborough Shoal generates no entitlement to an exclusive economic zone or continental shelf;
- Mischief Reef, Second Thomas Shoal and Subi Reef are low-tide elevation that do not generate entitlement to a territorial sea, exclusive economic exclusive zone or continental shelf, and are not features that are capable of appropriation by occupation or otherwise;
- Gaven Reef and McKennan Reef (including Hughes Reef) are low-tide elevations that do not generate entitlement to a territorial sea, exclusive economic exclusive zone or continental shelf, but their low-water line may be used to determine the baseline from which the breadth of the territorial sea of Namyit and Sin Cowe, respectively, is measured;
- Johnson Reef, Cuarteron Reef and Fiery Cross Reef generate no entitlement to an exclusive economic zone or continental shelf.[44]

Again, there is no mention of the legal status of Taiping Island and its right to generate what type of maritime zone in the Philippines' submissions. However, the island is indeed included in the legal arguments made by the Philippines in its memorial that was submitted to the Arbitral Tribunal on March 30, 2014.

The Philippines argues that the three largest features in the southern sector of the South China Sea, namely Itu Aba (Taiping Island), Thitu Island (known in the Philippines as *Pagasa* and in China as *Zongye Dao*) and West York Island (known in the Philippines as *Likas* and in China as *Xiyue Dao*) "differ from Scarborough Shoal, Johnson Reef, Cuarteron Reef and Fiery Cross Reef in terms of their areas, natural conditions and small population. But these differences are too minor to elevate such small, insignificant and remote features to the status of true islands that, based on their own natural elements and without material support from the mainland, can sustain human habitation and economic life of their own."[45] The Philippines argues that none of the three land features is capable of doing so.

The issue concerning whether to include Taiping Island in the legal arguments contained in the Philippines' Memorial gave rise to an internal debate

44 *Supra* note 5, at 271.

45 *Supra* note 5, para. 5.102, at 145.

over the legal strategy of the Philippines in the South China Sea arbitration case and figured in a controversy involving the appointment of Solicitor General Francis Jardeleza to the country's Supreme Court.[46] The Solicitor General was accused of treason or disloyalty for omitting Taiping Island in the Memorial.[47] Since the Philippines adopts a One-China policy which considers Taiwan a part of China, and that Taiping Island has been under Taiwan's control since 1956, it is argued that this island should be included in the Memorial. However, the Solicitor General directed the Philippines' international lawyer in The Hague to delete 14 paragraphs discussing Taiping Island from the Memorial to be submitted to the Arbitral Tribunal on March 30, 2014. In response to this instruction, on March 19, 2014, the two counsels in the Philippines' legal team, Paul Reichler and Lawrence Martin, sent a memo to the Philippine Foreign Secretary Albert del Rosario, informing him that removing Taiping Island from the claim would damage the Philippines' case. In the end, after a discussion of the issue between the Philippines' legal team, the Foreign Secretary, and President Aquino III, the President ordered the deletions of the Taiping Island-related paragraphs to be restored.[48] As a result, although Taiping Island is not included in the 15 submissions in the Memorial, its legal status as an island is challenged by the Philippines in the case.

The Philippines argues that Taiping Island is a not an "island" but a "rock" in accordance with Article 121(3) and therefore cannot generate entitlements to an EEZ or a continental shelf under UNCLOS. According to Senior Associate Justice Antonio T. Carpio of the Philippines, if the Arbitral Tribunal accepts this argument, it will declare that Palawan has a full 200-nm EEZ facing the South China Sea, which means that "all submerged features within this EEZ, like the Reed Bank and Malampaya, are subject to exclusive economic exploitation by the Philippines in term[s] of fisheries, oil and gas, and mineral resources."[49] In addition, if the Philippines has a full 200-nm EEZ in Palawan

46 Ellen T. Tordesillas, *Justice Carpio Explains Itu Aba Issue in the PH Suit vs China*, ABS-CBN NEWS.COM, Feb. 9, 2015, *available at* http://www.abs-cbnnews.com/blogs/opinions/02/08/15/justice-carpio-explains-itu-aba-issue-ph-suit-vs-china (last visited July 27, 2015)

47 Aries C. Rufo & Chay F. Hofilena, *The Inside story: Jardeleza Accused of Disloyalty to PH*, RAPPLER.COM, Aug. 19, 2014, *available at* http://www.rappler.com/newsbreak/66685-inside-story-jardeleza-disloyalty (last visited July 27, 2015).

48 Nikko Dizon, *'Integrity issue' vs SolGen: Legal Strategy or Disloyalty to Country?* PHILLIPINE DAILY INQUIRER, Aug. 20, 2014, *available at* http://globalnation.inquirer.net/109598/sol-gen-jardeleza-questioned-by-jbc-on-handling-of-phs-spratlys-claim (last visited July 27, 2015).

49 Ellen T. Tordesillas, *supra* note 46.

facing the South China Sea, "only the Philippines can create artificial islands on submerged areas or erect structures on [low-tide elevations] within its 200 NM EEZ," he said.[50]

On December 7, 2014, the PRC Ministry of Foreign Affairs issued a "Position Paper of the Government of the People's Republic of China on the Matter of Jurisdiction in the South China Sea Arbitration Initiated by the Republic of the Philippines," in which *inter alia* Beijing accuses the government of the Philippines of violating the One-China Principle and infringing upon the PRC's sovereignty and territorial integrity.[51] The Position Paper states that

> ... the Philippines has deliberately excluded from the category of the maritime features "occupied or controlled by China" the largest island in the Nansha Islands, Taiping Dao, which is currently controlled by the Taiwan authorities of China. This is a grave violation of the One-China Principle and an infringement of China's sovereignty and territorial integrity. This further shows that the second category of claims brought by the Philippines essentially pertains to the territorial sovereignty dispute between the two countries.[52]

On December 8, 2014, the PRC Embassy in the Netherlands deposited with the PCA, which is serving as the Registry for the South China Sea arbitral proceedings, a *Note Verbale*, asking the PCA, among other things, to forward the Position Paper to the individual members of the Arbitral Tribunal. On December 11, 2014, the PCA conveyed to the Parties that it had received these and forwarded to the members of the Tribunal copies of the *Note Verbale* and accompanying Position Paper. On December 16, 2014, the Parties to the case were invited to comment on a possible bifurcation of the proceedings, with a view to addressing some or all issues of the Tribunal's jurisdiction as a preliminary matter.

The Chinese Position Paper argues that the arbitral tribunal does not have jurisdiction over the case because: (1) the essence of the subject-matter of the arbitration is the territorial sovereignty over several maritime features in the South China Sea, which is beyond the scope of UNCLOS and does not concern the interpretation or application of the Convention; (2) the PRC and the Philippines have agreed, through bilateral instruments and the 2002 Declaration on the Conduct of Parties in the South China Sea, to settle their

50 *Id.*

51 Paragraph 22 of the Position Paper, which is available at the PRC MOFA's website at http://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1217147.shtml (last visited July 28, 2015).

52 *Id.*

relevant disputes through negotiations; by unilaterally initiating the present arbitration, the Philippines has breached its obligation under international law; and (3) even assuming, *arguendo*, that the subject-matter of the arbitration was concerned with the interpretation or application of the Convention, that subject-matter would constitute an integral part of maritime delimitation between the two countries, thus falling within the scope of the declaration filed by the PRC in August 2006 in accordance with the Convention, which excludes, *inter alia*, disputes concerning maritime delimitation from compulsory arbitration and other compulsory dispute settlement procedures.[53]

On December 16, 2014, the Arbitral Tribunal sent a request to the Philippines for further written argument, which contains 26 questions that are related to the Philippines' arguments made in its Memorial.[54] Among these questions, the Tribunal invited the Philippines to provide additional historical and anthropological information, as well as detailed geographic and hydrographic information, regarding Itu Aba, Thitu, and West York. In addition, the Tribunal asked the PRC and the Philippines to comment, among other things, if and when it would be useful to conduct a site visit, either by the Tribunal itself or a Tribunal appointed expert, to any of the maritime features in dispute. This inquiry received a negative response from the PRC.[55]

The Philippines was asked to file a supplemental written submission addressing the Arbitral Tribunal's request by March 15, 2015, and the PRC by June 16, 2015 to provide any comments in response to the supplemental written submission of the Philippines.[56] The Parties to the arbitral case were also invited to comment on a possible bifurcation of the arbitral proceedings, with a view to addressing some or all issues of the Tribunal's jurisdiction as a preliminary matter.

On March 16, 2015, the Philippines submitted a detailed response and extensive additional information to the Arbitral Tribunal, which consists of 12 volumes totaling over 3,000 pages. Volume I consists of 200 pages of written argument. Volume II consists of a 200-page atlas containing detailed information about 49 islands, reefs, and other features in the South China Sea.[57] It is

53 *Id.*

54 The list of the questions is on file with this author.

55 The information was obtained by the author from a Chinese scholar who is well informed about the South China Sea arbitration case.

56 Permanent Court of Arbitration, Press Release, Arbitration between the Republic of the Philippines and the People's Republic of China, Dec. 17, 2014.

57 Dept. of Foreign Affairs, Republic of the Philippines, *Statement on the Philippines' Supplemental Submission to the Arbitral Tribunal*, Mar. 17, 2015, *available at* http://www

certain that Taiping Island is included in this supplemental information. The Philippines intends to further argue that Taiping is not an "island," but a "rock".

The PRC reiterated that it will neither accept nor participate in the South China Sea arbitration case unilaterally initiated by the Philippines and did not submit its response to the Philippines' supplemental written information by the deadline set by the Arbitral Tribunal, that is, June 16, 2015. As a result, the Arbitral Tribunal considered the Chinese Position Paper as an objection to its jurisdiction over the case. Under Article 20, paragraph 1, of the Rules of Procedure, that was adopted by the Arbitral Tribunal on August 27, 2013,[58] the Tribunal should have power to rule on objections to its jurisdiction. In accordance with paragraph 3 of the same article, the Tribunal should rule on any plea concerning its jurisdiction as a preliminary question. After deciding to bifurcate the proceedings in this case, the Tribunal held an oral hearing on jurisdiction and admissibility at the PCA Peace Palace, The Hague, the Netherlands between July 7 and 13, 2015.[59]

The Tribunal decided not to open the hearing to the public. However, after receiving written requests from interested States, and having sought the views of the Parties, the Tribunal permitted the governments of Malaysia, Indonesia, Viet Nam, Thailand, and Japan to send small delegations to attend the hearing as observers. Originally, the hearing was scheduled to end on or before July 13, 2015.

Taiwan, a party to the sovereignty and maritime disputes in the South China Sea, has kept a close watch on the development of the arbitration case. The possibility for a third party intervention in the South China Sea arbitration case was ruled out by Taiwan because of its unique, complicated political status. Likewise, the suggestion to prepare an *amicus curiae* brief and submit it to the Arbitral Tribunal for the purpose of providing assistance to the Tribunal to consider or clarify the claims made in the Philippines' submission was also not accepted for similar reasons.

Taiwan was keen to send representatives to observe the hearings on the South China Sea arbitral case that was held at Peace Palace, The Hague, the Netherlands between July 7 and 13. Due to the sensitive political and sovereignty

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.dfa.gov.ph/index.php/newsroom/dfa-releases/5667-statement-on-the-philippines-supplemental-submission-to-the-arbitral-tribunal (last visited July 28, 2015).

58 For the text of the Procedure, visit the PCA website at http://www.pca-cpa.org/showpage65f2.html?pag_id=1529 (last visited July 282015).

59 Permanent Court of Arbitration, Press Release, Arbitration between the Republic of the Philippines and the People's Republic of China, July 7, 2015, *available at* http://www.pcacases.com/web/sendAttach/1301.

issues involved, Taiwan decided not to submit to the Tribunal a request to send representatives to observe the arbitral proceedings. Ironically, a small delegation from Indonesia, Japan, Malaysia, Thailand, and Vietnam were allowed to sit in to observe these critical proceedings.[60]

At the hearing, Professor Philip Sands, one of the counsels in the Philippines' legal team for the case, touched upon the legal issue concerning the status of Taiping Island. He argued that

> What China says is that we have "deliberately excluded" the largest "island" occupied by China, Itu Aba, and that we have been mischievous in doing this [footnote omitted].
>
> To be very realistic, the basis upon which the Philippines selected nine maritime features is explained fully in the Memorial [footnote omitted]. There are more than 750 features in the Spratly Islands, and possibly this Tribunal may want to engage in the exercise – which would last a very lengthy period of time, having regard to a similar experience in the case of Slovenia and Croatia on a huge number of different matters – but we felt it would simply be unmanageable and unreasonable for the Philippines to request the Tribunal to determine the nature of so many features, and we said so.
>
> So we have asked the Tribunal to rule only on those features that are occupied or controlled by China, on the basis that this would assist in the resolution of differences as to the entitlements generated by all the other features. Once we've got your award, we can apply your award to all the other features. So we have not "deliberately excluded" anything for any malign purpose; we have simply tried to be pragmatic in relation to what is doable in a reasonable period of time. And that was motivated, for right or for wrong, to assist the Tribunal. . . .
>
> . . . [O]ur written pleadings do address the largest features in the Spratlys, including Itu Aba, Thitu and West York. And we have demonstrated that the features in the Spratly area are "rocks" within the meaning of Article 121 of the Convention, so that none is capable of generating an entitlement to any EEZ or continental shelf.[61]

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60 Permanent Court of Arbitration, Press Release, Arbitration between the Republic of the Philippines and the People's Republic of China, July 13, 2015, *available at* http://www.pcacases.com/web/sendAttach/1304.

61 Final Transcript Day 1, *supra* note 7, at 86–88.

After the hearing, a summary of the Philippines' arguments was made available to the public on the PCA's website on July 13, 2015.[62] The summarized arguments include the following which is related to Taiping Island:

> According to [the] Philippines, the status of a feature under the Convention and the maritime zones that is capable of generating do not depend upon a prior determination of which State has sovereignty over the feature. There is therefore no need for the Arbitral Tribunal to consider sovereignty when ruling on the Philippines' submissions, as the status of the features will be the same irrespective of which State is sovereign.[63]

Based on the aforementioned development of the arbitral proceedings, it is clear that Taiping Island has an important role to play in the South China Sea arbitration case. So, how has Taiwan, a party to the South China Sea dispute that has controlled and administered the largest island in the Spratly archipelago since 1956, responded to the arbitral case filed by the Philippines against the PRC?

V Taiwan's Response to the South China Sea Arbitration Case

Taiwan's main concerns about the arbitration case include the following: (1) the Philippines' claim that China's maritime claims in the South China Sea based on its so-called 'nine dash line' are contrary to UNCLOS and invalid; and (2) Taiping Island, under Article 121(3) of the Convention, is qualified as a "rock" and therefore generates entitlement to only a territorial sea no broader than 12-nm. Regarding the first concern, it is interesting to note a report that appeared in *The Economist* in early October 2014 that misinterpreted ROC President Ma Ying-jeou's remarks on the ROC's sovereignty and maritime claims in the South China Sea made on September 1, 2014 at the opening ceremony of the Exhibition of Historical Archives on the Southern Territories of the Republic of China in Taipei.[64] The report stated:

62 Press Release, July 13, 2015, *supra* note 60.

63 *Id.* at 4.

64 *Joining the Dashes*, THE ECONOMIST, Oct. 4, 2014, http://www.economist.com/news/asia/21621844-south-china-seas-littoral-states-will-fight-museums-archives-and (last visited July 29, 2015).

> Unlike China, which has never spelled out whether it is claiming everything inside its U-shaped line – islands, rocks, shoals, reefs, fish, oil, gas and water – or just the islands, Mr. Ma was clear that the claim was limited to islands and 3 to 12 nautical miles of their adjacent waters. There were, he said, "no other so-called claims to sea regions."[65]

One week after the publication of the report in *The Economist*, Charles I-hsin Chen, the spokesperson and director of International Department of Kuomintang ("KMT"), sent a commentary to *The China Post* (Taipei), clarifying President Mas's remarks made at the Exhibition. He said,

> The article [in *The Economist*] mistakenly presents that Taiwan would hugely limit its claim to only the Taiping (Itu Aba) and Tungsha (Pratas) islands and 3 to 12 nautical miles of their adjacent waters – which is not true. Taiwan still bases its claim on the Location Map of the South China Sea, which was issued in 1935 and announced in 1947. The map covers all the islands, reefs and shoals and their surrounding waters. There were no objections from neighboring countries during that time. Moreover, ROC jurisdiction over the islands of the South China Sea has been recognized many times by international organizations and foreign governments, including the Conference of Directors of Far Eastern Weather Services in 1930, the International Civil Aviation Organization in 1955, and the U.S. government in 1960 for a mapping project under the Army Map Service Far East.[66]

In addition, Dr. Chih-Kung Liu, Representative of Taipei Representative Office in the UK, also sent a letter to the editor of *The Economist*, stating that

> When President Ma Ying-jeou spoke last September at the opening ceremony of the Exhibition of Historical Archives on the ROC's Southern Territories, he stated that when the ROC reclaimed and announced its sovereignty over the islands and their surrounding waters in 1947, the law of the sea existing at the time did not provide for maritime regimes other than territorial seas and contiguous zones. President Ma did not

65 *Id.*

66 Charles I-hsin Chen, *Ma's Peace Initiative in South China Sea is Feasible*, CHINA POST (Taipei), Oct. 10, 2014, *available at* http://www.chinapost.com.tw/commentary/letters/2014/10/10/419077/Mas-Peace.htm (last visited July 29, 2015).

> say that the ROC's claim was limited to the islands and three to 12 nautical miles of their adjacent waters, since the Location Map of the South China Sea Islands, published by the ROC government in 1947, covers both the islands and their surrounding waters.[67]

Furthermore, in March 2015, at a meeting of the Fulbright Foundation for Scholarly Exchange in Taipei, President Ma was asked by an American scholar whether the ROC would renounce its claims to the South China Sea. Ma replied: "Are you crazy? Of course we won't!" He added that giving up the sovereignty over the South China Sea is an "unconstitutional act."[68] Professor Edward Chen of Tamkang University's Graduate Institute of American Studies also warned that abandoning the U-shaped line might cause constitutional controversy.[69]

Based on these clarifications and remarks, it is clear that Taiwan's U-shaped line and historical right claims remain unchanged. It is also true that at present, there is no clear answer to the question concerning what exactly is the legal meaning and status of the line and the claim. Since Taiwan is adopting a delaying strategy, President Ma will not rush to clarify the legal meaning of Taiwan's U-Shaped Line before he leaves office in 2016.

Taiwan's strategy is likely to disappoint a number of foreign scholars who are making suggestions to the Ma administration to clarify the meaning of the U-shaped line, such as Jeffrey A. Bader,[70] Kenneth G. Lieberthal and Michael

67 Chih-Kung Liu, Letter to the Editor, *Taiwan and the South China Sea*, THE ECONOMIST, *available at* http://www.economist.com/news/letters/21629213-letters-editor (last visited July 29, 2015).

68 *Are You Crazy? Says Ma Ying-jeou to Scholar Who Asked If Taiwan will Renounce South China Sea Claims*, MY NEW LIFE IN ASIA (Blog), Mar. 20, 2015, http://my-new-life-in-asia.blogspot.tw/2015/03/are-you-crazy-says-ma-ying-jeou-to.html (Last visited July 29, 2015).

69 Edward Chen, *Abandoning U-Shaped Line Might Cause Constitutional Controversy*, UNITED DAILY NEWS, Sept. 19, 2014, *available at* http://2014.kmt.org.tw/english/page.aspx?type=article&mnum=112&anum=15154 (last visited July 29, 2015).

70 Jeffrey A. Bader, *The U.S. and China's Nine-Dash Line: Ending the Ambiguity*, BROOKINGS, Feb. 6 2014, *available at* http://www.brookings.edu/research/opinions/2014/02/06-us-china-nine-dash-line-bader (last visited July 29, 2015) (suggesting that "[t]he U.S. should discuss with Taiwan whether it can clarify its position on the nine-dash line, to make clear that its claims are consistent with UNCLOS.").

McDevitt,[71] Bonnie S. Glaser,[72] and Lynn Kuok.[73] However, it can be pointed out that Taiwan will encounter a big challenge if the Arbitral Tribunal makes a ruling on the PRC's nine-dashed line, declaring that the claim is inconsistent with UNCLOS in the year 2016 or later.

As for the second concern, Taiwan has responded much more actively to the Philippines' legal arguments over Taiping Island's right to generate maritime zones under UNCLOS than to Manila's legal arguments against the U-shaped or nine-dash line claim. On July 7, 2015, when the Arbitral Tribunal began its hearing on jurisdiction and admissibility for the South China Sea arbitration case at The Hague, President Ma stated at an international conference in Taipei commemorating the 70th anniversary of the ROC victory in the War of Resistance Against Japan that the ROC government will "staunchly defend" its sovereignty over Taiping Island in the South China Sea, consistent with international law.[74] In addition, he said, "In the future, the ROC government will continue development on Taiping [Itu Aba Island] with the aim of peace, to make it a hub for humanitarian assistance, environmental protection and scientific research in the Spratly Islands."[75] President Ma also stressed that Taiping Island meets the definition of an island under international law. Any attempt by other countries to deny Taiping its status as an island will not undermine its legal standing, he

71 Jeffrey A. Bader, Kenneth G. Lieberthal & Michael McDevitt, *Keeping the South China Sea in Perspective*, BROOKINGS, Aug. 2014, *available at* http://www.brookings.edu/research/papers/2014/08/south-china-sea-perspective-bader-lieberthal-mcdevitt (last visited July 29, 2015) (calling on Beijing to clarify its position on the "nine dash line" consistent with the relevant provisions of UNCLOS and pressing Taiwan to provide a similar clarification).

72 Bonnie S. Glaser, *A Role for Taiwan in Promoting Peace in the South China Sea*, CSIS, Apr. 15, 2014, *available at* http://csis.org/publication/role-taiwan-promoting-peace-south-china-sea (last visited July 29, 2015) (suggesting that "[a] first step could be for Taiwan to thoroughly review the Republic of China historical archives to fully understand the original intention behind the drawing of the 11-dash line. Subsequently, Taiwan should identify which of the land features it claims are islands that it believes are entitled to a 200 nautical mile (nm) EEZ and which are rocks (features which cannot sustain human habitation or economic life of their own) that are only entitled to a 12 nm territorial sea.").

73 Lynn Kuok, *Tides of Change: Taiwan's Evolving Position in the South China Sea*, BROOKINGS, May 2015, *available at* http://www.brookings.edu/research/papers/2015/05/taiwan-south-china-sea-kuok (last visited July 29, 2015) (suggesting that clarifying that its claims accord with UNCLOS and international law without expressly eschewing the dashed line).

74 *Ma: ROC to defend sovereignty, rights over Taiping Island*, WANT CHINA TIMES, July 8, 2015, http://www.wantchinatimes.com/news-subclass-cnt.aspx?id=20150708000051&cid=1101 (last visited July 29, 2015).

75 *Id.*

said.[76] Clearly these statements were made in response to the ongoing arbitral proceedings at The Hague. In particular, Taiwan is concerned about the Philippines' claim in its case that Taiping is not an island but a rock under Article 121 of UNCLOS.

Also on July 7, the ROC Ministry of Foreign Affairs issued an eight point statement on the South China Sea,[77] which again demonstrates Taiwan's concern about a possible negative outcome of the South China Sea arbitration case concerning the legal status of Taiping Island. Point Three of the Statement stresses that Taiping Island "indisputably qualifies" as an "island" under Article 121 of UNCLOS. It also emphasizes that the ROC government "will firmly defend this fact."[78] The Ministry makes it clear that [a]ny claims by other countries which aim to deny this fact will not impair the legal status of Taiping Island … and its maritime rights based on UNCLOS."[79] Point Eight of the statement provides that "[a]ny arrangement or agreement regarding Taiping Island … or other islands in the South China Sea and their surrounding waters that is reached without ROC participation and consent shall have no legal effect on the ROC and shall not be recognized by the ROC government."[80]

Taiping Island has been claimed by the ROC government since December 1946 and ROC troops have been garrisoned there since 1956. Taipei hopes to convince the members of the Tribunal that the land feature is not a rock, as argued by the Philippines in its Memorial, but an island under the Convention and therefore has the right to generate a 200-nm EEZ and continental shelf.

In order to demonstrate to the international community and to the Tribunal that Taiping has been under Taiwan's effective control since 1956, and that it is capable of sustaining human habitation and an economic life of its own, Taiwan's Ministry of Foreign Affairs posted "Our Island: The Atlas of Taiping Island of the Republic of China (Taiwan), Vol. 1" on its official website.[81] In addition, video clips and photographs are also made available to the public on the same page.[82] Finally, it is likely that President Ma will pay a visit to Taiping Island before the end of 2015. It is also possible for him to announce a roadmap

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76 *Id.*

77 Ministry of Foreign Affairs, Republic of China (Taiwan), *Statement on the South China Sea*, July 7, 2015, http://www.mofa.gov.tw/en/News_Content.aspx?n=1EADDCFD4C6EC567&s=EDEBCA08C7F51C98 (last visited July 29, 2015).

78 *Id.*

79 *Id.*

80 *Id.*

81 *Supra* note 8.

82 *Id.*

to implement the South China Sea Peace Initiative (SCSPI) that was proposed on May 26, 2015 in Taipei.[83]

VI Concluding Remarks

With the legal regime of islands, UNCLOS introduced a new rule regarding certain small islands defined in Article 121(3) as rocks. Any features in the South China Sea that fail to satisfy the rules are considered "rocks" and are not entitled to their own 200-nm EEZ and continental shelf. As no official clarification of Article 121(3) exists, coastal states in the South China Sea are interpreting the provision through the lens of their national maritime interests. As such, the Philippines argues that Taiping Island is a "rock" under Article 121(3) of the Convention and cannot therefore generate a maritime zone larger than a 12-nm territorial sea. This position is included in its Memorial submitted to the Arbitral Tribunal in March 2014 and reiterated in the oral arguments made by the Philippines' legal counsel at the hearing on jurisdiction and admissibility in The Hague in July 2015.

Following closely the development of the arbitral proceedings and particularly taking note of the Philippines' arguments on the legal status of Taipei Island, which is the largest land feature in the Spratly archipelago and is the only island under Taiwan's effective control, the ROC government has taken a number of actions and policy measures, aiming to convince the international community in general and the members of the Arbitral Tribunal in particular that Taiping Island is indeed "a full-fledged island" under Article 121 of UNCLOS. We can expect to see more actions by Taiwan in defending this position.

For the Arbitral Tribunal, if it decides by the end of 2015 that it has jurisdiction over the South China Sea arbitration case, it is not impossible for the Tribunal to rule on the legal status of Taiping Island when dealing with the Philippines' submissions. This ruling must be made in accordance with Article 9 of Annex VII to the Convention which says, "Before making its award, the arbitral tribunal must satisfy itself not only that it has jurisdiction over the dispute but also that the claim is well founded in fact and law."

This article argues that "in fact and law", Taiping Islands is "a full-fledged island," definitely not a "rock," and therefore has the right to generate a 200-nm

83 Office of the President, Republic of China (Taiwan), *President Ma's remarks at opening ceremony of "2015 ILA-ASIL Asia-Pacific Research Forum"*, May 26, 2015, http://english.president.gov.tw/Default.aspx?tabid=491&itemid=34796&rmid=2355 (last visited July 29, 2015).

EEZ in accordance with Article 121 of UNCLOS. The Philippines cannot interpret this article solely through the lens of its national interest, without correctly interpreting and applying the provision. Otherwise, other countries such as the United States, Japan, and Australia could also be challenged for their respective claims to land features, such as Kingman Reef, Okinotorishima, and Heard Island/McDonald Islands, as "islands" and have the right to claim a 200-nm EEZ or continental shelf under the Convention.

Annex 835

Gregory Poling, "Spratly Airstrip Update: Is Mischief Reef Next?, *Center for Strategic & International Studies* (16 Sept. 2015)

SPRATLY AIRSTRIP UPDATE Is Mischief Reef Next?

POTENTIAL NEW RUNWAY PRESENTS NEW HEADACHES

By Gregory Poling

Over the last year, the world has watched as China has gone from one airfield in the South China Sea to potentially four. Facilities on Woody Island in the Paracels already gave China the ability to monitor the northern South China Sea. Earlier this year, the addition of an airfield on Fiery Cross Reef provided a more southerly runway capable of handling most if not all Chinese military aircraft. And in June, satellite photos indicated that China was preparing to lay down another runway at Subi Reef. New photos taken on September 3 show grading work at Subi, providing further evidence that runway construction there is planned. Meanwhile work at the Fiery Cross airfield is well advanced, with China recently laying down paint.

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SUBI REEF. September 3, 2015. Possible runway construction is ongoing on the western rim of the reef. At the southeastern entrance, a dredger widens the access channel to the inner reef. To the northeast a second dredger completes land reclamation along the rim.

Satellite photos taken on September 8 contain an unanticipated development, indicating that China may be preparing to construct another airstrip at Mischief Reef. These images show that a retaining wall has been built along the northwest side of the reef, creating a roughly 3,000-meter rectangular area. This is the only part of the feature where China has chosen to use a retaining wall to straighten what would otherwise be an irregular landmass; on the rest of Mischief its reclamation work has followed the natural geography of the underlying reef. A cement plant has been set up in that area, indicating that significant construction is planned. This all echoes preparatory work seen earlier at Fiery Cross and Subi, suggesting another runway could be in the works.

FIERY CROSS REEF. September 3, 2015. Runway construction nears completion as paint is applied to the concrete on the western side of the reef. New building construction has appeared on the east side of the reef.

An airstrip at Mischief would be of particular concern to the Philippines. The potential runway would be just 21 nautical miles from the BRP Sierra Madre, a World War II-era tank landing ship deliberately grounded by the Philippines in 1999 that is home to a contingent of Philippine marines at Second Thomas Shoal. China has maintained a constant coast guard presence around Second Thomas since 2013 and attempted to prevent resupply of the Sierra Madre in March 2014. The potential airfield at Mischief Reef would also be just 60 nautical miles from Reed Bank, where the Philippines hopes to drill for natural case deposits over China's objections.

Fiery Cross sits in the western half of the Spratlys and the airstrip there most directly presents a hurdle to operations by Vietnam, which occupies most of that part of the chain. Subi is at the northern end of the Spratlys, just 15 nautical miles from the Philippine airstrip at Thitu Island and less than 40 from Taiwan's only holding on Itu Aba. A third airstrip on Mischief Reef, 100 nautical miles southeast of Subi, would complete the triangle, significantly boosting China's air patrol and interdiction capabilities over the contested waters and features of the Spratlys, heightening tensions, and presenting greater operational headaches for all the claimants as well as outside players like the United States.

MISCHIEF REEF. September 8, 2015. A square area approximately 3,000 meters long has been cleared and flattened along the northern rim of the reef. Some believe an airstrip may be built in this straightaway in the near future. At the western access channel into the inner reef, an active dredger is visible. To the east, a second concrete plant has been set up on the rim of the reef.

China is still dredging in the South China Sea. Satellite imagery of Subi Reef taken in early September shows dredgers pumping sediment onto areas bordered by recently built sea walls and widening the channel for ships to enter the waters enclosed by the reef. On Mischief Reef, a dredger is also at work expanding the channel to enable easier access for ships, possibly for future use as a naval base.

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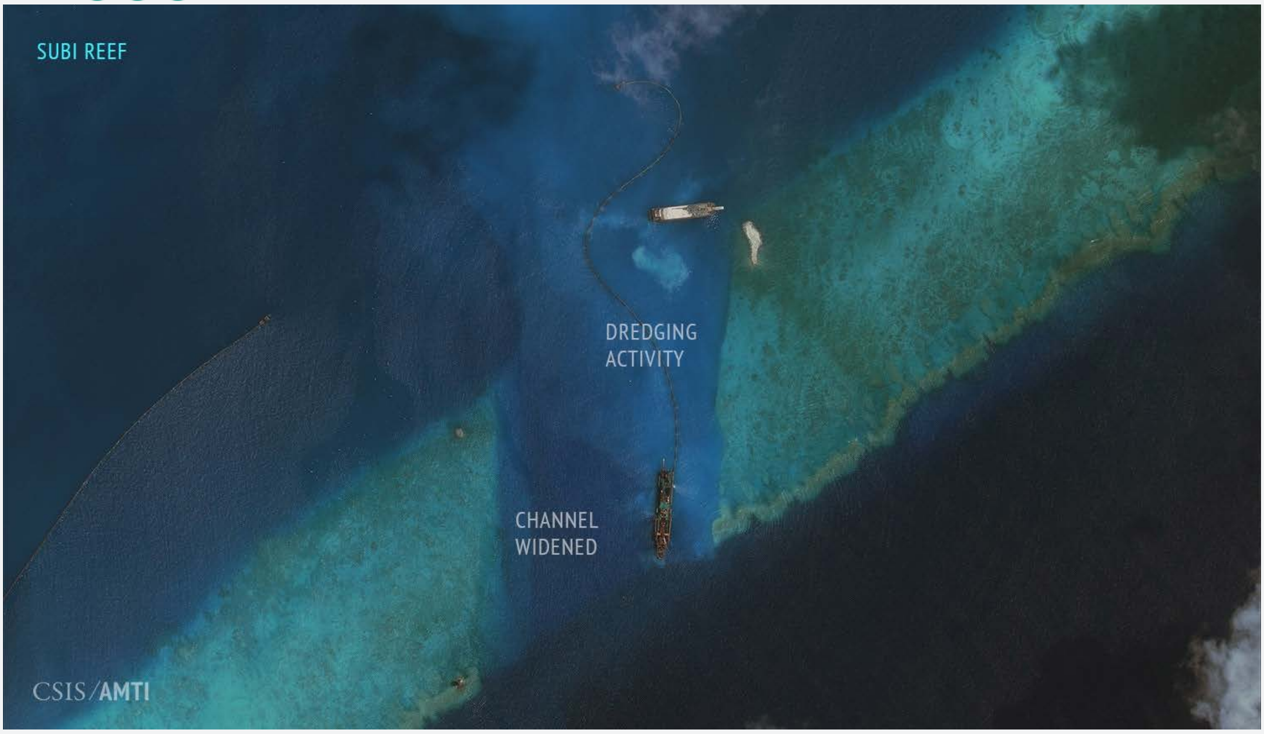

SUBI REEF. September 3, 2015. A dredger widens the access channel to the inner reef.

This activity comes in the wake of assertions by China that its land reclamation has ended in the Spratly Island chain. On August 5, during the ASEAN Regional Forum in Kuala Lumpur, Chinese foreign minister Wang Yi told reporters, "China has already stopped. You look, who is building? Take a plane and look for yourself." He did not pledge that China would refrain from construction and militarization on the newly-created islands, however.

Wang Yi reiterated that China's construction on the islands is mainly "to improve the working and living conditions of personnel there" and for "public good purposes." To date, however, China's activity appears focused on construction for military uses. Recently built structures on Fiery Cross Reef include a completed and freshly painted 3,000-meter runway, helipads, a radar dome, a surveillance tower, and possible satellite communication facilities.

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SUBI REEF. September 3, 2015. A dredger completes land reclamation at Subi reef's northeastern rim.

In its natural state, prior to being transformed into an artificial island, two small rocks at Fiery Cross Reef were above water at high tide and therefore, under the law of the sea, that land feature may qualify for a 12-nautical mile territorial sea. Subi and Mischief reefs were submerged under water and therefore they do not generate legal maritime zones and no state can claim sovereignty over them. At most they are allowed a 500-meter vessel traffic management zone to ensure navigational safety. Apparent Chinese preparations for building lengthy airstrips on Subi and Mischief raise questions about whether China will pose challenges to freedom of navigation in the air and sea surrounding those land features in the future.

The persistence of dredging along with construction and militarization on China's artificial islands underscore Beijing's unwillingness to exercise self-restraint and look for diplomatic paths to reduce tensions with its neighbors, the United States, and other nations with an interest in the preservation of peace and stability in the South China Sea. U.S. calls for all claimants in the South China Sea to halt land reclamation, construction, and militarization have been rejected by China, which views the status quo as unfavorable to its interests.

On the eve of President Xi Jinping's visit to the United States, Beijing appears to be sending a message to President Barack Obama that China is determined to advance its interests in the South China Sea even if doing so results in heightened tensions with the United States.

MISCHIEF REEF. September 8, 2015. A dredger is visible near the western access channel into Mischief Reef.

China's recent construction activity at Subi and Mischief reefs, while undermining anything other than the narrowest possible interpretation of China's recent claims that it was ceasing such activities, should come as no surprise when viewed against the backdrop of China's emerging maritime strategy under the leadership of President Xi Jinping. The Xi administration's increased emphasis on maritime matters was hinted at as early as the 18th Party Congress that brought Xi to power. Former president Hu Jintao, in his valedictory address to the congress, stated that "we should . . . resolutely safeguard China's maritime rights and interests, and build China into a maritime power." Though a simple statement, its significance lay in the fact that no Chinese leader had uttered such an intention in nearly 500 years.

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FIERY CROSS REEF. September 3, 2015. New construction on the eastern side of Fiery Cross reef.

At its core, Xi's approach reflects China's broader interest in developing more maritime strategic depth on its periphery as its interests expand well beyond its shores. In effect, China sees its activities in the South China Sea as contributing to its efforts to signal its regional neighbors, and the United States, that its forces intend to operate at times of their choosing out to the "second island chain" and beyond into the Western Pacific. In this context, China's latest construction efforts can be seen as a fundamental building block toward establishing effective control over this area that is foundational to achieving its broader ambitions.

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MISCHIEF REEF. September 3, 2015. New construction on the eastern side of Fiery Cross reef.

The Chinese military in May issued its latest Defense White Paper, which states that the People's Liberation Army (PLA) has been handed a new "strategic task," to "safeguard the security of China's overseas interests," especially in the maritime domain. As a consequence, the PLA Navy "will gradually shift its focus from 'offshore waters defense' to the combination of 'offshore waters defense' with 'open seas protection." Under these auspices, the PLA in the near future will be a force operating well beyond the "first island chain" and into the Indian Ocean. China's long-term ambition to have multiple aircraft carrier strike groups is designed to facilitate the overawing of lesser powers, enhance China's regional prestige, and provide the demonstration effect of near-constant presence. For rival claimants in the South China Sea, this is a game changer. China's clear military capacity will shape how the region behaves toward it without a need for menacing Chinese behavior. The recent developments at Subi and Mischief reefs must be properly understood in the context of this overall Chinese maritime game plan.

MISCHIEF REEF. September 8, 2015. Construction begins on Mischief Reef's northern rim. An area measuring 3,000+ meters in length has been cleared.

China's latest construction activities suggest that Beijing may be attempting to move from a local air and sea denial capability to an air and sea control posture in the South China Sea. Most public commentary to date has focused on the complications these airstrips could pose to peacetime interactions, particularly for other South China Sea claimants. With one airfield in the Paracels and another in the Spratlys, the People's Liberation Army (PLA) could already conduct significant peacetime patrol operations, providing a significant edge over its maritime neighbors. The investment of significant additional resources to build two new airfields in the same area of the South China Sea points to a strategy of dispersal and wartime utilization in contingency scenarios.

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SUBI REEF. September 3, 2015. Possible airstrip construction at Subi Reef.

There is no doubt that the United States and its allies and partners could neutralize these bases in wartime. However, doing so would require a concerted effort from U.S. forces, many of which would already be in high demand if a conflict were to occur. Moreover, the PLA could make approaching these airfields highly risky. In the air, PLA integrated air defenses would pose a threat to friendly aircraft, complicating the existing challenge of confronting PLA Air Force fighters. On the seas, long-range sensors and anti-ship cruise missiles would amplify the risk to surface naval forces throughout the region. Undersea, the PLA Navy could use diesel submarines and acoustic arrays to raise the hazard to U.S. submarines. In addition, defensive Chinese systems might be capable of protecting against most U.S. cruise missiles, thereby forcing U.S. forces to risk closer approaches to these reclaimed features.

SUBI REEF. September 3, 2015. Possible airstrip construction at Subi Reef.

At this point, we can only say conclusively that the PLA has access to a 3,000-meter airfield at Fiery Cross Reef, appears to be preparing another runway at Subi Reef, and has reclaimed land that could support a similar facility at Mischief Reef. However, there are compelling indicators that the PLA is on the cusp of a more significant operational capability than originally envisioned by outside observers.

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FIERY CROSS REEF. September 3, 2015. Runway completion and painting at Fiery Cross Reef. A large apron and taxiway is clearly visible.

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Annex 837

Ben Milligan, "The Australia-Papua New Guinea Torres Strait Treaty: a model for co-operative management of the South China Sea?", in *Beyond Territorial Disputes in the South China Sea* (R. Beckman et al., eds. 2013)

10. The Australia–Papua New Guinea Torres Strait Treaty: a model for co-operative management of the South China Sea?

Ben Milligan

INTRODUCTION

On 18 December 1978 Australia and Papua New Guinea (PNG) concluded a treaty concerning maritime delimitation and co-operative arrangements in the Torres Strait[1] (Torres Strait Treaty). The Torres Strait Treaty also addressed competing positions asserted by Australia and PNG concerning sovereignty over the Strait's insular features. This chapter provides a brief overview of the Torres Strait Treaty and its implementation by Australia and PNG. It then discusses the extent to which design features of the Treaty could be utilised as a model for co-operative management of the South China Sea.

I. POLITICAL AND PHYSICAL GEOGRAPHY OF THE TORRES STRAIT[2]

The Torres Strait is an area of water located between Cape York Peninsula in northern Australia and the island of New Guinea. The Strait connects

[1] Treaty between Australia and the Independent State of Papua New Guinea Concerning Sovereignty and Maritime Boundaries in the Area between the Two countries, Including the Area Known as Torres Strait, and Related Matters, signed 18 December 1978, entered into force 15 February 1985, 18 ILM 291; ATS 1985 No 4.

[2] For further discussions see S Kaye, *The Torres Strait* (The Hague: Kluwer Law International, 1997); D Lawrence and T Cansfield-Smith (eds) *Sustainable Development for Traditional Inhabitants of the Torres Strait Region* (Canberra: Australian Government Publishing Service, 1991); D Lawrence and HR Lawrence,

the Coral Sea in the east with the Arafura Sea to the west. It extends approximately 150 kilometres from north to south and 200 kilometres from east to west. The Strait is relatively shallow and contains more than 150 insular features, including islands, sand cays and drying reefs.[3] Approximately 17 of these islands are inhabited by the culturally and linguistically distinct 'Torres Strait Islander' people, many of whom maintain their traditional lifestyle.[4] The Torres Strait region is sparsely populated and is isolated from major population centres and infrastructure in Australia and PNG.[5]

A. Natural Resources

The natural environment of the Torres Strait is subject to a tropical climate and has a high degree of biodiversity.[6] The Strait provides habitats for several vulnerable or endangered species, notably dugongs and several species of turtle.[7] It has been recognised by a United Nations Environment Programme report as 'the most important dugong habitat in the world'.[8] The Strait also supports small commercial fisheries for several stocks including prawns, mackerel and rock lobster.[9] Although the economic activity based in the Torres Strait is of minor significance to the surrounding States, the Torres Strait people rely greatly on the region's marine living resources for their livelihoods and for food.[10] As discussed

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'The Torres Strait: the region and its people' in R Davis, *Woven Histories Dancing Lives: Torres Strait Islander Identify, Culture and History* (2004), online: http://lryb.aiatsis.gov.au/PDFs/davis_pt1.pdf; and Australian Senate, Foreign Affairs, Defence and Trade References Committee, *The Torres Strait: Bridge and Border* (November 2010), online: http://www.aph.gov.au/senate/committee/?url=fadt_ctte/completed_inquiries/2010-13/torresstrait/index.htm.

[3] Kaye, *supra* note 2, at 5–9.

[4] Lawrence and Lawrence, *supra* note 2.

[5] Kaye, *supra* note 2, at 12–13.

[6] Australian Department of Sustainability, Environment, Water, Population and Communities, Biodiversity, *Summary for the NRM Region Torres Strait, Queensland*, online: http://www.environment.gov.au/heritage/anhat/summaries/qld/pubs/summary-qld-torres-strait.pdf.

[7] See Australian Senate Committee Report, *supra* note 2, Chapter 9.

[8] United Nations Environment Programme, *Dugong Status Report and Action Plans for Countries and Territories* (2002), UNEP/DEWA/RS.02-1, online: http://www.unep.org/NairobiConvention/docs/dugong.pdf.

[9] Australian Maritime Safety Authority (AMSA) Document. Note also that there is traditional fishing for Dugong and Green Turtle.

[10] Australian Maritime Safety Authority, *Torres Strait:'Strait Facts'/Risk Assessment*, online: http://www.amsa.gov.au/marine_environment_protection/

in further detail below, Australia and PNG have established a moratorium concerning certain exploration and exploitation of the region's potential hydrocarbon resources.

B. Shipping and Navigation

The Torres Strait is also an important shipping route.[11] For example, it provides the shortest available route for vessels travelling from Southeast Asia to New Zealand, PNG, the South Pacific and the major population centres of the Australian east coast.[12] Navigation through the Torres Strait is complicated by several factors. Muddy waters in several locations obscure reefs and shifting sandbanks.[13] The Strait experiences tropical storms and heavy rain that greatly reduce visibility.[14] It is extremely difficult to predict tides in several locations.[15] Tidal patterns vary widely in different parts of the Strait and several locations experience strong tidal streams.[16] The navigable route through the Torres Strait is highly confined in both width and depth.[17] Very-large vessels do not use the Strait – the recommended maximum draft for transiting ships is currently 12.2 metres with an under-keel clearance of 10 per cent.[18] Navigation through the

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torres_strait/risk.asp. Prior to their decline in the 1960s, the pearling and pearl shell fishing industries were important contributors to the regional economy; see Kaye, *supra* note 2, at 39–40, 48.

11 Australian Maritime Safety Authority, ibid, notes the following: There are approximately 3000 transits of the Strait per year by vessels with LOA greater than 50 metres. The approximate breakdown of vessel traffic is as follows: bulk carriers (38%), general cargo (28%), containers (15%), loaded tankers (12%). See also Kaye, *supra* note 2, at 14–16.

12 Kaye, *supra* note 2, at 14.

13 Kaye, *supra* note 2, at 2.

14 Australian Maritime Safety Authority, *supra* note 10.

15 Kaye, *supra* note 2, at 4, who notes the following: Large ships require real time telemetry on tidal levels. Tidal data is broadcasted from several monitoring stations maintained by the Australian Government.

16 Ibid. See also R Johannes and J Macfarlane, *Traditional Fishing in the Torres Strait Islands* (Collingwood, Victoria: CSIRO Publishing, 1991), at 16–18; and E Wolanski, 'A Review of the Physical Oceanography of the Torres Strait' in Lawrence and Cansfield-Smith, *supra* note 2, at 135–7.

17 Australian Maritime Safety Authority, *supra* note 10, which notes the following: 'The western entry to the Torres Strait through Varzin Channel has a minimum width of 0.3 nm and depth of 10.5 metres. Prince of Wales Channel, the passage route in the central Torres Strait, has a minimum width of 0.3 nm and depth of 11.0 metres.'

18 See Australian Maritime Safety Authority, *Under Keel Clearance Management: Management of under-keel clearance for ships transiting Torres Strait*,

Strait is currently subject to a compulsory pilotage scheme administered by the Australian Government.[19]

II. COMPETING CLAIMS AND NEGOTIATION OF THE TORRES STRAIT TREATY[20]

A. Historical Background

In 1879, in response to concerted lobbying efforts by the colony of Queensland, the United Kingdom permitted the colony to annex islands located in the Torres Strait.[21] The United Kingdom subsequently proclaimed a separate protectorate over the south-eastern portion of New Guinea in 1884.[22] These acts brought the territory in and surrounding the Torres Strait under British control. The potential for competing jurisdictional claims arose in the Torres Strait in 1975 when the Territory of Papua New Guinea achieved independence from Australian administration.[23] The Australian government and Papua New Guinea territorial government commenced negotiations concerning maritime boundary delimitation in 1973.[24] A mutually acceptable agreement was not reached prior to PNG's independence and the negotiations continued until 1978.[25] Several factors delayed the final agreement set out in the Torres Strait Treaty, which will be discussed in the following paragraphs.

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online: http://www.amsa.gov.au/shipping_safety/great_barrier_reef_and_torres_strait/under_keel_clearance_management.asp.

19 For further discussion of the scheme and associated international legal issues see: S Bateman and M White, 'Compulsory Pilotage in the Torres Strait: Overcoming Unacceptable Risks to a Sensitive Marine Environment', (2009) 40 Ocean Dev & Int'l L 184; R Beckman, 'PSSAs and Transit Passage – Australia's Pilotage System in the Torres Strait Challenges the IMO and UNCLOS', (2007) 38 Ocean Dev & Int'l L 325.

20 For further discussion, see Kaye, *supra* note 2; H Burmester, 'The Torres Strait Treaty: Ocean Boundary Delimitation by Agreement', (1982) 76 AJIL 321; P Boyce and M White (eds), *The Torres Strait Treaty* (Canberra: ANU Press, 1981).

21 Kaye, *supra* note 2, at 36–8 and Burmester, *supra* note 20.

22 Ibid.

23 Kaye, *supra* note 2, at 90–1.

24 Kaye, *supra* note 2, at 90–1 and Burmester, *supra* note 20.

25 Ibid.

B. Sovereignty over Insular Features and Access to the Torres Strait's Resources

Under authorisation of the United Kingdom, most Torres Strait islands were annexed to the colony of Queensland in the 1870s, and subsequently became Australian territory. Australian sovereignty over insular features in the Torres Strait severely limited the potential scope of PNG's maritime jurisdiction and its access to the Strait's resources. The islands of Boigu and Saibai, for example, are located less than 10 kilometres from the PNG coast.[26] PNG considered this situation to be inequitable, particularly in light of its status as a newly independent developing State.[27] During the negotiations it attempted to secure sovereignty over insular features in the northern part of the Strait and greater access to the Strait's resources.[28]

C. Domestic Legal and Political Issues in Australia

The Queensland state government remained strongly opposed to any transfer of territory to PNG.[29] The Australian Constitution restricts the ability of the Australian federal government to override such opposition and, in any event, the co-operation of the Queensland state government was deemed to be essential for the successful implementation of an agreement with PNG.[30]

D. Welfare of Torres Strait Islanders

Many Torres Strait Islanders were opposed to any reallocation of sovereignty to PNG. It was perceived that the Australian Government could provide better protection of the Islanders' economic security and distinct cultural identity.[31]

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[26] For an illustrative map of several Torres Strait islands, see Figure 10.1. A detailed map can be found online: http://www.icsm.gov.au/mapping/images/torres.pdf.

[27] Kaye, *supra* note 2, at 90–2.

[28] Ibid.

[29] Ibid.

[30] Kaye, *supra* note 2, at 92 notes that: 'While there was some academic debate over the appropriate legal procedures by which islands could be transferred to PNG, it was clear that nothing could be ceded without at least the approval of the QLD Parliament and possible not without a referendum in the State.' For further discussion concerning Australian constitutional law see R Lumb, 'Legal aspects of the Torres Strait Treaty' in Boyce and White, *supra* note 20.

[31] Kaye, *supra* note 2, at 90–2.

The agreement reflected in the Torres Strait Treaty reconciled the divergent interests of Australia and PNG by establishing both maritime boundaries and several complementary co-operative mechanisms concerning management of the Torres Strait and its resources. The Treaty is a complex legal instrument, containing 32 articles and nine annexes. Key design features of the Treaty are discussed in the following paragraphs.

III. DESIGN FEATURES OF THE TORRES STRAIT TREATY[32]

A. Objectives of the Treaty

The preamble of the Torres Strait Treaty emphasises several key policy objectives, namely: establishment of an agreed position concerning maritime boundary delimitation and sovereignty over certain Torres Strait islands; protection of the traditional way of life and livelihood of Australian Torres Strait Islanders and Papua New Guineans living in and adjacent to the Strait; protection of the Strait's marine environment; freedom of navigation and over flight in the Torres Strait area for Australian and Papua New Guinean vessels and aircraft; and co-operative management and sharing of the Strait's fisheries and seabed mineral resources.

B. Delimitation of Maritime Boundaries

The Torres Strait Treaty establishes several maritime jurisdictional boundaries between Australia and PNG. A 'Seabed Jurisdiction Line' delimits the sovereign rights of each State over the continental shelf.[33] The Treaty explicitly recognises that these rights include 'jurisdiction over low-tide elevations, and the right to exercise such jurisdiction in respect of those elevations, in accordance with international law'.[34] A 'Fisheries Jurisdiction Line' delimits the sovereign rights of each State 'for the purpose of exploring and exploiting, conserving and managing fisheries resources other

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[32] For further discussion see Kaye, *supra* note 2, Burmester, *supra* note 20, and J Charney and L Alexander, *International Maritime Boundaries of the World* (Dordrecht/Boston: Martinus Nijhoff Publishers, 1993), at 929–75.

[33] Torres Strait Treaty, Art 4(1). The coordinates of the line are set out in Annex 5 of the Treaty.

[34] Torres Strait Treaty, Art 1(1)(i).

than sedentary species'.[35] Territorial sea boundaries are also established between the mainland coast of PNG and several islands which, as noted below, are recognised by the Treaty as belonging to Australia.[36]

In the eastern and western approaches to the Torres Strait the Seabed Jurisdiction Line and Fisheries Jurisdiction Line follow the same course, which apart from minor adjustments is equidistant from the mainland coasts of Australia and PNG.[37] In the central part of the Torres Strait each line follows a different course. The Seabed Jurisdiction Line runs north of an equidistance line between the mainland coasts, taking into account Australian sovereignty over certain Torres Strait Islands.[38] The Fisheries Jurisdiction Line turns sharply northward from the Seabed Jurisdiction Line to enclose several inhabited islands. The course of the Seabed Jurisdiction Line and Fisheries Jurisdiction Line in the central portion of the Strait is depicted in Figure 10.1.

The Torres Strait Treaty also refers to the 'residual jurisdiction' of Australia and PNG, which covers several matters including preservation of the marine environment, marine scientific research, and the production of energy from water currents and winds.[39] In non-territorial sea waters located between the Seabed Jurisdiction Line and Fisheries Jurisdiction Line, Australia and PNG may not exercise residual jurisdiction unless the other State consents.[40] Within these waters both States are also required to 'consult with a view to reaching agreement on the most effective method of application of measures involving the exercise of residual jurisdiction'.[41] The Treaty does not contain provisions concerning the exercise of residual

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[35] Torres Strait Treaty, Arts 4(2) and 1(1)(b). The coordinates of the line are set out in Annex 8 of the Treaty.

[36] Torres Strait Treaty, Art 3(1).

[37] For further discussion see Kaye, *supra* note 2, at 93–9; Charney and Alexander, *supra* note 32.

[38] Ibid.

[39] Torres Strait Treaty, Art 4(4) stipulates that the term 'Residual Jurisdiction' means: '(a) jurisdiction over the area other than seabed jurisdiction of fisheries jurisdiction, including jurisdiction other than seabed jurisdiction of fisheries jurisdiction insofar as it relates to *inter alia*: (i) the preservation of the marine environment; (ii) marine scientific research; and (iii) the production of energy from water, current and winds; and (b) seabed jurisdiction and fisheries jurisdiction to the extent that the exercise of such jurisdiction is not directly related to the exploration or exploitation of resources or to the prohibition of, or refusal to authorise, activities subject to that jurisdiction.' Burmester AJIL notes that 'Essentially . . . any exercise of jurisdiction not directly related to the control of seabed or fisheries resources falls within the definition of residual jurisdiction.'

[40] Torres Strait Treaty, Art 4(3).

[41] Ibid.

jurisdiction outside the area bounded by the Seabed Jurisdiction Line and Fisheries Jurisdiction Line.[42] In practice, the segments of these lines that follow a common course have been treated as an all-purpose maritime boundary by both Australia and PNG.

C. Allocation of Sovereignty

In the interest of clarity, the concept of 'sovereignty over an island' is expressly defined by the Torres Strait Treaty to include the territorial sea, insular features located within the territorial sea, underlying seabed and subsoil, and superjacent airspace.[43] Article 2(1) of the Treaty recognises Australian sovereignty over all islands located south of the Seabed Jurisdiction Line and 15 specified islands located northward.[44] Some of these 15 specified Australian islands are located north of both the Seabed Jurisdiction Line and the Fisheries Jurisdiction Line. Article 2(3) of the Treaty recognises the sovereignty of PNG over three small islands located immediately adjacent to the coast of New Guinea and over all islands located north of the Seabed Jurisdiction Line (except for the 15 allocated to Australia).

Article 3 of the Torres Strait Treaty contains several provisions concerning territorial sea limits in the Torres Strait. The limit of the territorial sea projected from the 15 Australian islands located north of the Seabed Jurisdiction Line is fixed at three miles, notwithstanding any subsequent change to the configuration of the relevant coastlines.[45] This restriction does not apply to an area of territorial sea located south of the Seabed Jurisdiction Line but projected from Pearce Caye – an island located less than three miles north of the Seabed Jurisdiction Line.[46] Australia is prohibited from extending its territorial sea northwards across the Seabed

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[42] For further discussion, see Burmester, *supra* note 20.

[43] Torres Strait Treaty, Art 2(4).

[44] Torres Strait Treaty, Art 2(2) provides that 'No island over which Australia has sovereignty, other than those specified' is located north of the Seabed Jurisdiction Line.

[45] Torres Strait Treaty, Art 3(2), which also provides that the three mile restriction applies even if there is a different result of a subsequent geographic survey. The fixed territorial sea limits are defined in Annex 3 of the Treaty and illustrated in Annexes 2 and 4. Kaye, *supra* note 2; This was done with an extraordinary degree of detail and is best illustrated in the case of Turnagain Island, which, although less than several miles long and a mile wide, has some 74 basepoints for the calculation of its territorial sea

[46] Torres Strait Treaty, Art 3(3).

Jurisdiction Line.[47] PNG is prohibited from (1) extending certain parts of its mainland territorial sea beyond three miles; (2) extending its archipelagic waters or territorial sea into the waters located between the Seabed Jurisdiction Line and Fisheries Jurisdiction Line; (3) designating archipelagic baselines in those same waters; and (4) extending its territorial sea southwards of the Seabed Jurisdiction Line.

D. A Complex Patchwork of Adjacent Maritime Jurisdiction

The practical effect of the above provisions is as follows: The Torres Strait Treaty recognises Australian sovereignty over the large majority of islands located in the Strait.[48] Waters located north of both the Seabed Jurisdiction Line and Fisheries Jurisdiction Line are subject to the jurisdiction of PNG, but also contain pockets of Australian territorial sea surrounding certain islands. Waters located north of the Seabed Jurisdiction Line and south of the Fisheries Jurisdiction Line are subject to the seabed jurisdiction of PNG, the fisheries jurisdiction of Australia, and contain pockets of Australian territorial sea surrounding certain islands. Each State is only entitled to exercise residual jurisdiction in these waters if the other State provides consent. Waters located south of both the Seabed Jurisdiction Line and Fisheries Jurisdiction Line are subject to Australian jurisdiction.

E. Zonal Joint Management of the Torres Strait

Article 10 of the Torres Strait Treaty establishes 'A Protected Zone in the Torres Strait' (Protected Zone) that comprises 'all the land, sea, airspace, seabed and subsoil' enclosed by a line described in Annex 9 of the Treaty.[49] The Protected Zone straddles the Seabed Jurisdiction Line and surrounds all Australian islands in the Torres Strait except for those located close to the Cape York Peninsula. It also incorporates several islands allocated by the Treaty to PNG. The approximate extent of the Protected Zone is depicted in Figure 10.1.

The Protected Zone has two stated purposes. Article 10(3) of the Torres Strait Treaty provides that the 'principal purpose of the Parties in establishing the Protected Zone, and in determining its . . . boundaries, is to

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47 Torres Strait Treaty, Art 3(4).
48 Torres Strait Treaty, Art 2(1).
49 For coordinates and illustrative maps of the Protected Zone, see Torres Strait Treaty, Annexes 2, 6, 7, and 9.

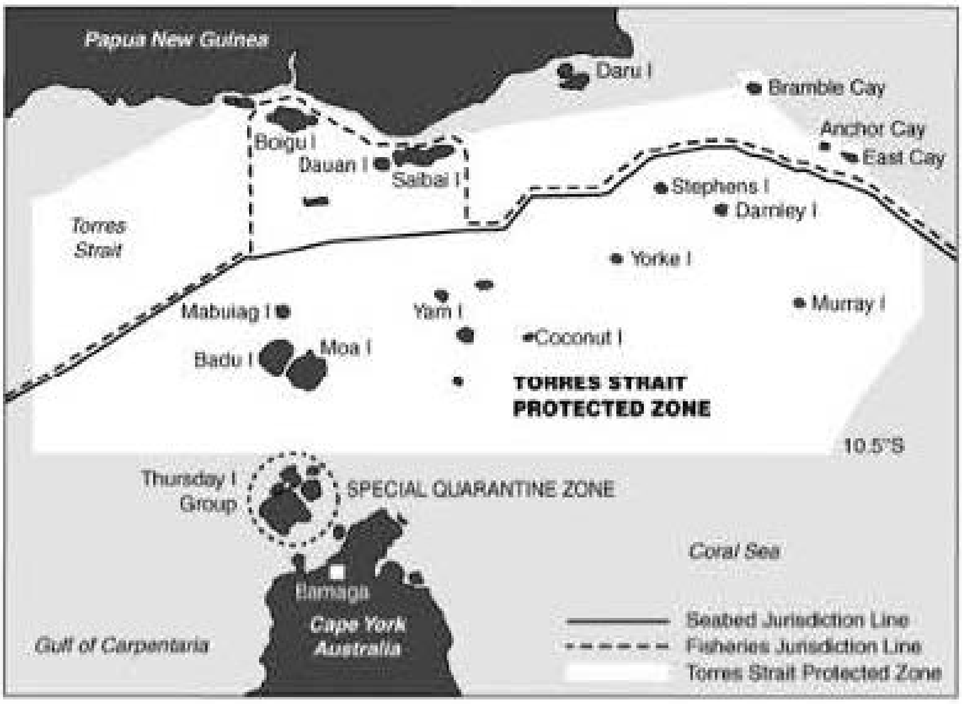

Figure 10.1 The Torres Strait Treaty: boundary delimitation and protected zone[50]

acknowledge and protect the traditional way of life and livelihood of the traditional inhabitants including their traditional fishing and free movement'. Article 10(4) of the Treaty provides that a 'further purpose of the Parties in establishing the Protected Zone is to protect and preserve the marine environment and indigenous fauna and flora in and in the vicinity of the Protected Zone'.

F. Cooperative Management of the Protected Zone

The Torres Strait Treaty contains complex provisions concerning the co-operative management of the Protected Zone and its resources by Australia and PNG. These provisions are addressed comprehensively in other literature[51] and will not be addressed in detail by this chapter. It

[50] This image is a derivate work of a map published on the Australian Department of Foreign Affairs website. Both the original and derivate works are subject to a Creative Commons Attribution 3.0 Australia licence.
[51] See for example, *supra* note 20.

is, however, relevant to note that within the Protected Zone, the Treaty provides several protections concerning the life and livelihood of traditional inhabitants of the Torres Strait. Australia and PNG are obliged to continue to permit free movement and the performance of lawful traditional activities (including traditional fishing) in and in the vicinity of the Protected Zone.[52] Certain traditional customary rights preserved by one State shall be extended to nationals of the other State on no less favourable terms.[53] Provided they are engaged in traditional activities, visitors to the Zone from either State are not subject to government controls concerning immigration, customs, quarantine or health.[54]

The Treaty also contains several mechanisms concerning environmental and wildlife protection in and in the vicinity of the Protected Zone. Australia and PNG are required to take legislative and other measures concerning the protection and preservation of the marine environment, including measures to prevent and control various sources of marine pollution.[55] In formulating these measures, each State is required 'take into account internationally agreed rules, standards and recommended practices which have been adopted by diplomatic conferences or by relevant international organisations'.[56] Both States are also required to consult and communicate with one another concerning (1) the environmental impact of planned activities and (2) the harmonisation and implementation of environmental protection and preservation measures.[57] Each State is obliged to use its best endeavours to control noxious species and identify and protect threatened indigenous fauna and flora.[58]

Articles 18 and 19 of the Torres Strait Treaty establish co-operative mechanisms concerning joint administration of the Protected Zone and implementation of the Treaty's provisions, including at a local level. Australia and PNG are required to designate one 'representative' each.[59] The two representatives are required to perform a wide variety of consultative and monitoring functions, particularly concerning the practical and local operation of the Treaty and the resolution of problems associ-

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52 Torres Strait Treaty, Art 11.
53 Torres Strait Treaty, Art 12.
54 Torres Strait Treaty, Art 16, which also reserves the right for each party to apply such measures in certain circumstances, including: to control abuses involving illegal entry or evasion of justice; and to address the outbreak or spread of disease or pests.
55 Torres Strait Treaty, Art 13(1) and (2).
56 Torres Strait Treaty, Art 13(1).
57 Torres Strait Treaty, Art 13(4)–(6).
58 Torres Strait Treaty, Art 14.
59 Torres Strait Treaty, Art 18(1).

ated with its implementation.[60] Each representative is based at a specified location in the Torres Strait region, unless circumstances require otherwise.[61] Both States are also required to establish and maintain a 'Torres Strait Joint Advisory Council' (Advisory Council)[62] comprised initially of at least two national representatives; at least one member from each of the relevant sub-national governments (the Government of Queensland from Australia and the Fly River Provincial Government from PNG); and at least three members representing the traditional inhabitants.[63] The functions of the Advisory Council are to review and discuss certain matters associated with implementation of the Treaty and to seek solutions to implementation problems.[64]

G. Seabed Mining and Drilling

Article 6 of the Torres Strait Treaty requires Australia and PNG to consult with a view to reaching agreement concerning the joint development of certain potential hydrocarbon deposits straddling the seabed boundary between both States.[65] Article 15 of the Torres Strait Treaty prohibits each party from undertaking or permitting seabed mining and drilling within the Protected Zone for a period of ten years following the Treaty's entry into force. As noted below, the moratorium on seabed mining and drilling in the Protected Zone has been extended on several occasions, most recently on an indefinite basis.

H. Joint Management of Marine Living Resources in the Protected Zone

The Torres Strait Treaty establishes a detailed co-operative framework concerning commercial fisheries in the Protected Zone. An important function of these provisions is to enable PNG to access a greater share of the Strait's marine living resources than its maritime zones would otherwise permit.[66] Article 20 of the Treaty affords priority to traditional fishing

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60 Torres Strait Treaty, Art 18(2)–(3).
61 Torres Strait Treaty, Art 18(4).
62 Torres Strait Treaty, Art 19(1).
63 Torres Strait Treaty, Art 19(6).
64 Torres Strait Treaty, Art 19(2). Note that the Advisory Council is specifically prohibited from assuming management or administration responsibilities, which the Treaty provides shall 'continue to lie with the relevant national, State, Provincial and local authorities': Art 19(3).
65 Note also Torres Strait Treaty, Art 5, concerning existing petroleum permits.
66 Kaye, *supra* note 2, at 103.

activities – provisions of the Treaty concerning commercial fisheries in the Protected Zone shall not prejudice traditional fishing, and both States are required to use best endeavours to minimise the impact of fisheries conservation measures on such activities. Articles 21–28 of the Treaty contain complex provisions concerning, inter alia: joint determination of a total allowable catch; allocation of this catch between Australia and PNG; negotiation of subsidiary conservation and management measures for individual fisheries; transitional measures; licensing arrangements; management of fishing within the Protected Zone by third States; and inspection and enforcement.

I. Other Cooperative Mechanisms

In addition to the various requirements discussed above, the Torres Strait Treaty obliges Australia and PNG to co-operate concerning the provision and maintenance navigational aids,[67] and the exercise of jurisdiction over certain shipwrecks.[68] Article 7 of the Treaty contains detailed provisions concerning freedom of navigation and over flight in the Torres Strait region and measures to be taken by Australia and PNG in this context.

J. Settlement of Disputes and Consultation

Article 29 of the Torres Strait Treaty provides that any dispute arising out of the interpretation or implementation of the Treaty shall be settled by consultation or negotiation. Article 30 of the Treaty obliges Australia and PNG to consult with each other, at the request of either State, on any matters relating to the Treaty.

IV. IMPLEMENTATION OF THE TORRES STRAIT TREATY

Despite being concluded in 1978, the Torres Strait Treaty did not enter into force until February 1985 upon exchange of instruments of ratification by Australia and PNG.[69] Final ratification of the Treaty was delayed until Australia and PNG could enact the required and complicated

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67 Torres Strait Treaty, Art 8.
68 Torres Strait Treaty, Art 9.
69 See Torres Strait Treaty, Art 32.

implementing legislation at multiple levels of government.[70] In the years following its signature the Torres Strait Treaty continued to receive firm support in Australia and PNG. Neither State appears to have seriously considered withholding ratification.[71]

In the two-and-a-half decades following its entry into force, the Torres Strait Treaty has continued to operate as the primary legal basis for close co-operation between Australia and PNG concerning management of the Torres Strait. Several aspects of the Treaty's co-operative mechanisms have been modified. The Advisory Council, established in accordance with Article 19 of the Treaty, has been supplemented by regular meetings between traditional inhabitants of the Torres Strait region[72] and regular meetings between government agencies involved in the Treaty's implementation.[73]

The initial ten year term of the Protected Zone seabed mining and drilling moratorium expired in 1995. The moratorium was extended on three occasions between 1995 and 2008.[74] In 2008 Australia and PNG agreed to extend the moratorium indefinitely.[75]

V. A MODEL FOR COOPERATIVE MANAGEMENT OF THE SOUTH CHINA SEA?

There are obvious parallels between the South China Sea and the Torres Strait. Both regions are subject to a tropical climate and exhibit a high degree of biodiversity.[76] The Torres Strait and South China Sea also contain complex coastal geography, being littered with a wide variety of islands, sand cays and drying reefs.[77] Apart from these general

[70] Charney and Alexander, *supra* note 32, at 929.

[71] Kaye, *supra* note 2, at 92.

[72] See Australian Department of Foreign Affairs and Trade, *Torres Strait Treaty and You*, online: www.dfat.gov.au/geo/torres_strait/index.htm. These are referred to as Traditional Inhabitants' Meetings.

[73] Ibid. These are referred to as Treaty Liaison Meetings.

[74] Australian Minister for Foreign Affairs and Trade, Press Release, 'Extension of the Torres Strait Mining Moratorium' (12 February 2008), online: www.foreignminister.gov.au/releases/2008/fa-s033_08.html.

[75] Ibid.

[76] Concerning biodiversity of the South China Sea, see Y Song, 'A Marine Biodiversity Project in the South China Sea: Joint Efforts Made in the SCS Workshop Process', (2011) 26 Int'l J Mar & Coast L 119.

[77] Concerning insular features in the South China Sea, see, e.g.: R Smith, 'Maritime Delimitation in the South China Sea: Potentiality and Challenges', (2010) 41 Ocean Dev & Int'l L 214.

characteristics of physical geography the two regions have little in common. Key differences will be discussed in the following paragraphs.

A. Economic and Strategic Significance

In sharp contrast to the Torres Strait region, the South China Sea is proximate to and surrounded by major population centres of the Asia-Pacific region. In absolute terms and for the surrounding coastal States, the economic and strategic significance of the South China Sea is not comparable to that of the Torres Strait. For example, fishing activities in the South China Sea produce approximately 10 per cent of the global catch,[78] which represents the fourth largest regional catch of the world's 19 major fishing regions.[79] South China Sea fisheries are a key source of livelihood for millions of people living in the region.[80] The South China Sea also contains some of the world's most important shipping lanes, which run both north–south between the Straits of Malacca and the East China Sea, and east–west from East Asia to Californian ports and the Panama Canal.[81] These shipping lanes are critical supply routes for oil imported by Japan, the People's Republic of China (PRC), the Republic of China/Taiwan (Taiwan) and the Republic of Korea.[82] There is persistent speculation that the South China Sea contains large untapped offshore hydrocarbon reserves, although recent research suggests that even on

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[78] C Schofield, 'Dangerous Ground: A Geopolitical Overview of the South China Sea' in S Bateman and R Emmers, *Security and International Politics in the South China Sea: Towards a Cooperative Management Regime* (Oxford/New York: Routledge, 2009), at 14–18.

[79] United Nations Environment Programme (UNEP), *Global International Waters Assessment: South China Sea: Regional Assessment 54* (2005), at 40–1, online: http://www.unep.org/dewa/giwa/areas/reports/r54/giwa_regional_assessment_54.pdf.

[80] C Rahman and M Tsamenyi, 'A Strategic Perspective on Security and Naval Issues in the South China Sea', (2010) 41 Ocean Dev & Int'l L 315.

[81] See (United Kingdom) Admiralty, *Ocean Passages for the World*, 5th edn (United Kingdom Hydrographic Office, 2004), at 240–3, cited in Rahman and Tsamenyi, ibid. A commonly cited statistic is that vessel traffic across the South China Sea involves, on an annual basis, approximately half of the global merchant fleet tonnage: Rahman and Tsamenyi, ibid.

[82] Japan, South Korea and Taiwan each import more than 80% of their crude oil via the South China Sea. Between 80–90% of oil imported by China (which imports over 50% of its total oil consumption) transits the South China Sea: Rahman and Tsamenyi, *supra* note 80.

optimistic estimates, these reserves would make a marginal contribution to the energy needs of the surrounding States.[83]

B. Importance of Insular Features for Human Settlement

As noted above, an overarching objective of the Torres Strait Treaty is to protect the life and livelihood of traditional inhabitants of the islands in the Torres Strait. Although several insular features in the South China Sea are inhabited, for the vast majority of features human habitation is dependent on food and water transported from elsewhere.[84] Accordingly, the interests of a culturally and linguistically distinct indigenous island population are not central to management of the South China Sea.

C. Complexity of Territorial and Jurisdictional Disputes

Prior to conclusion of the Torres Strait Treaty, competing positions concerning territorial sovereignty and maritime jurisdiction were asserted on a bilateral basis by a developed country (Australia) and a relatively smaller developing former dependent territory (PNG) who shared a common legal heritage and a close co-operative relationship. In contrast, the South China Sea is subject to a complex patchwork of overlapping claims to maritime zones of national jurisdiction asserted by Brunei, Indonesia, Malaysia, the Philippines, PRC, Taiwan and Viet Nam.[85] Further, all

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[83] Nick Owen, 'The Value of South China Sea Hydrocarbon Resources' (paper presented at Workshop concerning Maritime Energy Resources in Asia and Opportunities for Joint Development, Ho Chi Minh City, 5–7 August 2010) (unpublished), which finds the following: Optimistic forecasted production rates from undeveloped reserves in the South China Sea will not offset demand for imported oil. Rather, increasing consumption and falling productivity from existing fields is projected to far exceed the estimated production capacity of undeveloped reserves. With the exception of Brunei, all countries bordering the South China Sea are projected to become net importers of crude oil before 2015.

[84] Only a few insular features have surface fresh-water and around 13 islands have terrestrial vegetation that indicates a significant degree of soil formation: J.W. McManus *et al*, 'Toward Establishing a Spratly Islands International Marine Peace Park: Ecological Importance and Supportive Collaborative Activities with an Emphasis on the Role of Taiwan', (2010) 41 Ocean Dev & Int'l L 270. The largest island in the Spratly archipelago – Itu Aba (or Tai-Ping) is only approximately 1.4 kilometres long and 400 metres wide. The second largest island in the Spratly archipelago – Thitu Island (or Zhongye Dao) has an area of only 0.27 square kilometres. See: Smith, *supra* note 77.

[85] For further discussion see Chapter 2 in this volume, 'International Law, UNCLOS and the South China Sea' by Robert Beckman.

of these claimants, bar Indonesia, assert competing claims to territorial sovereignty over some or all of the insular features located in the South China Sea.[86]

D. Political and Military Tensions

Australia and PNG have a long history of peaceful and co-operative relations and shared priorities concerning the modalities of co-operative management in the Torres Strait. In the decades following World War II the Torres Strait region has been of limited military significance and no military tensions exist between Australia and PNG.[87] In contrast, relations between several of the South China Sea claimants are associated with a high degree of political and military tension. The competing territorial and jurisdictional claims asserted in the South China Sea are closely intertwined with strong nationalist political sentiment and key strategic interests of the relevant claimants. Given the salient differences discussed above, the design features of the Torres Strait Treaty, which will be discussed in the following paragraphs, are likely to be of limited use for addressing the competing positions advanced by South China Sea claimants.

E. Explicit Recognition of Sovereignty

As noted above, the Torres Strait Treaty clearly and explicitly recognises the sovereignty of Australia or PNG over certain insular features. It is difficult to imagine the application of equivalent provisions in a South China Sea context, at least in the medium term. The South China Sea claimants exhibit a high degree of sensitivity concerning sovereignty and jurisdictional disputes and are reluctant to act in a manner that may be perceived as detracting from their own claims.[88] Efforts by the relevant governments to acknowledge or seek a compromise concerning competing claims in the South China Sea are readily misconstrued during national

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86 Robert Beckman, ibid.

87 See Kaye, *supra* note 2, at 16–17, who also notes that it is difficult to place mines or operate large naval vessels in the Torres Strait.

88 For example, scholars have noted that, from the perspective of the PRC, recognition by the other claimants of their sovereignty and jurisdiction in the South China Sea is a precondition for discussions the Sea's co-operative management: Peter Kien-hong Yu, 'Setting Up International (Adversary) Regimes in the South China Sea: Analyzing the Obstacles from a Chinese Perspective', (2007) 38 Ocean Dev & Int'l L 147.

political debate as an inexcusable 'sell-out' of national interests. Further, allocation of any sovereignty to Taiwan would be politically impossible given the current diplomatic position of PRC concerning the status of the island and its government. Perhaps a better model for the South China Sea would be to develop measures that (1) do not mention sovereignty and jurisdictional issues at all, or (2) apply without prejudice to existing claims. Alternatively, co-operative measures could acknowledge a singular bearer of sovereignty and jurisdiction in a defined area, without specifying the identity of that State.[89]

F. Formal and Close Cooperation at Multiple Levels of Government

The Torres Strait Treaty also provides in formal terms for close co-operation between Australia and PNG in multiple functional contexts. Successful implementation of the Treaty depended upon implementation of complex legislation at multiple levels of government in Australia and PNG. Negotiation and implementation of the Treaty required sustained political will in both States over a period of several years. Given current political tensions in the South China Sea region and the diverse political and legal systems of the relevant claimants, the prospects of success for an equivalent implementation process would appear to be limited. Perhaps a better model for the South China Sea would be the further development of informal co-operative mechanisms, including: (1) communication channels between national authorities, (2) coordinated implementation and enforcement of existing national laws, and (3) coordinated development of complementary national laws and policy.

G. Emphasis on Protection and Conservation

The Torres Strait Treaty places a strong emphasis on environmental protection and resource conservation. It affords clear priority to traditional (as opposed to commercial) fishing activities and establishes a moratorium concerning hydrocarbon development. These design features are not appropriate for a South China Sea context, given the high degree of existing economic activity in the region and the dependence of surrounding States on such activity.

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[89] The latter suggested model is analogous to the basis on which negotiations have proceeded recently between PRC and Taiwan.

H. No Provision for Military Relations

The Torres Strait Treaty is not designed to reduce military tensions or strategic competition between its parties and does not contain provisions addressing these matters. Reduction of military tensions and strategic competition in the South China Sea is integral to co-operative management of the region.

Although the above aspects of the Torres Strait Treaty have limited utility given the present status of relations between the South China Sea claimants, the Treaty does contain several innovative design features that may serve as useful models for them to consider, as will be discussed in the following paragraphs.

I. De-coupling of Maritime Jurisdiction and Territorial Sovereignty

As noted above, certain Australian islands in the Torres Strait have no effect on the course of the maritime boundaries established by the Torres Strait Treaty. Indeed, several Australian islands are surrounded by waters subject to the jurisdiction of PNG. The de-coupling of maritime jurisdiction and territorial sovereignty enabled negotiators of the Torres Strait Treaty to simultaneously address Australia's desire to retain sovereignty over Torres Strait islands, and PNG's desire to gain greater control over the Strait's resources. The application of a similar approach in the South China Sea could facilitate exchange between claimants of strategic control over disputed insular features in return for authority over the surrounding waters and their resources.

J. De-coupling of Seabed and Water-Column Jurisdiction

The separate course of the Seabed Jurisdiction Line and Fisheries Jurisdiction Line defined in the Torres Strait Treaty enabled Australia to guarantee the ability of Torres Strait Islanders to access fisheries resources in the central Torres Strait without compromising PNG's access to potential seabed resources in that region.[90] The application of a similar approach in the South China Sea could facilitate exchange between the

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[90] See Kaye, *supra* note 2, at 95. Note however that there are several legal uncertainties associated with the allocation of superimposed maritime jurisdiction to different coastal States – for further discussion see Max Herriman and Martin Tsamenyi, 'The 1997 Australia-Indonesia Maritime Boundary Treaty: A Secure Legal Regime for Offshore Resource Development?', (1998) 29 Ocean Dev & Int'l L 361.

claimants of control over hydrocarbon resources in return for greater access to marine living resources of the region.

K. De-coupling of Resource Management and Jurisdictional Boundaries

Fisheries resources within the Torres Strait Protected Zone are managed on a zonal basis by Australia and PNG, reflecting the intention of Australia and PNG to 'ignore the jurisdictional delimitation provisions within the Protected Zone and to manage it as an entity'.[91] In a South China Sea context the application of a similar zonal management mechanism could provide a basis for the claimants to access a mutually acceptable share of marine resources, notwithstanding the underlying jurisdictional characteristics of the zone. Alternatively, this mechanism could enable South China Sea claimants to exchange underlying maritime jurisdiction in a defined zone in return for a greater share of the zone's resources.

L. Functionally Comprehensive Management

A noteworthy feature of the Torres Strait Treaty is the specific provisions concerning all functional aspects of coastal State jurisdiction, including those relating to preservation of the marine environment, marine scientific research and the production of energy from water currents and winds. Much of the current discussion concerning co-operative management of the South China Sea focuses on specific resources, in particular fisheries and offshore hydrocarbon deposits. The Torres Strait Treaty provides a model for managing these resources without overlooking other important functional rights and responsibilities of the relevant coastal States.

M. Commercial Fisheries Management

Putting the prioritisation of traditional fishing to one side, the detailed and flexible provisions in the Torres Strait Treaty concerning commercial fisheries management may provide a useful model for co-operative management of marine living resources in the South China Sea.

N. Accounting for Complex and Dynamic Physical Geography

The measures set out in Articles 2 and 3 of the Torres Strait Treaty (discussed above) are designed to prevent the delicate compromise reflected in

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91 Burmester, *supra* note 20.

the Treaty from being undermined by subsequent changes to the physical geography of the Torres Strait. They provide a useful model for avoiding unintended jurisdictional consequences associated with the disappearance of insular features, the formation of new insular features, and other coastline changes. Such provisions are particularly important given the predicted rise of global sea levels.

Annex 838

Jeff Smith, "The US-China South China Sea Showdown", *The Diplomat* (21 Oct. 2015), *available at* http://thediplomat.com/2015/10/the-us-china-south-china-sea-showdown/

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The US-China South China Sea Showdown

U.S. freedom of navigation operations could take the U.S.-China relationship past a point of no return.

By **Jeff Smith**
October 21, 2015

The United States and China are hurtling toward a showdown over Freedom of Navigation in the the South China Sea. The U.S. Navy is poised to sail near seven artificial islands China constructed in the Spratly archipelago over the past two years as a means to challenge any excessive or illegitimate Chinese sovereignty claims there. In Beijing, meanwhile, opposition to U.S. Freedom of Navigation Operations (FONOPs) around the artificial islands is hardening, as evidenced by the threat China's state-run Xinhua news agency issued last week:

> [America's] provocative attempts to infringe on China's South China Sea sovereignty are sabotaging regional peace and stability and militarizing the waters...China will never tolerate any military provocation or infringement on sovereignty from the United States or any other country, just as the United States refused to 53 years ago [during the Cuban Missile Crisis].

The commentary is troubling for several reasons. First, it continues a trend of increasingly confrontational and escalatory language. In May, Beijing was describing U.S. FONOPS around the artificial islands as "dangerous and irresponsible"; now they are an intolerable provocation and infringement on sovereignty. Second, as it was written in a state-owned Party mouthpiece, the article carries greater weight than the occasional caustic threat from a retired PLA general. Third, the language serves to further box China's leaders into more hardline positions, restricting their options for de-escalation and compromise. Finally, it represents how close the U.S. and China are to a crisis that could have and should have been avoided.

Not Their First Rodeo

Though it's been largely forgotten, this isn't the first stare-down between China and the Obama administration, and it's not the first time the latter has mishandled the situation. On March 26, 2010, early in Obama's first term, a North Korean midget submarine launched an unprovoked, surprise attack on the South Korean naval corvette *Cheonon* in the Yellow Sea, sinking the ship and killing 46 sailors.

While China refused to condemn the attack, in the aftermath Washington and Seoul announced a series of naval exercises to demonstrate resolve in the face of North Korean aggression. On June 1, news reports claimed the U.S.-ROK would conduct naval exercises in the Yellow Sea spearheaded by a U.S. aircraft carrier, the *George Washington*.

The *George Washington* had traversed the Yellow Sea as late as the previous October with no major protest from

Beijing, but China responded to the announcement with protests of "resolute opposition" accompanied by hawkish commentary from retired PLA generals. A diplomatic game of chicken ensued. First, Obama tried to split the difference, hosting exercises led by the *George Washington* in the less-contentious Sea of Japan. Yet the move was interpreted as a sign of American weakness and an embarrassment to South Korea, which had publicly claimed the *George Washington* would stand with it in the Yellow Sea.

In early August the Pentagon announced that "in the coming months" the *George Washington* would indeed take part in exercises in the Yellow Sea. "China is suffering the indignity of exercises close to its shores," explained Deputy Secretary of State James Steinberg, "and though they are not directed at China, the exercises are a direct result of China's support for North Korea and unwillingness to denounce their aggression."

Yet weeks later the administration *again* changed course when a Pentagon spokesman stated the *George Washington* would not participate in forthcoming exercises in the Yellow Sea. The standoff reached a conclusion only after another act of North Korean belligerence in November. Only a few months after the attack on the *Cheonon*, the DPRK unleashed a reckless artillery barrage on South Korea's Yeonpyeong Island, killing four and wounding 18. Days later the *George Washington* was dispatched to the Yellow Sea for drills and since then U.S. carriers have exercised in the Yellow Sea multiple times without major protest from Beijing.

A New Test in the South China Sea

Over the last two years China has dredged almost 3,000 acres of sand atop seven underwater features and rocks it occupies in the disputed South China Sea, creating new "artificial islands" atop which it has already built military-grade facilities and airstrips. The rapid pace of construction caught much of the U.S. government and analytical community off-guard, capturing mainstream attention only this year after U.S. think tanks like the Asia Maritime Transparency Initiative began publishing vivid satellite imagery demonstrating the unprecedented scope and scale of China's land reclamation work.

(The UN Convention on the Law of the Sea (UNCLOS) does not prohibit land reclamation but Article 60 bars states from claiming expanded rights for artificial islands built atop what were previously just rocks and low-tide elevations (LTEs). Rather than the expansive 12-nautical mile (nm) territorial sea and 200 nm Exclusive Economic Zone (EEZ) granted to "natural" islands, UNCLOS stipulates that artificial islands are only entitled to the rights enjoyed by the original feature before land reclamation — a 12 nm territorial sea for rocks above water at low tide, and a 500-meter safety zone for LTEs below water at low tide).

Fearing that China may claim expanded rights for the new artificial islands, almost immediately U.S. analysts began to call for "Freedom of Navigation Operations" (FONOPS) around the artificial islands. The FONOP program, in operation since 1979, simply involves sailing and flying ships and planes through waters and airspace to challenge (and make clear America does not recognize) illegal or excessive territorial claims.

This May, the FONOPS question garnered greater attention and urgency when U.S. Pacific Command invited a CNN crew to board a P-8 maritime surveillance aircraft as it patrolled the South China Sea near (but not within 12 nm of) China's artificial islands. Later broadcast on CNN, the crew recorded a Chinese operator identifying himself as "the Chinese Navy" and demanding the P-8 — which he said was entering a Chinese "military alert zone" — "leave immediately."

Even though China has refused to clarify what status it is claiming for the artificial islands, the warning raised concerns as UNCLOS does not recognize a "military alert zone" for any feature at any distance, let alone beyond 12 nm. The incident prompted renewed calls for the Obama administration to launch FONOPS within 12 nm of at least the features known to be LTEs prior to land reclamation, specifically Mischief Reef and Subi Reef (the others may have a legal case for a 12 nm territorial sea but not a 200 nm EEZ).

Shortly after the P8 incident, U.S. Defense Secretary Ashton Carter repeatedly asserted (three times in one week, by my count) that the U.S. military "will fly, sail, and operate wherever international law allows." Yet still no FONOPS were ordered while China's rhetoric began to grow more confrontational. On May 25 China's Foreign Ministry warned that FONOPS were: "highly likely to cause miscalculation and untoward incidents in the waters and airspace" and were "utterly dangerous and irresponsible." The same day, the more nationalist *Global Times* barked: "If the United States' bottom line is that China has to halt its [land reclamation] activities, then a U.S.-China war is inevitable in the South China Sea."

With the ball in America's court, the Obama administration's response was remarkably tepid. OnJune 18, U.S. Assistant Secretary of State for East Asian and Pacific Affairs Daniel Russel gave a public briefing in which he said: "As important as [the] South China Sea is … it's not fundamentally an issue between the U.S. and China." Puzzled by the statement, this writer responded with an article for *The Diplomat*, "Let's Be Real: The South China Sea IS a

China-US Issue," that argued the administration's delay on FONOPS represented a major strategic miscalculation. It implored Obama to "expeditiously and directly challenge any claim of expanded rights for the artificial islands by ordering the U.S. military to fly and sail within the legal limits accorded by UNCLOS." The reasoning was simple:

> *The longer America waits to challenge any new precedent, the more firmly it becomesprecedent. Further delay could actually raise the prospect for conflict and offer China an opportunity to blame Washington for any future confrontation by disrupting what had emerged as a peaceful status quo.*

It was not a particularly controversial position. The FONOPS question offers the rare case in foreign policy where the "gray zones" are overwhelmed by an abundance of black and white; where there is a clear and obvious policy option that is politically, legally, strategically, and morally sound, and supported by Congress, the Department of Defense, the U.S. military, America's regional partners, and the vast majority of international legal scholars and regional analysts.

Under questioning from the Senate Armed Services Committee, on September 17 even the head of U.S. Pacific Command, Admiral Harry Harris, admitted that he supported FONOPs around China's artificial islands. At the same hearing, Assistant Secretary of Defense for Asian and Pacific Security Affairs David Shear revealed that the operations were still awaiting a green-light from the White House, which has not approved a FONOP within 12 nm of the Chinese features since 2012.

A Risky Game of Chicken

What the White House has failed to appreciate throughout this drama is the longer it talks about FONOPS without actually conducting them, the more volatile the situation becomes, and the more pressure China's leadership feels to publicly adopt ever more strident and entrenched opposition. The rhetoric that has emerged out of Beijing in just the past month already exceeds anything witnessed during the Yellow Sea stare-down. Consider:

- On September 15, Chinese Vice Admiral Yuan Yubai, commander of the People's Liberation Army Navy's (PLAN) North Sea Fleet, told an international conference "the South China Sea, as the name indicates, is a sea area that belongs to China" and has done so since the Han Dynasty in 206 B.C.
- On September 16, PLA Senior Colonel Li Jie defended China's construction of military-grade airstrips on the artificial islands: "This is our backyard, we can decide what vegetables or flowers we want to grow."
- On October 2, the *New York Times* published an interview with popular firebrand Colonel Liu Mingfu in which he warned: "There are flames around Asia, and every place could be a battlefield in the future."
- On October 8, the *New York Times* published additional comments from Colonel Liu Mingfu, including: "[the U.S. and Japan] have been inciting our neighbors to provoke us…we are ready to engage in war"; "China has been doing all it can to prevent such a war, but we will surely be prepared for it"; "the U.S. has been punching & stabbing others with fists and knives" and; "China-US relations have entered the final stage of the game. It's a dangerous stage. There will be a final game between the two nations."
- On October 10 a "senior Chinese military official" told *Newsweek*: "There are 209 land features still unoccupied in the South China Sea and we could seize them all."
- On October 11 China's a Chinese Foreign Ministry spokesman stated: "We will never allow any country to violate China's territorial waters and airspace in the Spratly Islands, in the name of protecting freedom of navigation."
- On October 15 the nationalist *Global Times* was quoted as saying: the PLA "should be ready to launch countermeasures according to Washington's level of provocation…if the U.S. adopts an aggressive approach it will be a breach of China's bottom line, and China will not sit idly by."
- On October 15 Admiral Yang Yi warned the PLA would deliver a "head-on blow" to any foreign forces "violating" China's sovereignty.
- On October 16 Xinhua warned FONOPS "will leave China no choice but to beef up its defense capabilities." FONOPS would be a "grave mistake for [the U.S.] to use military means to challenge China" and "could lead to dangerous misunderstanding between the two militaries." China "will respond to any provocation appropriately and decisively."

It's not just belligerent rhetoric Beijing has employed, either. On September 4, for the first time ever, China dispatched naval vessels within 12 nm of Alaska's Aleutian Islands. It's noteworthy that their presence in U.S. territorial waters overlapped with a high-profile visit to Alaska by Obama. (The blatant double standard – sending warships through America's territorial sea while threatening the U.S. if it were to do the same to China – is of little concern to Beijing. In 2013 the Chinese Navy began patrolling in the EEZs around Hawaii and Guam, yet it maintains that U.S. military vessels must seek consent from Beijing to operate in Chinese EEZ). Less than two weeks after the incident in Alaska, a Chinese Xian JH-7 fighter-bomber "intercepted" a U.S. Air Force RC-135 in an "unsafe encounter" over international waters in the Yellow Sea, reportedly crossing within 500 feet of the nose of the U.S. plane.

The U.S. may not have suffered for dithering in 2010 in the Yellow Sea, and FONOPS around China's artificial islands may well proceed in the coming days and weeks without incident. But the U.S. is playing an exceedingly dangerous game of chicken with an increasingly dangerous actor. This is not the China of 2010. This is a more capable, confident, nationalist, and dangerous China. The margin for error is shrinking and the lesson this administration (and those that succeed it) must draw from this episode is: the next time there is a challenge to Freedom of Navigation, it must be addressed quietly and – most important – immediately.

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Annex 839

Chiang Huang-chih, "Itu Aba claim a distracting waste", *Taipei Times* (27 Nov. 2015), *available at* http://www.taipeitimes.com/News/editorials/archives/2015/04/02/2003614945

TAIPEI 台北時報 TIMES

Itu Aba claim a distracting waste

By Chiang Huang-chih 姜皇池 /
Thu, Apr 02, 2015 - Page 8

When asked if he would disclaim Itu Aba Island (Taiping Island, 太平島) of the Spratly Islands (Nansha Islands, 南沙群島), President Ma Ying-jeou (馬英九) replied quite atypically, saying that such ideas were "crazy." When it comes to territorial disputes, our countrymen are unusually brave, not to mention that Taiwan still controls Itu Aba Island. However, the question is why a huge sum of money has been spent on this tiny island more than 1,600km away from Taiwan proper.

Strategically speaking, Itu Aba Island is surrounded by shallow water and reefs. Merchant vessels basically avoid the area. Moreover, nearby islands within 10 nautical miles (18.5km) of Itu Aba Island are controlled by various other nations. Itu Aba Island is by no means in a position that allows it to control the sea lanes in the South China Sea.

From a military standpoint, can this island be used as a military base or port for warships? There is no oil or food on the island. There used to be fresh water, but after decades of over-extraction there is nothing left and water must be imported from Taiwan. All necessities, except sunlight and air, have to be supplied from outside the island.

How could Itu Aba possibly serve as a base for warships?

Furthermore, although Itu Aba Island is the largest of the naturally occurring Spratly Islands, its area covers only 45 hectares.

The terrain is flat, and there is no place to be used as a shelter; nor can any effective shelter be built on it. A military base on this island could be annihilated instantly.

During peacetime, it is workable to practice military parades and drills, raise the flag and sing the national anthem on the island, but once peace is over, all personnel on the island would be left with two choices: Surrender, or die for the country. There is no chance that they would be able to defend themselves until rescue arrives.

In terms of resources, there is not a single Taiwanese fishing boat within 800km of Itu Aba, because the distance is too far and the commercial value of the catch and revenue are not enough to cover operational costs.

Ironically, the maritime areas are the fishing grounds of Taiwan's neighbors, such as China, the Philippines and Vietnam. Over the past decades, Itu Aba Island has been used as an aid station or shelter for fishermen from these nations. Whenever they are suffering from any form of ailment or are in need of help of any kind, they call on Itu Aba for humanitarian aid.

As for the rumored oil resources, there is no evidence that there is abundant oil on the island. If there were, war would likely ensue, and not a drop of it would be sent back to Taiwan proper.

What about Taiwan's right to make itself heard on the global stage?

Taiwan has occupied this island for more than half a century, the longest of any nation, but whenever Itu Aba is discussed internationally, Taiwan has never been allowed to the table.

Before stepping down in 2008, then-president Chen Shui-bian (陳水扁) finished the construction of the island's airport and visited in person, publishing the Spratly Initiative. He is the only leader of any nation to have visited the Spratly Islands in person, but so what?

Let us not forget that the Spratly Islands are comprised of hundreds of atolls and islets, and that Itu Aba is just one of them. If even one small island is already beyond reach for Taiwan, how could we have the capability to lay claim to the entire Spratly Islands chain?

Furthermore, our current Spratly Islands policy was made decades ago, in a different situation, to complement the policy to destroy the eternally wicked Chinese communists and rescue our fellow countrymen suffering in China.

Today, however, ambassadors from the eternally wicked communist China are ordering us about as if they were representatives from heaven and our suffering fellow countrymen are now supporting us all.

Do we still uphold the old doctrine that we and the Chinese communists cannot coexist and that we have an obligation to retake China?

The "Republic of China" is no longer the China that covers 960 million hectares, has a population of 1.4 billion and boasts a history of thousands of years of dominance in eastern Asia.

National strength has weakened, the political climate regarding the Spratly Islands is ambivalent and money has been squandered defending the indefensible.

Is it time to face the music and carefully make the necessary adjustments?

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Translated by Ethan Zhan

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Annex 840

D. Pauly & V. Christensen, "Stratified Models of Large Marine Ecosystems: A General Approach and an Application to the South China Sea", in *Large Marine Ecosystems: Stress, Mitigation, and Sustainability* (K. Sherman, et al., eds., 1993)

Chapter 15

Stratified Models of Large Marine Ecosystems: A General Approach and an Application to the South China Sea

Daniel Pauly and Villy Christensen

Introduction

This contribution provides an approach for constructing models of large marine ecosystems (LMEs) as defined in Sherman (1990), Sherman and Alexander (1986, 1989), and Sherman and Gold (1990).

This contribution results from an attempt to follow up on some of the implications of the LME concept for ecological modeling, especially approaches that place emphasis on fish and other living resources, and hence on fisheries management. Conversely, we shall neglect models that emphasize only the lower part of food webs.

Modeling of LMEs: The Need, the Constraints, and a Resolution

Given our inability to conduct controlled experiments[1] at the LME scale and the absence of a comprehensive theory that could predict interactions within LMEs and their evolution through time, modeling of such systems appears to be a necessary tool to link understanding of organism-level interactions with ecosystem dynamics (Toft and Mangel, 1991).

The ecological models that might be considered for describing LMEs can be grouped into two broad, nondistinct classes: (i) dynamic models, built of coupled differential equations describing major transfer and growth rates and integrated to provide time series of, for example, biomasses for key species/groups; and (ii) steady-state models, in which the species/groups compared are assumed to maintain their biomass (and related statistics) around some average level, valid for the period under consideration.

Andersen and Ursin (1977) and Laevastu and Favorite (1977) developed models of the first type to describe resource dynamics in the North and Bering seas, respectively, and Larkin and Gazey (1982) developed the first simulation model of a tropical LME, the Gulf of Thailand.[2]

The latter model was used to illustrate that relatively simple simulation models can be rapidly constructed, parameterized, and used to test various competing hypotheses on the interactions among the resources of an LME, and between fisheries and their resources.

An often encountered problem with more comprehensive dynamic models is that the complex interactions among the simulated processes often lead to invalidation, even when using input data well within observed ranges. There are various routes for overcoming this constraint. One, briefly sketched by Larkin and Gazey (1982), consists of drastically reducing the number of processes that are simulated and increasing the number of external inputs. An example of this approach is the reduction of the North Sea model of Andersen and Ursin (1977) to Multispecies Virtual Population Analysis (MSVPA), which, for the fish in the system, requires the input of sizes at-age (rather than simulating individual fish growth) and which combines (externally inputted) catch-at-age data with numbers of consumed prey items to estimate biomasses using VPA (Sparre, 1991).

Another approach for dealing with the problem is to abandon all pretenses of being able to model LMEs realistically in the time domain, and to turn to the steady-state models described above.

Thus, Polovina (1984) reduced a dynamic

model, the Bering Sea model of Laevastu and Favorite (1977), to a static system of linear equations in which, for each species/group,

Production = exports + mortality
due to predation + other mortality ...1)

or in more detailed fashion, for any species/group (i),

$P_i = Ex_i + \Sigma B_j(Q/B_j)(DC_{ji}) + B_i(P/B_i)(1-EE_i)$ ...2)

where P_i is the production during any nominal period (here, 1 year) of group i; Ex_i represents the exports (fishery catches and emigration) of i; Σ_j represents summation over all predators of i; B_j and B_i are the biomass of the predator j and group i, respectively; Q/B_j is the relative food consumption of j; DC_{ji} is the fraction that i constitutes of the diet of j; B_i is the biomass of i; and $(1-EE_i)$ is the other mortality of i, that is, the fraction of i's production that is not consumed within, or exported from, the system under consideration. (In the text below, we refer to EE as "ecotrophic efficiency"; its definition is inverse to that of "other mortality.")

Polovina and Ow (1983) implemented this approach in the form of a program called ECOPATH, which they used to estimate the biomasses of the major species/groups of French Frigate Shoals, a coral reef system north of Hawaii.

Since its original presentation, the ECOPATH approach has been extended to include estimation of not only biomasses, but also of other variables in equation (2), and description of the network of trophic flow between the "boxes" of a model using the theory of Ulanowicz (1986) and related concepts (Christensen and Pauly, in press, a).

These changes led to a much improved ECOPATH II software system (Christensen and Pauly, 1991). The ECOPATH II was applied to a wide variety of aquatic ecosystems, ranging from aquaculture ponds in China to the Antarctic Shelf (Christensen and Pauly, in press, b). This exercise allowed evaluation of various aspects of the approach. Notably, it led to the conclusion that steady-state models such as ECOPATH can be used to model systems that are changing with time either: (i) by constructing models that apply to longer periods with no major changes in biomasses, and during which all rates and states can be averaged (see Walsh, 1981); or (ii) by constructing a model representing a "snapshot" of a rapidly changing situation, such as representing the midpoint of the growing period in an aquaculture pond, or a given month in a system subjected to strong seasonal oscillations (Jarre and Pauly, 1990[3]).

Our models are based on the first of these two approaches, with the bulk of the data used for model construction stemming from the decade from the mid-1970s to the mid-1980s.

The South China Sea: The Reality and the Models

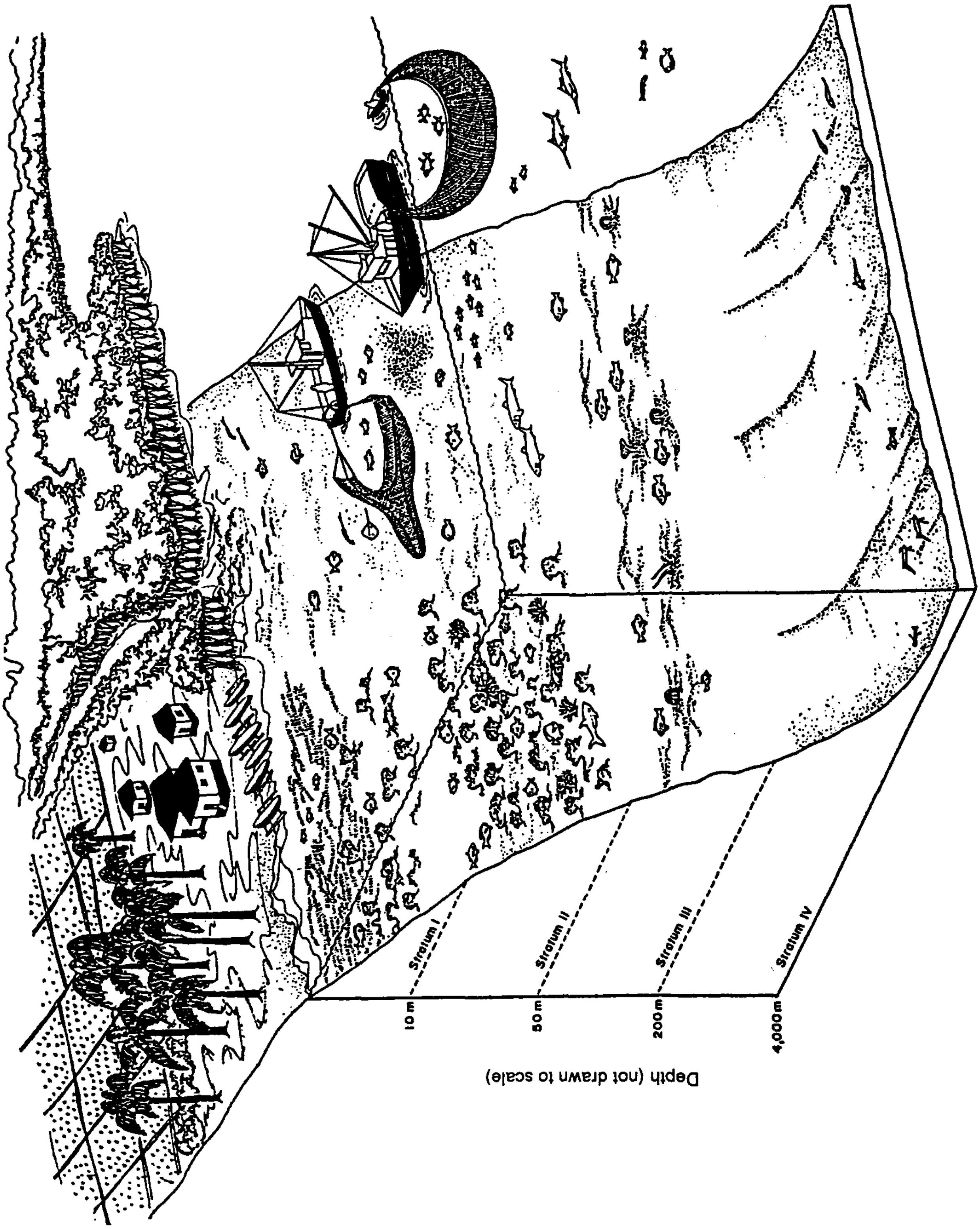
Figure 1 defines the South China Sea (SCS) as discussed here. We see the SCS as bounded in

Figure 1. Map of the South China Sea, as defined in this paper (i.e., 3.5 x 10^6 km^2), with 50 and 200 m isobaths and major coralline areas (thin dotted lines).

(1) We are aware that various uncontrolled experiments have been and continue to be conducted at the scale of the LME, for example, through overfishing or massive pollution.

(2) Walsh (1975) developed another early simulation model of a tropical LME, the Peruvian upwelling system; this is not discussed further here because it dealt mainly with phytoplankton production and consumption (i.e., with the lower part of the food web) and hence could not be used to deal with fishery management issues (as opposed, for example, to the model of the same system documented in Jarre *et al.*, 1991).

(3) This paper will appear in revised form in Christensen and Pauly (in press, b), together with other contributions from the same meeting cited here.


Depth (not drawn to scale)
10 m
50 m
200 m
4,000 m
Stratum I
Stratum II
Stratum III
Stratum IV

the north by the 25th parallel linking Taiwan and the Chinese mainland, and to the east by the Taiwanese coast, the 121° line between Taiwan and Luzon, by straight lines from Luzon to Mindoro and from Mindoro to Palawan, and by a line linking Palawan to northwestern Borneo (Shindo, 1973).

The southern limit is defined by a line crossing the Bangka and Karimata straits between Sumatra and Borneo at 3° S, while the western limit is the line crossing the Malacca Strait at 103° E, slightly west of Singapore.

The western border of the SCS includes a number of large subsystems, such as the Gulf of Thailand and the Gulf of Tonkin. These gulfs are completely open to the SCS proper. The SCS, as we have defined it, is an ecosystem bounded by rather narrow straits and sills. This system can be conceived as having negligible biological exchanges with other marine ecosystems. A point illustrating this is that the surface salinity in the SCS proper is relatively low because of large inflow from rivers and limited water exchange with open oceans (Wyrtki, 1961).

Overall, the SCS covers $3.5 \times 10^6 km^2$, or about 15 times the minimum size of an LME as conventionally defined (Sherman and Alexander, 1989). One implication of our choice of system is that we could not construct any single, manageable trophic box model reflecting the biological diversity of the subsystems (mangrove, coral reefs, soft-bottom communities, open seas) composing the SCS as a whole.

The approach we used was, therefore, to represent the overall system by a series of interlinked models representing subsystems (i.e., strata) as identified in Table 1. Here, the stratification ensures that the estimated biomasses of various species/groups and the extent of their trophic interactions remain biologically meaningful. Yet the interconnections between subsystems ensure that the overall system functions as an ecosystem, that is, with its various parts interacting (via export or import of production or detritus).

As a compromise between ecological reality and actual availability of data, we used the following strata for our overall SCS model (from inshore to offshore, see also Fig. 2):

(Ia) Estuarine, mangrove-lined, shallow waters down to 10-m depth

(Ib) Reef-flats/seagrass-dominated shallow waters down to 10-m depth

(IIa) Soft-bottom communities, from 10 to 50 m

(IIb) Coral reef communities, from 10 to 50 m

(III) Deep shelves, from 50 to 200 m

(IV) Oceanic waters, all areas deeper than 200 m.

The surface area of each stratum was determined by planimetry, whereas the separation of stratum I into Ia and Ib and of stratum II into IIa and IIb was done on the basis of a 9:1 ratio estimated by visual assessment of mangrove and coral maps in White (1983). This results, for the corals, in a total area for the SCS, which closely matches the estimate of Smith (1978) for the northern part of the "Southeast Asian Mediterranean."

We have further divided the most productive stratum (IIa) by describing soft-bottom communities from 10 to 50 m depth, into six substrata as follows (Table 1):

Table 1. Summary statistics for 10 subareas of the South China Sea (SCS).

Model	Depth (m)	Area ($10^3 km^2$)
A. Shallow waters	0 – 10	172
B. Reef-flats/seagrass	0 – 10	21
C. Gulf of Thailand	10 – 50	133
D. Vietnam/China	10 – 50	280
E. NW Philippines	10 – 50	28
F. Borneo	10 – 50	144
G. SW SCS	10 – 50	112
H. Coral reef	10 – 50	77
I. Deep shelf	50 – 200	928
J. Open Ocean	200 – 4,000	1,605
Total SCS	0 – 4,000	3,500

Figure 2. Schematic representation of a "slice" of the South China Sea (SCS) illustrating major elements considered in our 10 submodels of the SCS. Stratum I (0–10 m) comprises two subareas (mangrove-lined, "estuarinized" coasts, right, and reef-flats/seagrasses, left). Stratum I is exploited mainly by small-scale fishermen, including gleaning by women and children. Stratum II (10–50 m) also comprises two subareas (soft-bottom communities, right, and coral reefs, left). The former of these two subareas supports extensive trawl fisheries. Stratum III (50–200 m) represents the deep shelf, generally trawlable, but often unexploited because of technological or economic constraints. Stratum IV (200–4,000 m) represents the oceanic part of the SCS, in which only the large pelagics (tuna, billfishes) are exploited. (See text for details and quantitative estimates relating to this graph [kindly drawn by Mr. Chris Bunao, International Center For Living Aquatic Resources Management ICLARM Manila, Philippines]).

(i) Gulf of Thailand
(ii) Vietnam/China (the Vietnamese coast and southern China including Taiwan)
(iii) Northwest Philippines (entire Philippine SCS Coast)
(iv) Borneo (the northwestern coast of Borneo)
(v) Southwest SCS (representing the coast of eastern peninsular Malaysia, especially Kuala Terengganu, and southeastern Sumatra).

Each stratum or substratum is represented by a steady-state model constructed using the ECOPATH II software with the data documented briefly below. The following major biological interactions were assumed.

- The detritus (especially mangrove leaf litter), and the fish and invertebrate production not consumed inshore are exported from stratum I to the detritivores and carnivores of stratum II.
- The detritus, and the fish and invertebrate production not consumed in stratum II are exported to stratum III.
- The detritus, and the fish and invertebrate production not consumed in stratum III are exported to stratum IV.
- Only stratum IV exports detritus out of the South China ecosystem (for burial on the sediments covering bottoms deeper than 200 m).

The "real" SCS is characterized by far more interactions among its subsystems; however, we believe it appropriate at this stage to present a simplified implementation of our approach—one that would allow us to retain simplicity and ease of application.

Source of Data and Model Construction

For all consumer groups in all models, it is assumed that 20% of the consumption is not assimilated (Winberg, 1956). Throughout, wherever biomasses are not known, it is assumed that 95% of the production is eaten or caught (Ricker, 1968). A diskette with the 10 data sets is available from the authors, along with the ECOPATH II software and a user's manual (Christensen and Pauly, 1991).

Model A: Shallow waters (0–10 m, all around SCS)

This model for shallow waters (Fig. 3) is based on data from the Gulf of Thailand. The catches from the Gulf of Thailand in 1979 (SEAFDEC, 1981) were separated into two depth ranges (0–10 m and 10–50 m), based on the assumption that the large-scale fishery (excluding bamboo stake traps) operates between 10- and 50-m depth, whereas the small-scale fishery operates in the shallower parts of the gulf, where the bamboo stake traps are also located.

The biomass of the apex predators (mainly tuna) is from Olson and Boggs (1986) and originally pertained to a stock of eastern Pacific tuna. The diet matrix and estimates of production and consumption were nearly identical to that of the Gulf of Thailand model (below) with only minor adjustment to reflect differences in abundances.

The estimates of production and consumption rates were also taken from model C.

Model B: Reef-flats/seagrasses (0–10 m all around SCS)

The model for reef-flats/seagrasses (Fig. 4) is based on a model of areas near Bolinao, northwest Luzon, Philippines, described by Aliño *et al.* (1990).

The Bolinao model is characterized by extremely high primary production of seagrass and seaweeds, comparable to that of the most productive terrestrial ecosystems (Rodin *et al.*, 1975). This type of ecosystem is common only in the Philippine part of the SCS (White, 1983). We have therefore reduced the production of benthic producers in our model of reef-flats/seagrasses to 20% of the Bolinao model, so that the resulting primary production becomes similar to that of the other shallow water area (model A).

Model C: Gulf of Thailand (soft bottom, 10–50 m)

The groupings for this model of the Gulf of Thailand soft-bottom community (Fig. 5) are mainly based on information in Pauly (1979), assuming that only the tuna fishery operates in areas of the gulf that are deeper than 50 m. Zooplankton biomasses were adopted from Piyakarnchana (1989), assuming a mean water depth of 30 m and leading to a rather high estimate of 17.3 $g \cdot m^{-2}$. The benthic biomass is from Piyakarnchana (1989); those for the demersal fish groups are from Pauly (1979).

No reliable estimates of biomass were available for pelagics; the biomass of apex predators was based on information from Olson and Boggs (1986).

Only a few estimates of production/biomass ratios (P/B) are available from the Gulf of Thailand. For phytoplankton, the total produc-

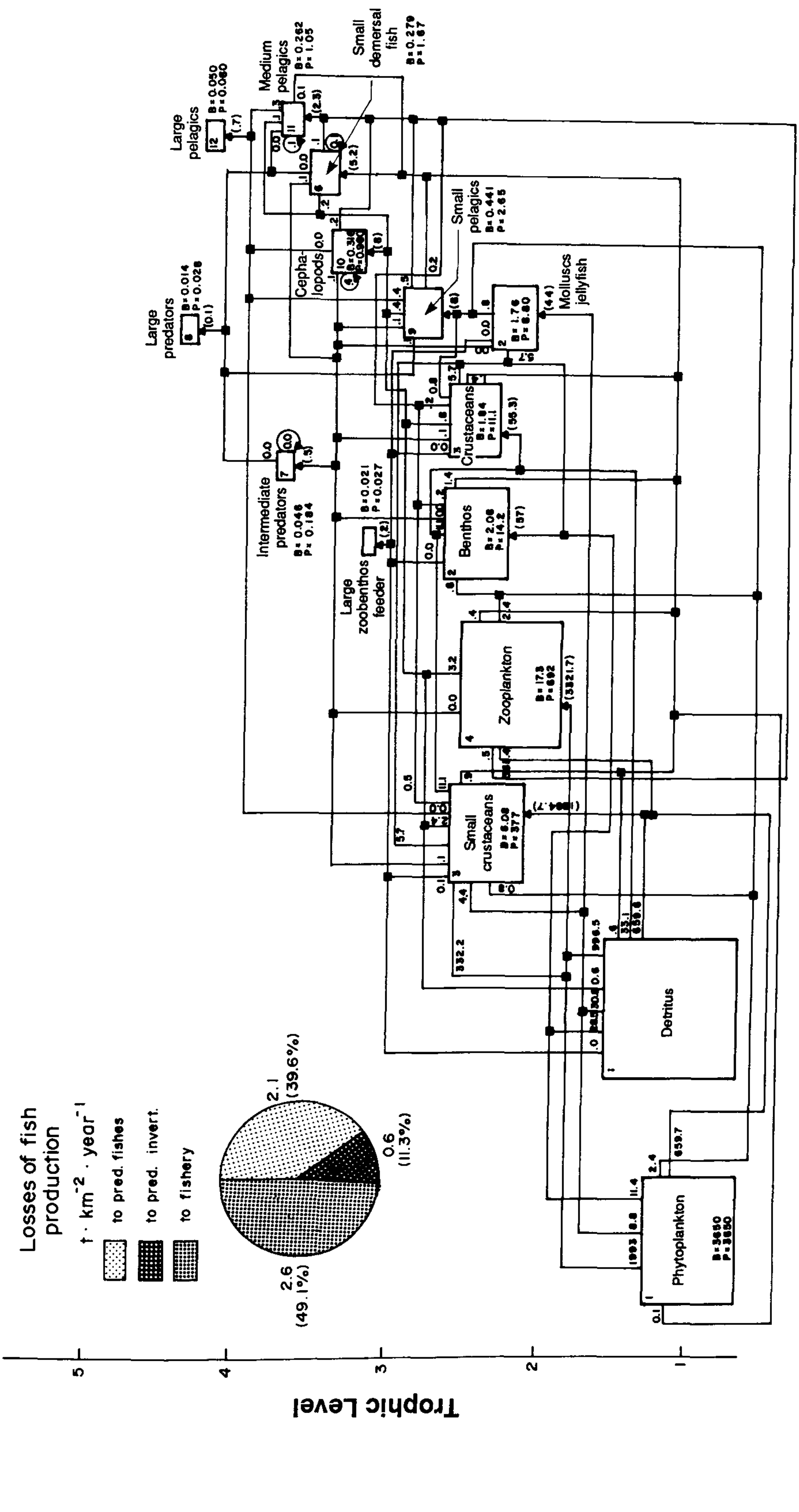


Figure 3. Model (A) of shallow waters (0–10 m) around the SCS, excluding reef-flat/seagrasses. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • year^{-1}; catches, respiration, and detrital backflows are omitted; see text for details on construction; based on miscellaneous data, including catches in SEAFDEC, [1981].)

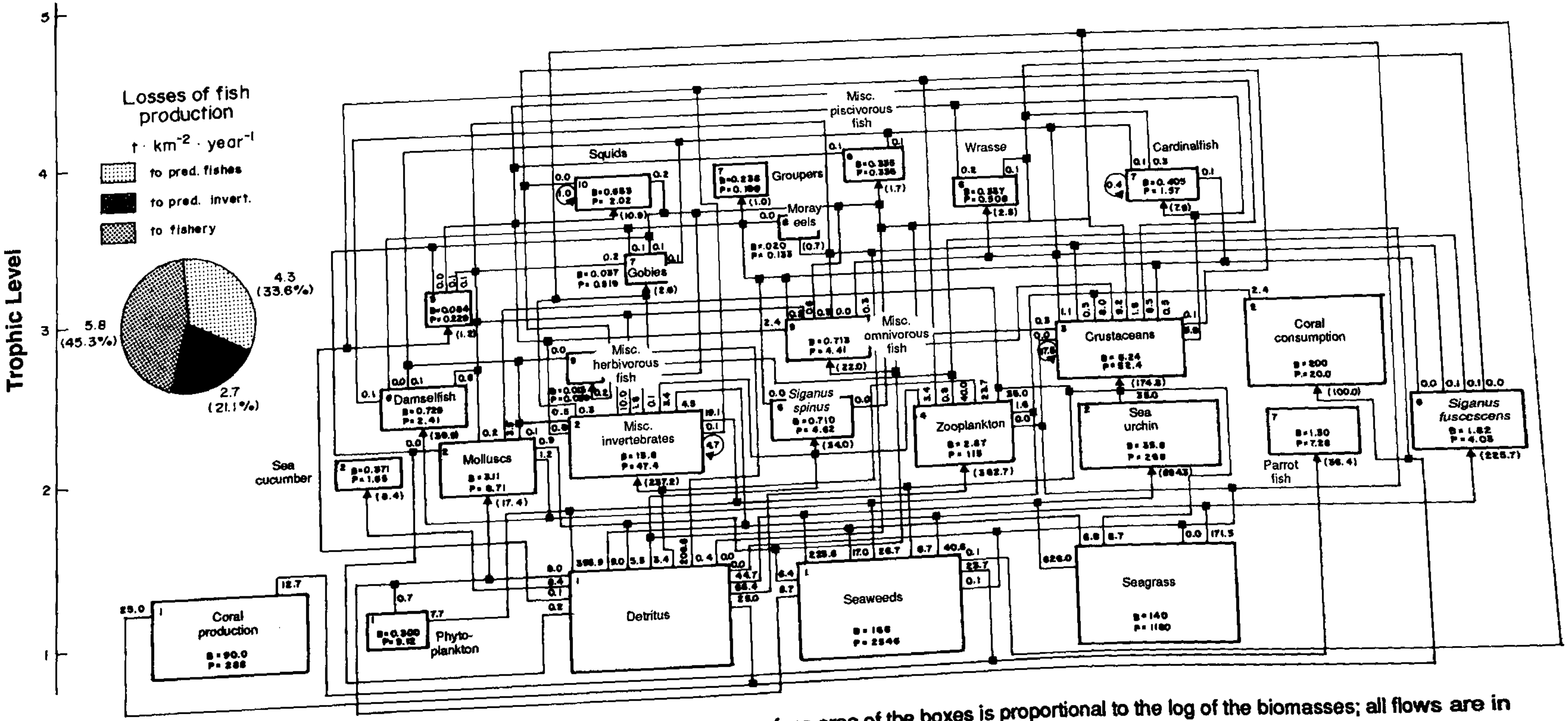


Figure 4. Model (B) of reef-flat/seagrasses areas (0–10 m) around the SCS. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km⁻² • year⁻¹; catches, respiration, and detrital backflows are omitted; see text for details on construction; based on Aliño *et al.*, [1990].)

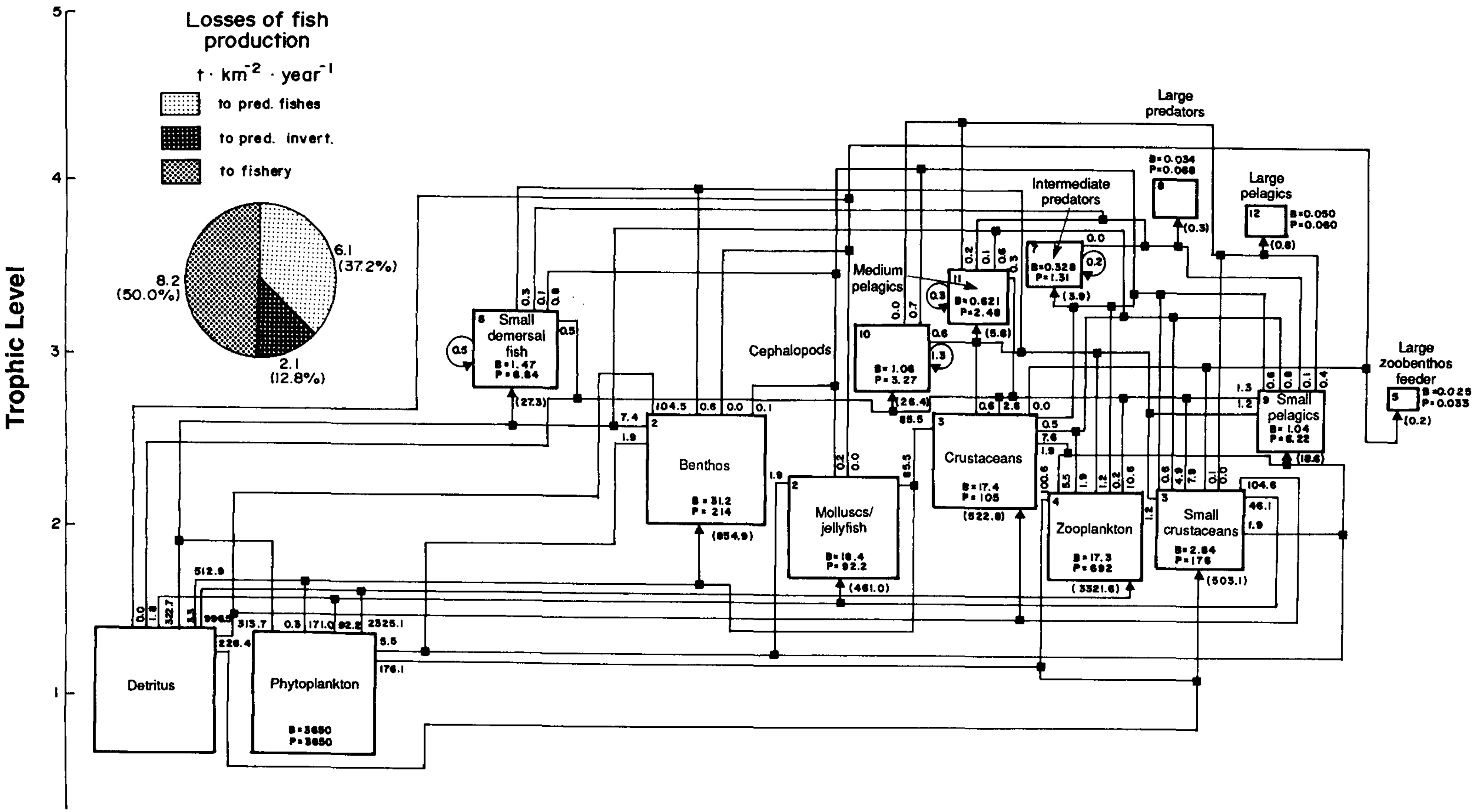


Figure 5. Model (C) of the Gulf of Thailand 10–50 m soft-bottom community. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • year^{-1}; catches, respiration, and detrital backflows are omitted; see text for details on construction; based on various information, with emphasis on data in Pauly [1979] and Piyakarnchana [1989].)

tion is approximately 1 g wet weight • m-2 • day-1 (Piyakarnchana, 1989). Jellyfish and molluscs were assumed to have a P/B ratio that is intermediate between the values reported by Silvestre *et al.* (1990) for heterotrophic benthos and the value for shrimps/crabs used here. The estimates for cephalopods and zooplankton are based on Buchnan and Smale (1981) and Polovina (1984), respectively. The P/B ratio for shrimp is based on Chullasorn and Martosubroto (1986), and the P/B ratio for benthos is from Liew and Chan (1987). The estimate for crustaceans is from Silvestre *et al.* (1990).

For the rays (i.e., our "large zoobenthos feeders") and for large predators, we have used the P/B estimates of Liew and Chan (1987). The P/B ratio for intermediate predators is within the range reported by Pauly (1980); the estimates for small pelagics and for small demersal fishes are based on Chullasorn and Martosubroto (1986).

The P/B value for medium-sized pelagics was assumed to be intermediate between those for large predators and for small pelagics. The P/B ratio for large pelagics was again from Olson and Boggs (1986).

For most fishes, consumption/biomass ratios (Q/B) were estimated from the regression of consumption as a function of temperature, weight, and feeding mode given by Pauly *et al.* (1990). Weights were estimated from mean lengths given by Pauly (1979). Mean Q/B values were estimated from the biomass-weighted means of Q/B values of the various species/groups.

For jellyfish, molluscs, and crustaceans, Q/B was estimated based on an assumption of a gross food conversion efficiency (production/consumption) of 0.2.

Q/B ratios of 29 and 16.6 were used for shrimp and cephalopods, respectively (Sambilay *et al.*, 1990). For zooplankton, a Q/B estimate of 192 was adopted from Ikeda (1977). The Q/B value for large pelagics was adopted from Olson and Boggs (1986).

There are a number of sources for diet compositions of the abundant fishes in Gulf of Thailand waters. Menasveta (1980) provides qualitative but useful information. Quantitative information is available in Menasveta (1986) for cephalopods, in Browder (1990) for shrimp, and in Liew and Chan (1987) for large zoobenthos feeders and large predators. Their diet compositions have been adapted here, in slightly modified form, to reflect local conditions.

The diet composition of small demersal prey fish is based on Yamashita *et al.* (1987), who give quantified diets for seven species/groups in this category, and on Menasveta (1980), who reports on the diet of two species. Yamashita *et al.* (1987) describe the diet of six intermediate predators. These, together with data in Siti and Taha (1986), Menasveta (1980), and Pauly (1979) were used to derive an average diet composition.

The sources of SCS diet compositions are as follows: small pelagics from Yamashita *et al.* (1987) and Menasveta (1980); medium-sized pelagics from Menasveta (1980); and large pelagics from Olson and Boggs (1986) and Tandog-Edralin *et al.* (In press).

Model D: Vietnam/China (Cape Cambodia–China, 10–50 m)

This is a very productive area for which primary production and phytoplankton biomass estimates are given by Nguyen (1989).

From the mid-1970s to the mid-1980s great changes occurred in Vietnam; thus, information on the fisheries is limited. Menasveta *et al.* (1973) reported that a substantial fraction of Vietnamese catches were taken by artisanal, nonmechanized boats in coastal and estuarine areas. Therefore, Vietnamese catch data are not included in the present (more offshore) model (Fig. 6). Yeh (1981) reports that the demersal resources off southern Vietnam were exploited primarily by Taiwanese vessels, and gives catch and effort data. Based on this information, catches and biomasses for the demersal fish groups could be estimated. These data are assumed to be representative for the whole Vietnam/China area.

The biomass of planktivorous fish was estimated by Nguyen (1989) as 3 g • m^{-2} for the whole Vietnamese shelf area and was separated into small and medium-sized pelagics based on an assumed 2:1 ratio. The catches for these groups were set at zero.

For the fish groups mentioned above, the P/B ratios were then estimated using the ECOPATH II program, assuming an ecotrophic efficiency of 0.95.

Zooplankton biomass and P/B were taken from Nguyen (1989) and the cephalopod biomass and catches from Yeh (1981).

For other groups, P/B and Q/B values are assumed to be similar to the values of model C.

Model E: Northwest Philippines (all Philippine coast, 10–50 m)

This model of the soft-bottom community along the northwestern Phillipine coast (Fig. 7) is based on data recently assembled by Guarin (1991) for an ECOPATH II model of the Lingayen Gulf, northwestern Philippines. This is a soft-bottom area fished intensively, mainly by trawlers (Silvestre *et al.*, 1989).

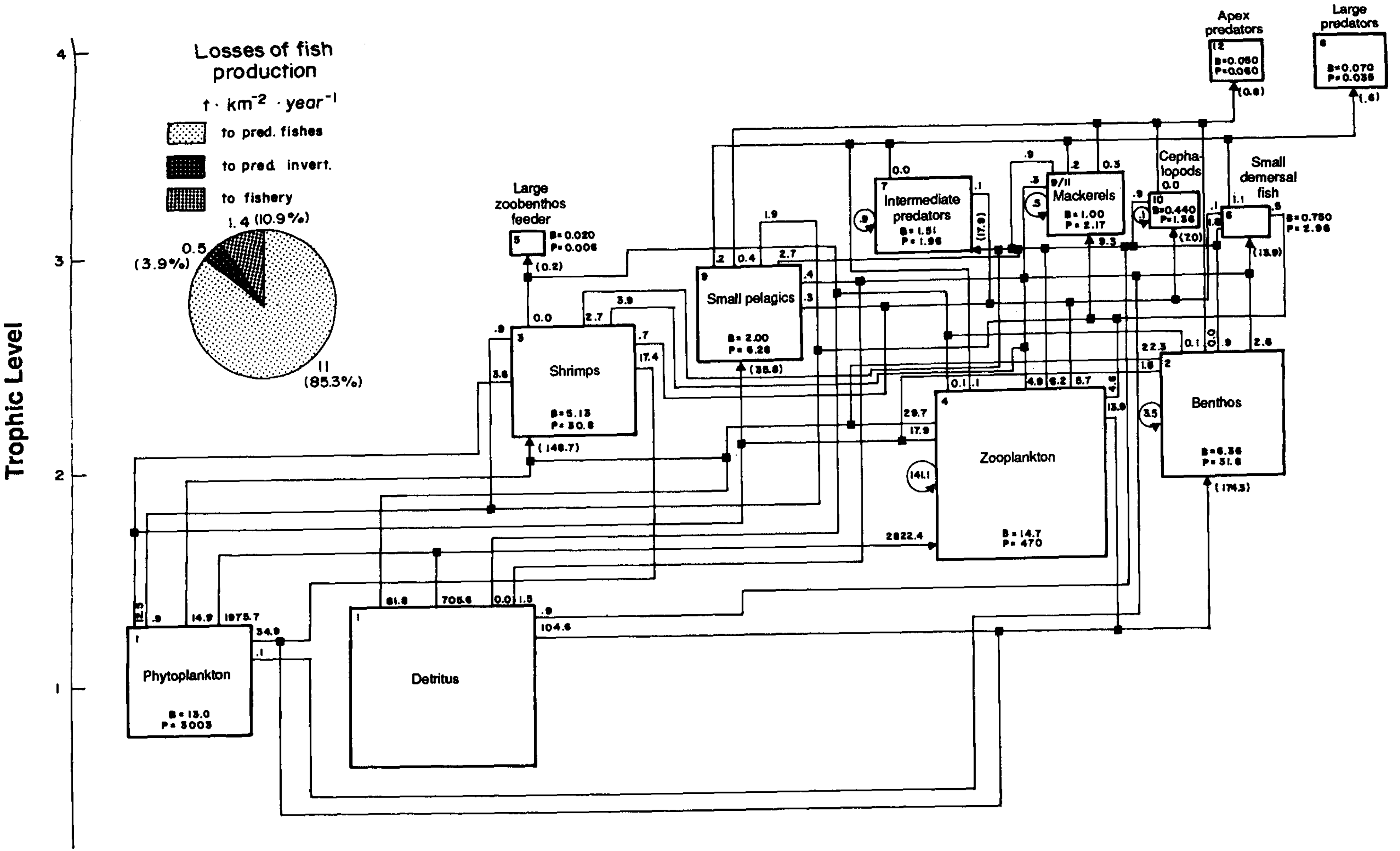


Figure 6. Model (D) of the soft-bottom community (10–50 m) off the coast of Vietnam and southern China, including Taiwan. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • year^{-1}; catches, respiration, and detrital backflows are omitted; see text for details on construction; based on various data sets, with emphasis on Nguyen [1989] and Yeh [1981]).

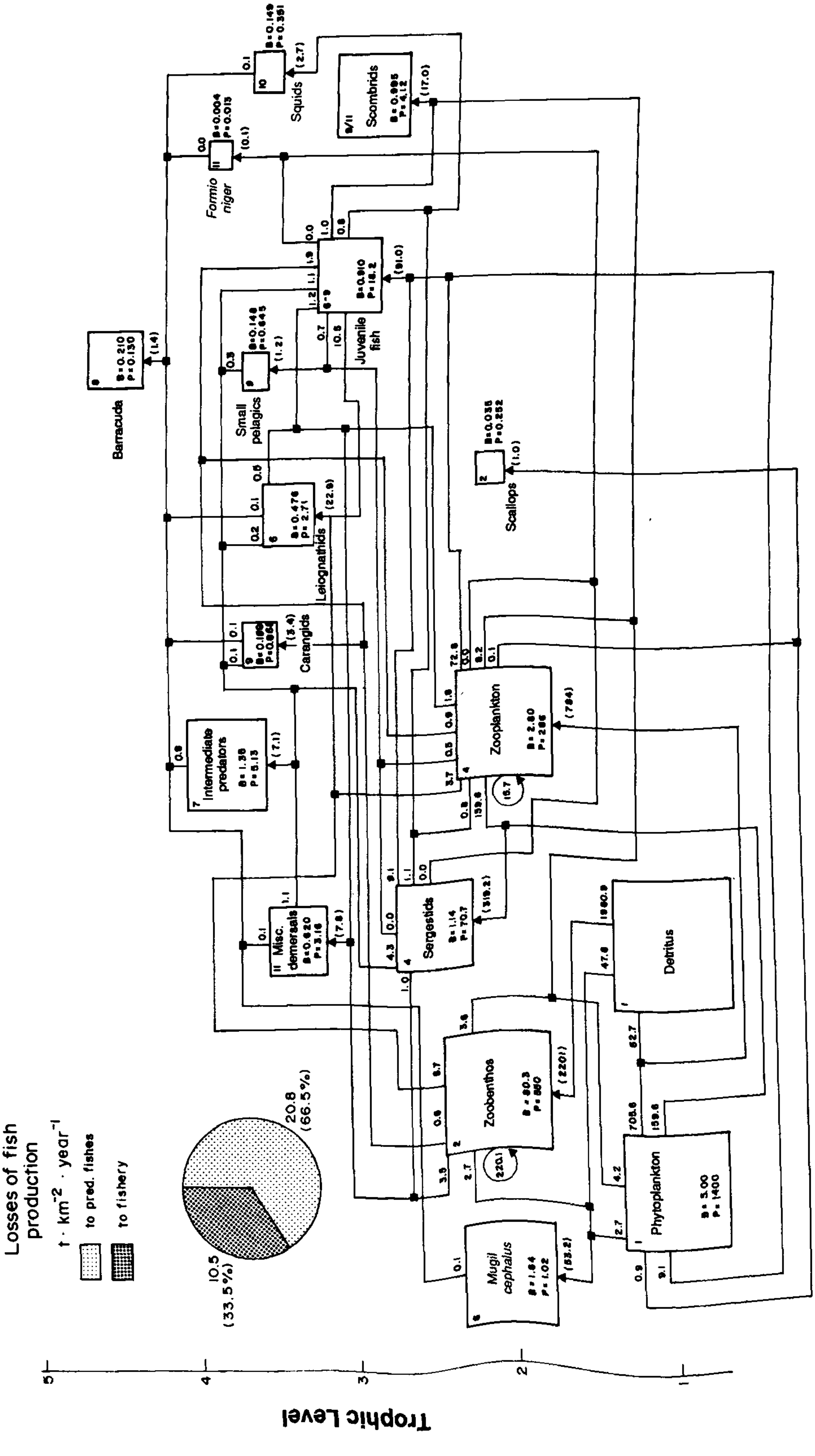


Figure 7. Model (E) of the 10–50 m soft-bottom community along the northwestern Philippine coast. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • year^{-1}; catches, respiration and detrital backflows are omitted; see text for details on construction; based on preliminary information from the Lingayen Gulf, assembled by Ms. F. Y. Guarin [pers. com.].)

Model F: Borneo (all Borneo coast, 10–50 m)

This model of the soft-bottom community (Fig. 8) is based on the model by *Silvestre et al.* (1990) of the moderately exploited Brunei Shelf and is also considered representative of the areas off Sarawak and Sabah, which have nearshore (0–10 m) fisheries, but where the more offshore areas only began to be exploited during the time period considered here.

Model G: Southwestern South China Sea (eastern peninsula of Malaysia and southeastern Sumatra, 10–50 m)

This model of the soft-bottom community (Fig. 9) is a modification of that of Liew and Chan (1987), who constructed a model of the area off Kuala Terengganu, on the eastern coast of western peninsular Malaysia. For this model, primary production is two-thirds of that in the Gulf of Thailand. This is supported by the pattern of primary production given by Lieth (1975) and the Food and Agriculture Organization of the United Nations (FAO) (1981).

Model H: Coral reefs (all around SCS, 10–50 m)

The model of coralline areas (Fig. 10) is based on Polovina's (1984) model of the French Frigate Shoals (FFS), north of Hawaii. This "import" of an entire model in the SCS appears legitimate because their latitudes are compatible. However, to render this model compatible with the other nine, we added detritus and detritivory by heterotrophic benthos.

FFS is an unfished ecosystem, whereas coral reefs in the SCS tended, in the 1970s, to be at least moderately exploited. To adjust for this, we deleted three apex predators (birds, monk seals, and tiger sharks) from the original model and treated their prey consumption as fishery catches. This adjustment resulted in a catch composition roughly similar to that observed from coral reef fisheries in the Philippines (Murdy and Ferraris, 1980).

Model I: Deep shelf (all around SCS, 50–200 m)

The deep shelf area utilized in this deep shelf model (Fig. 11) occupies more than one-quarter of the total SCS area. Yeh (1981) reported that the predominant fishing activity in this area is by Taiwanese vessels.

The primary production for this subsystem was estimated to be 0.2 g C • m^{-2} • day^{-1} or approximately 730 g wet weight • m^{-2} • $year^{-1}$ (Nguyen, 1989). In line with this relatively low primary production, the biomass of zooplankton is assumed to be 25% of that off Vietnam/China (10–50 m), whereas its P/B and Q/B values were taken as equal to those in model C.

For shrimp and crabs there are no catch or biomass data, and other parameters are assumed to be identical to those in model C. The benthos parameters were adopted from model D.

Information on catches of demersal fish groups is sparse. Based on the South China Sea Programme (SCSP) (1978), the catches in 1975 in two deep offshore areas (Gulf of Thailand, depths over 50 m, and Natuna Islands–Central Sunda Shelf) were estimated as 45,100 tonnes from 318,000 km^2 (i.e., 0.11 tonnes • km^{-2}). This estimate reflects a low fishing pressure and is assumed to be representative of the whole area. The biomasses of the demersal groups and cephalopods were estimated using data in Yeh (1981); the Q/B estimates were from model C.

No information seems available on the pelagic stocks in this subsystem. We have therefore assumed that the biomasses of small and medium-sized pelagics are 50% of those in model D. For both groups, the Q/B values were assumed to be similar to those in model C. The large pelagics group was assumed to have the same parameters as the other models.

Model J: Oceanic waters (central SCS, 200–4000 m)

This stratum covers nearly one-half of the SCS (1.6 million km^2). The fisheries are limited to catching large pelagic fishes, mainly tunas.

The system represented by this open-ocean community model (Fig. 12) is divided into the following components based on Blackburn (1981), Rowe (1981), and Mann (1984):

- Apex predators (tuna, billfish, swordfish, sharks, and porpoise) occurring in the upper 200–300 m. Olson and Boggs (1986), based on studies conducted in the eastern Pacific, estimated the biomass of this group as approximately 0.05 g wet weight • m^{-2}; the corresponding P/B was 1.2 $year^{-1}$ and the Q/B, 15 $year^{-1}$. Their paper also presents the diet composition of yellowfin tuna, used here as representative of the whole group. In the absence of reliable data for the SCS, the catch per area was also taken from this source.

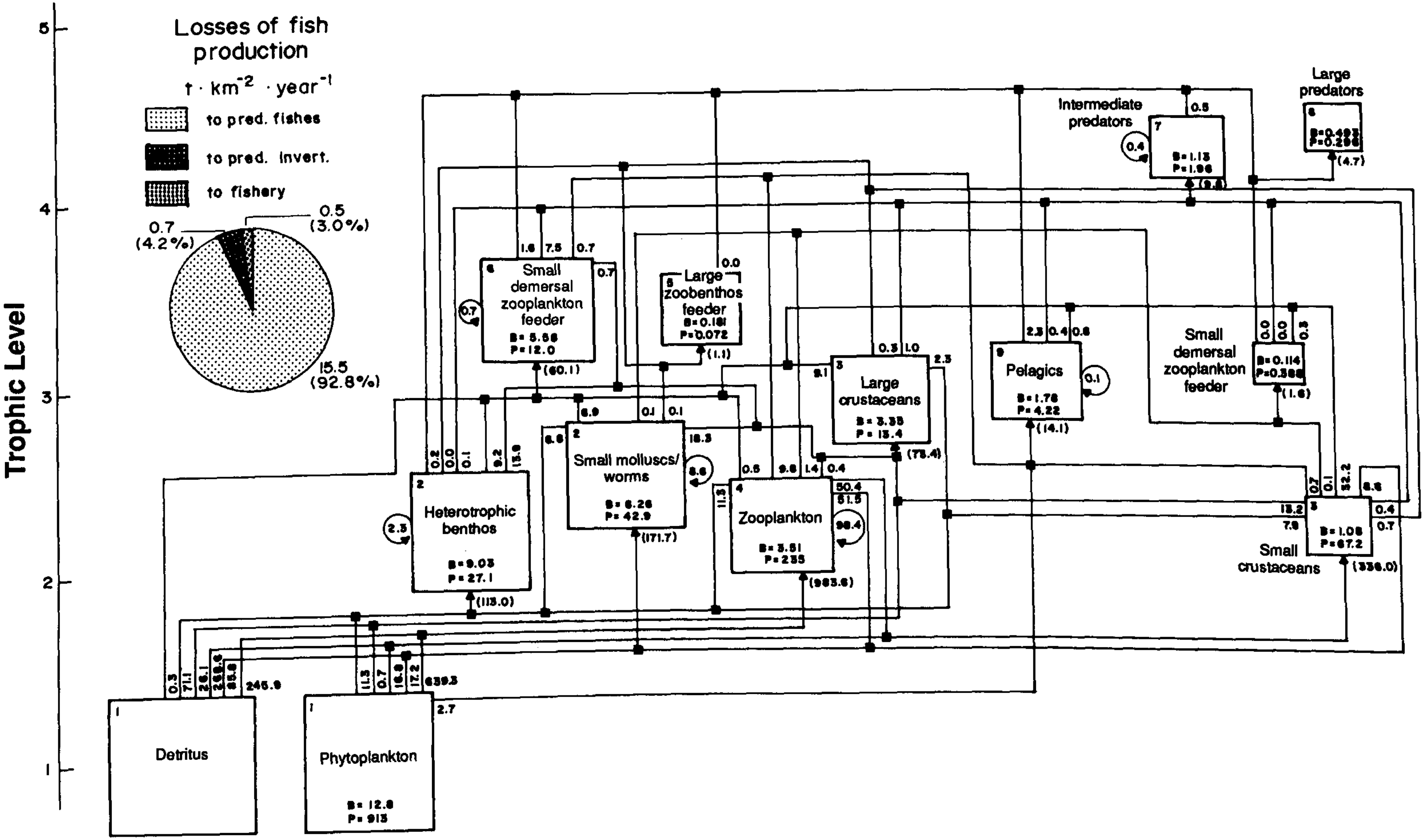


Figure 8. Model (F) of the 10–50 m soft-bottom community along the northwestern coast of Borneo. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • $year^{-1}$; catches, respiration, and detrital backflows are omitted; see also Table 1 and text for details on construction; adapted from a model of the Brunei Shelf assembled by Silvestre *et al.* [1990].)

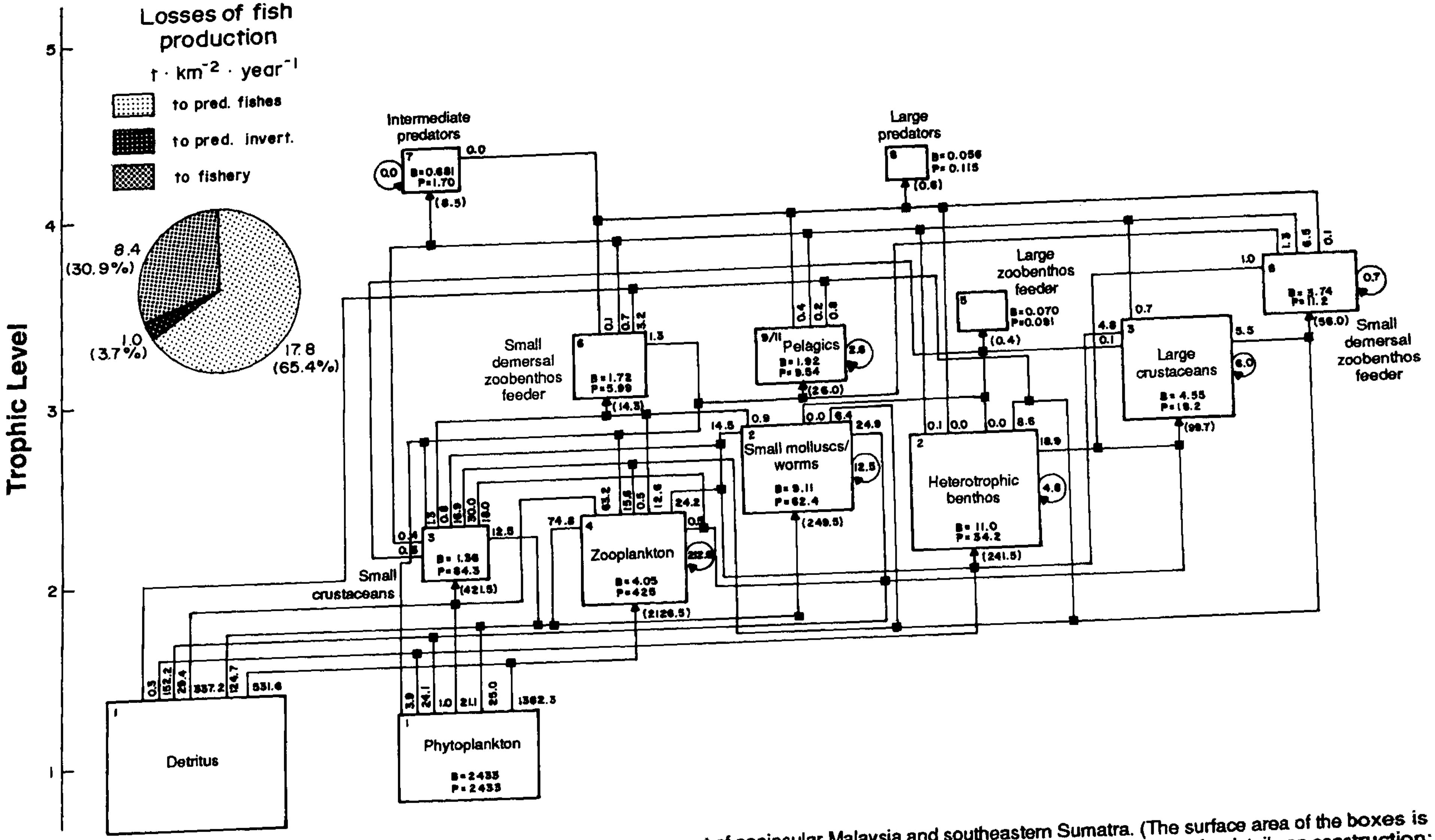


Figure 9. Model (G) of the 10–50 m soft-bottom community along the eastern coast of peninsular Malaysia and southeastern Sumatra. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • $year^{-1}$; catches, respiration, and detrital backflows are omitted; see text for details on construction; modified from model of Kuala Terengganu, Malaysia, of Liew and Chan [1987].)

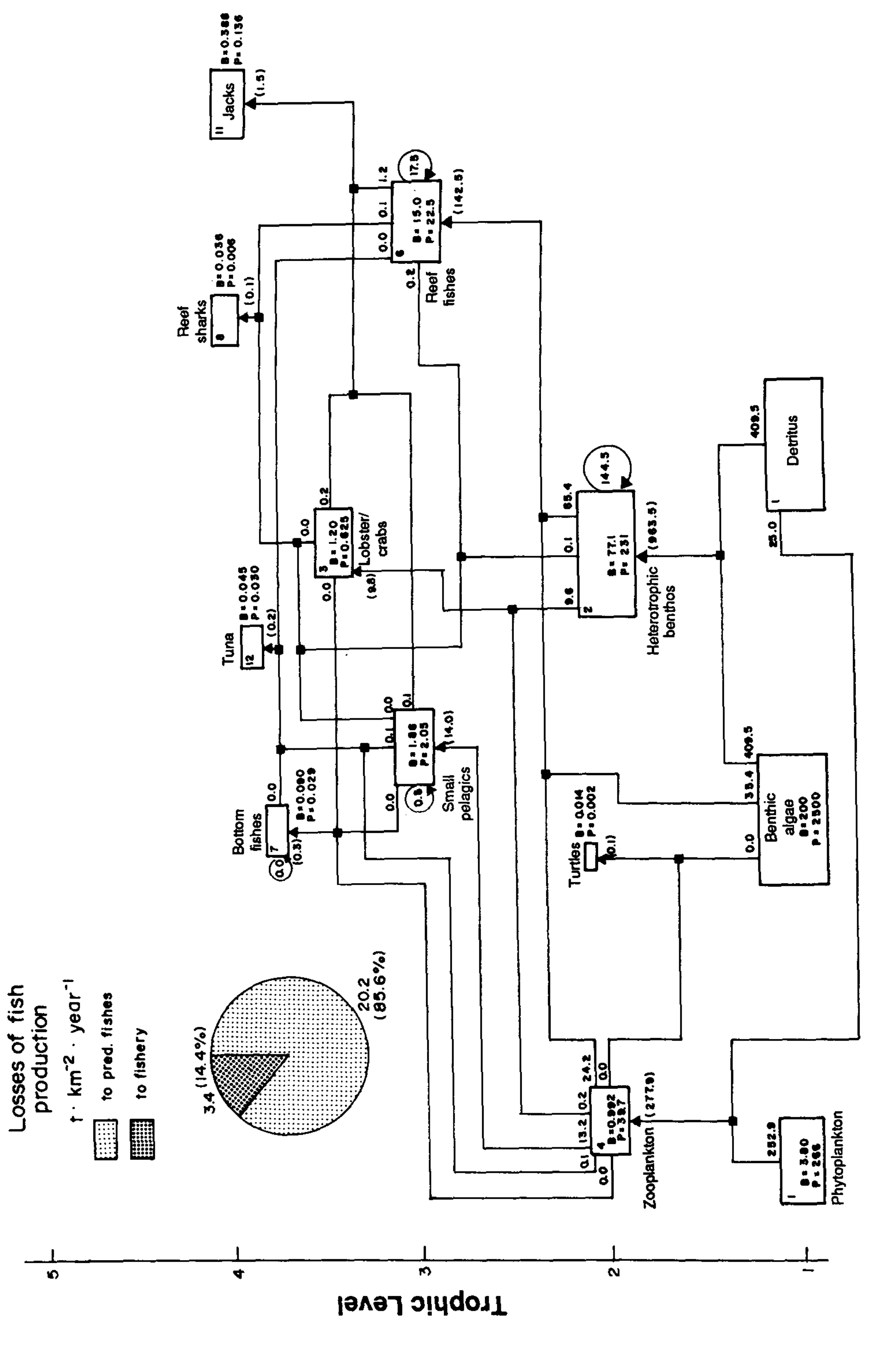


Figure 10. Model (H) of 10–50 m coralline areas around the SCS. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km^{-2} • year^{-1}; catches, respiration, and detrital backflows are omitted; see text for details on construction; adapted from Polovina [1984], through deletion of three top predators and their replacement by the fishery, and the addition of detritus and detritivory by heterotrophic benthos.)

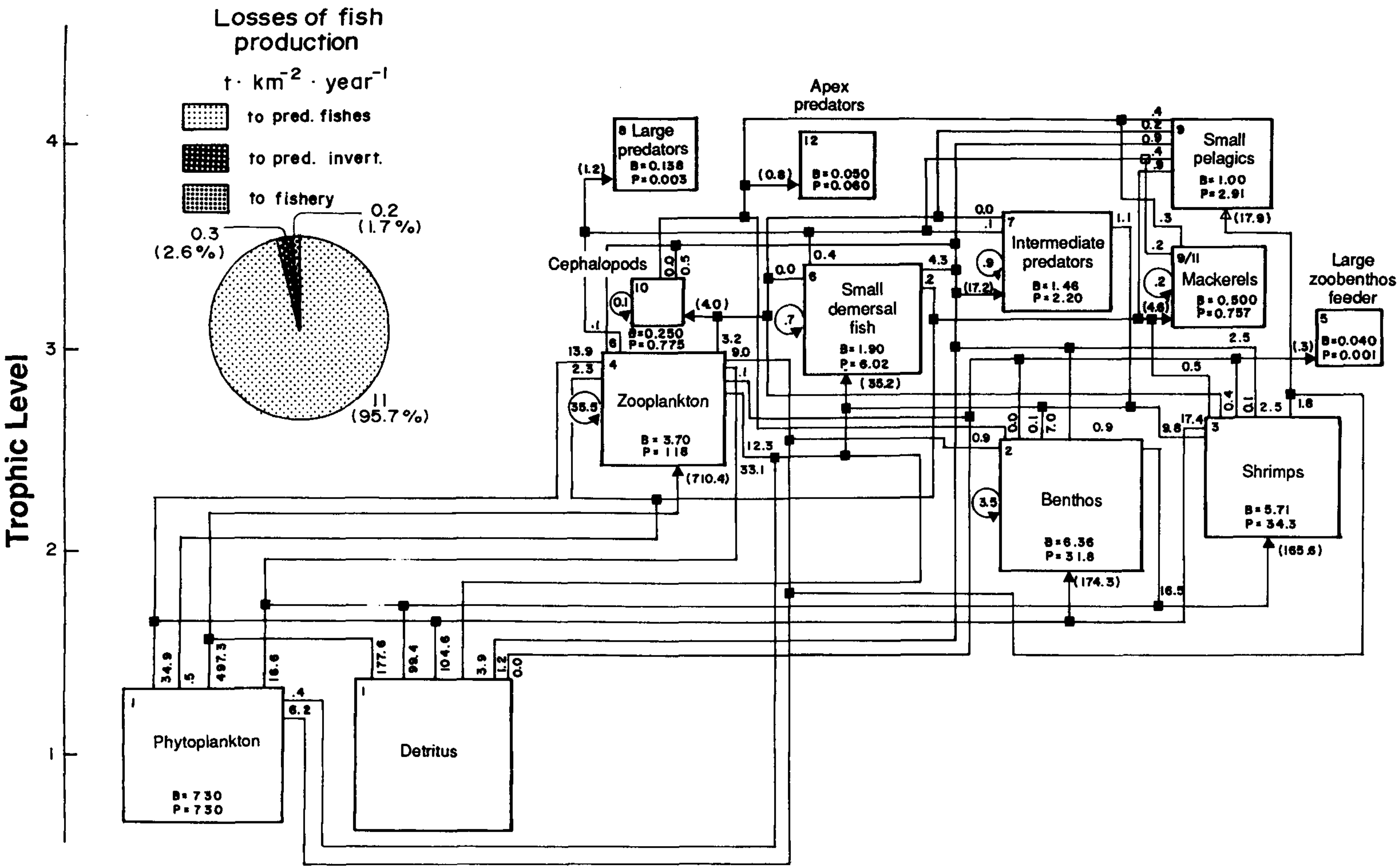


Figure 11. Model (I) of the 50–200 m soft-bottom, deeper shelf communities around the SCS. (The surface area of the boxes is proportional to the log of the biomasses; all flows are in tonnes • km⁻² • year⁻¹; catches, respiration, and detrital backflows are omitted; see text for data sources and details on construction.)

- Epipelagic nekton (mackerel, small tuna, nomeids, flyingfish, cephalopods) occurring in the upper 200–300 m. Mann (1984), considering oceanic areas in general, gives a biomass of 0.5 g • m^{-2} and a production of 0.5–1.3 g • m^{-2} • $year^{-1}$ (i.e., a P/B of 1.0–2.6 $year^{-1}$). We adopted a P/B value of 2 $year^{-1}$ and assumed a Q/B value of 9.3 $year^{-1}$, as for mackerel in model C. The diet composition is based mainly on Mann (1984).
- Mesopelagics (myctophids, gonostomatids, and sternoptychids) occurring between 200 and 1,000 m during daytime. At night, a large proportion of the mesopelagics migrate to the epipelagic zone to feed, mainly on zooplankton. The biomass of this group is assumed to be 2.6 g • m^{-2} based on data from the western central Pacific in Gjøsaeter and Kawaguchi (1980). Mann (1984) estimated the biomass to be in the range of 1.75–3.0 g • m^{-2}. As in Mann (1984), who used a bioenergetic model and derived a Q/B value of 2.9 $year^{-1}$ for the mesopelagics, we set the P/B value to 0.6 $year^{-1}$. Hopkins and Baird (1977) estimated that more than 70% (by volume) of their food consists of crustaceans.
- Bathypelagics (anglerfish and Cyclotone) occurring at depths greater than 1000 m. These fish tend to minimize their energy expenditure and are capable of taking prey over a large size range. Mann (1984) reported a biomass of 0.02 g • m^{-2} and a P/B of 0.1 $year^{-1}$. We used a Q/B value of 0.4 $year^{-1}$.
- Benthic fish (Bathysaurus, Chlorophthalmidae, Macrouridae, Moridae, and Brotulidae) for which there is scarce quantitative information. According to Mann (1984), their joint biomasses range from 1.0–2.0 g • m^{-2} (we used 1.5), and their P/B values from 0.05 to 0.10 $year^{-1}$ (we used 0.075); Q/B was assumed to be 0.3 $year^{-1}$. The diet composition was assumed based on scattered information in Mann (1984) and constrained the limited number of boxes used to describe the system.
- Benthos (amphipods, shrimp, and other decapods). Mann (1984) reported biomass as 5.0 g • m^{-2}, with a P/B value of 0.1 $year^{-1}$; Q/B was assumed as 0.4 $year^{-1}$.
- Zooplankton (larger copepods, euphausiids, and decapods). Blackburn (1981) reported biomasses as 8–13 g • m^{-2} (we used 10 g • m^{-2}), and Mann (1984) reported a P/B ratio of 0.5 $year^{-1}$. Q/B was assumed to be 2.5 $year^{-1}$.
- Phytoplankton. Blackburn (1981) reported primary production rates from oceanic areas of 0.1–0.5 g C • m^{-2} • day^{-1}. We adopted a value of 400 g wet weight • m^{-2} • $year^{-1}$, corresponding to a value in the lower part of the range given by Blackburn (1981).
- Microzooplankton. Blackburn (1981), in a review of low-latitude gyral regions, summarized information suggesting that the biomass of microzooplankton (which is usually not sampled) may be about 25% of that of net-caught zooplankton. The P/B and Q/B ratios were assumed to equal only half the P/B and Q/B values of inshore zooplankton, because of lower primary production.

Results and Discussion

The models

Each of the 10 models in this study has been drawn so that the area of a box is proportional to the logarithm of the biomass of the box. All boxes included the biomass (B) and production (P), in tonnes wet weight • km^{-2} and tonnes • km^{-2} • $year^{-1}$, respectively. To minimize the number of "wires" needed to draw the connections (i.e., energy flows) between groups, we used the following rules: (i) flows exiting a box do so from the top half of a box, whereas flows entering a box do it in the lower half, and (ii) flows exiting a box cannot branch, but they can be combined with flows from other boxes, if they all go to the same box.

Backflows to the detritus box, respiration, and fishery catches have been omitted on Figures 3–12 for the sake of clarity. Nonetheless, all boxes have been balanced by the ECOPATH II system so that inputs equal outputs.

Based on these models, some generalizations can be made. They are presented in Table 2, which includes the total primary production of each of the 10 areas. This varies between 4,000 g • m^{-2} • $year^{-1}$ in the highly productive reef-flat/seagrass area down to 400 g • m^{-2} • $year^{-1}$ in the open-ocean waters.

Primary production

The general pattern of primary production indicates high production in coastal and gulf areas and decreasing production with

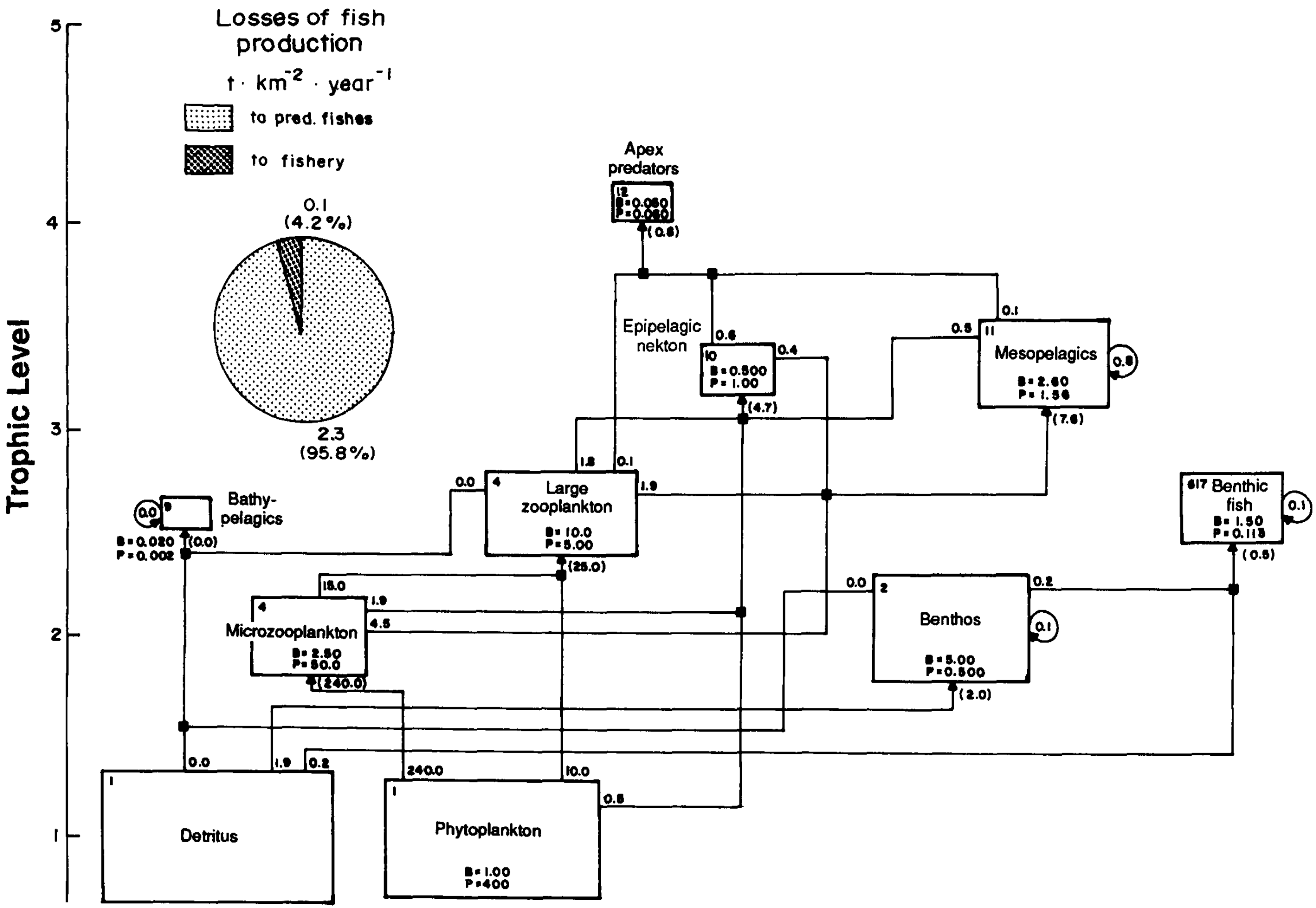


Figure 12. Model (J) of the 200–4,000 m SCS open-o boxes is proportional to the log of the biomasses; all flows are in tonnes •
km^{-2} • year^{-1}; catches, respiration, and detrital backflov details on construction.)

Table 2. ISSCAAP numbers and common names of fish and invertebrates caught in the SCS and their corresponding "boxes" in ECOPATH II models in Figs. 3 to 12.

ISSCAAP numbers*	Common names†	"Box" number‡	ISSCAAP numbers*	Common names†	"Box" number‡
921	sea weeds	1	3403	mullets	6
941	misc. plants	1	391/392	misc. fishes (+ 3320/3412)	6
831	sponges	2	3301/2	catfishes & eels	7
751	sea urchins	2	3303	lizardfish	7
752	sea cucumbers	2	3305	groupers	7
761	jellyfish	2	3307/8	misc. snappers	7
581	misc. mollusks	2	3313	drums & croakers	7
541	mussels	2	3316	bigeyes	7
531/2	oysters	2	3404	threadfins	7
551	scallops	2	381	sharks	8
561	cockles	2	3304	pike & conger eels	8
562	misc. bivalves	2	3402	barracuda	8
421	swimming crabs	3	351/2/3/4	clupeids	9
422	mangrove crabs	3	373	Indian mackerels	9
431	spiny lobsters	3	3309	fusilier	9
432	slipper lobsters	3	3405	round scads	9
451/2	penaeid shrimps	3	3408	hardtail scads	9
471	misc. crustaceans	3	571/2	cuttlefish/squids	10
—	sergestids/zooplankton	4	3410	black pomfret	11
382	rays	5	375	hairtail	11
311/3/4	flounders, soles	6	374	Indopacific mackerel	11
312	Indian halibut	6	371/2	king mackerel	11
3306	sillago whiting	6	3406/7	misc. jacks	11
3311	pony fishes	6	3411	white pomfret	11
3312	grunters/sweetlips	6	355	wolfherring	11
3314	goatfishes	6	368	sailfish & billfish	12
3317	breams	6	361–367	tuna & frigate mackerels	12
3319	rabbitfishes	6			

* These numbers refer to a coding system developed by FAO, the "International Standard Statistical Classification of Aquatic Animals and Plants."

† Some common names were adjusted to account for the pooling of ISSCAAP groups.

‡ Number-specific definition of the "boxes" (see text and Figs. 3–12, 14) are:
1: benthic producers
2: misc. invertebrates
3: crustaceans (excl. plankton)
4: sergestids/zooplankton
5: large zoobenthos feeders
6: small demersal prey fishes
7: intermediate predators
8: large predators
9: small pelagics
10: squids and cuttlefish
11: medium pelagics
12: large pelagics

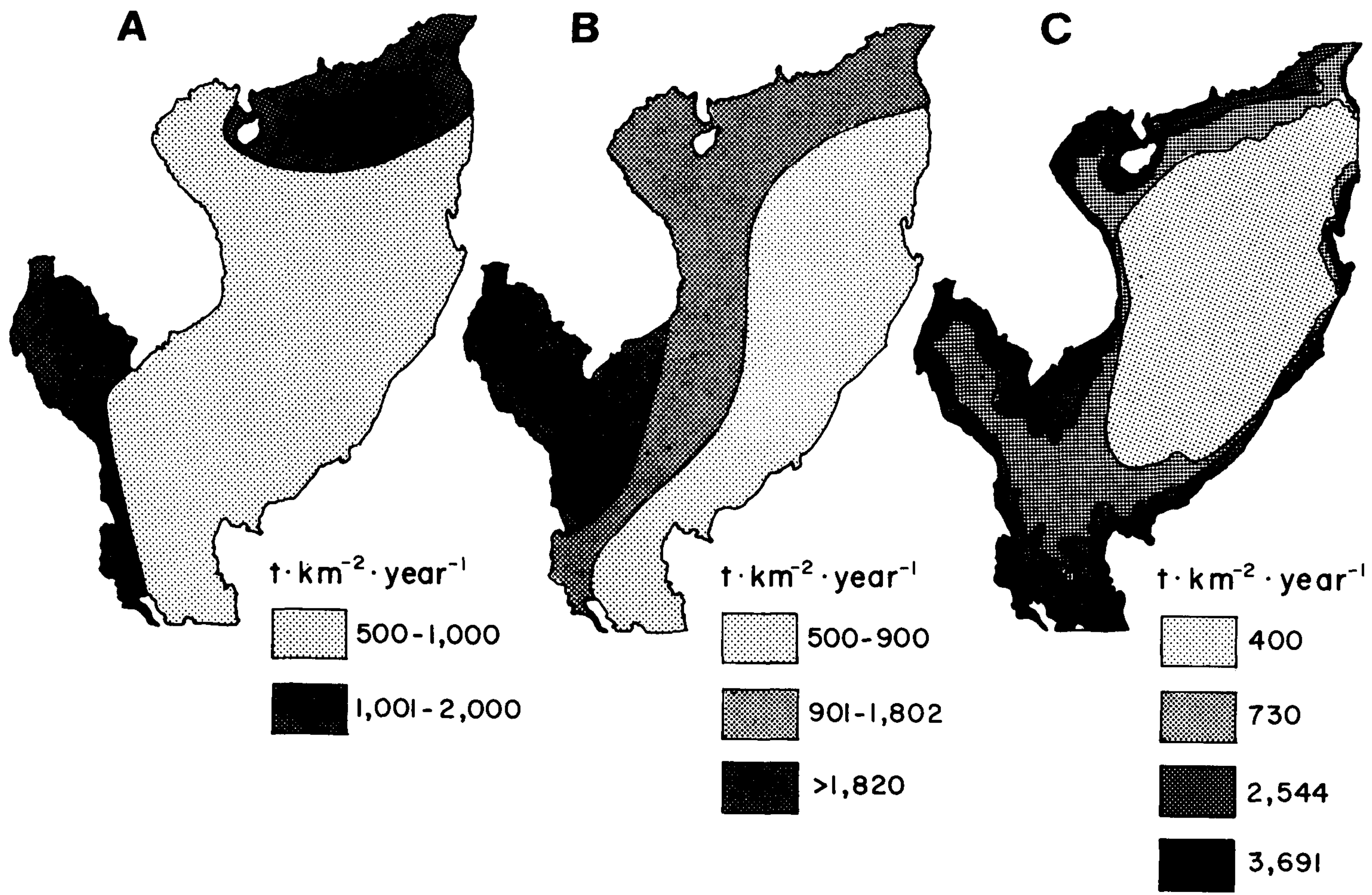


Figure 13. Mean annual distribution of primary production in the SCS. Map A, adapted from Lieth (1975), suggests a primary production of $3.36 \cdot 10^9$ tonnes per year for the entire SCS. Map B, adapted from FAO (1981), suggests a total primary production of $4.2 \cdot 10^9$ tonnes per year if one assumes, as in Lieth (1975), an upper limit of 2,000 tonnes • km^{-2} • year^{-1} for the Gulf of Thailand and adjacent areas. Map C presents our depth-based stratification; the corresponding estimate of total production is $4.0 \cdot 10^9$ tonnes, within the range of the other two estimates.

depth. This does not match the distribution patterns given by FAO (1981) or by Lieth (1975), both of whom reported a northwest/southeast gradient in the primary production of the SCS (Fig. 13a, b, and c). Based on our 10 submodels, we estimated a mean primary production of the whole SCS ecosystem of 1,143 tonnes • km^{-2} • $year^{-1}$, corresponding to 4.0×10^9 tonnes wet weight • $year^{-1}$. From planimetry of the primary production maps given by Lieth (1975) and FAO (1981) (Figs. 13a and b), total primary production for the SCS system ranges from 336 to 418 million tonnes carbon • $year^{-1}$, which neatly brackets our estimate (if a carbon-to-weight conversion factor of 10 is used, as we have done throughout).

Transfer efficiencies

Table 2 also gives transfer efficiencies between trophic levels. For this analysis, the consumption of each group in each system has been split in discrete trophic levels (Christensen and Pauly, 1991). These transfer efficiencies depend on the structure of the food webs (and thus on a multitude of assumptions, many of which may not have been met), yet a general pattern emerged with an overall mean transfer efficiency of around 9%. This is in line with values generally assumed—but often not estimated. Table 2 also suggests that there is no correlation between the mean transfer efficiencies of various models, which vary from 4% to 15%, and primary productivity in the areas represented. Thus, even the least productive offshore systems pass their energy up the food chain as efficiently as the more productive coastal systems.

Transfer efficiencies from primary producers to fishery catches can be viewed as measures of the efficiency of the various fisheries and are found to vary by two orders of magnitude between systems (Table 2). This indicates that the systems are harvested at different trophic levels. A difference of one trophic level between fisheries implies a difference of at least one order of magnitude in their catches—even if the systems these fisheries exploited are otherwise similar.

Catch estimates (Table 3)

The highest catches come from the coastal areas, the Gulf of Thailand, and the southwestern SCS. The estimated catches add up to nearly 5 million tonnes • $year^{-1}$. Small demersal fishes, small pelagics, and intermediate predators are the most important groups caught (Fig. 14a). In order to compare the annual catch data with those from SEAFDEC (1981) for the year 1979, the latter had to be adjusted to fit our definition of the SCS. Thus, we included 33% of the overall catch of Taiwan, the catches from eastern peninsular Malaysia (from Sarawak and Sabah), and from the Gulf of Thailand (totaling 1.96 million tonnes).

Table 3. Summary statistics for 10 models, representing different subareas of the SCS.

Model	Fig.	Primary production ($t \cdot km^{-2} \cdot year^{-1}$)	Transfer efficiency (%) by trophic level* II	III	IV	Geometric mean	Transfer efficiency from primary production to fishery (%)
A. Shallow waters	3	3,650	6.2	3.1	9.6	5.7	0.17
B. Reef-flats/seagrass	4	4,023	8.6	11.0	6.6	8.6	0.33
C. Gulf of Thailand	5	3,650	7.2	13.8	7.0	8.9	0.26
D. Vietnam/China	6	3,003	3.5	10.7	6.9	6.4	0.05
E. NW Philippines	7	913	9.3	8.9	9.3	9.2	1.23
F. Borneo	8	913	15.9	18.4	11.7	15.1	0.08
G. SW SCS	9	2,433	11.7	15.1	8.7	11.5	0.35
H. Coral reef	10	2,766	10.0	1.4	—	3.7	0.14
I. Deep shelf	11	730	8.0	13.0	8.1	9.4	0.03
J. Open Ocean	12	400	9.3	12.3	7.4	9.5	0.01
SCS Weighted means	2	1,143	8.3	10.4	7.0	9.2	0.12

* II refers to first consumer level, III to second, etc.; transfer efficiencies computed after removal of cycles.

We added Vietnamese catches (approximately 700,000 tonnes) (Nguyen, 1989), Chinese catches (e.g., 400,000 tonnes) (Shindo, 1973), and catches from Hong Kong, northwest Philippines, Cambodia, Brunei, northwest Indonesia, and Singapore. The total catch is about 4 million tonnes annually—a figure similar to our estimate and to the figure of 4.6 million tonnes derived by Marr (1976) for the SCS as defined here. We conclude that our models incorporate and/or lead to a reasonable estimate of total catches.

Potential catches

The notable differences in the efficiency of the fishery discussed above raise the question whether the catches can be increased by directing the fishery toward the lower parts of the food web. One way to consider this is to look at the fate of the fish production within the system. To facilitate this, pie charts were added to each submodel (Figs. 3–12) showing the fate of fish production. For all submodels, the bulk of the fish production is consumed by fish predators, while the fisheries and invertebrate predators take the rest.

Total fish production in the SCS area is estimated at about 30 million tonnes annually. About 13% is harvested by the fisheries and the rest is eaten by predators (Fig. 14 a, b).

If we assume that it is possible to harvest all systems as efficiently as the fully exploited coastal systems (i.e., models A, B, C, and G, but disregarding E, the northwest Philippines system, whose transfer efficiency may be biased upward because of a low estimate of primary production), we obtain a mean potential fishery efficiency of 0.275% of primary production. If the less-exploited systems could be harvested with this efficiency, the additional catches from the SCS would be about 5.8 million tonnes annually, more than doubling the catch; however, this potential may not be feasible in practice. The Vietnam/China system was only lightly exploited in the period covered here, the mid-1970s to mid-1980s. The potential for the area is estimated to be 1.86 million tonnes per year, corresponding to an increased catch rate of 1.6 to 8.2 tonnes • km^{-2} • $year^{-1}$, which is extremely high and probably unrealistic.

The Bornean coast, beyond 10 m deep, was not exploited intensively in the late 1970s, and this is reflected in the potential for increases in catch of some 260 thousand tonnes • $year^{-1}$. This corresponds to an increase in catch rate of 0.7-2.5 tonnes • km^{-2} • $year^{-1}$. Much of this potential has probably been realized, since the fishery in Sarawak and Sabah has increased considerably in the last decade.

The potential for the deeper coralline areas is estimated at about 300,000 tonnes • $year^{-1}$, doubling the catch and bringing the total catch rate to about 7.5 tonnes • km^{-2} • $year^{-1}$. There are large coralline areas in the central part of the SCS that are only lightly exploited. Because catch rates for intensively exploited coral areas can exceed 20 tonnes • km^{-2} • $year^{-1}$ (Alcala, 1981; White, 1989), we conclude that there may be a basis for some increase. However, because the model is based on data from outside the region, we stress that one should consider these estimates with care.

The bulk of the additional potential 5.8 million tonnes • $year^{-1}$ comes from the deeper areas of the SCS. This potential may not be realized because it is difficult to fish the deeper areas in a way that is economically viable.

The same problems also occur with regard to the abundant offshore resources of mesopelagic fish such as myctophids. It may well be that the only realistic way to harvest these resources is by catching their predators, the large pelagics and cephalopods.

FAO (1981) estimated the potential of the SCS at 3.3 and 2.8 million tonnes • $year^{-1}$ for demersal and pelagic fishes, respectively. Our corresponding estimates are 2.6 and 1.5 million tonnes • $year^{-1}$.

The potential catches presented here are tentative, as were those of FAO (1981); however, this does not mean that the method we employed is not useful. Indeed, the problems associated with estimating potential catches in data-sparse areas make even indicative approaches worthwhile.

Many fisheries in the region suffer from high fishing pressure, use of small-meshed nets, and sometimes from destructive fishing methods (Pauly and Chua, 1988). Carefully designed, new fishing regimes could therefore, even in these cases, be expected to lead to increased catches.

Detritus flows within the South China Sea

The models we have presented here can be linked to show the flow of detritus within the SCS system (Table 5, Fig. 14c). Total sedimentation is estimated at 10^9 tonnes • $year^{-1}$ or 25% of primary production. Assuming all of this to be deposited at depths in excess of 200 m, the total input to the bottom is about 650 tonnes • km^{-2} • $year^{-1}$. This estimate is one order of magnitude higher than the estimate of Rowe and Gardner (1979) for the deep North Atlantic. Expecting a higher estimate for the SCS, and bearing in mind our assumption that all detritus is deposited in the deepest stratum (which makes up only 50% of the SCS) and that we

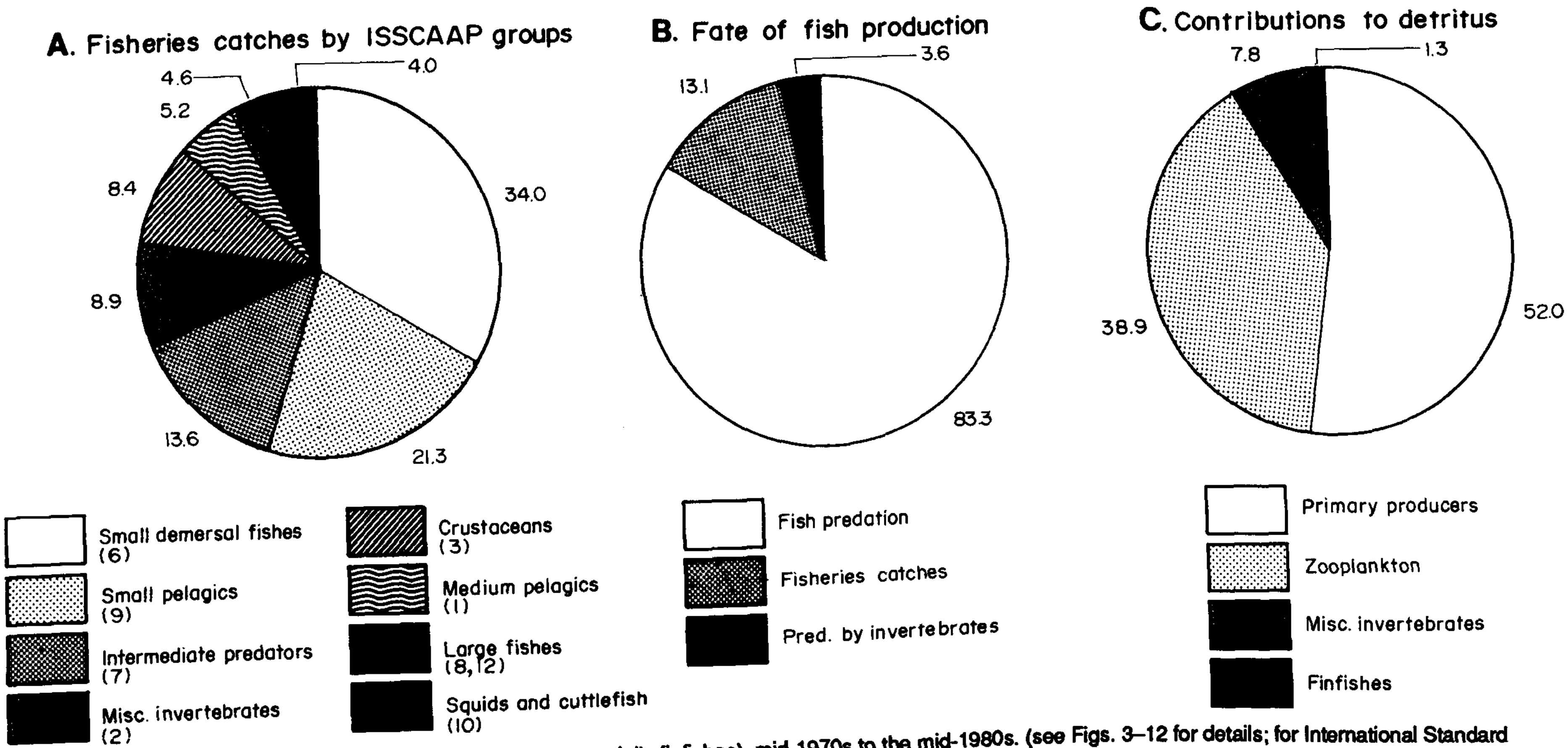


Figure 14. Fate of biological production for the entire SCS (especially finfishes), mid-1970s to the mid-1980s. (see Figs. 3–12 for details; for International Standard Statistical Classification of Aquatic Animals and Plants [ISSCAAP] groupings, see Table 2).

A- Percent composition of fisheries catches by ISSCAAP groups.
B- Percent of fish production consumed by fish predators, harvested as fisheries catches, and consumed by invertebrate predators.
C- Percent contribution to detritus of primary producers, zooplankton, miscellaneous invertebrates, and finfishes.

Table 4. Estimated catches ($t \cdot km^{-2} \cdot year^{-1}$) in 10 submodels from the SCS, representative of the late 1970s.

Group/Model*	A	B	C	D	E	F	G	H	I	J	Total ($103^{t} \cdot year^{-1}$)
1. Primary producers	—†	0.988	—	—	—	—	—	—	—	—	21
2. Miscellaneous invertebrates	1.840	5.210	0.053	—	0.210	0.003	—	—	—	—	439
3. Crustaceans (excl. plankton)	1.455	0.276	0.594	—	—	0.174	0.174	0.404	—	—	411
4. Sergestids/zooplankton	—	—	—	—	0.350	—	—	—	—	—	10
5. Large zoobenthos feeders	0.026	—	0.022	0.006	—	0.012	0.086	—	0.001	—	21
6. Small demersal predators	1.075	5.409	5.449	0.408	4.514	0.136	1.541	2.375	0.036	—	1,672
7. Intermediate predators	0.140	0.440	0.251	0.867	3.220	0.060	1.556	0.129	0.077	—	664
8. Large predators	0.260	—	0.058	0.033	0.130	0.058	0.110	0.006	0.003	—	49
9. Small pelagics	0.925	0.006	1.497	—	0.340	0.283	5.126	0.831	—	—	1,047
10. Squids and cuttlefish	0.152	0.750	0.440	0.255	0.176	—	—	—	0.023	—	198
11. Medium pelagics	0.402	—	0.921	—	0.320	—	—	—	—	—	257
12. Large pelagics	0.042	—	0.050	0.050	—	—	—	0.028	0.050	0.050	157
Total		6.083	13.079	9.335	1.619	11.260	0.726	8.593	3.773	0.190	0.050
Total catch ($10^3 t \cdot year^{-1}$)	1,046	275	1,242	453	315	105	962	291	176	80	4,945
Potential catch§ ($10^3 t \cdot year^{-1}$)	—	—	—	1,860	—	257	—	295	1,688	1,686	5,786

* Refer to Table 1 for the stratification of the SCS used in this analysis.

† Dashes indicate missing information or zero catches.

‡ From SEAFDEC (1981), referring to the year 1979.

§ This "potential" may not be realizable (see text).

Table 5. Estimated flows (10^3t • year^{-1}) of excess fish and detritus production for the SCS.

Model*	Fish		Detritus	
	Import	Export	Import	Export
A	0	60	0	30,000
B	0	280	0	56,000
C	60	410	15,000	22,000
D	120	180	31,000	260,000
E	10	23	3,100	3,800
F	60	330	16,000	30,000
G	50	210	12,000	64,000
H	30	130	8,500	150,000
I	1,300	4,300	530,000	700,000
J	4,300	0	700,000	1,000,000

* See Table 1 and text for definition and construction.

have no independent estimate of flux to the deep bottom layer from other highly productive tropical areas, we conclude that our estimate, although high, is not unrealistic.

We initiated this exercise in response to the challenge represented by the LME concept and are surprised and pleased to see that some sense has come out of our rather crude modeling approach. We view our results as an indication of the robustness of the approach incorporated in ECOPATH II and are confident that the steadily increasing number of aquatic ecosystems that are being quantified using steady-state models will help to improve our understanding of the ecology of LMEs.

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Annex 841

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Effects of cyanide on corals in relation to cyanide fishing on reefs

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Abstract. Small fragments of the zooxanthellate corals *Pocillopora damicornis* and *Porites lichen* were subjected to a range of cyanide concentrations for various times (i.e. to various cyanide doses). Doses encompassed those likely to be experienced by corals as a result of various cyanide fishing practices. Following the highest doses, corals died; after medium doses, they lost their zooxanthellae (symbiotic algae) resulting in a discolouration or 'bleaching'; and after the lowest doses they lost zooxanthellae but not in sufficient numbers to cause noticeable discolouration. Respiratory rates of *P. damicornis* were inhibited by 10–90% following exposure to cyanide but recovered to pre-exposure levels within 1–2 h after transfer to clean sea water.

Extra keywords: bleaching, zooxanthellae.

Introduction

Cyanide has been used as an asphyxiant in the collection of aquarium fish in the Philippines since the early 1960s (Rubec 1986); up to 90% of aquarium fish exported from the Philippines have been collected by using cyanide (Hingco and Rivera 1992). Recently, Johannes and Riepen (1995) have reported increasing and largely uncontrolled use of cyanide on reefs in South-East Asia to supply a restaurant-based demand for live fish. The Asian live-fish market is expected to expand, with much of the increased demand coming from China. This will increase the practice of cyanide fishing, which has already spread from the Philippines to Sri Lanka (Couchman and Beumer 1992), Indonesia and Taiwan (Pajaro 1992).

There are several cyanide fishing techniques. In the simplest, sodium cyanide (NaCN) tablets are placed in small plastic bottles (e.g. used shampoo bottles) filled with sea water. The milky fluid produced in the bottles is squirted in the direction of a fish, which may be hiding in a coral colony, coral thickets or holes in the reef matrix. Divers then collect the asphyxiated fish (Johannes and Riepen 1995). In other techniques, cyanide is placed inside portions of bait which are thrown overboard, or it is made into a paste, combined with finely minced fish and then thrown overboard. Fish eat poisoned baits and rise to the surface, stunned and vomiting. Regurgitated, cyanide-laden baits may then be ingested by other fish and the cycle repeated, or baits may sink to the coral substratum, slowly releasing cyanide (Johannes and Riepen 1995). In other cases, 55-gallon drums of cyanide have been dumped into a shallow reef environment, or cyanide has been pumped from 5-gallon containers onto the reef (J. McManus personal communication 1995). Regardless of the technique used, reef corals come into contact with cyanide.

Cyanide fishing has been banned in many South-East Asian countries. However, widespread illegal cyanide fishing continues, and anecdotal reports from fishermen and tour-boat operators suggest that it damages corals. Only two studies on the effects of cyanide on corals have been published, both associated with determining the mechanisms of coral calcification. Photosynthesis and calcification of the staghorn corals *Acropora cervicornis* and *A. formosa* were inhibited at concentrations greater than 1×10^{-5} M cyanide (Chalker and Taylor 1975; Barnes 1985). Respiration in intact branch tips of *A. formosa* was not completely inhibited at the highest concentration tested, ~1×10^{-4} M NaCN, suggesting the existence of cyanide-resistant respiration in either the zooxanthellae or the host (Barnes 1985). Cyanide-resistant respiration has been observed in the symbiotic anemone, *Aiptasia pulchella* (Pickles 1992); cyanide resistance did not occur in either zooxanthellae-free tissue suspensions or aposymbiotic *A. pulchella* (lacking zooxanthellae), but it did occur in host-free zooxanthellae suspensions, and the cyanide-resistant respiration in the intact symbiosis therefore appears to be attributable to the zooxanthellae (Pickles 1992).

The present paper describes the physiological responses of the common reef corals *Pocillopora damicornis* and *Porites lichen* to various doses of cyanide and the effects of cyanide on respiratory rates in *P. damicornis*.

Materials and methods

All experiments were conducted in November 1995 at One-Tree Island, a mid-shelf lagoonal reef towards the southern limit of the Great Barrier Reef, Australia (Fig. 1).

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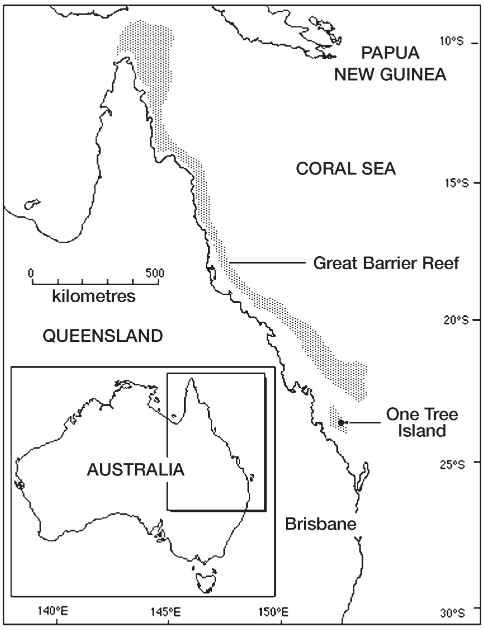

Fig. 1. Location of One-Tree Island on the Great Barrier Reef, Australia.

Toxicity tests

Fifteen colonies of *Pocillopora damicornis* (brown ecomorphs, see Takabayashi and Hoegh-Guldberg 1995) were collected from 1–2 m depth in the lagoon. Approximately 100 small coral fragments 40 mm long were cut from the colonies (5–10 fragments per colony) and their bases inserted into small acrylic tubes to provide support (prepared fragments are referred to as 'explants' hereinafter). Small (50 × 50 mm) colonies of *Porites lichen*, a small 'boulder' coral, were collected from the tops of the microatolls in the lagoon. Encrusting epiflora and epifauna were trimmed from the bases of these colonies. All corals were placed in running sea water under reduced lighting (<40 µmol photon m^{-2} s^{-1}) for 3–4 h prior to the experiments.

Specimens of *P. damicornis* and *P. lichen* were exposed to 2×10^{-1} M, 2×10^{-2} M, 2×10^{-3} M, or 2×10^{-4} M cyanide (nominal concentrations), for 1, 5, 10, 20 or 30 min. Incubation media using freshly collected unfiltered sea water were prepared immediately before each experiment. Media were stirred with a magnetically coupled stir bar before and during experiments. In each experiment, five replicate specimens of each coral species were randomly selected from the pool of prepared corals and placed in a 2-L plastic container holding 1 L of incubation medium. After incubation, corals were transferred to an aquarium receiving a supply of running sea water for 15–20 min, then secured to an acrylic tray at 1–2 m depth on the reef. Two controls were used for each species. For the first control set, called the 'Parent Colony' (PC), five corals were randomly selected from the pool of prepared corals and frozen prior to the incubations. A second set of five corals, 'Handling Controls' (HC), were exposed to an ambient sea-water solution alone for 30 min during the exposure experiments. Experimental and control corals were examined for mortality, general health and appearance for up to 12 days following incubations. Corals were frozen after the observation period.

Respirometry

The effect of cyanide on coral respiration was measured in a 4-chamber coral respirometer (see Klumpp *et al*. 1987 for details). All experiments used large fragments (60 mm) of *P. damicornis* colonies (brown ecomorphs) cut from 12 colonies (1–2 m depth) in the lagoon. Respiratory rates were determined during a series of 10–20 min incubations for ≈1–2 h before and after exposure to sea water with cyanide (1×10^{-1} M, 2×10^{-2} M or 2×10^{-3} M cyanide) for 7·5, 5 or 2·5 min, or to sea water without cyanide (control) for 7·5 min. Corals were exposed to cyanide outside the respirometry chambers to avoid contamination of the oxygen electrodes. During incubations, a black cloth was draped over the chambers to reduce light levels to <1 µmol photon m^{-2} s^{-1}. Water temperature during each of the incubations was 26°C ± 1°C.

Respirometry experiments were conducted over 3 days and used four different pieces of coral each day. During incubation, oxygen concentrations were logged every 20 s, and every 10–20 min the chambers were flushed with fresh sea water for 2 min to prevent oxygen concentrations from falling below 75% saturation. After pre-exposure incubation, each piece of coral was removed from the respirometer chamber and placed in 1 L of sea water containing cyanide (prepared as above) or in sea water without cyanide (control). Following this exposure, corals were transferred to running sea water for 10–15 min to flush any residual cyanide from the coral, then returned to the respirometer chambers for determination of respiratory rates for 1–2 h. Respiratory rates for each colony were expressed relative to the mean respiratory rate of the coral in the pre-exposure incubation period. At the end of each experiment, corals were transferred back to the reef, secured at 1–2 m depth and examined daily for 1 week.

Processing of corals

The tissues of *P. damicornis* corals involved in the toxicity tests were removed from the skeletons with a jet of re-circulated sea water (WaterPik, Johannes and Wiebe 1970). Zooxanthellae densities and algal chlorophyll-*a* (chl-*a*) concentrations were determined according to the techniques outlined in Jones (1997). The population density of zooxanthellae and the concentration of chl-*a* in the *P. lichen* colonies were not determined because the tissues could not be adequately stripped from the coral with the WaterPik, probably because of deeper penetration of the tissues within the skeletal matrix. For *P. damicornis*, bone-white skeletons were produced after use of the WaterPik, and microscopy showed that no algae or host tissues remained on the skeleton.

Data are presented as mean ± 95% confidence intervals. To test the null hypothesis that the concentration of cyanide or duration of exposure had no effect on zooxanthellar density or chl-*a* concentration, data were analysed ($\alpha = 0{\cdot}05$) by Type I ANOVA (Anon. 1994). Dunnett's test of significance was used to compare the nature of significant differences by comparing the means for treatment with control (HC) means. Prior to all analysis, assumptions of normality (Shapiro–Wilks' test) and homogeneity of variance (Welch's test) were tested.

Results

Toxicity tests

P. damicornis explants exposed to 2×10^{-1} M cyanide for 10, 20 and 30 min discoloured from a normal brown to almost bone-white within 12 h and died within 24 h. Eventually the pale tissue began sloughing off the skeletons and small fish (banded humbugs, *Dascyllus aruanus*) were observed grazing on the disintegrating coral tissues. After 5–6 days, a thin layer of green algae covered the bare skeletons. *P. damicornis* explants exposed to 2×10^{-1} M cyanide for 5 min discoloured from brown to a light tan within 24 h. Similarly, colonies exposed to 2×10^{-2} M cyanide for 10, 20 and 30 min discoloured to a light tan, almost white, colouration. No discolouration or mortality was observed in corals exposed to 2×10^{-3} M or 2×10^{-4} M cyanide or ambient sea-water controls.

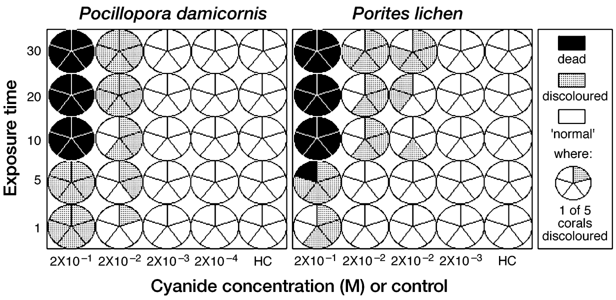

Fig. 2. Mortality and visual assessment of discolouration in five explants of *Pocillopora damicornis* and *Porites lichen* 6 days after exposure to a cyanide solution. (Only *P. damicornis* for the 2×10^{-4} M cyanide solution. *Porites lichen*, replicate experiments at 2×10^{-2} M). *P. damicornis* classified as discoloured if light brown, light tan/yellow or white. *P. lichen* classified as discoloured if bright green–yellow. HC, handling control.

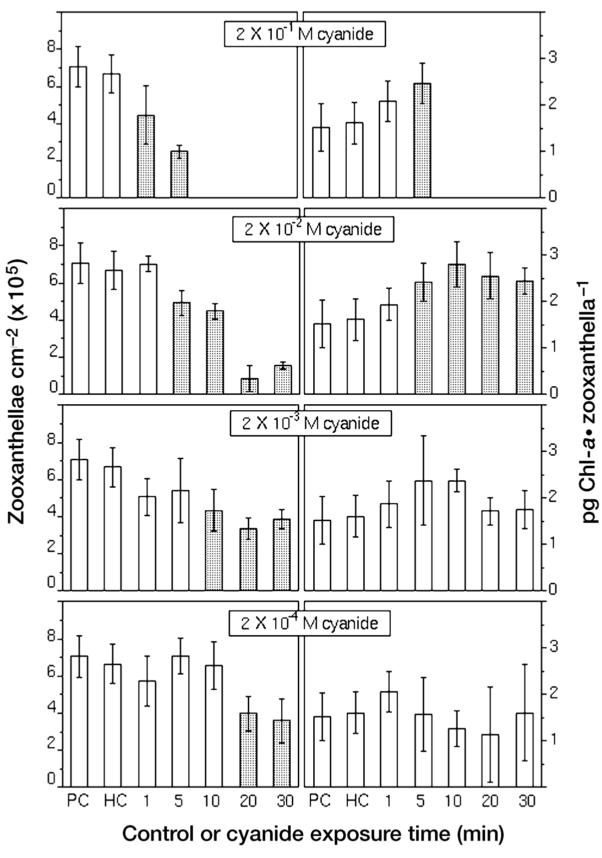

Fig. 3. Zooxanthellae density (hundred thousands of zooxanthellae per cm^2) and algal pigment concentration (pg chl-*a* per zooxanthella) in *P. damicornis* 12 days after exposure to cyanide. PC, parent colony control; HC, handling control. Significant differences in algal densities or algal pigment concentration (ANOVA, $P < 0{\cdot}05$) between experimental and control colonies (HC) are indicated by shading.

All *P. lichen* colonies exposed to 2×10^{-1} M cyanide for 10, 20 or 30 min died. It was difficult to determine the exact time of death because the colonies became covered in a thick dark-grey 'mucus-like' tunic within 12–24 h. After 7 days the tunics began to lift off, revealing a grey skeleton devoid of tissues. The skeletons then became progressively fouled with algae. No change in coral colouration was observed before the tunics were formed. No colonies that produced tunics survived.

Some of the *P. lichen* colonies exposed to 2×10^{-1} M cyanide for 5 min discoloured from a normal dark green–yellow to a bright green–yellow (Fig 2). A similar discolouration was observed in some of the colonies exposed to 2×10^{-2} M cyanide for 10, 20 or 30 min (Fig. 2). No discolouration or mortality was observed in corals exposed to 2×10^{-3} M cyanide or to ambient sea water.

The number of corals that discoloured and the intensity of discolouration reached a maximum 6 days after exposure to cyanide for each coral species. By the end of the 12-day observation period, many of the corals appeared to have regained some of their colouration. This effect was subtle, and no coral previously classified as discoloured was re-classified as normally coloured.

Discoloured *P. damicornis* explants contained fewer zooxanthellae than the normal brown control colonies at the end of the 12-day recovery period (Fig. 3). After exposure to 2×10^{-1} M or 2×10^{-2} M cyanide solution, the algal density in the coral tissues was inversely proportional to the duration of exposure (Fig. 3). The algal densities in explants exposed to the 2×10^{-3} M cyanide solution for 10, 20 or 30 min or to 2×10^{-4} M cyanide solution for 20 or 30 min ($3{\cdot}4$–$4{\cdot}5 \times 10^5$ zooxanthellae per cm^2) were significantly different than those in control corals (HC = $6{\cdot}6 \times 10^5 \pm 1.0$ zooxanthellae per cm^2, ANOVA $P < 0{\cdot}05$), although experimental corals were the same colour as control corals (Fig. 2). Discoloured *P. damicornis* had higher algal chl-*a* concentrations than control colonies (Fig. 3). When no significant loss of zooxanthellae was measured, the algal chl-*a* concentrations were similar to control values ($1{\cdot}6 \pm 0{\cdot}4$ pg chl-*a* per zooxanthella).

Respirometry

Corals exposed to 1×10^{-1} M cyanide for 2·5, 5 or 7·5 min discoloured to a light tan within 12 h. The next day, colonies had discoloured further to a pale yellow. Corals exposed to 2×10^{-2} M cyanide for 7·5 and 5 min were paler than the parent colonies after 24 h. No colour change was observed in corals exposed to 2×10^{-3} M cyanide or in control colonies.

Respiratory rates of control corals after transfer to an ambient sea-water solution for 7·5 min were the same as before the manipulation. However, for the controls used in the 2×10^{-2} M cyanide and 1×10^{-1} M cyanide experiments there was a slight increase in respiratory rate as the experiment progressed (Fig. 4).

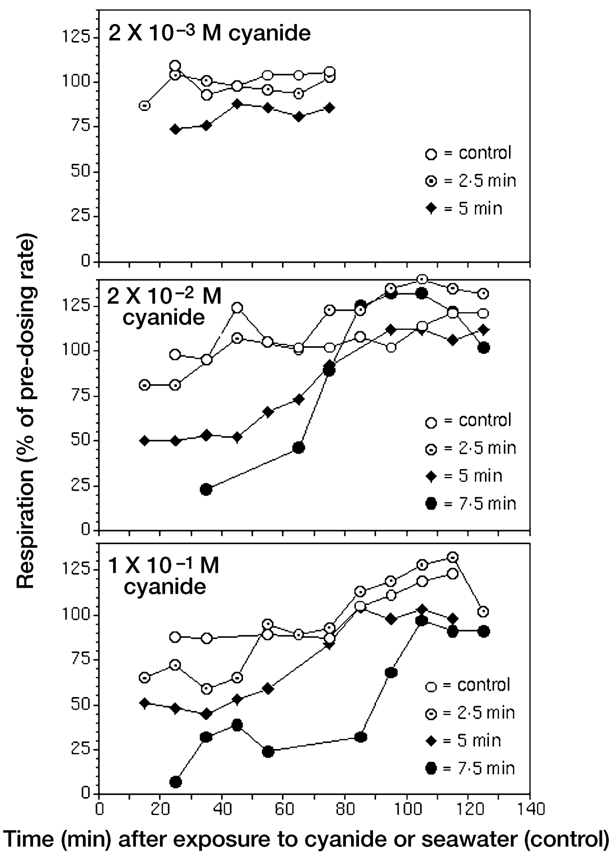

Fig. 4. Respiratory oxygen consumption in fragments of *P. damicornis* following exposure to ambient sea water for 7·5 min (controls), or to cyanide for 2·5, 5 or 7·5 min (1 coral for each line plot). Respiratory rates (over 10-min intervals) for each coral expressed relative to the mean respiratory rate determined over a ≈1–2 h period before cyanide exposure. Data for exposure to 1 × 10^{-4} M cyanide solution for 7·5 min not determined because of failure of the oxygen sensor.

In contrast, corals exposed to cyanide solutions showed markedly lower rates of oxygen consumption (Fig. 4). A >90% inhibition of respiration occurred in the coral exposed to 1 × 10^{-1} M cyanide for 7·5 min (the highest dose of cyanide tested during respirometry). At the lowest dose tested (i.e. 2 x 10^{-3} M for 2·5 min) the respiratory rate of the coral was inhibited by 10–20% of the 'normal' rate (Fig. 4). Respiratory rates of corals exposed to cyanide returned to pre-incubation levels within ~0·5–2.0 h (Fig. 4).

Discussion

The most obvious response of the corals *Pocillopora damicornis* and *Porites lichen* to sublethal doses of cyanide was a change in colouration, a 'bleaching'; the degree of discolouration was dependent on cyanide concentration and duration of exposure, i.e. on cyanide dose. Most corals are brown, gaining their colour from photosynthetic pigments of the zooxanthellae in their tissues. Bleaching describes the change in colouration as white skeleton becomes visible through the transparent animal tissues following a reduction in either the number of zooxanthellae (Yonge and Nicholls 1931) or the pigment concentration of the zooxanthellae (Hoegh-Guldberg and Smith 1989) or both. The fact that densities, but not chl-*a* concentrations, of zooxanthellae were lower after exposure of *P. damicornis* to cyanide suggests that discolouration was due to a decrease in zooxanthellae density.

The vivid colouration of some scleractinian corals and hydrocorals is due to pigments in either the skeleton or the animal tissues (Dove *et al.* 1995). Such corals do not bleach (whiten) following loss of zooxanthellae, but change from dull colours (blues, mauve–pinks or greens) to 'brighter' variations of the same colour. This effect probably accounts for the changes in colour of *P. lichen* from a normal brown–yellow to a bright yellow–green following exposure to higher cyanide doses in the present study.

Loss of zooxanthellae is a typical stress response to abnormal environmental conditions (Brown and Howard 1985) and has been observed in corals exposed to a diverse range of natural and artificial stresses including terpenes (toxic secondary metabolites of soft corals, Aceret *et al.* 1995), heavy metals (Harland and Brown 1989; Jones 1997) and elevated water temperatures (Glynn 1993). Bleaching has been observed in corals following exposure to quinaldine, a chemical used in the collection of fish (Jaap and Wheaton 1975), to particulate peat (Dallmeyer *et al.* 1982) and to depressed water temperature (Kobluk and Lysenko 1994).

Bleaching results in a loss of photosynthetic potential (Porter *et al.* 1989), cessation or reduction of growth (Coles and Jokiel 1978; Porter *et al.* 1989; Goreau and McFarlane 1990) and a decrease in reproductive output (Szmant and Gassman 1990). Loss of zooxanthellae can, however, be a sublethal response. There are numerous reports of recovery of pigmentation by bleached corals (Yonge and Nicholls 1931; Hoegh-Guldberg and Smith 1989; Porter *et al.* 1989; Fitt *et al.* 1993). In colonies of *P. damicornis* and *Acropora formosa* that lost 40–99% of their zooxanthellae during a natural bleaching event on the Great Barrier Reef, zooxanthellae density recovered to a steady-state level in 16–24 weeks (Jones 1995; Jones and Yellowlees 1997). An additional stage in the recovery process involves the restoration of storage lipid to pre-bleaching levels (Fitt *et al.* 1993). The time taken for corals to fully recover from loss of zooxanthellae can take between 6 months and 1 year.

Colonies of *P. damicornis* that had lost significant quantities of zooxanthellae during the present toxicity tests had significantly higher algal chl-*a* concentrations than control corals. Studies conducted after natural bleaching events have also found that bleached corals, with lower than normal algal densities, often have higher algal chl-*a* concentrations (Hoegh-Guldberg and Smith 1989; Fitt *et al.* 1993; Jones, in press; but see also Kleppel *et al.* 1988; Porter *et al.* 1989). The higher algal chl-*a* concentration may reflect increased nutrient availability for the remaining zooxanthellae as a result of decreased algal competition (Høegh-Guldberg and Smith 1989; Jones and Yellowlees 1997).

Visual estimates of the degree of discolouration in the *P. damicornis* explants after 6 days did not correlate with the measured decreases in zooxanthellae density after 12 days (Figs 2 and 3). Similarly, colonies of *A. formosa* that lost 40–50% of their zooxanthellae during a period of elevated sea-water temperature did not discolour (Jones, in press). Hence, corals may be suffering from stress-related loss of algal symbionts both in the field and in laboratory manipulations without any gross observable effect; this must be taken into account when interpreting results of reef surveys conducted after cyanide fishing or natural bleaching events.

Given the known properties of cyanide as a respiratory inhibitor, it is not surprising that oxygen consumption by corals was markedly lower after exposure to cyanide. However, all corals in the present study survived the exposure despite 80–90% inhibition of oxygen consumption. Pickles (1992) reported that respiratory rates of the symbiotic anemone *Aiptasia pulchella* measured 24 h after 4-h exposure to 6·5 ppm KCN were not significantly different from control rates. The time taken for the corals to return to pre-dosage respiratory rates varied from 0·5 h to ~2 h, depending on cyanide concentration and duration of exposure. The increase in respiratory rates of some of the control corals as the experiment progressed (Fig. 4) suggests a small 'stress-effect' of the experimental procedure and a requirement of >2 h for the corals to recover from the exposure to cyanide.

Effects of cyanide fishing on corals

One approach to relate the results from laboratory studies to conditions occurring *in situ* is to calculate the dose of a pollutant encountered in both situations. This technique has primarily been used to estimate the effects of crude and chemically dispersed oil on marine organisms (Anderson *et al.* 1984; McAuliffe 1986, 1987). Thus, in the present toxicity tests with *P. damicornis*, cyanide concentration (M) multiplied by the exposure time (min) yields a cyanide dose as 'M-min' cyanide. Cyanide dose can then be related to mortality and algal density; all corals exposed to doses above 2 M-min cyanide died, below a dose of 2×10^{-3} M-min no significant algal loss occurred, and between these doses various degrees of algal loss occurred (Fig. 5).

During cyanide fishing on reefs, corals are likely to experience initially high (10^{-1} to 10^{-2} M) rapidly fluctuating concentrations of cyanide that ultimately fall to very low levels (10^{-5} to 10^{-6} M) in seconds to hours. The initial cyanide concentration, the proximity to target fish and the local hydrological conditions will determine the dose experienced by corals. Johannes and Riepen (1995) estimated the cyanide concentration in a typical squirt bottle to be $\approx 4{\cdot}1 \times 10^{-1}$ M, which gives the milky-white solution observed during cyanide fishing. In a situation where a coral thicket is exposed to cyanide directly from a squirt bottle and the cyanide concentration decreases logarithmically (i.e. decreasing to 4×10^{-6} M cyanide in ~8 min), a coral will be exposed to $\sim 4{\cdot}5 \times 10^{-1}$ M-min cyanide; according to the present results (Fig. 5), this would result in significant loss of zooxanthellae.

The technique outlined above must be interpreted with care, because the response of a coral to a very brief exposure to a high concentration may not be the same as the response to a long exposure to a very low concentration. A threshold dose to initiate loss of zooxanthellae is likely to be more time-dependent at lower cyanide concentrations.

Nevertheless, high concentrations of cyanide are used during cyanide fishing, loss of zooxanthellae can occur after very short (1-min) exposures to these concentrations, and inhibition of photosynthesis and calcification can occur after 30-min exposure to only $\sim 1 \times 10^{-5}$ M cyanide (Chalker and Taylor 1975; Barnes 1985), so cyanide fishing may have deleterious effects on corals in the immediate vicinity. Use of dyed water has revealed that water was trapped in a stagnant zone behind a 1-m-diameter coral head for 30 min (Wolanski and Jones 1980). Under such conditions, and also during the more destructive fishing techniques such as pumping cyanide from surface boats, coral mortality is likely to be extensive.

It was assumed in the present experiments that the corals that were not dead 12 days after exposure to cyanide

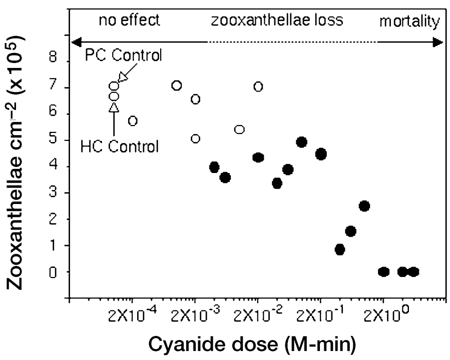

Fig. 5. Relationship between cyanide dose ('M-min', see text) and zooxanthellae density (hundred thousands of zooxanthellae per cm^2) in colonies of *P. damicornis* 12 days after exposure. Each point represents the mean of five corals (including the HC and PC controls). Filled symbols represent significant differences in algal densities relative to control (HC) explants (ANOVA, $P < 0{\cdot}05$, see Fig. 3).

would survive, but this has not been confirmed; further studies should investigate long-term survival of corals after cyanide exposure, the longer-term effects of exposure to low concentrations, and the effects of experimental doses in the field.

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Annex 842

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Effects of cyanide on coral photosynthesis: implications for identifying the cause of coral bleaching and for assessing the environmental effects of cyanide fishing

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ABSTRACT: Modulated chlorophyll fluorescence techniques were used to examine the effects of cyanide (NaCN) from cyanide fishing on photosynthesis of the symbiotic algae (zooxanthellae) located within the tissues of the zooxanthellate hard coral *Plesiastrea versipora*. Incubating corals for 3 h in a cyanide concentration of $>10^{-5}$ M NaCN under a saturating light intensity (photosynthetically active radiation [PAR] intensity of 250 µmol quanta m^{-2} s^{-1}) caused a long-term decrease in the ratio of variable to maximal fluorescence (dark-adapted F_v/F_m). The effect of cyanide on dark-adapted F_v/F_m was light dependent; thus F_v/F_m only decreased in corals exposed to 10^{-4} M NaCN for 3 h under PAR of 250 µmol quanta m^{-2} s^{-1}. In corals where dark-adapted F_v/F_m was significantly lowered by cyanide exposure, we observed significant loss of zooxanthellae from the tissues, causing the corals to discolour (bleach). To further examine the light-dependent effect of cyanide and its relation to loss of zooxanthellae, corals were exposed to 10^{-4} M NaCN or seawater only (control), either in darkness or under 250 µmol quanta m^{-2} s^{-1}. A significant decrease in dark-adapted F_v/F_m and loss of zooxanthellae only occurred in corals exposed to cyanide in the light. These results suggest cyanide causes the dissociation of the symbiosis (bleaching) by affecting photosynthesis of the zooxanthellae. Quenching analysis using the saturation-pulse technique revealed the development of high levels of non-photochemical quenching in cyanide-exposed coral. This result is consistent with the known property of cyanide as an inhibitor of the dark reactions of the Calvin cycle, specifically as an inhibitor of ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco). Therefore, chronic photoinhibition and an impairment of photosynthesis of zooxanthellae provides an important 'signal' to examine the environmental effects of cyanide fishing during controlled releases *in situ*.

KEY WORDS: Bleaching · Cyanide · Zooxanthellae · Coral · Chlorophyll fluorescence

INTRODUCTION

Cyanide has been used on coral reefs in the Asia-Pacific region to facilitate the capture of fish for the aquarium trade for several decades. More recently, cyanide usage has grown considerably to supply a rapidly growing restaurant-based demand for live reef fish (Johannes & Riepen 1995). Methods of cyanide fishing and other destructive fishing practices associated with the live reef fish trade have been discussed in Johannes & Riepen (1995) and Jones & Steven (1997). Cyanide fishing is banned in many Asia-Pacific countries; however, widespread illegal fishing continues. There is particular concern over the environmental effects of cyanide on hard corals since they provide the framework for the reef structure and homes for fish and reef biota (Johannes & Riepen 1995).

In a recent laboratory-based study, it was shown that brief exposure to elevated cyanide concentration caused the corals *Pocillopora damicornis* and *Porites lichen* to lose their symbiotic photosynthetic algae

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(zooxanthellae, Jones & Steven 1997). Similar loss of zooxanthellae from corals has been observed in response to variation in a wide range of physical and chemical parameters (Brown & Howard 1985, Hoegh-Guldberg & Smith 1989, Jones 1997). Loss of zooxanthellae causes corals to discolour, and the stress response has been called 'coral bleaching'. This term is normally associated with the discolouration of corals following periods of elevated seawater temperatures (see, for example, Hoegh-Guldberg & Salvat 1995, Brown 1996). Why cyanide causes coral to bleach is presently unknown and is the subject of the present communication.

Cyanide is a respiratory poison; its toxicity is based upon a high affinity for the ferric heme form of cytochrome a3 (cytochrome oxidase). In addition, cyanide also affects photosynthesis, through formation of a stable complex with ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco, Wishnik & Lane 1969) or inhibition of plastoquinone-oxidoreductase (Buchel & Garab 1995). Thus, cyanide may cause the loss of zooxanthellae from corals by suppressing host respiration and/or suppressing algal photosynthesis. Previous studies have shown that exposure of corals to high doses of cyanide (10^{-1} to 10^{-3} M NaCN), such as those used during cyanide fishing, causes a temporary reduction in respiratory rate (Jones & Steven 1997). Chalker & Taylor (1975) and Barnes (1985) report that photosynthetic oxygen evolution in *Acropora cervicornis* and *A. formosa* is reduced following exposure to 10^{-5} M NaCN.

In this study, we use pulse-amplitude-modulated (PAM) chlorophyll fluorescence techniques (Schreiber et al. 1986) to examine the effect of cyanide on photosynthesis of coral, and to determine its relationship with coral bleaching. Fluorescence at ambient temperature stems almost exclusively from chlorophyll associated with the antennae of photosystem II (PSII). One of the most useful parameters that can be measured using PAM fluorometry is the ratio of variable (F_v) to maximum fluorescence (F_m). $F_v = F_m - F_0$, where F_0 is the initial fluorescence when all reaction centres in PSII are open and F_m is the maximal fluorescence determined after the application of a saturating white light pulse, i.e. when all PSII reaction centres are closed. When determined in a dark-adapted state, the ratio is a measure of the maximum potential quantum yield of PSII. Changes in F_v/F_m can be used to evaluate reductions of PSII activity caused by acute stress (Schreiber & Bilger 1987). Photoinhibition by excessive light is the main cause for reduction of F_v/F_m (Krause & Weis 1991), but other stress factors, such as heat and cold stress in the light, can lead to photoinhibition and lowering of PSII quantum efficiency.

MATERIALS AND METHODS

Coral selection, collection and preparation procedures. All experiments were conducted with the hard coral *Plesiastrea versipora* (Lamarck, 1816) a faviid coral which occurs on tropical reef systems throughout the Indo-Pacific (Veron 1993). Colonies were collected from 5 to 6 m depth from Fairlight and Middle-Head, Port Jackson (NSW, Australia), and transported to the re-circulating seawater system at The University of Sydney. Several days after collection the coral fragments were cut into small pieces (surface area of 3 to 5 cm^2) and mounted onto numbered holders with marine epoxy (Vepox, Vessey Chemicals). The coral colonies were placed in aquaria under photosynthetically active radiation (PAR, 400 to 700 nm; measured with a Li-Cor 190SA quantum sensor) of 30 to 40 µmol quanta m^{-2} s^{-1}. Corals were held for 14 to 21 d under a 12 h light:12 h dark cycle before experimentation.

Experimental program. *Plesiastrea versipora* were exposed to various concentrations of cyanide under different light intensities in several experiments conducted over 3 mo. During these experiments, light was provided by fluorescent cool white tubes recessed within a light reflector array to increase irradiance intensity. Light levels were further adjusted by inserting neutral density filters (50% normal density) between the corals and the light banks. Cyanide solutions were made immediately before each experiment using analytical grade NaCN (Sigma Chemicals) dissolved in seawater from the re-circulating seawater aquarium. Cyanide or control (seawater-only) solutions were stirred throughout the incubations using magnetically coupled stir bars. All experiments were conducted in a constant temperature room at 22°C, and started between 12:00 and 13:30 h (6 h after the start of the daily illumination period). When chlorophyll fluorescence parameters were measured over several days, readings were taken at 17:00 h.

Photosynthesis versus irradiance (*PI*) curves were measured for 7 corals using a 'photo-respirometer' comprising 4 separate 90 ml water-jacketed acrylic chambers. Each chamber had a false bottom enclosing a stir-bar powered by a magnetic stirrer. Actinic light was provided by 50 W quartz-halogen spotlights, illuminating each chamber from opposite sides. Respiratory O_2 consumption and photosynthetic O_2 production were measured using Clark-type electrodes (Strathkelvin Instruments, Glasgow, UK) inserted into the chamber tops. Sensors were connected via oxygen polarizing units to an analogue to digital converter (ADC-1, Remote Measurement Systems, Seattle, USA) which was controlled by data acquisition software

(DATACAN IV, Sable Systems, Los Angeles, USA). Oxygen concentrations were measured every 6 s from an average of 2 consecutive voltage readings from each sensor. The voltage of the sensors was calibrated using air-saturated seawater at the incubation temperature (22°C) and salinity (34‰) and oxygen purged (nitrogen-bubbled) seawater.

Corals were exposed to darkness or to 7 different irradiance levels (~8 to 500 µmol quanta m^{-2} s^{-1}). Different irradiance levels were obtained by inserting neutral density filters between the lights and incubation chambers housing the corals. The maximal rate of gross photosynthetic production at saturating light intensities ($P_{m(gross)}$; µmol O_2 cm^{-2} s^{-1}), the light intensity at which the initial slope of the *PI* curve intersects the $P_{m(gross)}$ value (I_k; µmol quanta m^{-2} s^{-1}), and respiration of the symbiosis at irradiance (I) = 0 (R; µmol O_2 cm^{-2} h^{-1}) were estimated by fitting a nonlinear hyperbolic tangent function to the data comprising the *PI* curve (Jassby & Platt 1976). The model has the form:

$$P = P_{m(gross)} \cdot \tanh(I/I_k) + R$$

where P is the production at any photon irradiance. The goodness of fit for the function was assessed using a least squares regression of predicted versus observed values (r^2). Residual variances were minimized with multiple iterations of altered parameter sets using the Solver Utility of Microsoft Excel 1997.

To study the influence of different cyanide concentrations, corals were exposed to 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} and 10^{-7} M NaCN for 3 h under a PAR of 250 µmol quanta m^{-2} s^{-1}. Cyanide solutions were poured into 3 replicate 200 ml containers at each cyanide concentration, and 2 corals placed in each of the test containers. At the end of the incubations, corals were dark-adapted before measuring F_v/F_m (see 'Chlorophyll fluorescence measurements'). Dark-adapted F_v/F_m was measured daily for 11 d and the corals were then sacrificed to determine the density of zooxanthellae.

To determine the influence of different light intensities on dark-adapted F_v/F_m, corals were exposed to 10^{-5} M NaCN cyanide or seawater (controls) for 3 h under irradiances of 0, 62.5, 125 and 250 µmol quanta m^{-2} s^{-1}. Corals were then dark-adapted before measuring F_v/F_m.

To study the relationship between a decrease in dark-adapted F_v/F_m and loss of zooxanthellae, corals were exposed to either 10^{-4} M NaCN or ambient seawater (control) in either darkness or 250 µmol quanta m^{-2} s^{-1} PAR for 3 h. Three replicate containers with 4 corals in each container were used for each treatment. F_v/F_m was measured in dark-adapted samples immediately after the experiment, and then daily for 20 d. Corals were then sacrificed to determine the density of zooxanthellae.

To study the effect of cyanide on maximum effective quantum yield, photochemical quenching (qP) and non-photochemical quenching (qN), corals were exposed to 10^{-4} M NaCN or ambient seawater (control) under 250 µmol quanta m^{-2} s^{-1} light for 0.5 h. Maximum effective quantum yield, qP and qN were determined using a TEACHING-PAM fluorometer.

Chlorophyll fluorescence measurements. Chlorophyll fluorescence was measured using PAM fluorometry (Schreiber et al. 1986) using either of 2 recently developed chlorophyll fluorometers (DIVING-PAM and TEACHING-PAM, Walz, Effeltrich, Germany). The TEACHING-PAM fluorometer was used for determining photochemical quenching and non-photochemical quenching in cyanide-exposed corals; all other measurements were made with the DIVING-PAM fluorometer. In both fluorometers, 3 µs pulses of a light-emitting diode (LED) are used as the measuring light (peak emission at 650 nm). In the DIVING-PAM fluorometer, fluorescence is detected at wavelengths above 710 nm. Saturation pulses (8000 µmol quanta m^{-2} s^{-1} PAR, 800 ms pulse width) are provided by a halogen lamp. In the TEACHING-PAM fluorometer, an LED (660 nm) is used to provide actinic light illumination and saturation pulses (3500 µmol quanta m^{-2} s^{-1} PAR, 800 ms pulse width). During analysis with the TEACHING-PAM, small pieces of coral (~3 cm^2 surface area) were placed on a glass slide with a few drops of seawater over the 2 mm exit point of the measuring head (Schreiber et al. 1997). During analysis with the DIVING-PAM fluorometer, the fibre-optic light guide was gently pressed on the surface of the coral, which was held in seawater.

The photochemical energy conversion in PSII can be evaluated by both fluorometers by using saturating pulses of light. These cause a temporary saturation of energy conversion at the PSII reaction centres (Schreiber et al. 1986, Genty et al. 1989). Two consecutive measurements can be used to estimate the maximum potential quantum yield in a dark-adapted sample (i.e. placed in darkness for 20 min) or the maximum effective quantum yield of a sample in an illuminated state. Firstly, weak pulsed red light (<1 µmol quanta m^{-2} s^{-1}) was applied to determine F_0 in a dark-adapted state or F in an illuminated state. Secondly, a saturating pulse was applied to determine the F_m value (in a dark-adapted state) or F_m' (in an illuminated coral). The change in fluorescence (ΔF) caused by the saturating pulse in relation to the maximal fluorescence yield (F_m or F_m') has been shown to be a good measure of quantum yield (Genty et al. 1989). Thus $\Delta F/F_m$ (dark-adapted sample) = F_v/F_m = maximum potential quantum yield, and $\Delta F/F_m'$ (illuminated sample) = maximum effective quantum yield.

In addition to maximum effective quantum yield, photochemical [$qP = (F_m' - F)/(F_m' - F_0)$] and non-photochemical [$qN = (F_m - F_m')/(F_m - F_0)$] quenching coefficients were calculated using the TEACHING-PAM fluorometer. During quenching analysis we used the pre-programmed sequence of commands and instrumental settings available with the DA-TEACH software (Protocol No. 4 in 'saturation pulse mode', DA-TEACH v.1.00g, Walz). In this procedure, corals were dark-adapted before measuring F_0 and F_m. The actinic light was turned on, and the fluorescence (F) measured. A series of saturation flashes were applied at 20 and 40 s intervals, the new F_m value (F_m') determined and qP and qN calculated.

Biomass determination. Coral tissues were stripped from the skeletons with a jet of re-circulated filtered seawater using a WaterPik™. The slurry produced from the tissue-stripping process was homogenized in a blender for 30 s and the volume of the homogenate (~100 ml) recorded. The number of zooxanthellae in 10 ml aliquots of the homogenate was measured using a hemacytometer (8 replicate counts). Total zooxanthellae per coral was calculated after correcting for the volume of the homogenate. Density of zooxanthellae was expressed as number per unit surface area. Surface area was measured using an image analysis program (NIH-image) from digital pictures of the coral calibrated against images of graph paper of known surface area. Densities of zooxanthellae in a subset of corals (field controls) were also measured in order to examine whether the handling and preparation procedures caused any significant loss of zooxanthellae. Field controls were measured whenever fresh corals were collected over the experimental program.

Data are presented as mean ($\bar{x}$) ± standard deviation (SD). Data are analyzed ($\alpha = 0.05$) using analysis of variance (ANOVA). Assumptions of normality (Shapiro-Wilks test) and homogeneity of variance (Welch's test) were tested, and where appropriate the data transformed (arc sine). Dunnett's test of significance was used to examine the nature of significant differences.

RESULTS

Plesiastrea versipora display a clearly defined saturating *PI* response (Fig. 1), with a $P_{m(gross)}/R$ ratio of 2.7 ± 0.3 and $I_k = 67 \pm 31$ µmol quanta m^{-2} s^{-1}.

Corals exposed to 10^{-2} and 10^{-3} M NaCN under 250 µmol quanta m^{-2} s^{-1} PAR retracted deeply within their calices. At the other cyanide concentrations, no tentacle retraction was observed. Dark-adapted F_v/F_m of corals exposed to $\geq 10^{-5}$ M NaCN decreased as a function of increasing cyanide concentration (Fig. 2). Mean dark-adapted F_v/F_m in corals exposed to concentrations $\geq 10^{-5}$ M NaCN were significantly different from control corals (Fig. 2, $p < 0.05$, ANOVA).

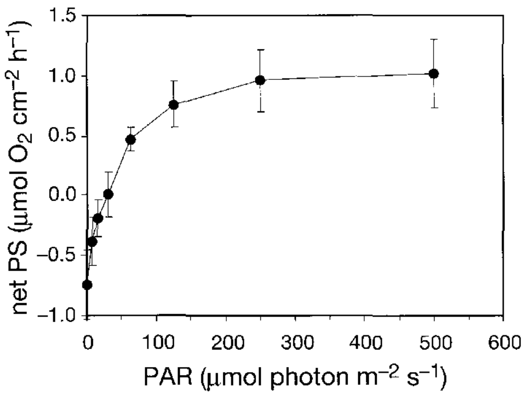

Fig. 1. *Plesiastrea versipora.* Net photosynthesis (PS) versus irradiance (PAR) (*PI*) curve for the corals used in the study. Fitted curve is a hyperbolic tangent function (see text). Data are expressed as $\bar{x}$ ± SD, n = 7

All corals exposed to 10^{-2} NaCN died within 24 h. Twenty-four hours after experimentation, dark-adapted F_v/F_m of corals exposed to 10^{-4} M NaCN was lower than that of corals exoposed to 10^{-3} M NaCN and remained lower for the rest of the monitoring period (Fig. 3). After the initial decrease, dark-adapted F_v/F_m of corals exposed to 10^{-3}, 10^{-4} and 10^{-5} M NaCN increased rapidly during the monitoring period. After 11 d, only F_v/F_m in corals exposed to 10^{-4} M NaCN was lower than control corals.

During the first 4 to 5 d of the monitoring period, corals exposed to 10^{-3}, 10^{-4} and 10^{-5} M NaCN discoloured from a dark to a pale green/brown. After 11 d, the number of zooxanthellae of corals exposed to

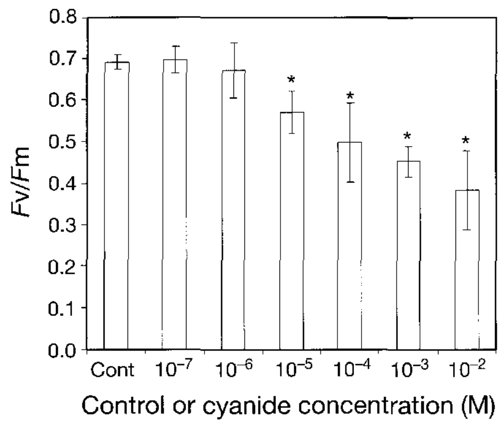

Fig. 2. *Plesiastrea versipora.* Dark-adapted F_v/F_m in corals 20 min after exposure to 10^{-7} to 10^{-2} M NaCN for 3 h under PAR of 250 µmol quanta m^{-2} s^{-1}. Data are expressed as $\bar{x}$ ± SD, n = 6. Significantly different from control: $^{*}p < 0.05$ (ANOVA)

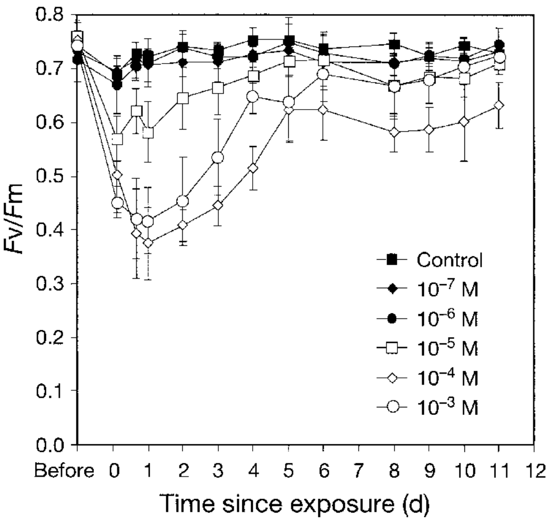

Fig. 3. *Plesiastrea versipora.* Dark-adapted F_v/F_m in corals following exposure to cyanide concentrations in the range 10^{-7} to 10^{-3} M NaCN for 3 h under PAR of 250 µmol quanta m^{-2} s^{-1}. Data are expressed as $\bar{x} \pm$ SD, n = 6

these cyanide concentrations was lower than of control corals (exposed to seawater only) or of freshly collected corals (Fig. 4), corresponding to significant differences between control and experimental treatments ($p < 0.05$, ANOVA). There was no significant difference in the number of zooxanthellae between control corals and freshly collected corals (1.7 ± 0.2 × 10^7 zooxanthellae cm^{-2}, n = 12), suggesting that the preparation and manipulative procedures had no measurable effect, in terms of loss of zooxanthellae, on the corals.

Dark-adapted F_v/F_m of corals exposed to 10^{-5} M NaCN under 250 µmol quanta m^{-2} s^{-1} PAR (0.57 ± 0.41, n = 5) was 20% lower than control corals (0.69 ± 0.013) which were exposed to ambient seawater under the same irradiance; these values were significantly different ($p < 0.05$, ANOVA, Fig. 5). There were no significant differences in dark-adapted F_v/F_m of cyanide-exposed and control corals at the other irradiances tested.

Twenty-four hours after experimentation, dark-adapted F_v/F_m of corals exposed to cyanide (10^{-4} M NaCN) in the light was lower than levels measured before the experiment or in the other treatments (Fig. 6A). Dark-adapted F_v/F_m of corals exposed to cyanide in the light returned to levels measured in control corals over the subsequent 20 d monitoring period. There were 2 distinct phases of the recovery, a fast phase from Day 1 to Day 6, and a second slower phase from Day 7 until the end of the experiment. Discolouration of the corals (bleaching) was observed during the first phase. The number of zooxanthellae in corals exposed to cyanide in the light was ~40% of the densities in other treatments or in colonies freshly collected from the field, corresponding to a significant difference ($p < 0.05$, ANOVA, Fig. 6B).

Representative original dark-light induction curves of control or cyanide-treated corals are shown in Fig. 7. Saturating pulses were applied at regular intervals to assess qP and qN and to measure maximum effective quantum yield ($\Delta F/F_m'$). Maximum potential quantum yield (F_v/F_m) was measured before each recording by the application of a saturation pulse to a previously dark-adapted sample. Control corals show high levels of qP and yield, indicating high PSII activity (Fig. 7A). The initial rise of qN reflects the build-up of a ΔpH, as

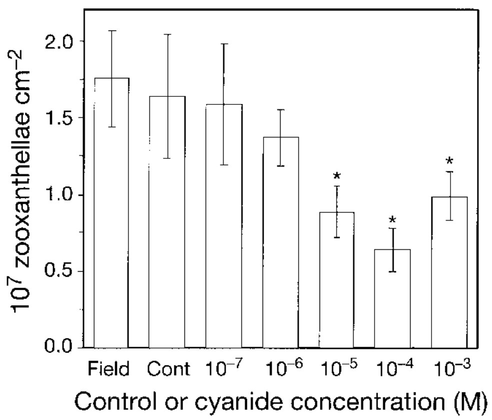

Fig. 4. *Plesiastrea versipora.* Mean numbers of zooxanthellae in corals following exposure to cyanide concentrations in the range 10^{-7} to 10^{-3} M NaCN for 3 h under PAR of 250 µmol quanta m^{-2} s^{-1}. A mean number for freshly collected corals is also given. Data are expressed as $\bar{x} \pm$ SD, n = 6. Significantly different from control: *$p < 0.05$ (ANOVA)

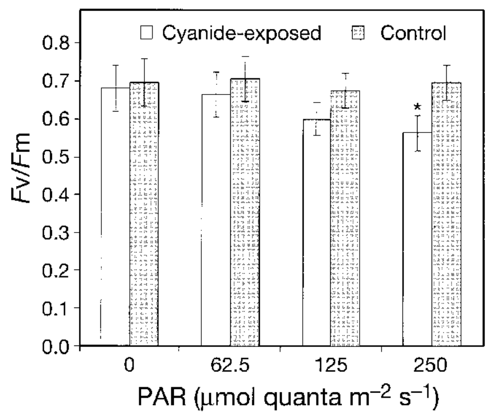

Fig. 5. *Plesiastrea versipora.* Dark-adapted F_v/F_m in corals exposed to 10^{-5} M NaCN or seawater (control) for 3 h under PAR of 0, 62, 125, or 250 µmol quanta m^{-2} s^{-1}. Data are expressed as $\bar{x} \pm$ SD, n = 5. Significantly different from controls: *$p < 0.05$ (ANOVA)

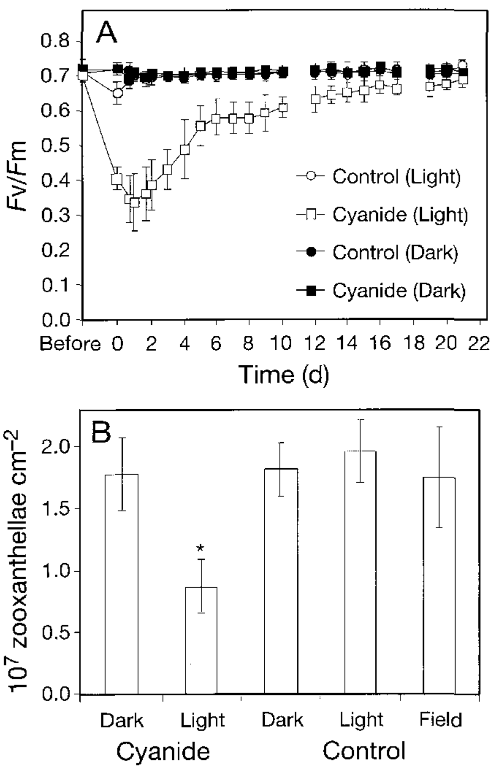

Fig. 6. *Plesiastrea versipora*. (A) Dark-adapted F_v/F_m in corals following exposure to 10^{-4} M NaCN or seawater (control) for 3 h under PAR of 250 µmol quanta m^{-2} s^{-1} or darkness. Data are expressed as $\bar{x} \pm$ SD, n = 12. (B) Mean number of zooxanthellae at the end of the 20 d experiment. Significantly different from control: *$p < 0.05$ (ANOVA)

Calvin cycle enzymes are not yet light activated and ATP accumulates. Calvin cycle activation by increased pH consumes ATP, and the ΔpH is dissipated, corresponding to a decrease in qN. In cyanide-treated coral light-induced non-photochemical quenching of fluorescence yield was considerably enhanced (Fig. 7B). At the same time, the effective quantum yield decreased with respect to the control. qN did not relax during illumination, but increased in an initially rapid and then slower phase. Hence, there was no induction of Calvin cycle activity as occurs in control corals (Schreiber & Bilger 1987).

DISCUSSION

Our data confirm previous observations that corals lose their symbiotic algae (zooxanthellae) when exposed to elevated concentrations of cyanide (Jones & Steven 1997), and provide several important insights into the mechanism associated with the dissociation of the coral-algal symbiosis (bleaching).

Dark-adapted F_v/F_m in zooxanthellae of *Plesiastrea versipora* was 0.7 to 0.75, slightly lower than observed in higher plants, but typical for marine algae (Falkowski et al. 1994). Exposure of *P. versipora* to cyanide concentrations $\geq 10^{-5}$ M caused a significant decrease in dark-adapted F_v/F_m. Chalker & Taylor (1975) and Barnes (1985) reported a decrease in photosynthesis in staghorn corals *Acropora cervicornis* and *A. formosa* exposed to 10^{-5} M NaCN. Our studies show that the effect of cyanide is light dependent. Thus, exposure of corals to cyanide at an irradiance intensity sufficient to saturate photosynthesis caused a significant decrease in dark-adapted F_v/F_m, whilst exposure to the same concentration at lower intensities or in darkness had no measurable effect. Importantly, a significant decrease in dark-adapted F_v/F_m preceded a reduction in density of zooxanthellae in the tissues and subsequent tissue discolouration (bleaching; for example, compare Fig. 2 with Fig. 4). This is most clearly highlighted in the experiment in which corals were exposed to the same cyanide concentration in the dark or in the light. In this experiment, a significant decrease in dark-adapted F_v/F_m and density of zooxanthellae only occurred in corals exposed to cyanide in the light (Fig. 6). Collectively, these results suggest that cyanide causes the dissociation of the coral-algal symbiosis by affecting photosynthesis of the zooxanthellae as opposed to host or symbiont respiration.

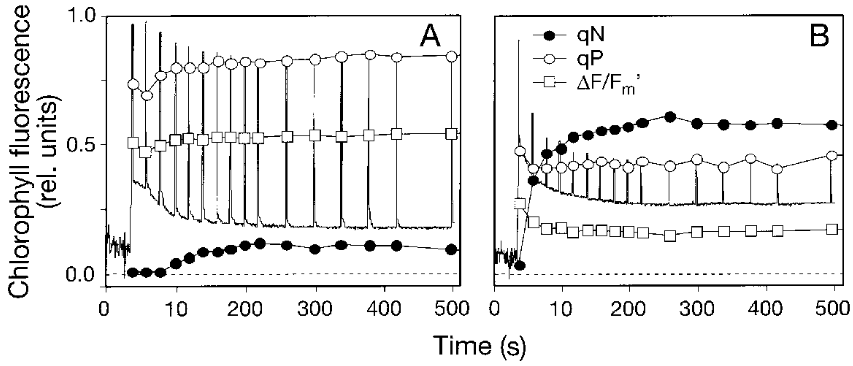

Fig. 7. *Plesiastrea versipora*. Original recordings of dark-light induction curves with fluorescence quenching analysis by the saturation pulse technique of (A) control coral and (B) coral exposed to 10^{-4} M NaCN under 250 µmol quanta m^{-2} s^{-1} light for 0.5 h. Quenching analysis was conducted with a TEACHING-PAM chlorophyll fluorometer. qP: photochemical quenching, qN: non-photochemical quenching and $\Delta F/F_m'$: maximum effective quantum yield (see text)

The light- and cyanide-dependent decrease in dark-adapted F_v/F_m is symptomatic of photoinhibition. Photoinhibition encompasses processes associated with the lowering of the efficiency of photosynthetic energy utilisation, reversibly or irreversibly, in the short term or long term (Osmond 1994). Two types of photoinhibition, dynamic and chronic, have been distinguished, separable by their relaxation times. Dynamic photoinhibition encompasses short-term, rapidly reversible decreases in quantum yield, associated with PSII antennae-based dissipation of excess light as heat. Chronic photoinhibition involves a slowly engaged and slowly reversible decline in yield, associated with the loss of PSII reaction centre function (Osmond & Grace 1995). The long-term (>24 h) decrease in dark-adapted F_v/F_m measured in this study suggests zooxanthellae were chronically photoinhibited by the elevated cyanide concentrations.

To further examine the nature of the impairment of algal photosynthesis we used the saturation pulse technique to examine photochemical (qP) and non-photochemical (qN) components of fluorescence quenching. Corals exposed to low levels of cyanide developed high levels of qN. Non-photochemical quenching is considered to reflect a mechanism for photoprotection, i.e. to prevent over-reduction of the photosynthetic electron transport chain by dissipation of excess absorbed light energy in the PSII antenna system as heat (Demmig-Adams 1990). Non-photochemical quenching occurs when the rate of light-driven electron transport exceeds the rate of ADP/Pi recycling by the dark reactions of photosynthesis (Schreiber & Neubauer 1990). The development of qN in cyanide-treated corals is consistent with the ability of cyanide to act as an inhibitor of the dark reactions of the Calvin cycle, specifically as an inhibitor of Rubisco (Wishnick & Lane 1969). In fact, cyanide is routinely used to inhibit Calvin cycle activity during studies of chlorophyll fluorescence and plant physiology (see, for example, Kobayashi & Heber 1994). When Calvin activity is affected, the supply of NADP+ for reduction and ADP and Pi for phosphorylation is slowed. If incoming light is continually funneled into the electron transport chain, then this may lead to its over-reduction, and subsequent damage to the PSII reaction centre (Styring & Jegerschöld 1994).

Under conditions in which assimilatory electron flow is impaired, for example, under heat stress (Weis 1981, Schreiber & Bilger 1987), photoprotective mechanisms are available to prevent photoinactivation of PSII under high light levels. Recently, it has become clear that in addition to its role in ATP formation, the formation of a ΔpH, which accompanies vectorial proton transport, functions to lower PSII with respect to PSI (Weis & Berry 1987). Both cyclic electron flow at PSI and O_2-dependent electron flow have been implicated as contributing to the formation of the regulatory ΔpH when assimilatory electron flow becomes limiting. O_2-dependent electron flow consists of 2 tightly linked light-driven partial reactions, the Mehler reaction (in which oxygen reduction results in superoxide and H_2O_2 production) and photoreduction of monodehydroascorbate (MDA), which is formed by the ascorbate peroxidase reaction (the enzyme catalysed reduction of H_2O_2 by ascorbate). Collectively, these reactions are referred to as the Mehler-ascorbate-peroxidase (MAP) cycle. Cyanide also inhibits ascorbate-peroxidase activity (Asada & Takahashi 1987, Kobayashi & Heber 1994). The extent of an active MAP cycle in zooxanthellae is presently unknown; however, cyanide has the potential not only to cause an over-reduction of the electron transport chain by blocking assimilatory electron flow, but also to limit photoprotective down-regulation of PSII by inhibiting ascorbate-peroxidase activity. During cyanide fishing, corals may experience considerably higher concentrations than those used in the present study. In these situations the effect on photosynthesis should be viewed in terms of multiple effects of cyanide on several processes associated with photosynthesis, including inhibition of the oxidation of plastoquinone-oxidoreductase (Buchel & Garab 1995), as well as detoxification mechanisms associated with the removal of active oxygen species (i.e. ascorbate-peroxidase, Asada & Takahashi 1987).

Dark-adapted F_v/F_m in cyanide-damaged coral returned to normal levels during the post-exposure recovery period, possibly reflecting repair and/or assembly of new centres in the PSII repair cycle (Aro et al. 1993). However, this interpretation is complicated by the loss of zooxanthellae observed during the study. Previous studies have shown that the reduction of zooxanthellae during heat stress and elevated copper concentrations is largely caused by export of the zooxanthellae from the tissues (Hoegh-Guldberg & Smith 1989, Jones 1997). If corals preferentially lost 'impaired' zooxanthellae (i.e. those with lower yields), then this may also result in an increase in dark-adapted F_v/F_m, as the population becomes progressively dominated by 'healthy' zooxanthellae (i.e. those with higher yields). On further inspection, it can be seen that the dark-adapted F_v/F_m recovered in an initial fast phase (occurring over the space of ~6 d) and a subsequent slower phase (see Figs. 3 & 6). Discolouration of the corals only occurred in the first phase. We suggest that the initial rapid recovery of dark-adapted F_v/F_m in the first phase is primarily associated with the selective export of impaired zooxanthellae. The second phase may signify the PSII repair cycle and/or an increase in the number of healthy zooxanthellae through algal division (Jones & Yellowlees 1997).

Dark-adapted F_v/F_m in corals exposed to 10^{-3} M NaCN was lower than in corals exposed to 10^{-4} M NaCN immediately after the 3 h experiment, consistent with a normal dose-response relationship (Fig. 2). However, 24 h after the experiment, dark-adapted F_v/F_m in the corals exposed to 10^{-4} M NaCN was lower than in corals exposed to 10^{-3} M NaCN, and remained lower for the rest of the monitoring period (Fig. 3). Discolouration (bleaching) of the tissues was more pronounced in the corals exposed to 10^{-4} M NaCN than in corals exposed to 10^{-3} M NaCN, consistent with a lower density of zooxanthellae in the tissues after 11 d (Fig. 4). Thus, overall, exposure of corals to a cyanide concentration of 10^{-4} M NaCN appeared to have a greater effect than exposure to a cyanide concentration an order of magnitude higher. One possible explanation for this unusual effect is that corals exposed to 10^{-3} M NaCN retracted within their calices during the experiment. In all other treatments, and during the recovery period, the polyps from all corals appeared expanded. *Plesiastrea versipora* has large polyps and a very deep tissue layer (~10 mm). Retraction of the polyps within the calices is likely to cause shading of zooxanthellae at the base of the polyp and perhaps exclusion of cyanide from the inner tissues. When chlorophyll fluorescence parameters were determined after the 3 h incubation, measurements would have been made from zooxanthellae in the coenosarc and upper parts of the tentacles which were exposed to the full experimental irradiance and/or cyanide concentration. However, when measurements were taken in the recovery period, when the polyps were expanded, fluorescence measurements would include previously shaded zooxanthellae. Given the light-dependent effect of cyanide, this may have had a significant effect on average dark-adapted F_v/F_m measured by the fluorometer. If this is the case, then polyp retraction affords protection to the coral from photochemical damage, as has been suggested during sub-aerial exposure (Brown et al. 1994).

Recent technical advancements in the development of a fibre-optic microprobe in combination with a modified PAM fluorometer have allowed measurements of chlorophyll fluorescence characteristics of cells within leaves of higher plants (Schreiber et al. 1996). Such systems have an adequate resolution (20 µm) for examining fluorescence characteristics of zooxanthellae within different parts of the coral polyp. These techniques may prove particularly insightful in measuring self-shading in cyanide-exposed corals, or during studies of photoinhibition in corals exposed to high photosynthetic photon flux density.

It has been suggested from studies on the effect of heat stress on photosynthesis of cultured zooxanthellae that when the symbionts become a net burden to the host they are expelled (Iglesias-Prieto 1997). Our results support this proposition. Interestingly, the effects of cyanide on zooxanthellae are very similar to the effects of elevated water temperature. For example, in both instances there are high levels of non-photochemical quenching (Fig. 7, see also Warner et al. 1996 and Jones et al. 1998a) and a lowering of dark-adapted F_v/F_m, symptomatic of damage to PSII (Fig. 2, see also Fitt & Warner 1995, Warner et al. 1996, Jones et al. 1998a). During cyanide-mediated toxicity, light is a secondary variable that is essential to elicit loss of zooxanthellae (Fig. 6B); a similar interaction between light and temperature has also been reported for corals during laboratory experiments (Coles & Jokiel 1978) and in observations of bleaching on the upper sunlight-exposed surfaces of corals during bleaching events (Harriott 1985). It has recently been suggested that elevated seawater temperature causes bleaching in coral by primary damage to PSII (Warner et al. 1996). Whilst damage to PSII appears to be the case with cyanide-induced bleaching, it is likely not to be the primary site of action but a secondary effect, which is light-dependent and subsequent to 'sink' limitation in electron transport

Beyond certain minimal irradiances, cyanide has the potential to cause chronic photoinhibition of zooxanthellae within the tissues of coral. Loss of zooxanthellae and subsequent bleaching of the tissues reported during cyanide exposure appears to be closely associated with damage to photosynthesis of the zooxanthellae. In this laboratory-based study, we exposed coral to static cyanide concentrations under carefully controlled incubation periods and light intensities. *In situ* during cyanide fishing, corals are likely to experience rapidly fluctuating cyanide levels depending upon the starting cyanide concentration and proximity to the target fish (Jones & Steven 1997). Light levels are also likely to be highly variable depending on weather conditions and sea state. Our results suggest that a decrease in dark-adapted F_v/F_m and changes in photosynthetic electron transport provide important signals with which to assess the effects of cyanide on corals *in situ*. Future studies on the effect of cyanide on corals should therefore consider impairment of photosynthesis as an important 'effect criterion' (see Jones et al. 1998b).

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Annex 843

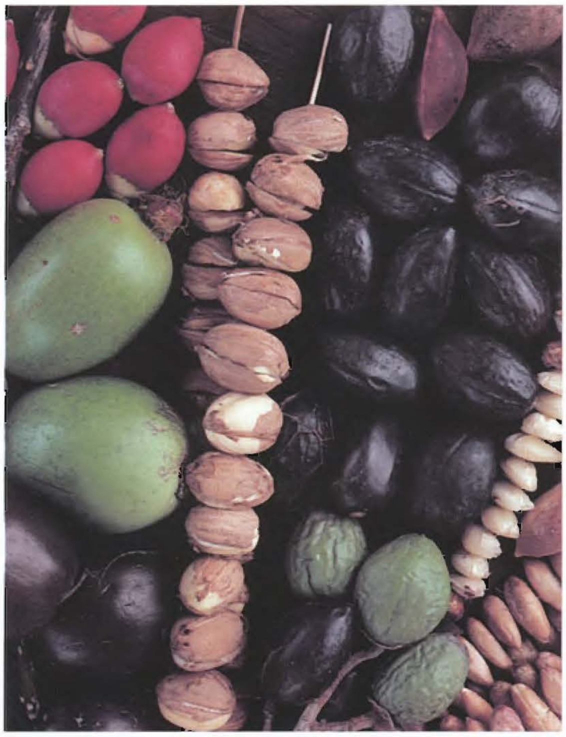
A. Waiter & C. Sam, *Fruits of Oceana* (2002), *available at* http://aciar.gov.au/files/node/578/mn85_pdf_45615.pdf

Annie Walter and Chanel Sam

with collaboration from

Marie-Claire Bataille, Jean-Marie Bompard, Pascale Bonnemère, Serge Tcherkesoff

FRUITS OF OCEANIA



English translation by
Paul Ferrar

with collaboration from
Christine Moulet, Harry Ferrar
and Klara Beresnikoff

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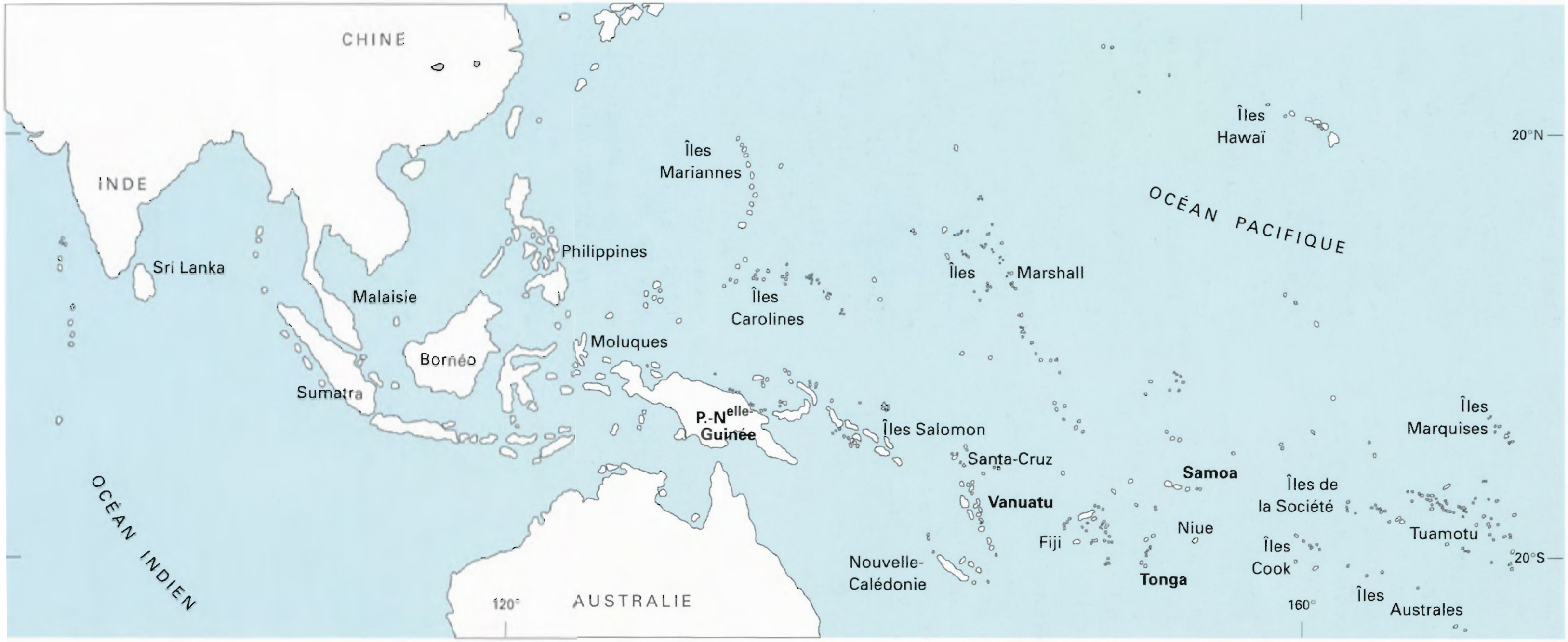


The South Pacific
For key to French names see map on p. 82

Species
Pandanus tectorius Parkinson

Family
Pandanaceae

Common names (English and French)
Pandanus
Screwpine
Pandanus
Vacouet

Name in Bislama
pandanas

Consumption
Irregular; food that is gleaned.

Part eaten
Seeds.

Toxicity
None.

Description

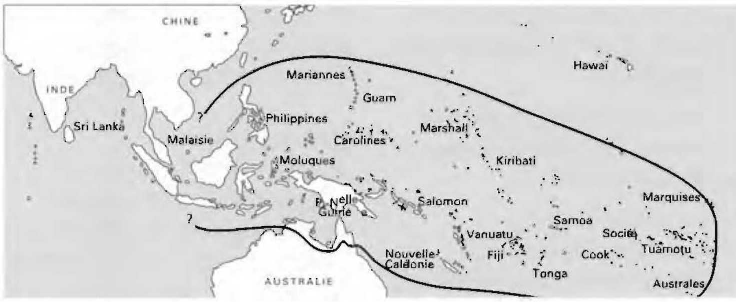
Small tree (5-10 m); trunk narrow; numerous large adventitious roots; crown not very dense. Leaves long and narrow (longer than 1 m), thick but pliable, apex frayed; margins with or without spines. Flowers grouped in male or female inflorescences (dioecious). Fruit (syncarp) single, green then orange when ripe, made up of a number of drupes that are light green on the upper part of the fruit, white on the lower part and yellow in the middle portion, polymorphic and variable in size (1.5 to 7 cm). This variability is marked from one tree to another, and may even occur to a lesser extent between different syncarps on the same tree. The drupes each contain 2 or 3 white seeds, ovoid, 1 cm long.

Morphological variability

This species shows great morphological variability, doubtless because it has been cultivated since ancient times. The peoples of Vanuatu distinguish about ten different local forms. Some botanists split *Pandanus tectorius* into several species, the geographical distribution of some of which is very narrow (St John, 1989).

Ecology and exploitation

P. tectorius is a very common tree in Vanuatu. It is found in stands on beaches and shores with calcareous soils, close to villages, and in remnant or secondary forests where it



Pandanus tectorius: the synonymy between *P. tectorius* and *P. odoratissimus* L. f. is not recognised by all authors, and it is therefore difficult to fix the western limit of the geographical distribution. One may, however, refer to a *P. tectorius* complex being distributed from the Philippines to Polynesia and from the Caroline Islands to the tropical coast of Australia, via all the islands of Oceania (Stone, 1976).

is an indicator of ancient habitations. The species is wild along the sea edge, and mainly cultivated in the villages. Distributed by marine currents or by pre- or post-European seafarers, it multiplies naturally by seeds or by cuttings of shoots that grow at the bases of the trees. This intensive cultivation has produced some cultivars that have particularly flexible leaves, the margins of which are free of spines.

Alimentary uses

In the Marshall Islands and in Kiribati, a large number of cultivars have been selected for their edible fruits. In Papua New Guinea, the fruits are eaten very occasionally. They are simply sucked when fully ripe to obtain a sweet juice. The same use is made of them in Samoa and Tonga. In Vanuatu children, and sometimes also adults, nibble the seeds.

Other uses

In Vanuatu, and throughout the Pacific, this pandanus is used above all for its leaves, which are the main material used for basket-making and similar work (the leaves are softened in the fire, cut up into narrow strips, steeped in water and then bleached in the sun and dried). According to the object to be woven – a mat, a basket or a hat – the weaver will choose from the variety of trees at his or her disposal. Some have smooth leaves, pliable and without spines, which are particularly sought after for basketry. In Tonga, necklaces and belts for dancers are made with the fragrant fruits. Once dried, the fibrous base of the fruit is used as a brush for decorating *tapa* (Whistler, 1991). In Wallis the fruits and the bracts of male inflorescences are used for plaiting into necklaces.

Other edible species

Worldwide, there exist close to 600 species of *Pandanus*, many endemic to a particular region, others traditionally cultivated. Apart from the species that we have covered (pp. 210-218) there exist in the Pacific, particularly in New Guinea, other species with edible pulp or seeds (*cf.* list at end of book, p. 277). In particular we mention:

P. brosimos Merr & Perry: perhaps the wild ancestor of *P. jiulianettii*;

P. houlettei Ridley: Peninsular Malaysia; pericarp sweet and edible;

P. leram Jones ex. Fontana: Nicobar Islands, Maldive Islands, Andaman Islands, Java and Sumatra;

P. ysabelensis St John: in Solomon Islands the pulp is sucked like sugar cane.

References

Brown (1951), Dupuy & Guiot (1992), Henderson & Hancock (1989), St John (1989), Stone (1976), Verheij & Coronel, eds. (1992), Whistler (1991).

Species
Pipturus argenteus (Forster f.) Weddell

Family
Urticaceae

Common names (English and French)
Pipturus
Pipturus

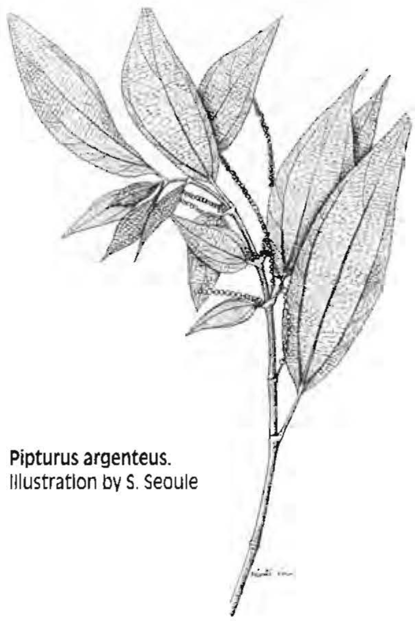
Consumption
Occasionally by children, and a food in times of shortage.

Part eaten
Fruits.

Toxicity
None.

Description

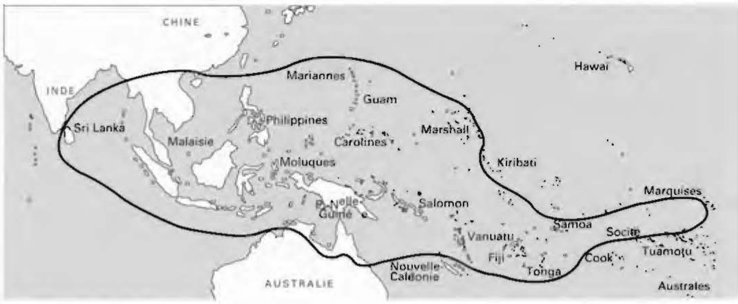
A not very high tree (5-10 m), small trunk that is smooth and slightly fissured. Leaves simple, alternate, dark green above and silvery underneath, oval or sometimes elliptical (12-15 x 5-8 cm), base cordate and apex acuminate or acute; 3 pairs of main veins arising from the petiole; margins dentate; petiole 4-8 cm long. Flowers grouped in bunches on an inflorescence that is some centimetres long, minute; white petals. Fruits sessile, green and then white when mature, rounded (3 mm in diameter), with minute seeds and furnished with protuberances.



Pipturus argenteus.
Illustration by S. Seoule

Morphological variability

Several varieties have been distinguished in this species which is variable in its morphology. According to Smith (1981), the variety present in Vanuatu, *Pipturus argenteus* var. *lanosus* Skottsberg, likewise occurs in Fiji, Rotuma, Tonga, Niue, Samoa, the Marquesas Islands and the Society Islands. Additional collections will be necessary for sorting out the taxonomy of this species.



Pipturus argenteus: present from Sri Lanka to the Marquesas Islands. Absent from New Caledonia, the Cook Islands, the Tuamotu Islands and also from Kiribati.

Ecology and exploitation

In Vanuatu *P. argenteus* is found in all open areas and in fallows ancient or modern, up to 500 m altitude. The species grows well in stony soils. It is a wild tree, but is protected because it provides timber for construction. It fruits throughout the year. Among the Ankave of Papua New Guinea, it grows in ancient gardens and in forests in areas where landslips have occurred.
In Fiji the species is found from sea level up to 1,000 m altitude, in Samoa up to 700 m altitude.

Alimentary uses

In Vanuatu children nibble the ripe fruits in the way that sweets are sucked. In times of food scarcity all the population turns to these fruits, which though minute are sufficiently abundant to provide a sweet and palatable foodstuff. The fruits are also eaten by children in Tokelau.

Other uses

In Vanuatu the tree provides timber for construction of above-ground frameworks of buildings. In Samoa and in Tonga, fishing lines and nets of excellent quality are made from fibres extracted from the bark. Among the Ankave, the sap of the tree is used as glue, and the fruits are eaten by the birds.

Other edible species

The genus *Pipturus* comprises 40-50 species distributed from the Mascarene Islands to Polynesia, via the Indo-Malayan Region and Australia. No other species is recorded as having fruits that are eaten.

References

Christophersen (1971), Henry (1968), Parham (1972), Smith (1981), Stone (1970), Whistler (1984b), Yuncker (1971).

Annie Walter, medical doctor and ethnobotanist with IRD (formerly ORSTOM), and **Chanel Sam**, curator of the Herbarium in Port Vila (Vanuatu), worked together to study the food plants of Vanuatu, in particular the fruiting trees.

Oceania, a vast ocean area dotted with tiny islands, is home to a large number of fruiting trees, which are symbols of the legendary life of paradise and plenty in the region. Species grow there that are not well known outside Oceania, but which provide the island communities with varied and tasty foods. Eaten for thousands of years in that region of the world, they are nowadays making their appearance in the international marketplace.

From Melanesia to Polynesia women and men, heirs to an ancient knowledge and experts on their own flora, were questioned and were listened to. This work, which covers about fifty of the commoner fruiting species, is based upon the knowledge and teaching of these people. Richly illustrated with photographic plates, botanical drawings and distribution maps, it provides a comprehensive guide to these foods.

Each species is the subject of an individual dossier of assorted information: Latin name, common names, botanical description, ecology and exploitation, alimentary usages, other uses, etc.

To peruse this manual, discovering the tropical nuts and fruits, is like travelling from island to island, from the Highlands of New Guinea to the Polynesian shores, along the way becoming acquainted with the Oceanian way of life.

Key Words

Fruits - Océania - Tropical forest - Ethnobotany - Alimentation

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Annex 844

V. Christensen, et. al., "Fisheries Impact on the South China Sea Large Marine Ecosystem: A Preliminary Analysis Using Spatially-Explicit Methodology", in *Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries*, WorldFish Center Conference Proceedings, No. 67 (G. Silvestre, et al., eds. 2003)

Fisheries Impact on the South China Sea Large Marine Ecosystem: A Preliminary Analysis using Spatially-Explicit Methodology*

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Abstract

A multiple regression model is derived, based on biomass estimates in 16 mass-balance food web (Ecopath) models, which explains 68 % of the variation in the data at hand, and shows that the abundance of fish with trophic levels of 3.0 or more in the South China Sea area had declined, by 2000, to less than half its value in 1960. This is worrisome, as this generalizes to the entire region declining trends observed in local areas within the South China Sea. Moreover this estimate is almost surely too conservative, given the method we used. This declining trend is compatible however with the fishing 'down marine food webs', reported from well studied parts of the South China Sea, notably the Gulf of Thailand, where the mean trophic levels of landings have declined, indicating gradual replacement in the underlying ecosystems of large, long lived, high-trophic level fishes by small, short-lived, low trophic level species often described as 'trashfish'. The only exception to these trends is Brunei, whose offshore oilrigs have led to regulations precluding trawling across much of the shelf, thus in effect creating a marine reserve. We conclude by pointing out that marine reserves are indeed one approach that will have to be used if the present declining trends are to be reversed, along with a rollback of excessive fishing effort.

Introduction

Fisheries impact not only on the stocks they exploit, but also the ecosystems in which the stocks are embedded (Gislason et al. 2000; Hall 1998). This is particularly true for demersal trawl fisheries, which

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are non-selective and also impact on the habitat on which the fish depend. Indeed, contrary to a still widely spread perception, fisheries are causing the major impact on marine ecosystems, far outweighing effects such as pollution and environmental changes. This is particularly true in Southeast Asia where regime shifts such as are observed in the North Pacific do not appear to occur, and hence where fisheries operate in an almost pure 'experimental' setting (Christensen 1998; Pauly and Chuenpagdee 2003).

We investigate here the impact of fisheries on the South China Sea system using a subset of the data collected and models constructed during the ADB-RETA 5766 project (Sustainable Management of Coastal Fish Stocks in Asia), and a spatially-explicit methodology developed for analyzing fisheries impact on marine ecosystems (Christensen et al. 2003).

Materials and Methods

Materials

Table 1 summarizes the major characteristics of the mass-balance food web (Ecopath) models, used here as starting point for this analysis.

The spatially explicit primary production data used here originated as SeaWiFS data, as processed by the European Union's Joint Research Center, in Ispra, Italy (Hoepffner et al. unpublished data), based on a model that incorporates estimated chlorophyll, photosynthetically active radiation, and sea surface temperature patterns (Behrenfeld and Falkowski 1997). The data are average values for 1998.

Depth information by ½ by ½ degrees of latitude/longitude was obtained from the ETOPO5 data-set available on the U.S. National Geophysical Data Center's Global Relief Data CD (*www.ngdc.noaa.gov/products/ngdc_products.html*).

Table 1. Overview of ecosystem models used for estimating abundance patterns of fish biomasses around the South China Sea.

Area covered	Year(s)	Spatial cells	Functional groups	Reference
Gulf of Thailand	1963, 1973, 1980	45	29, 40, 29	Christensen (1998), Vibunpant et al. (this vol)
Peninsular Malaysia, west coast	1970, 1990	48	15	Alias M. (this vol.)
Peninsular Malaysia, east coast	1972	63	15	see Annex A (this paper)
Sabah	1972	17	29	Garces et al. (this vol.)
Sarawak	1972	81	29	Garces et al. (this vol.)
Central Java, north coast	1979	15	27	Nurhakim (this vol.)
Deep South China Sea (50 - 200 m)	1980	160	13	Pauly and Christensen (1993)
Ocean part, South China Sea (> 200 m)	1980	509	10	Pauly and Christensen (1993)
Vietnam, coast (< 50 m)	1980	44	13	Pauly and Christensen (1993)
Brunei Darussalam	1989	19	13	Silvestre et al. (1993)
San Miguel Bay, Philippines	1993	1	16	Bundy (1997); Bundy and Pauly (2001)
San Pedro Bay, Philippines	1994	8	16	Campos (this vol.)
Vietnam, southwest	1994	63	15	see Annex B (this paper)

Methods

The methodology we have used to predict the biomass of fish in the South China Sea draws on a combination of ecosystem modeling, information from hydrographic databases, statistical analysis, and GIS modeling (Christensen et al. 2003). The mapping of biomass changes was performed using a series of steps as follows:

1. The 16 models of Table 1 were re-expressed on a spatial basis (again using ½ by ½ degree cells, corresponding to 30 by 30 miles at the Equator) using the spatial model Ecospace, with particular attention to the rapid decline in biomass of demersal fish with depth that is known to occur in South East Asia (Pauly 1989). For each of the spatial models, the cells were distributed between habitats based on depth only. The following depth strata were used for all models: (1) < 10 m, (2) 11 - 50 m, (3) 51 - 100 m, (4) 101 - 200 m, (5) 201 - 1000 m, and (6) > 1000 m. These yielded estimates of biomass by Ecopath functional groups for each of the spatial cells covered by each model, which ranged from 1 to 509 cells (see Table 1).

2. The biomass of different functional fish-groups were re-expressed as a single value representing all fish with a trophic level of 3.0 or higher, (excluding, however the unexploited meso- and bathypelagics and deep-sea benthic fish in the model representing the deepest, central part of the South China Sea; see Table 1).

3. Regression analyses were performed using multiple linear regression in S-Plus 6. We used the software's additive and variance stabilizing transformation, (AVAS) to decide how individual variables are best transformed to obtain linearity.

4. A multiple regression was identified which predicted the fish biomass based on the year for which the biomass was estimated (expressed as log (year - 1959)), primary production in each half-degree cell (log transform), and the mean depth of each cell (log transform). To prevent the records from models covering large areas from overwhelming those from other models, each of the records was weighted in the regression analysis by the inverse of the square root of the number of non-land cells in the model to which it belonged. As data material we extracted 1 158 records based on the ½ by ½ degree spatial cells of the 16 ecosystem models in Table 1. Each of the records included estimates of fish biomass (trophic level ≥ 3.0), depth, primary production, and year of the model.

5. Following a first run of regression in Step 4, and an examination of the residuals, it was clear that the biomass values for the 1989 Brunei-model where higher than the model predicted. This is expected as fishing is very limited in Brunei, due to offshore oil rigs which fishing vessels may not approach (Cruz-Trinidad et al. 1997; Pauly et al. 1997). Thus a dummy variable was used to indicate whether a cell belonged to the EEZ of Brunei or not.

6. Using the regression the biomass for each cell represented was predicted and plotted for 1960 and 2000, representing the extremes for the period covered.

Results and Discussion

Based on the data in Table 2, we conclude that the multiple regression we derived is adequate in that it explains the major part of the variance in the dataset (R^2 = 0.68), and the partial regression coefficients (slopes) all have the expected signs. The t-values in Table 2 indicate the internal 'ranking' of the parameters, i.e. they identify those that matter most (or where the probability of exceeding the t-value by chance is smallest). However, due to covariation between variables the 'rankings' should be treated with extreme caution. We note that the highest t-value is associated with the depth parameter, followed by the year, then primary production. The intercept is estimated least reliably, which is the reason why we abstain from presenting absolute biomass estimates obtained through the multiple regression.

Table 2. Parameter estimates and associated test statistics for multiple linear regression to predict the biomass (log, g·m^{-2}) for fishes (TL > 3.0) in the South China Sea during the period from early 1960s to late 1990s. The variables are arranged by t-value (value relative to standard error, given) corresponding to adjusted partial slopes (Blalock 1972). All parameters are highly significant.

Variable (Unit)	Value	Std. error	t-value	Pr(>|t|)	Transformation
Depth (m)	-0.293	0.013	-22.7	0.000 000 0	Logarithmic
Year (year - 1959)	-0.760	0.043	17.6	0.000 000 0	Logarithmic
Brunei (0 or 1)	1.167	0.132	8.84	0.000 000 0	None
Primary production (gC•m^{-2}•year^{-1})	0.407	0.073	5.61	0.000 000 0	Logarithmic
(Intercept)	2.045	0.438	4.68	0.000 003 3	–

Figure 1 shows the transformation required to obtain linearity in the models. Based on this, log transformations were deemed suitable for all parameters apart from the dummy variable identifying the Brunei-variable. Further, Figure 2 shows the distribution of predicted versus observed values. There is no obvious pattern suggesting the model failed to linearize, or to include a key variable.

Figure 3 contrasts the maps of biomass distribution from the multiple regression model for 1960 against that for 2000. The high fish concentrations originally occurring in the Malacca Strait, the Gulf of Thailand, along the northern coast of Kalimantan and in other productive areas around the South China Sea, had completely disappeared by 2000, with the exception of the waters off Brunei, where fishing is forbidden around offshore oil rigs, a theme to which we return below. As estimated by the multiple regression and illustrated in Figure 3, fish biomass has strongly declined over the last 40 years, with present biomass generally less than half their values in 1960. This decline is most probably underestimated, as the catch per unit of effort of research trawlers in the Gulf of Thailand decreased from over 400 kg·hour^{-1} in 1961 to around 30 kg·hour^{-1} in the 1990s (Eiamsa-ard and Amornchairojkul 1997; Pauly 1979), with similar declines reported elsewhere.

This underestimation is a feature of the approach used here, which leads to conservative estimates. A similar conservative result was obtained in an earlier application of the above methodology to the North Atlantic, where individual species have declined far more sharply than estimated by the multiple regression used for biomass prediction (Christensen et al. 2003).

We also note that the decline of trawlable biomass documented here accompanied strong changes in species composition, noted by various authors as early as the 1960s (Pauly 1979; Pope 1979), a feature that can be straightforwardly reproduced by simulation modelling.

Figure 4 illustrates this through the example of the Gulf of Thailand, whose catches have stagnated since the 1970s, in spite of a massive increase in fishing effort, and a strong decline in the mean trophic level of the catch. These changes imply the loss (or at least disproportional decline) of large, long-lived high-trophic level species in the system, and their partial replacement with small short-lived, low trophic level species, used as duck and fish feed in the case of the Gulf of Thailand (Pauly and Chuenpagdee 2003).

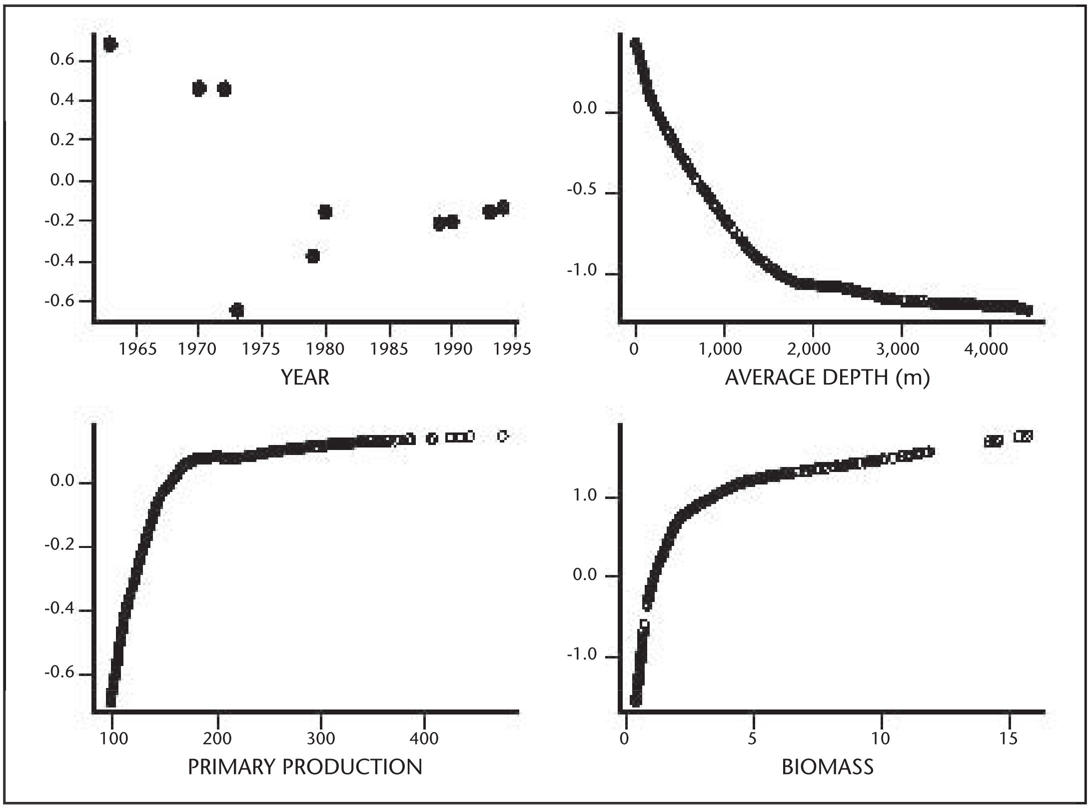

Fig. 1. AVAS transformations indicating how parameters (X-axis) should be transformed (Y-axis indicate biomass, linear scale) to linearize the individual parameters while considering their joint effects. These results indicate that logarithmic transformations are reasonable for year, depth, and primary production.

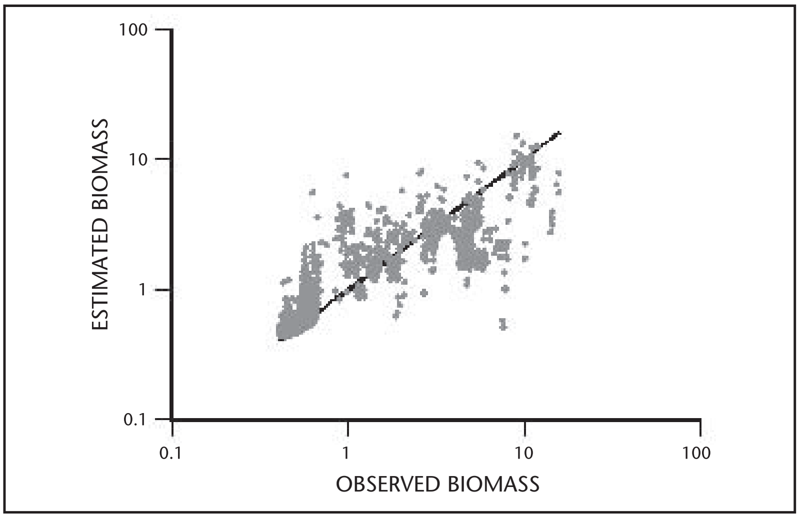

Fig. 2. Plot of predicted versus observed biomass ($g \cdot m^{-2}$). The predicted values are from the regression in Table 2, the 'observed' values from the spatialization of Ecopath models described in the Methods section.

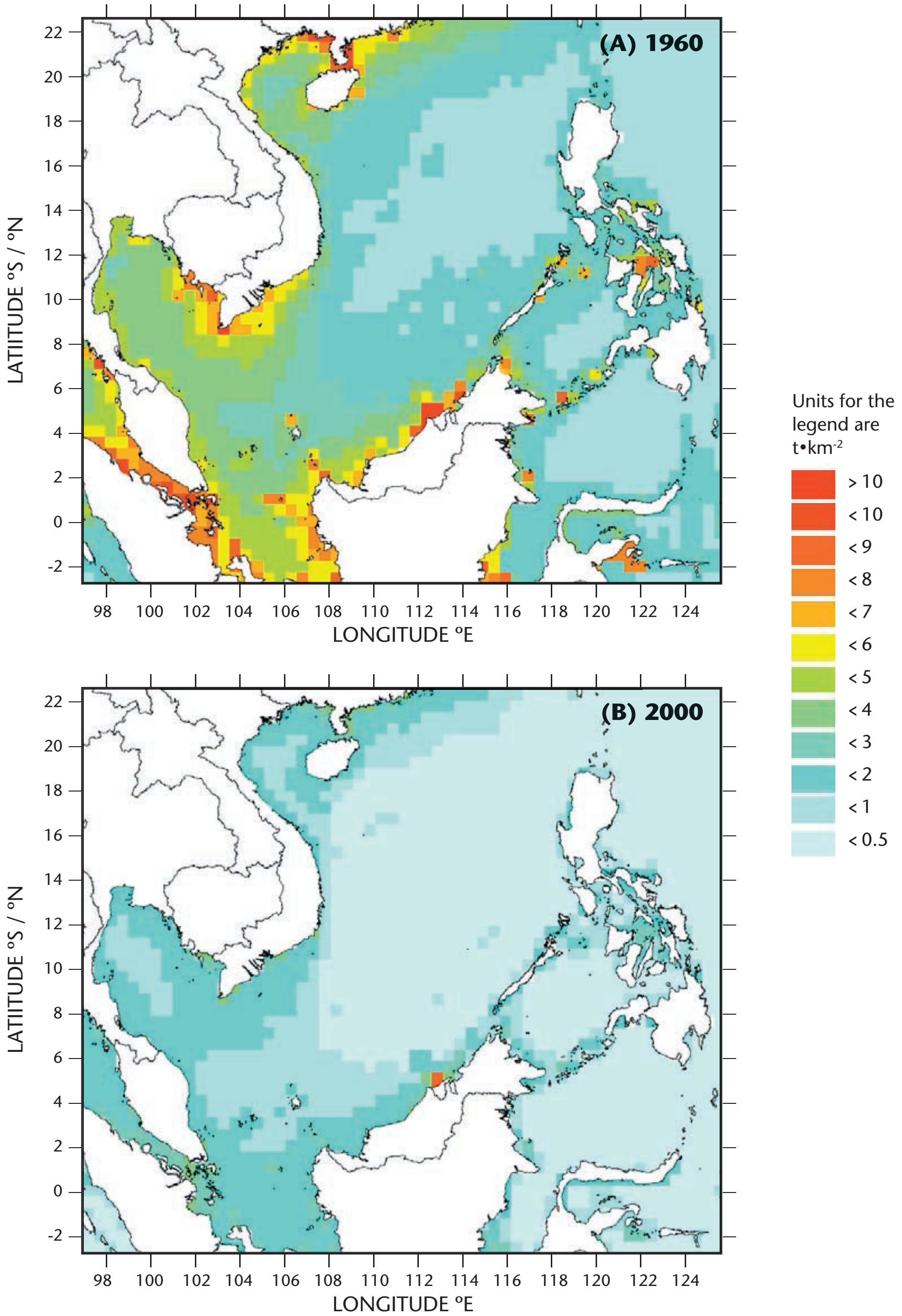

Fig. 3. Biomass distributions for fishes (trophic level ≥ 3.0) in the South China Sea large marine ecosystem in (A) 1960, and (B) 2000. The distributions are predicted from linear regressions based on log-transforms of depth, year, and primary production. Note that the high coastal concentrations in the early period have nearly completely disappeared - except for the Exclusive Economic Zone of Brunei.

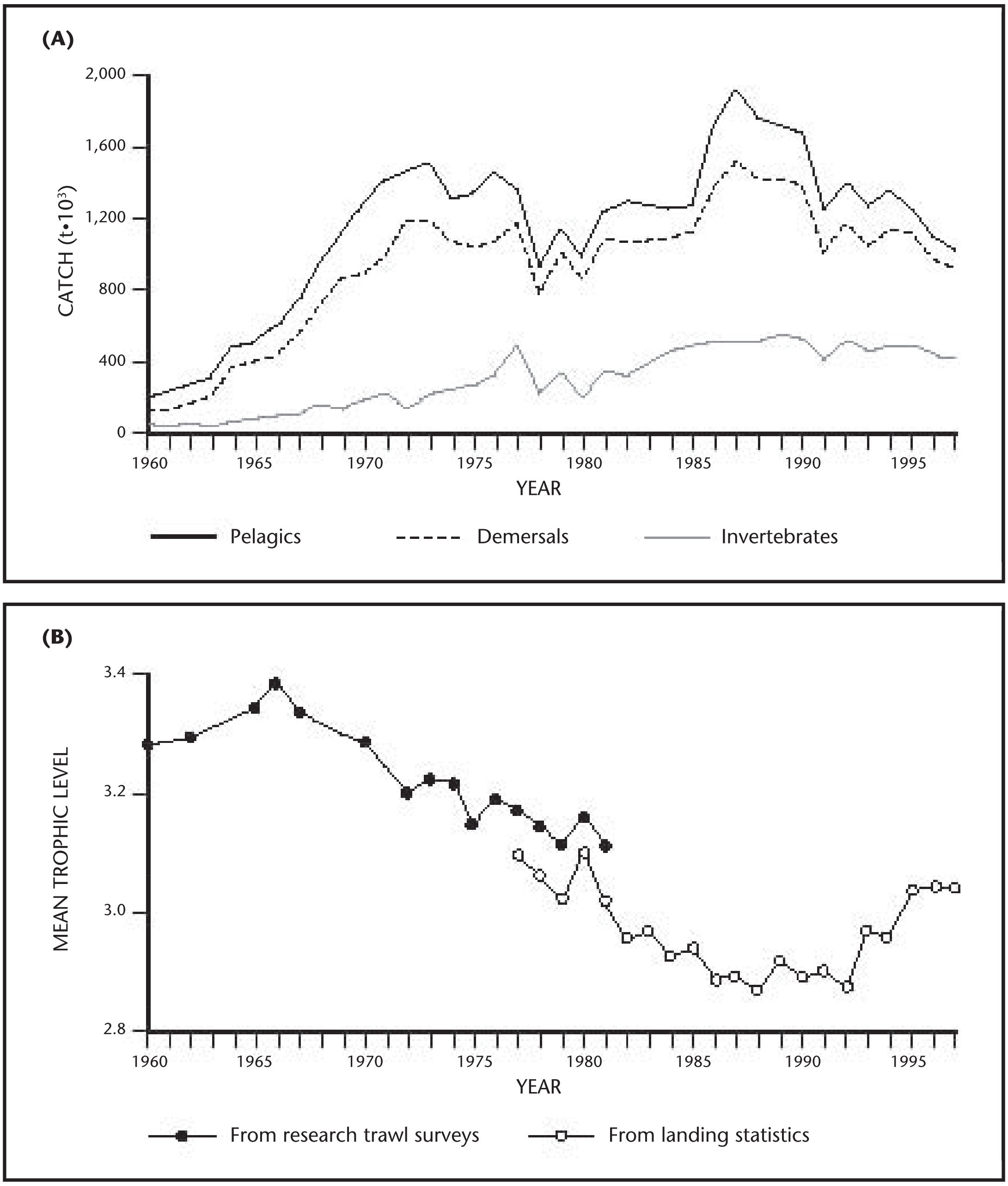

Fig. 4. Impact of fishing on the Gulf of Thailand ecosystem, an example of trends in the South China Sea:
(A) Catches, by major species groups (excluding tuna and other large pelagics). Note stagnation and decline of demersal catches, following their rapid increase in the 1960s and 1970s. Also note increasing contribution of small and medium pelagics, and overall decline in the 1990s.
(B) Trophic level (TL) trends in the catch of research trawlers (reflecting relative abundances in the ecosystems), and in the total landings (both series excluding large pelagics). Lower TL's in 1977 to 1997 series are due to inclusion of small pelagics and other low-TL organisms caught by gear other than trawl (adapted from Pauly and Chuenpagdee 2003)

The methodology deployed here thus diagnoses the same problems for the South China Sea that occur throughout the world, notably a complete absence of sustainability (Pauly et al. 2002). Indeed, if present trends are not reversed, fisheries are heading for a collapse of their underlying resource base, and of the ecosystems on which the fisheries depends (Pauly et al. 2002). At the same time, this study gives a pointer toward an important component of a solution for the over-fishing problem in South East Asia as well as elsewhere, through the example of Brunei - the only country in the region that has a significant part of its shelf effectively closed to fishing due to the presence of offshore oil rigs, around which fishing is not permitted. This has limited the Brunei trawl fishery to a small area near Muara, the only industrial port. While the small exploited area near Muara exhibits the same signs of over-fishing as the rest of South East Asia (Pauly 1989), a significant part of the biomass on the rest of the Brunei shelf has been retained, thus allowing for export of larvae and other live stages to adjacent areas, and the maintenance of functioning ecosystems.

It is hard to conceive how the depleted demersal stocks of the other areas of the South China Sea could be replenished without closing areas to fishing, or at least to trawling. The 1980 trawling ban in Indonesia might be instructive here as well (Sardjono 1980), though it is quite evident that the gain that could have been realized through the closure has been quickly dissipated, at least in the Java Sea by an enormous expansion of small scale fisheries and of an industrial pelagic fishery.

Thus, we cannot but reiterate that capping, and ultimately reducing fishing effort, including that of small scale fisheries is the only long term solution to halting, and reversing the worrying trends described here.

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Annex A.
Notes on the construction of the Ecopath model for the east coast of Peninsular Malaysia (1970).

In constructing the 1970 Ecopath model, the 1990 mass-balance trophic model constructed for the coastal fisheries ecosystem of the west coast of Peninsular Malaysia (see Alias, this vol.) was used. The ecosystem is partitioned into 15 trophic groups with biomasses for selected groups (e.g. large zoobenthos feeders) obtained from research (trawl) surveys conducted in the area in 1970. Biomass values were calculated using stock density estimates from Talib et al. (this vol.) ~ 5.092 5 t•km^2, and species composition from the trawl surveys (Jothy et al. 1975).

Total landings for each species/group were obtained from catch statistics of the Department of Fisheries for 1970. The 1970 P/B (=Z) values of the all-fished groups were calculated using the following equations:

$$Z_{70} = [\, Z_{90}\, (F_{70} + M)\,] \,/\, (F_{90} + M) \qquad \text{(Eqn. 1)}$$

where: Z_{90} is the 1990 total mortality values, F_{90} the estimated fishing mortality (1990); F_{70} the estimated fishing mortality (1970); M is the natural mortality and was assumed to be the same in 1970 and 1990. F_{70} was estimated:

$$F_{70} = (F_{90} \times C_{70}) \,/\, C_{90} \qquad \text{(Eqn. 2)}$$

where: F_{70} is the fishing mortality (1970); F_{90} is the estimated fishing mortality (1990); C_{70} is the total catch for the species/group in 1970; and C_{90} is the total catch for the species/group in 1990.

Table A1 presents the basic input and output parameter values used in modeling the coastal fisheries ecosystem off the west coast of Peninsular Malaysia.

Table A1. Basic input and output (in parenthesis) parameter values used in modeling the coastal fisheries ecosystem off the west coast of Peninsular Malaysia.

Ecological group	Biomass (t·km^{-2})	P/B (year^{-1})	Q/B (year^{-1})	EE	Catch (t·km^{-2}·year^{-1})
Mammals	0.02	0.05	30.00	(0.00)	–
Large predators	(0.02)	2.86	7.30	(0.69)	0.02
Large pelagics	(0.17)	3.93	9.55	0.95	0.17
Medium pelagics	(0.15)	2.43	10.00	0.95	0.05
Large zoobenthos feeders	0.25	3.90	7.85	0.95	0.02
Intermediate predators	(0.78)	7.49	15.00	(0.12)	0.42
Small demersal species	2.54	(0.21)	23.74	0.95	0.43
Small pelagics	(0.62)	3.75	12.9	0.95	0.86
Crustaceans (excl. plankton)	(6.55)	5.11	21.81	0.95	0.07
Misc. invertebrates	(5.96)	5.51	11.02	0.95	–
Squids	(4.40)	4.10	10.51	0.95	0.05
Turtles	0.02	1.50	3.50	(0.00)	–
Zooplankton	(2.66)	67.00	280.00	0.95	0.03
Aquatic plants	(14.08)	71.15	–	0.50	–
Detritus	100.0	–	–	(0.38)	–

Note: P/B = Production/Biomass ratio, Q/B = Consumption/Biomass ratio, EE = Ecotrophic efficiency.

Annex B.
Notes on the construction of the Ecopath model for the southwest coast of Vietnam (1994).

The primary source of quantitative information (i.e. biomass) in determining the input data for the model were obtained from results of the trawl surveys conducted in southwest Vietnam between 1993 to 1995. Other sources of information on the study area include (Khoi et al. 1995) for plankton studies, and (Chung and Ho 1995) for zoobenthos fauna. Only the biomasses estimated from the trawl surveys in southwest Vietnam were used as input values for demersal groups i.e. demersal predators, Leiognathids and other small demersals. Biomass values for zoobenthos were taken from results of a zoobenthos study in the seawaters of Vietnam (Chung and Ho 1995).

The food web model consists of 15 functional groups, i.e. 13 consumer groups, a producer (phytoplankton) group and a detritus group (see Table B1). The species composition and biomass data from the trawl surveys were used to determine the ecological groups. The aggregation process for this model was performed based on similarities in habitat, body size, growth and mortality rates and diet composition, after the method proscribed by (Christensen and Pauly 1996; Pauly and Christensen 1993). Such information (notably for fish) was mainly obtained from the FishBase database (www.fishbase.org). Table B2 summarizes the basic input and output parameter values used in modeling the coastal fisheries of southwest Vietnam.

Table B1. Species composition for the 15 functional groups of the southwest Vietnam Ecopath model[a]

Ecological Groups	Species/taxa included
Large predators	Sharks (Carcharinidae), Scombridae
Tuna	Scombridae (*Scomberomorus* spp., *Auxis* spp., *Euthynnus* spp., *Thunnus* spp.)
Medium pelagics (except Tuna)	Carangidae, Trichiuridae, Stromateidae
Small pelagics	Clupeidae and Engraulidae
Other pelagics	Carangidae, Caesionidae, Scombridae (*Rastrelliger* spp.)
Cephalopods	Includes squids (*Loligo* spp.), cuttlefish (*Sepia* spp.) and octopus (*Octopus* spp.)
Demersal predators	Apogonidae, Ariidae, Cepolidae, Cynoglossidae, Drepanidae, Fistularidae, Gobiidae, Holocentridae, Meneidae, Monocanthidae, Nemipteridae, Muraenidae, Ostraciidae, Paralichthyidae, Pegasidae, Platycephalidae, Plotosidae, Polynemidae, Priacanthidae, Rhinobathidae, Sciaenidae, Syngnathidae, Synodontidae, Tetraodontidae, Lethrinidae, Serranidae, Scorpaeinidae
Reef fish	Chaetodontidae, Labridae, Pomacentridae
Leiognathids	*Gazza minuta, Leiognathus* spp., and *Secutor* spp.
Other small demersals	Bothidae, Cynoglossidae, Gerreidae, Haemulidae, Mullidae, Nemipteridae, Psettodidae, Siganidae, Sillaginidae, Soleidae, Sparidae, Teraponidae Sciaenidae
Crustaceans (crabs & shrimps)	Portunidae, Palinuridae, Scyllaridae, Penaeidae
Zoobenthos	Crustacea, Polychaeta, Coelenterata Echinodermata, Porifera (Chung and Ho 1995)
Zooplankton	Copepoda, Chaetognatha (Khoi et al. 1995)
Phytoplankton	
Detritus	Comprised of particulate and dissolved organic matter

[a] Fish groups are only listed as families, complete species list can be found in the species composition of trawl surveys (Thouc and Dat 2000).

Table B2. Basic input and output (in parenthesis) parameter values used in modeling the coastal fisheries ecosystem off the southwest coast of Vietnam.

Ecological group	Biomass ($t \cdot km^{-2}$)	P/B ($year^{-1}$)	Q/B ($year^{-1}$)	EE	Catch ($t \cdot km^{-2} \cdot year^{-1}$)
Large predators	(0.01)	1.20	15.00	0.50	0.003
Tuna	(0.02)	0.80	(4.00)	0.95	0.004
Medium pelagics	(0.05)	1.50	(7.50)	0.95	0.015
Small pelagics	(0.21)	3.35	17.60	0.95	0.025
Other pelagics	(0.12)	3.00	(12.00)	0.90	0.048
Cephalopods	(0.08)	3.10	16.00	0.95	0.000
Demersal predators	1.21	3.00	12.00	(0.27)	0.151
Reef fish	(0.10)	2.00	12.00	0.70	0.021
Leiognathids	0.49	3.00	17.50	(0.60)	0.061
Other small demersals	0.21	(3.70)	18.50	(0.70)	0.026
Crustaceans	(2.85)	4.00	21.90	0.95	0.003
Zoobenthos	20.00	6.57	27.40	(0.64)	–
Zooplankton	(4.26)	50.00	200.00	0.90	–
Phytoplankton	(6.87)	120.00	–	0.90	–
Detritus	120.00	–	–	0.53	–

Note: P/B = Production/Biomass ratio, Q/B = Consumption/Biomass ratio, EE = Ecotrophic efficiency.

Annex 845

K. Warren-Rhodes, et al., "Marine Ecosystem Appropriation in the Indo-Pacific: A Case Study of the Live Reef Fish Food Trade", *Ambio: A Journal of the Human Environment*, Vol. 32, No. 7 (Nov. 2003)

Article

Kimberley Warren-Rhodes, Yvonne Sadovy and Herman Cesar

Marine Ecosystem Appropriation in the Indo-Pacific: A Case Study of the Live Reef Fish Food Trade

Our ecological footprint analyses of coral reef fish fisheries and, in particular, the live reef fish food trade (FT), indicate many countries' current consumption exceeds estimated sustainable per capita global, regional and local coral reef production levels. Hong Kong appropriates 25% of SE Asia's annual reef fish production of 135 260–286 560 tonnes (t) through its FT demand, exceeding regional biocapacity by 8.3 times; reef fish fisheries demand outpaces sustainable production in the Indo-Pacific and SE Asia by 2.5 and 6 times. In contrast, most Pacific islands live within their own reef fisheries means with local demand at < 20% of total capacity in Oceania. The FT annually requisitions up to 40% of SE Asia's estimated reef fish and virtually all of its estimated grouper yields. Our results underscore the unsustainable nature of the FT and the urgent need for regional management and conservation of coral reef fisheries in the Indo-Pacific.

INTRODUCTION

The demand for live seafood in Asia has spawned a lucrative trade in live coral reef fish (1, 2) that in 1995 had an estimated global annual retail value of over USD 1 billion. The live reef fish food trade (FT) began in the early 1960s and today furnishes reef fish from the Indo-Pacific to restaurants and seafood markets in Southeast (SE) Asia and the Far East (3).

The high revenues of the live reef fish food trade (FT) are counterbalanced by 2 serious ecological problems: *i)* over-exploitation of target species; and *ii)* cyanide fishing (1, 4-6). Each year, the FT markets an estimated 25 000-54 000 t of reef fish (50-100 million individuals) from SE Asia and the Indo-Pacific (1). The bulk of these fish are groupers (Family, Serranidae), with several other reef fish families including the wrasses (Family, Labridae, especially the humphead wrasse, *Cheilinus undulatus*) and snappers (Family Lutjanidae) (3). Many are caught in such numbers that the FT is almost certainly contributing to overfishing of several species preferred in the trade in the Philippines and Indonesia, major source countries for the trade (1). In some areas, certain of these species are caught using destructive fishing techniques such as cyanide (4, 7). Not only is this toxin nonselective, but its use affects both target and nontarget fishes and invertebrates by taking unwanted bycatch and possibly killing living corals (7).

There are concerns that the FT is inflicting an unacceptably heavy impact on coral reefs and reef resources in SE Asia and the Indo-Pacific. These areas contain over 90% of the world's coral species and include the highest global marine biodiversity (8). Because these reefs provide over 1 billion people in Asia with food, and their primary source of daily animal protein (4, 5), their destruction and fisheries over-exploitation threaten current and future regional food security and socioeconomic development (4, 9, 10).

This article examines the marine ecosystem area appropriated by major Asian economies for the FT. Hong Kong was chosen as the focus of this article for two reasons. First, it is the largest trader and major consumer of live reef food fish in the world. Second, in contrast to other demand-side economies (e.g. Singapore, mainland China), data are available to examine Hong Kong's role in the trade, facilitating an in-depth analysis of its marine ecological footprint (MEF). However, even the Hong Kong data underestimate the true scale of the imports of live fish into Hong Kong (6).

MARINE ECOLOGICAL FOOTPRINTS

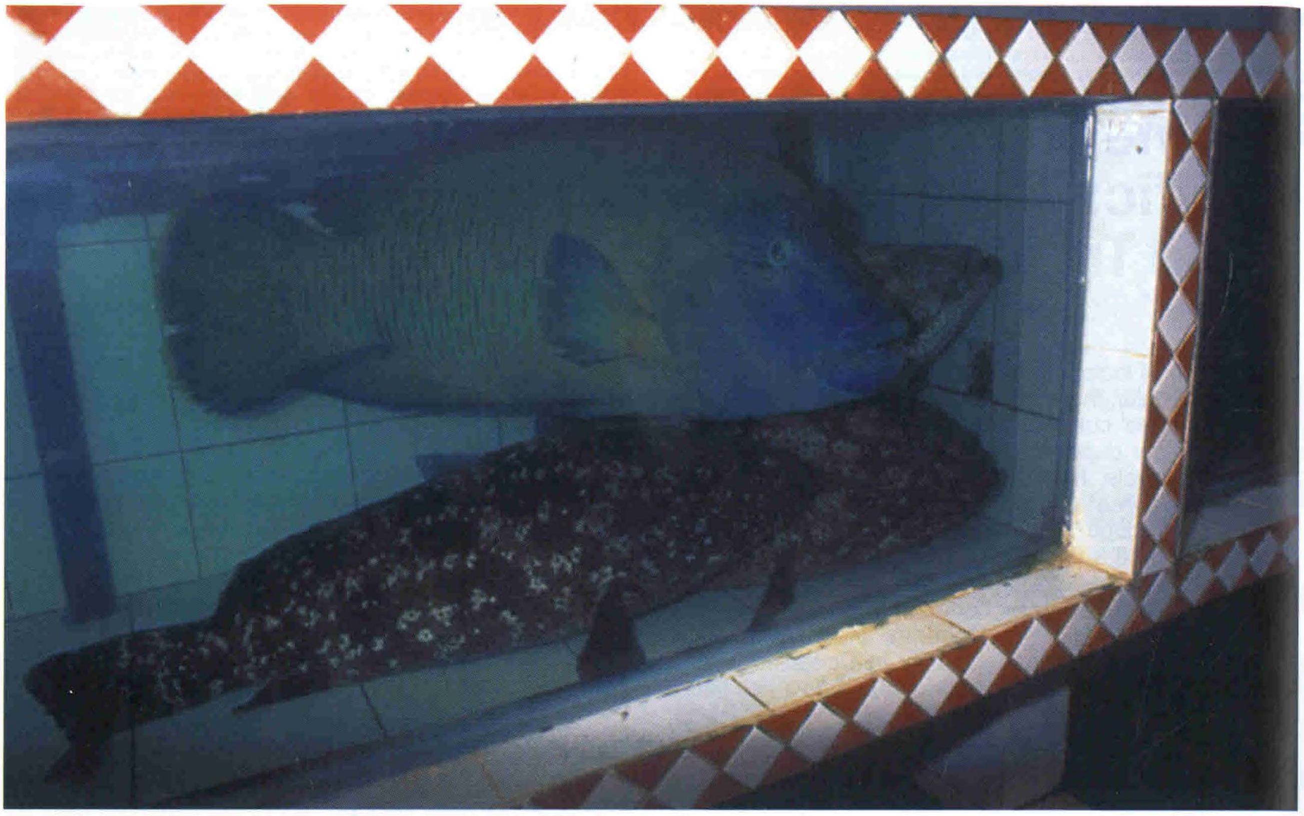
The Concept

Marine ecological footprints (MEF) measure the marine ecosystem area appropriated by populations to supply seafood and other marine products and services (11-13). Because these products and services are often not fully reflected in conventional economic and trade analyses, MEFs are important tools for calculating the hidden support provided by natural ecosystems and the real costs of that support (14). MEFs can be computed for global, regional, and local (e.g. country or city) scales, or they can focus on specific activities such as mariculture or the FT (14-16). MEFs can be calculated (11-14) as ratios (e.g. # times above or below sustainable levels, as in Table 1) or areas (e.g. km^2 appropriated coral reef, as in Tables 2 and 3), and here we report our results in both forms (17). In this article, we apply the MEF concept to coral reef fisheries to answer the following question: What proportion of SE Asia's and the Indo-Pacific's coral reef fisheries production is needed to supply the FT in Asia, and in particular Hong Kong's annual demand for live reef fish, and can this demand be sustained by available reef resources?

Biocapacity

The MEF, which represents the demand for marine biological production, can be compared to an area or region's biological productive capacity, or "biocapacity" (16). For global sea area, this biocapacity is calculated by dividing the amount of productive ocean area on the earth by the world's population (16), or it is expressed as the quantity of seafood available per capita globally on a sustainable basis (18).

Before proceeding with the MEF case study for the FT and Hong Kong, it is first useful to examine MEFs within a more general fisheries context. To that end, the next section presents sustainable coral reef fisheries production and consumption estimates for global, regional and country/city levels. We base these estimates on globally available data sets (19) and generally accepted assumptions about fisheries yields and consumption. While these figures enable a systematic comparison across many countries and regions, their generality precludes them from illuminating specific trade activities like the FT. For this case, more specific data regarding live reef fish consumption, trade, and production are needed. These data are available for the city of Hong Kong, and in the case study we use this information to calculate a more accurate MEF for coral reef fisheries consumption.



Serious and rapid declines in several species have occurred as a direct result of the FT, including the humphead wrasse, *Cheilinus undulatus* shown here. Consequently, they have been categorized as vulnerable in the World Conservation Union's (IUCN) Red List of threatened species (43). Photo: Y. Sadovy.

SEAFOOD CONSUMPTION IN A GLOBAL, REGIONAL AND CITY-LEVEL FISHERIES CONTEXT

Coral reef biocapacity can be estimated from coral reef surface area and average reef seafood yields. Highly variable estimates of average sustainable seafood yields and global coral reef surface cover result in a wide possible range of theoretical biocapacities. Therefore, for simplification, the text and tables present point estimates based on currently available data and/or general scientific consensus. Footnotes provide details of the full range of assumptions and results based on extensive sensitivity analyses.

Global and regional coral reef biocapacities in this study are based on the most current reef area estimates by Spalding et al. (20) and indicate significant differences among regions in estimated sustainable levels of seafood production from coral reefs. At the global scale, coral reefs cover a surface area of 284 300 km^2 (20, 21) and could supply an estimated Maximum Sustainable Yield (MSY) of nearly 1.5 million t (Mt) yr^{-1}, based on seafood yields of 5 t km^{-2} yr^{-1} (22). This global coral reef biocapacity equates to 0.2 kg of seafood cap^{-1} yr^{-1} (Table 1) (23). Coral reefs in SE Asia could potentially produce sustainably an estimated 0.5 Mt seafood yr^{-1}, and supply the SE Asia population of 663 million with 0.7 kg cap^{-1} yr^{-1} (Table 1). For the Indo-Pacific region as a whole, the corresponding figures are 1.3 Mt seafood yr^{-1} and 1.5 kg cap^{-1} yr^{-1}. In the less populated Western Pacific region (i.e. developing Oceania as defined by FAO), a much higher coral reef biocapacity could supply seafood at 45 kg cap^{-1} yr^{-1}.

Global and regional biocapacities can be compared to an individual country's or city's consumption of coral reef fish and seafood. Assuming that per capita coral reef seafood consumption is 10% of total seafood consumption for SE Asian economies and 25% for all other countries in the Indo-Pacific (22, 24) our MEF estimates suggest that most countries and cities exceed global and regional per capita coral reef biocapacities (25). In the Indo-Pacific, current reef seafood demand of all countries combined requires an estimated 677 854 km^2 of reef area (Table 2)—over 2.5 times the total available coral reef area of the region (26). In SE Asia, total seafood demand is about 4 times the sustainable total production theoretically available from coral reefs in the region, requiring nearly 577 000 km^2 of reef area (Table 2). Certain individual economies in SE Asia, such as Hong Kong, Japan, and Malaysia, have a particularly high demand, appropriating about 9 times (Table 1) what can be sustainably produced per capita by reefs in SE Asia.

Country and city-level biocapacities for coral reef resources can be computed by multiplying a country's or city's individual total coral reef area by a sustainable yield factor for seafood that comes only from coral reefs, which varies from 5-15 t km^{-2} coral reef. In addition to comparing this biocapacity with the country and city-level reef seafood consumption figures derived above, which include not only reef species but also freshwater species and marine species not exclusive to coral reefs, we employ alternative and more accurate approaches based on detailed FAO species-level fisheries data, when available. We retain the consumption figures described above (i.e. 10% of total seafood supply) as high estimates of coral reef fisheries consumption and compare these to alternative figures based on the following assumptions: *i)* moderate consumption level—10% of demersals, other marine fish, and invertebrates categories of FAO fisheries data; and *ii)* low consumption level—10% of demersals only (27). It should be noted that given the uncertainties, inadequacies, and possible distortions in these and other FAO fisheries statistics (27, 28), the 2 sets of estimates presented above should be treated with caution (27). For

Table 1. Coral reef biocapacities and marine ecological footprints (MEF) as ratios for coral reef fisheries at global, regional, and local levels, 1997.

CORAL REEF BIOCAPACITIES (kg cap^{-1} yr^{-1})		A. Coral reef seafood supply (kg cap^{-1} yr^{-1})	B. MEF Global Coral Reefs	C. MEF SE Asia Coral Reefs	D. MEF D. Oceania Coral Reefs	E. MEF Indo-Pacific Coral Reefs
a. Global	0.2-1.6					
b. SE Asia	0.7-4.3					
c. Indo Pacific	1.5-8.9					
d. Developing Oceania	45-136			SE		INDO-
City/State	Population ('000)			ASIA		PACIFIC
Hong Kong	6511	6.0	24.6	8.3		4.0
Japan	126038	6.6	27.2	9.2		4.5
Korea, R.	45731	5.1	20.8	7.0		3.4
China	1222630	2.6	10.6	3.6		1.7
Taiwan	21577	3.9	15.9	5.4		2.6
Macau	450	3.3	13.4	4.5		2.2
Indonesia	203380	1.8	7.5	2.5		1.2
Malaysia	20983	5.4	22.0	7.4		3.6
Philippines	71430	3.0	12.4	4.2		2.0
Singapore	3427	3.4	13.9	4.7		2.3
Thailand	59736	3.4	13.8	4.7		2.3
Vietnam	76387	1.7	7.1	2.4		1.2
Burma	43936	1.8	7.2	2.4		1.2
Laos	5032	0.9	3.5	1.2		0.6
Cambodia	10478	0.9	3.5	1.2		0.6
Brunei	308	2.1	8.8	3.0		1.4
Australia	18329	4.6	18.8			3.1
Hawaii	1189	2.1	8.5			1.4
Fiji	786	8.3	33.8		0.18	5.5
Solomon Islands	404	8.6	35.3		0.19	5.8
Micronesia	112	10.1	41.4		0.22	6.8
Vanuatu	177	6.7	27.5		0.15	4.5
French Polynesia	223	17.1	70.2		0.38	11.5
Cook Islands	19	13.4	54.7		0.29	9.0
Papau New Guinea	4499	3.6	14.6		0.08	2.4
Kiribati	80	19.6	80.1		0.43	13.1
New Caledonia	202	6.5	26.5	DEVELOPING	0.14	4.4
Tonga	98	8.0	32.8	OCEANIA	0.18	5.4
Guam	158	0.6	2.5		0.01	0.4
Marshall Is.	58	2.2	9.1		0.05	1.5
Palau	18	21.8	89.2		0.48	14.6
Tuvalu	11	5.9	24.2		0.13	4.0
Nauru	11	9.1	37.3		0.20	6.1
Niue	2	13.8	56.3		0.30	9.2
Tokelau	1	50.0	204.8		1.10	33.6
Samoa	172	15.7	64.2		0.35	10.5
American Samoa	61	1.7	7.1		0.04	1.2
N. Marianas	66	12.7	51.9		0.28	8.5
Sri Lanka	18274	5.1	20.7			3.4
India	966192	1.2	4.8			0.8
Maldives	263	41.3	169.1	INDIAN OCEAN		27.8
Seychelles	75	16.4	67.3	& RED SEA		11.0
Mauritius	1133	5.4	22.0			3.6
Kuwait	1732	2.8	11.6			1.9
Saudi Arabia	19749	1.8	7.3			1.2

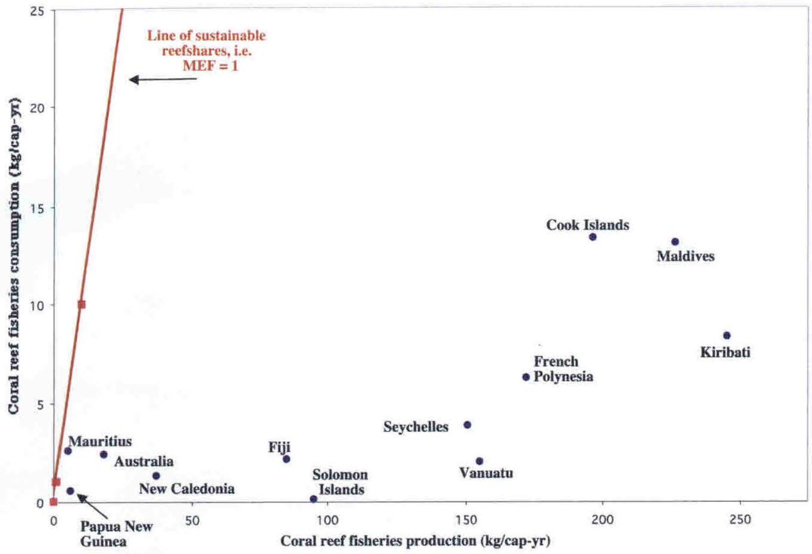
Notes:

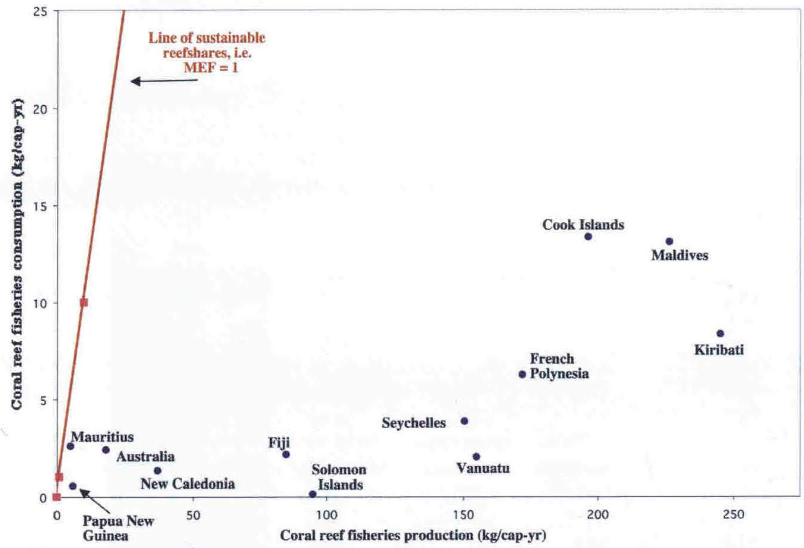
i. An expanded version of this table, including region definitions, is available through the authors.

ii. Results can be interpreted as follows: An MEF *i)* = 1, means the city or population is exactly self-sufficient, *ii)* > 1, coral reef resource consumption is not locally self-sufficient, or *iii)* < 1, the region or city is more than self-sufficient and is living within its own ecological means, e.g., Hong Kong's consumption exceeds SE Asia's sustainable coral reef production by 8.3 times (i.e., column A divided by SE Asia coral reef biocapacity, with rounding).

iii. Biocapacities are obtained by dividing maximum sustainable yield (MSY) by world or regional population for 1997. For coral reef biocapacities, the range in values reflects uncertainty (5-15 t km^{-2} yr^{-1} seafood yields) in coral reef MSY.

iv. Coral reef supply (column A) is assumed to be 10% of total seafood supply for all countries in SE Asia and 25% of total seafood supply for all Indo-Pacific countries, excluding SE Asia. Total seafood supply (apparent consumption) data are from the FAO Fisheries Circular No. 821 Revision 5, 1961-1997 and FAO Food Balance Sheets (http://www.fao.org/apps).





Figures 1a and b.
Estimates of individual country or city coral reef fisheries biocapacities and MEFs in SE Asia and the Indo-Pacific. Positions above the MEF = 1 line indicate where coral reef seafood consumption of the region or city exceeds its own coral reef biocapacity, whereas positions at MEF ≤ 1 suggest self-sufficiency and consumption within the population's own ecological means. The values shown represent moderate consumption estimates (10% for SE Asia and 25% for Indo-Pacific, excluding SE Asia, of values for FAO demersals and other marine fish and invertebrate categories) and seafood yields from coral reefs of 10 t km^{-2} yr^{-1}.

simplicity, the range of estimates for reef fisheries consumption is not shown in Figures 1a or 1b, but can be viewed in more detailed graphs available through the authors. This analysis of coral reef biocapacity and consumption levels provides further indication that a few major economies in SE Asia exhibit a disproportionately heavy footprint on reef ecosystems in SE Asia—they consume more reef-associated seafood than can be sustainably generated by, and are depleting the entire region's natural capital in, coral reefs. In contrast, Pacific island nations consume a maximum of 20% of Oceania's annual coral reef biocapacity. Oceania thus remains the last region in the Indo-Pacific with healthy sustainably harvested coral reef fisheries, and it is for this reason that this location is increasingly being targeted by the food trade.

CASE STUDY: ECOSYSTEM APPROPRIATION BY THE FT

The estimates presented in Table 1 and previous sections are based on aggregate global and regional data sets; more detailed methods and statistics are needed to recalculate the regional sustainable fisheries production for coral reefs in SE Asia and the Indo-Pacific. The case study of Hong Kong allows a more detailed examination of the MEF of Hong Kong and of all FT demand countries combined.

Sustainable Coral Reef Fisheries Production in the Indo-Pacific and SE Asia

To estimate the impact of the FT, the sustainable production of coral reefs must be considered. Because production is a function of many factors, we present a range of optimistic to pessimistic scenarios based on varying production linked to coral reef health, reef fishery maximum sustainable yields, and fishing pressure.

Estimates of coral reef area, health and fishery yields
The sections below outline our assumptions for subsequent calculations and analyses.

i) **Coral reef surface area.** Coral reefs comprise approximately 0.1-0.5% of the world's ocean floor (20, 21). Of the world's coral reefs 30% are in SE Asia, with 18% of the total located in Indonesia and the Philippines (29). We assume the following coral reef surface areas (30): *i)* global—284 300 km^2; *ii)* SE Asia—91 700 km^2; and *iii)* Indo-Pacific—259 600 km^2 (excluding the E. Pacific). While these figures are based on a restricted definition of a coral reef (21), limiting the area to known, mapped shallow-water reefs, we employ these estimates because near-surface reefs are the most biologically productive and economically important for fisheries (31), they are the main targets of the FT, and higher figures may overestimate total global reef habitat (21). However, for comparison, sensitivity analyses with higher reef area values were run and are discussed in the following sections as upper bounds for coral reef production.

ii) **Coral reef health.** Coral reef health—based on total live coral cover—significantly affects fisheries production, with healthier reefs being more productive (32). Coral reef health is typically assessed based on total live coral cover. For health status, we employed data from Bryant et al.'s comprehensive survey (5), which revealed the following percentages for SE Asia and the Indo-Pacific regions, respectively: *i)* excellent condition—3% and 20%; *ii)* good—15% and 40%; *iii)* fair—26% and 30%; and *iv)* poor—56% and 10%.

iii) **Coral reef fishery yields.** We base optimistic reef fishery yields on McAllister (33) and pessimistic yields on Dalzell (34). McAllister showed total reef fishery production of 3-18 t km^{-2} yr^{-1} for reefs in poor to excellent health. Dalzell reviewed sustainable yields from tropical reef fisheries, which varied

Table 2. Coral reef ecosystem appropriation and coral reef fisheries consumption estimates, 1997 data.

City or country	Reef area km²	Appropriated ecosystem area (km²)	Coral reef fisheries consumption (t yr⁻¹)	# times above or below own coral reef biocapacity
Hong Kong	1-2	6238	31 188	3119
Japan	2900	110 913	554 567	38
Korea, R.	1-2	28 719	143 595	14 360
China	1510	327 665	1 638 324	217
Taiwan	940	12 083	60 416	13
Macau	0	232	1161	na
Indonesia	51 020	20 338	101 690	<1
Malaysia	3600	12 296	61 480	3
Philippines	25 060	11 286	56 430	<1
Singapore	100	na	na	na
Thailand	2130	15 890	79 449	7
Vietnam	1270	17 875	89 373	14
Myanmar	1870	12 829	64 147	7
Laos	0	50	252	na
Cambodia	0	314	1572	na
Brunei	na	9	43	na
TOTAL SE ASIA	91 700	576 737	2 883 686	
Australia	48 960	12 220	61 101	<1
Fiji	10 020	904	4520	<1
Solomons	5750	12	61	<1
Micronesia	5490	na	na	na
Vanuatu	4110	107	535	<1
Fr. Polynesia	6000	345	1723	<1
Cook Islands	1120	0	0	na
Papua New Guinea	13 840	607	3037	<1
Kiribati	2940	143	716	<1
New Caledonia	6000	118	591	<1
OCEANIA	114 220	14 457	72 283	
Sri Lanka	680	4020	20 101	6
India	6000	72 464	362 322	12
Maldives	8920	701	3504	<1
Seychelles	1690	128	641	<1
Mauritius	870	714	3569	<1
Kuwait	110	338	1689	3
Saudi Arabia	6660	8295	41 473	<1
TOTAL IF	259 600	677 854	3 389 268	

Notes:
i. Reef area data are from (20).
ii. The above assumes coral reef seafood consumption is 10% (for SE Asia) and 25% (for Indo-Pacific, excluding SE Asia) of values for FAO demersals' and 'other marine fish' categories and that sustainable coral reef fisheries yield is 5 t km^{-2} yr^{-1}.
iii. na = data not available.
iv. Data for Tonga, Guam, Marshall Islands, Tuvalu, Nauru, Niue, Tokelau, Samoa, Am. Samoa and N. Marianas not available for categories other than reef area.

from 0.1-44 t km^{-2} yr^{-1}. From this and other reviews (35, 36), the consensus holds that while total yields much higher than 5 t km^{-2} yr^{-1} are possible for some reefs in SE Asia and the Indo-Pacific, those well in excess of 15 t km^{-2} yr^{-1} are rare.

iv) **Reef fishery finfishes and grouper yields.** The reef fishery yield above includes both finfishes and invertebrates (34). The FT, however, focuses heavily on finfishes, and in particular, on groupers and larger reef fishes. Based on Cesar (J. McManus, pers. comm., as cited in Cesar (10)), we assume finfishes constitute two-thirds of total yields. Groupers comprise 0-15% of the finfish yields, depending upon the reef's health status and the degree of fishing pressure (10, 35).

v) **Fishing pressure.** Fishing intensity also reduces yield, with catch rates of grouper and other top predators declining (down to 1/3 or 1/2 of virgin reefs in < 5 years) as fishing pressure intensifies (34). We assume that half of the coral reef surface area (for any health condition) is under heavy fishing pressure, which reduces estimated yields by 50%, and that half is under moderate or light fishing pressure, which we assume has a negligible effect on long-term yields.

Our calculations indicate coral reefs in excellent and good condition could furnish 80-90% of grouper yields in SE Asia and the Indo-Pacific, whereas those in fair and poor condition would contribute only 10-20% of the total. These results underscore the critical importance to fisheries in these regions of protection of reefs in good condition and rehabilitation of reefs in less healthy states.

Estimates of total sustainable reef fisheries production in SE Asia and the Indo-Pacific

Based on the assumptions above (37-39), coral reef production values for SE Asia and the Indo-Pacific are indicated in Table 4. Sensitivity analyses for all factors were run. However, for simplicity we report the point estimate we believe to be the most representative value for current coral reef fisheries production, which assumes coral reefs to be typically in fair to poor condition in this region (5) and a midpoint figure for fishery yields (i.e. a total of about 10 t seafood km^{-2} yr^{-1} and 5 t finfishes km^{-2} yr^{-1}) from Dalzell (34). With these assumptions, total sustainable production of coral reef finfishes and groupers, respectively, in the Indo-Pacific is estimated at approximately 650 000 t yr^{-1} and 50 000 t yr^{-1}. Within SE Asia, annual coral reef biocapacity is 135 000 t of finfishes and 7300 t of groupers. SE Asia, therefore, can potentially supply only about 15% of the Indo-Pacific's total estimated sustainable grouper production. These estimates approximately double when McAllister's (33) higher yields are used (Table 4).

Estimates of Coral Reef Ecosystem Appropriation

Consumption of seafood in Hong Kong and for the FT

The Hong Kong Special Administrative Region is a highly developed metropolitan area supporting nearly 7 million people on a total land area of 1097 km² (built-up area, 120 km²). Hong Kong possesses abundant sea area (1700 km²), but with its own fisheries stocks severely depleted, no local management, little mariculture to supplement fishery yields, and a high and growing demand for seafood, it is almost exclusively dependent upon marine ecosystems beyond its borders for seafood supplies (40). Total per capita seafood consumption in Hong Kong is 46-60 kg yr^{-1} (40, 41). As the largest FT importer, Hong Kong's demand accounts for about 60% of the FT (with an estimated 50% re-exported to mainland China, (42)), placing the total annual volume of the FT at 25 000-54 000 t, with 15 000-31 500 t mainly from grouper, but also from other reef fish like snappers and humphead wrasse (1, 6).

MEF for Hong Kong's role in the FT

Based on Hong Kong's estimated annual imports in 1997 of 32 000 t of live reef fish, our results show that this single economy appropriates 3%–5% of the Indo-Pacific's, or about 10–25% of SE Asia's, estimated sustainable reef fish harvest (Table 3). This corresponds to a minimum MEF for Hong Kong's annual share in the FT of approximately 0.1-0.2 ha cap^{-1}; i.e., it appropriates the production of at least 6500–13 000 times its own coral reef area.

If Hong Kong's demand for groupers is specifically examined (18 900 t yr^{-1} in 1997), it can be seen that 140-260% of SE Asia's total sustainable grouper production is appropriated (Table 3). Although some percentage of Hong Kong's demand

	Appropriated ecosystem area (km²)		Percentage of reef fisheries production appropriated	
	SE Asia coral reefs	Indo-Pacific coral reefs	SE Asia coral reefs	Indo-Pacific coral reefs
Hong Kong's total reef fish consumption				
optimistic scenario	10 552	6838	12	3
pessimistic scenario	22 356	13 224	24	5
Hong Kong's grouper consumption				
optimistic scenario	129 153	53 076	137	20
pessimistic scenario	245 088	98 068	259	37
FT's total reef fish consumption				
optimistic scenario	17 067	11 059	19	4
pessimistic scenario	36 158	21 388	39	8
FT's total grouper consumption				
optimistic scenario	208 886	85 843	228	33
pessimistic scenario	396 393	158 610	432	61

Table 3. Estimates of the appropriated marine ecosystem area and percentage of coral reef production appropriated by Hong Kong and the live reef fish trade (FT).

Notes:
i. The percentage of reef fisheries production appropriated refers to that from either SE Asia or the Indo-Pacific, but not both. For example, current consumption by Hong Kong appropriates either 11% of SE Asia's production or 3% of the Indo-Pacific's total.

is re-exported to China, this total demand exceeds SE Asia's entire coral reef fisheries' regenerative capacity for groupers. The implications of Hong Kong's (and southern China's) high and very probably unsustainable appropriation of annual coral reef fisheries production in SE Asia are sobering. As our analysis shows, Hong Kong (and southern China) annually remove up to 25% of SE Asia's total sustainable reef fisheries catch and virtually all of its grouper stocks. This high appropriation of coral reef resources presumably partly explains why Hong Kong fishing fleets and traders must continually relocate to sustain annual market demand (43).

MEF for the entire FT

On an annual basis, the FT in Asia markets as much as 40% of SE Asia's sustainable coral reef finfishes production. For groupers, the trade sells up to 4 times the sustainable yield of SE Asian reefs, or as much as 60% of the entire Indo-Pacific region's annual sustainable grouper production (Table 3). The FT as a whole is a significant consumer of coral reef fisheries resources throughout the Indo-Pacific region, and its annual demand must be considered and integrated into regional coral reef management and protection plans.

Impacts on the MEFs from cyanide fishing, mariculture and overfishing

Other activities exacerbate the high levels of exploitation. In addition to overfishing, the use of cyanide in some areas damages coral reefs (7, 44), possibly impairing their capacity to produce fish and seafood. High fish mortalities and poor fishing practices also characterize FT operations, with average mortalities estimated at 50% between capture and retail sales (43) and a heavy focus on reef fish spawning aggregations which cannot withstand heavy fishing pressure (1, 43). Lastly, coral reef fish mariculture, which supplements grouper supply for the FT, also engenders negative ecological impacts. Hundreds of millions of juveniles are caught for this industry throughout SE Asia and traded internationally around the region. Many of these are young fish and millions die from poor culture and transport conditions, while the pollution and use of wild fish to feed cultured groupers is also a matter of concern (45, 46). Coral reef destruction and biomass lost in the above ways are not reflected in trade figures or regulatory initiatives. If such losses were included in our analyses, the MEF estimates would be substantially higher.

DISCUSSION AND CONCLUSIONS

This study provides the first analysis of the scale of coral reef fish appropriation by the FT. It suggests that Hong Kong and southern China appropriate unsustainable quantities of reef fish with a high MEF and significant impact to reef ecosystems within SE Asia and the Indo-Pacific. Although this MEF analysis is limited to the quality of underlying data and assumptions, and reflects only a static picture of coral reef fisheries (e.g. does not incorporate dynamics in seafood demand or the complex nature of reef ecosystems) (12, 47, 48), its results are valuable in assisting policymakers to *i)* identify the largest regional consumers of coral reef resources; *ii)* assess the ramifications of this consumption; *iii)* quantify the pressures on and limits of coral reef ecosystems' regenerative biocapacity; and *iv)* identify management and conservation needs at local and regional scales.

Need for Coral Reef Fish Fisheries Data Collection

Our analysis and those of others on the FT highlight the lack of systematic and accurate data for coral reef fish fisheries and reflect the general paucity of fishery information in SE Asia (28). Given the importance of these ecosystems and their resources to global marine biodiversity and regional economic prosperity and food security (49), we urge organizations such as the FAO, the Asia-Pacific Economic Cooperation (APEC), etc. to foster the collection of more accurate and detailed annual statistics on coral reef fisheries and promote more sustainable practices, such as the Code of Conduct for Responsible Fisheries.

Developing Countries with Healthy Coral Reefs Own an Economically Valuable Resource

In supply-side nations of the FT, it is not widely understood that the trade, by appropriating and degrading the capacity of coral reef ecosystems, is severely limiting their current and future food security and socioeconomic development. A sustainable nondestructive FT can in theory make both the supply and the consuming country better off. In this case, large footprints of some countries and small ones of others would be exactly what trigger welfare-enhancing trade. However, the welfare gains of trade can turn into net welfare losses to the exporting country (and to the world) when the trade is ecologically unsustainable or destroys the natural resource base (50). In the long-term, supply countries, and in particular individual fishermen and villages, that receive only a small fraction of FT profits, are

Table 4. Coral reef surface area and estimated finfish and grouper sustainable yields for SE Asia and the Indo-Pacific.

Coral reef surface area (km^2)	SE Asia	Indo-Pacific
excellent	2751	36 331
good	13 755	80 915
fair	23 842	74 212
poor	51 352	68 142
Total	91 700	259 600
Total sustainable coral reef finfish production (t yr^{-1})		
optimistic scenario	286 563	1 251 988
pessimistic scenario	135 258	647 353
Total sustainable coral reef groupers production (t yr^{-1})		
optimistic scenario	13 828	95 260
pessimistic scenario	7287	51 557

Notes:
i. Coral reef surface area is based on (20).
ii. Coral reef health conditions are from (5).
iii. Optimistic scenario assumes total yields of 3-18 t km^{-2} yr^{-1} from (33); pessimistic scenario assumes total yields of 1-10 t km^{-2} yr^{-1} from (34).

being inadequately compensated for the rapid loss of coral reefs and their present and future fisheries production. Economic assessments of the benefits or otherwise of this trade to potential source countries in the Pacific must factor in the potential for the FT to rapidly lead to overexploitation of their reef resources.

Regional-scale Management and Local Revitalization of Coral Reef Fish Fisheries

Clearly, overexploitation of coral reef fisheries in SE Asia and the Indo-Pacific is not an issue to be managed solely on the supply end. Demand-side participants in the FT are directly responsible for the significant appropriation of reef fish in these regions and the concomitant ecological impacts; consequently they share a large responsibility for the proper management of the trade at their end. Consumers in economies heavily involved in the FT, particularly Hong Kong, southern China, Taiwan, Singapore, and Malaysia, could support this effort through informed and sustainable choices in live reef fish food purchases. A fundamental shift from local to regional-based fisheries management must also occur, whereby multiple human impacts at many scales are addressed through a coordinated approach (51). Our analyses reflect the need for institutional actions that include: *i)* reducing coral reef fish capture and protecting healthy reef fish populations from overexploitation by the FT; *ii)* establishing marine protected areas (52) and instituting temporary and permanent closures of at least a portion of the fishing grounds in SE Asia, and certainly in the case of spawning aggregations, to allow depleted fisheries to recover (51); *iii)* revitalizing local fisheries in demand countries; *iv)* requiring live reef fishermen and traders to adopt codes of responsible fishing practices; *v)* monitoring trade (both export and import); *vi)* taking a precautionary approach to becoming involved in the FT and; *vii)* investigating full-cycle grouper aquaculture to supply reef fish, if it is carried out in a sustainable way (46).

Without urgently needed reform, the FT will continue to deprive people in the Indo-Pacific of the full economic benefits of their reef fish resources and the world of its potentially irreplaceable marine biological heritage. "It is clear… that the environmental, social, and political problems arising from the live reef fishery are not just enormous, but also enormously complex. There is no simple solution. The issues must be addressed at a variety of levels using a variety of regulatory, educational, scientific, and economic tools" (1, 53).

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16. Wackernagel, M., Lewan, L. and Borgstrom Hansson, C. 1999. Evaluating the use of natural capital with the ecological footprint: Applications in Sweden and subregions. *Ambio 28*, 604-612. For global sea area, biocapacity is 0.55 ha of productive sea space per capita (population data for 2000).
17. MEFs can be calculated using the following basic formula:

Surface needed to produce the consumed quantity	=	SC	=C/P
Consumption of a defined area	=	C	
Production per hectare	=	P	
Actual productive surface of defined area	=	AS	
Marine ecological footprint(MEF)	=	**SC/AS**	

From this definition, derived MEF values are as follows : *i)* = 1, the city or population is exactly self-sufficient; *ii)* > 1, resource consumption and/or waste assimilation are not locally self-sufficient, i.e., more surface area is needed than is actually part of the city or population's defined area; or *iii)* < 1, the region or city is more than self-sufficient and living within its own ecological means. Because waste assimilation services of marine ecosystems are not considered here, our results are likely to be underestimates of the MEFs at all scales.
18. The quantity of seafood available per capita on earth is the productive ocean area divided by the earth's population (global population 1997) times the maximum sustainable supply per ha of productive ocean, or 0.5 ha cap^{-1} x 28 kg fish ha^{-1} yr^{-1} = 14 kg fish cap^{-1} yr^{-1}.
19. The data sources are: Food and Agriculture Organization of the United Nations (FAO), FAO website databases: http://apps.fao.org. State of World Fisheries and Aquaculture 1998. FAO, Rome. Regional and country fisheries production figures are from FAO Fishstat website database, 1996 and 1997 data. Fish and seafood supply for individual countries are obtained from FAO Agrostat (website) database, FAO Food Balance Sheets, 1997 data. Because 'supply', as defined by FAO, includes losses from storage, transport, processing, etc., we used this measure for total consumption, rather than direct or actual per capita consumption. Population data are from FAO Agrostat website Database, 1997.
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21. The full range of estimates for global coral reef cover is 284 300 to 4 million km^2: *i)* 617 000 km^2 from Smith, S. 1978. Coral reef area and the contribution of reefs to processes and resources of the world's oceans. *Nature 273*, 225-226; and *ii)* 0.6 to 4 million km^2 from Kleypas, J.A. 1997. Modeled estimates of global reef habitat and carbonate production since the last glacial maximum. *Paleoceanogr. 12*, 533-545.
22. The MSY could range from 1.5-9 Mt yr^{-1}. The lower value is calculated by multiplying representative estimates of global coral reef area (20) by sustainable coral reef seafood yields of 5 t km^{-2} yr^{-1}. The upper value assumes less restrictive definitions of coral reef area by Smith (21), multiplied by estimated sustainable yields of 15 t km^{-2} yr^{-1}, and corresponds to about 10% of global fisheries catch, similar to that reported by the International Union for the Conservation of Nature (IUCN), Hulm, P. and Pernetta, J. 1993. *Reefs at Risk: Coral Reefs, Human Use and Global Climate Change. A Programme of Action.* IUCN, Gland, Switzerland, www.aims.gov.au/pages/research/project-net/reefs-at-risk/apnet-rar00.html. Because lower yields (5 t km^{-2} yr^{-1}) are now viewed by fisheries ecologists to more accurately reflect average coral reef sustainable yields (see notes 34 and 35), we adopt this value throughout the text and tables as a precautionary estimate unless otherwise noted but also provide estimates using higher yields in accompanying footnotes.

23. We calculate the following ranges in MSY and theoretical biocapacities:
global coral reefs: 0.2-1.6 kg seafood cap^{-1} yr^{-1} (0.005-0.01 ha reef cap^{-1});
SE Asia: 0.5-2.7 Mt seafood yr^{-1} and 0.7-4.3 kg seafood cap^{-1} yr^{-1};
Indo-Pacific: 1.3-7.8 Mt seafood yr^{-1} and 1.5-8.9 kg seafood cap^{-1} yr^{-1};
Developing Oceania: 45-136 kg seafood cap^{-1} yr^{-1}.
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25. If more optimistic reef data (e.g., Smith reef area estimates) and yields (e.g., 15 t km^{-2} yr^{-1}) are assumed (results not shown), the values in Table 1 (columns B to E) would be 2-6 times lower. Even at these much lower levels, with the exception of developing Oceania, most SE Asian and Indo-Pacific countries exceed sustainable coral reef seafood consumption levels. Furthermore, the results in Table 1 (column A) are likely to underestimate consumption, since bycatch from commercial harvesting is not included, and to overestimate biocapacities (Table 1), as we did not exclude any portion of productive coral reef space for species and habitat preservation as recommended by the Brundtland report, World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press, Oxford.
26. Larger yield assumptions (15 t seafood km^{-2} yr^{-1}) give the following range of appropriated ecosystem areas: Indo-Pacific—53 500-459 500 km^2; SE Asia—35 000- 365 000 km^2. Total coral reef seafood demand and area appropriation in the Indo-Pacific is 0.1-5.3 times larger than total available coral reef production and area (largest possible range), and 0.2-12 times total available production and area in SE Asia; estimates in the text assume 'moderate' coral reef seafood consumption and coral reef biocapacity values based on 5 t seafood km^{-2} yr^{-1} (e.g., 1.3 Mt total MSY for the Indo-Pacific).
27. Data on marine fisheries are from several different sources: *i)* food balance sheets 'by main groups of fish species in live weight…" contained in the *FAO Fisheries Circular No. 821 Revision 5, 1961-1997 Fish and Fishery Products, World Apparent Consumption Statistics Based on Food Balance Sheets,* December 1999, FAO, Rome; and *ii)* online fishery statistics and database, such FISHSTAT and the Fishery Data Collection in FAOSTAT at http://apps.fao.org and http://www.fao.org/fi/statist. Although these databases represent the most comprehensive and detailed fisheries information available, nonetheless *i)* serious gaps and conflicting data for many countries exist; *ii)* statistics for coral reef fish species are not tabulated as a specific category; and *iii)* statistics for coral reef proxy categories (e.g., for the FAO demersals category) are incomplete for many countries, especially in the Western Pacific. For example, these deficiencies will tend to underestimate coral reef resource consumption, since they do not include *i)* bycatch, or for many countries *ii)* subsistence fisheries data or certain types of reef fish consumption (e.g., groupers).
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30. Spalding et al.'s (20) global coral reef surface area of 284 300 km^2 is broken down into the following regional categories: *i)* Middle East—21 600 km^2; *ii)* Indian Ocean—32 600 km^2; *iii)* Southeast Asia—91 700 km^2; *iv)* Pacific oceans—115 900 km^2; *v)* Caribbean—20 000 km^2; and *vi)* Atlantic ocean—1600 km^2. The Indo-Pacific region has an estimated 261 200 km^2 of coral reefs (259 600 km^2 excluding E. Pacific) and is defined as including Southeast Asia, the Indian ocean, the Red Sea, Northern and Southern Pacific oceans, and the Arabian Gulf.
Other estimations (see note 21) predict a total global coral reef area between 0.6 and 4.0 million km^2. The differences between the various estimates arise because of the way that coral reefs are defined—in particular the maximum depth to which reef growth (typically from 150 m to less than 30 m) is restricted by ambient light levels. Spalding et al.'s global total is only 40% of that calculated in Smith (see 21 above). Smith's regional values also differ significantly (182 000 km^2 and 520 000 km^2 for SE Asia and the Indo-Pacific, respectively).
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39. Sensitivity analyses performed using a combination of coral reef health data from Bryant et al. (5) and the World Bank (37) give a larger range than the results shown in Table 4 for the total maximum sustainable production of coral reef fisheries in the Indo-Pacific: finfish—463 502 to 1 325 348 t yr^{-1}; groupers—28 627 to 103 247 t yr^{-1}.
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52. Marine protected areas represent one management approach widely advocated for coral fish and invertebrate fisheries and for protecting the reef habitat itself.
53. This article is dedicated to the lifelong scientific contributions, dedication and marine conservation efforts of Robert Johannes. The authors thank M. Spalding at the UNEP World Conservation Monitoring Centre (www.wcmc.org.uk) for coral reef area data. Valuable insights and improvements to the manuscript from Kevin Rhodes, Denise McCorry, Andrew Cornish, Daniel Pauly and an anonymous reviewer were also greatly appreciated.
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Annex 846

“Cayratia trifolia”, in *Weeds of Upland Crops in Cambodia* (2009), *available at* http://aciar.gov.au/files/node/11477/mn141_weeds_of_upland_crops_in_cambodia_khmer_tr_19691.pdf

Annex 846

WEEDS OF UPLAND CROPS IN CAMBODIA

Australian Government

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WEEDS OF UPLAND CROPS IN CAMBODIA

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ROBERT MARTIN & POL CHANTHY

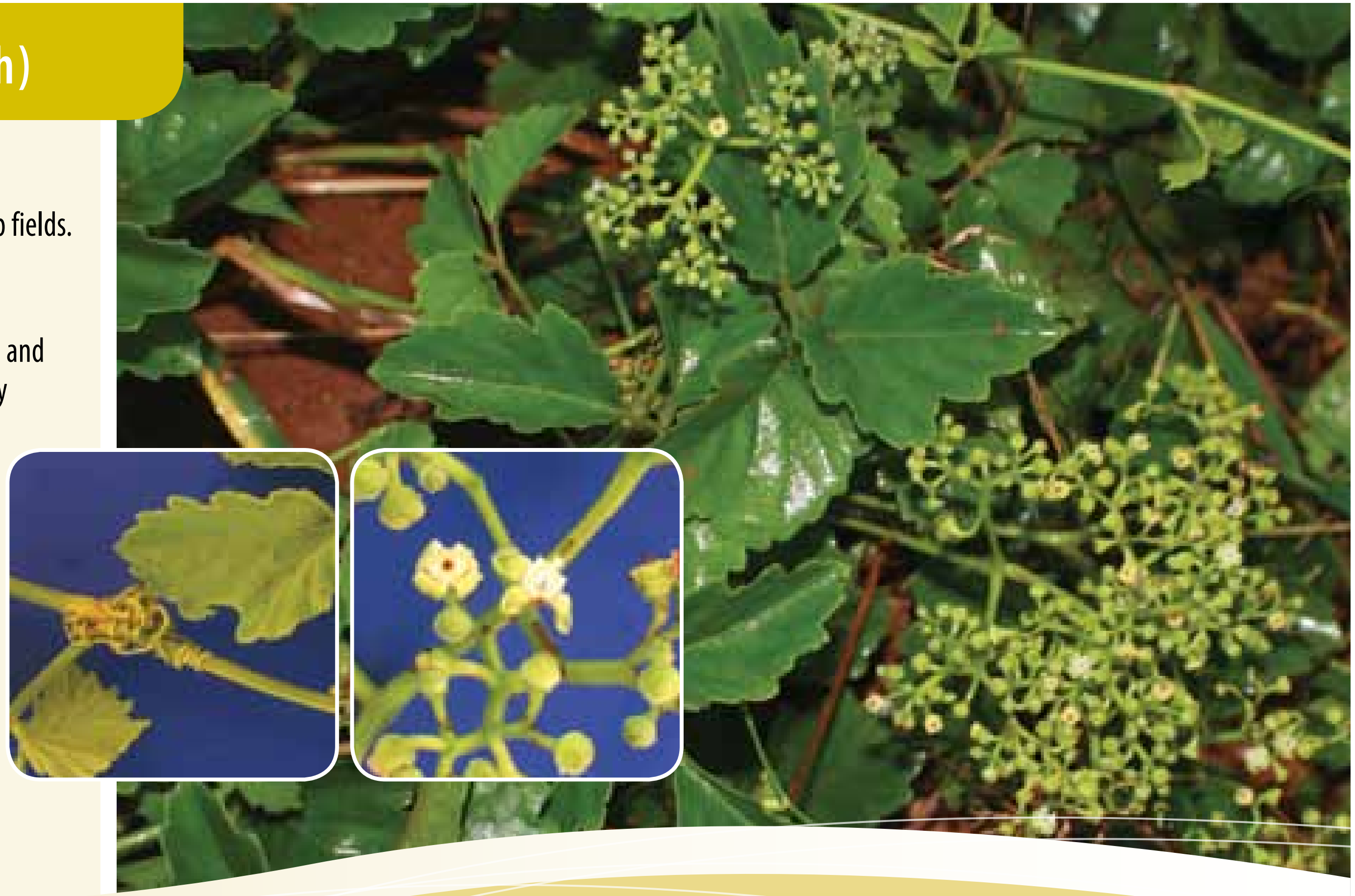
Cayratia trifolia (Voir Trardeth)

DISTRIBUTION

Occurs along roadsides, on wasteland, and in upland crop fields.

DESCRIPTION AND BIOLOGY

Vine with smooth, trifoliate leaves generally 3-8 cm long and 2-5 cm broad. The leaflets are ovate to deltoid and deeply toothed. Tendrils arise opposite from each leaf along the stem. The flower heads are 6–10 cm long corymbs or umbels, and the flowers are small and white to cream. The fruits are rounded berries, green turning black.



AGRICULTURAL IMPORTANCE

This plant occurs around and in upland crop fields but is unlikely to tolerate continuous cultivation.

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Annex 847

P.L.A. Erftemeijer, et al., “Environmental Impacts of Dredging and Other Sediment Disturbances on Corals: A Review”, *Marine Pollution Bulletin*, Vol. 64, No. 9 (2012)

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Review

Environmental impacts of dredging and other sediment disturbances on corals: A review

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ABSTRACT

A review of published literature on the sensitivity of corals to turbidity and sedimentation is presented, with an emphasis on the effects of dredging. The risks and severity of impact from dredging (and other sediment disturbances) on corals are primarily related to the intensity, duration and frequency of exposure to increased turbidity and sedimentation. The sensitivity of a coral reef to dredging impacts and its ability to recover depend on the antecedent ecological conditions of the reef, its resilience and the ambient conditions normally experienced. Effects of sediment stress have so far been investigated in 89 coral species (~10% of all known reef-building corals). Results of these investigations have provided a generic understanding of tolerance levels, response mechanisms, adaptations and threshold levels of corals to the effects of natural and anthropogenic sediment disturbances. Coral polyps undergo stress from high suspended-sediment concentrations and the subsequent effects on light attenuation which affect their algal symbionts. Minimum light requirements of corals range from <1% to as much as 60% of surface irradiance. Reported tolerance limits of coral reef systems for chronic suspended-sediment concentrations range from <10 mg L^{-1} in pristine offshore reef areas to >100 mg L^{-1} in marginal nearshore reefs. Some individual coral species can tolerate short-term exposure (days) to suspended-sediment concentrations as high as 1000 mg L^{-1} while others show mortality after exposure (weeks) to concentrations as low as 30 mg L^{-1}. The duration that corals can survive high turbidities ranges from several days (sensitive species) to at least 5–6 weeks (tolerant species). Increased sedimentation can cause smothering and burial of coral polyps, shading, tissue necrosis and population explosions of bacteria in coral mucus. Fine sediments tend to have greater effects on corals than coarse sediments. Turbidity and sedimentation also reduce the recruitment, survival and settlement of coral larvae. Maximum sedimentation rates that can be tolerated by different corals range from <10 mg cm^{-2} d^{-1} to >400 mg cm^{-2} d^{-1}. The durations that corals can survive high sedimentation rates range from <24 h for sensitive species to a few weeks (>4 weeks of high sedimentation or >14 days complete burial) for very tolerant species. Hypotheses to explain substantial differences in sensitivity between different coral species include the growth form of coral colonies and the size of the coral polyp or calyx. The validity of these hypotheses was tested on the basis of 77 published studies on the effects of turbidity and sedimentation on 89 coral species. The results of this analysis reveal a significant relationship of coral sensitivity to turbidity and sedimentation with growth form, but not with calyx size. Some of the variation in sensitivities reported in the literature may have been caused by differences in the type and particle size of sediments applied in experiments. The ability of many corals (in varying degrees) to actively reject sediment through polyp inflation, mucus production, ciliary and tentacular action (at considerable energetic cost), as well as intraspecific morphological variation and the mobility of free-living mushroom corals, further contribute to the observed differences. Given the wide range of sensitivity levels among coral species and in baseline water quality conditions among reefs, meaningful criteria to limit the extent and turbidity of dredging plumes and their effects on corals will always require site-specific evaluations, taking into account the species assemblage present at the site and the natural variability of local background turbidity and sedimentation.

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1. Introduction

Coastal construction, land reclamation, beach nourishment and port construction, all of which involve dredging, are increasingly required to meet the growing economic and societal demands in the coastal zone worldwide. In tropical regions, many shorelines are not only home to people but also to coral reefs, one of the most biodiverse ecosystems on earth (Hoeksema, 2007). World-wide, ∼3 billion people depend more or less directly on coral reefs for a significant part of their livelihood, obtaining their protein needs or other essential commodities (Bryant et al., 1998). Even if not necessarily sustaining human life in many wealthier regions of the world, the economic value of the realised tourism potential of coral reefs can be enormous. For example, three southern Florida counties (Miami-Dade, Broward and Palm Beach) derive ∼6 billion dollars annually from reef-oriented tourism and fisheries (Johns et al., 2001). Clearly, coral reefs are a biologically as well as economically valuable resource worth protecting. Unfortunately, coastal construction and dredging is frequently unavoidable in their immediate vicinity (Salvat, 1987).

The excavation, transportation and disposal of soft-bottom material may lead to various adverse impacts on the marine environment, especially when carried out near sensitive habitats such as coral reefs (PIANC, 2010) or seagrass beds (Erftemeijer and Lewis, 2006). Physical removal of substratum and associated biota from the seabed, and burial due to subsequent deposition of material are the most likely direct effects of dredging and reclamation projects (Newell et al., 1998; Thrush and Dayton, 2002). Dredging activities often disturb sediments reducing visibility and smothering reef organisms (Dodge and Vaisnys, 1977; Bak, 1978; Sheppard, 1980; Fortes, 2001). Coastal engineers and conservation officials need to balance the needs of a healthy economy, of which construction and dredging are often an integral part, with those of a healthy environment. Managing these potentially conflicting priorities can at times be a formidable challenge, particularly where coral reefs are concerned (Smith et al., 2007).

In many cases, dredging operations have contributed to the loss of coral reef habitats, either directly due to the removal or burial of reefs, or indirectly as a consequence of lethal or sublethal stress to corals caused by elevated turbidity and sedimentation. Dredging activities potentially affect not only the site itself, but also surrounding areas, through a large number of impact vectors (e.g. turbid plumes, sedimentation, resuspension, release of contaminants, and bathymetric changes) (Wolanski and Gibbs, 1992). Effects can be immediate or develop over a longer time frame and they may be temporary or permanent in nature. Some coral species appear to be more sensitive than others to increases in turbidity or sedimentation that are commonly associated with dredging operations. Their responses to such increases may depend on typical local conditions and vary between seasons. In general, the impact from dredging on corals and coral reef ecosystems is complex and far from fully understood. Yet there is an extensive body of experience to learn from. This experience lies with dredging contractors, in assessment reports, in monitoring data and in scientific literature derived from field-based and laboratory studies.

In this review we examine the environmental impacts of dredging on corals. We outline the type and level of dredging operations near coral reefs; provide an overview of the general impacts of sediment disturbances on corals; examine the current state of knowledge regarding sensitivity among and within coral species, tolerance limits and critical thresholds; and, finally, discuss mitigating factors and the potential for recovery. Where appropriate, these findings are illustrated with case studies. The focus of this review is limited to the effects of dredging on corals. The nomenclature of the coral species discussed in this review has been updated according to the most recent taxonomic revisions. The effects of dredging on other reef-associated organisms were not considered, except those depending on corals as specific host organisms. A similar analysis for seagrasses can be found in Erftemeijer and Lewis (2006). Information sources for the review included peer-reviewed scientific literature, "grey" literature in the form of environmental impact assessments, consultancy and technical reports, and additional information obtained from members of Working Group 15 of the Environmental Commission of the World Association for Waterborne Transport Infrastructure (PIANC, 2010). While the emphasis of this review is on the impacts of dredging, the findings and implications presented here are equally applicable to other sediment disturbances as sources of elevated turbidity or sedimentation (rivers, natural resuspension, flood plumes, bottom-trawling, etc.).

2. Dredging near coral reefs

An overview of 35 selected case studies of documented dredging operations in, near or around coral reef areas is presented in Table 1, which provides an indication of the scale and type of impact that dredging operations can have on corals and coral reefs. Undoubtedly, there are many more cases of coral damage associated with dredging operations worldwide, some of which are reported in confidential documents or in local languages, to which access is limited. Many of the historical dredging operations and port developments near coral reefs have never been documented and effects on corals were rarely quantified. The actual scale of dredging damage to coral reefs worldwide can therefore be assumed to be much greater than the available literature may suggest. Not all dredging projects near coral reefs lead to mortality of corals and not all observed changes in coral health in the immediate vicinity of dredging sites are necessarily the result of dredging-induced turbidity. Indeed, distinguishing the effects of anthropogenic disturbances from natural dynamics in the marine environment can be a challenge and calls for an appropriate monitoring design (Underwood, 2000; Stoddart et al., 2005). Nevertheless, the cumulative effects of dredging, filling and other coastal construction activities in coral reef environments have collectively resulted in major adverse ecological impacts on many reefs (Maragos, 1993).

Coral reefs are generally recognised as biogenic structures, but it is rarely appreciated that over half of the material in most coral reef complexes is actually made up of sediments (Hubbard et al., 1990; Dudley, 2003). Over 90% of the sediments on most coral reefs consist of carbonate (aragonite, high-magnesium calcite and calcite) produced by the growth and subsequent destruction of reef organisms as well as pre-existing reef rock through physical, chemical and biological erosion processes. Only on nearshore fringing reefs do silicate mineral grains from weathered and eroded igneous or metamorphic rocks (terrigenous sediments) constitute a significant part of the sedimentary material (Dudley, 2003). With time, the skeletons of primary and secondary reef organisms and loose sediments may be changed into a firm sedimentary rock (reef rock) and eventually into a dense solid limestone through consolidation of reef material, binding, cementation and diagenesis (Hubbard et al., 1990; Dudley, 2003). Levels of sedimentation in coral reef environments can vary substantially over spatial and temporal scales, often by several orders of magnitude within kilometres and weeks (Wolanski et al., 2005). Sedimentation is usually highest on inshore reefs and sheltered, wave-protected parts of reef systems, and decreases with distance from shore and with increasing exposure to wave energy (Wolanski et al., 2005).

Due to their geotechnical nature, limestone and coral materials tend to break when dredged and/or transported hydraulically

Table 1
Selected case studies of dredging operations near coral reefs and their impacts.

Country	Location	Year	Activity/purpose	Scale of impact/damage	References
Arabian Gulf	Various countries & locations	1990s–2008	Various mega-reclamations, coastline modifications and associated dredging	Widespread loss and degradation of productive coastal habitats incl. large stretches of coral reef	Sheppard et al. (2010)
Australia	Mud Island, Moreton Bay	1940s–1991	Coral dredging for cement manufacture	Loss of corals, development of shingle ridges that have restricted tidal flushing impacting adjacent mangroves	Allingham and Neil (1995)
Australia	Magnetic Island	1972	Dredging	Reduction in herbivores and reef dwellers	Marszalek (1981)
Australia	Cleveland Bay and Magnetic Island, Queensland	1970s	Capital & maintenance dredging at Ross River mouth and disposal at various dump sites in Cleveland Bay (peak in the early – mid 1970s)	Extensive burial of seagrass and coral habitats and impacts on mangroves (in combination with cyclones)	Pringle (1989)
Australia	Nelly Bay	2000–04	Capital dredging (35,000 m^3) for marina	18 ha Construction area; no detectable impact immediately outside construction area	Chin and Marshall (2003) and Koloi et al. (2005)
Australia	Dampier, DPA & HI	2003–04	Capital dredging for port construction/ expansion total dredged volume 4.1 million m^3	one site 80% loss within 1 km from dredging site, no discernable change due to dredging at other sites	Blakeway (2005) and Stoddart and Stoddart (2005)
Australia	Hay Point	2006	Capital dredging for port construction/ expansion total dredged volume 9 million m^3	2–5% Loss of coral cover at 2 islands up to 6 km away from dredging site	Smith et al. (2007)
Australia	Dampier, HI	2006–07	Capital dredging for port expansion total dredged volume 3.4 million m^3	<10% Gross coral mortality at impact sites	Hanley (2011)
Australia	Cape Lambert A	2007–08	Capital dredging for port construction/ expansion total volume 2.5 million m^3 in <5 months	<3% Net coral mortality at impact sites	Hanley (2011)
Australia	Mermaid Sound, Pluto	2007–10	Capital dredging for port construction/ expansion total dredged volume 14 million m^3	<6% Reduction in coral cover (Zone A) due to thermal bleaching; <5% net coral mortality in Zone B; <10% coral bleaching at monitoring sites in Zone C	Hanley (2011)
Bahrain	Fasht Al-Adham (east coast)	1985–92	Dredging and industrial development	Loss of at least 22 hectares of coral reef and degradation of a further 8 ha due to increased turbidity and sedimentation	Zainal et al. (1993)
France	Guadeloupe	1979	Dredging	Unbalanced fish community – disappearance of 20 out of 29 spp.	Galzin (1982)
French Polynesia	Tahura lagoon, Moorea	1981	18 ha dredged	Destruction of corals, reduced species composition, changes in invertebrate fauna favouring gastropods instead of crustaceans, disruption of stability of reef & lagoon ecosystems	Naim (1981)
French Polynesia	Tiahiti (36 sites)	1959–1983	Dredging by hydraulic shore & bucket dredgers total volume 2.5–3.0 × 10^6	Dredge & fill destroyed 43% of fringing reefs in Papette and 75% in FAAA region; hard bottoms colonized by turf algae after dredging; fish populations reduced	Gabrie et al. (1985)
Hong Kong	Ninepin Islands	1991–93	Trailer dredging of up to ~400 million m^3 at 20 borrow areas	Build-up of fine sediment in shallow water; 40% reduction in live coral in 3 months; sign. increase in % *Acropora* colonies damaged	Hodgson (1994)
Indonesia	Turtle Island, Bali	1997	Dredging & reclamation (20 million m^3)	No detectable impacts at 1 km from work area; used an adaptive monitoring & mgt. approach	Driscoll et al. (1997)
Kiribati	Fanning Island	1971	Dredging	Live coral cover reduced from 62% to 31% over time	Roy and Smith (1971)
Malaysia	Bintulu	2005	Dredging at borrow areas (4 million m^3)	No detectable impacts at nearest reef ~2 km from borrow area	Doorn-Groen (2007)
Micronesia	Truk Atoll, Eastern Caroline Islands	1981	Dredging (2 million cubic yards)	Fish abundance and diversity significantly reduced	Amesbury (1981)
Netherlands Antilles	Piscadera Bay, Curacao	1972	Dredging	*Porites astreoides* (plating form) died as result of inability to reject sediment; calcification rates of *Madracis mirabilis* and *Agaricia agaricites* decreased by ~33% over a 4-week period	Bak (1978)
Netherlands Antilles	Bonaire	1980–83	Dredging and large coastal resort development	Significant coral mortality due to sedimentation and excavation for channel & breakwater construction	van 't Hof (1983)
Thailand	Phuket	1981	Tin dredging; 11.6 km^2 dredged with 3 tin dredgers (200,000 yd^3/month)	Reefs adjacent to dredging severely damaged by sedimentation (4% coral cover compared to 26–34% in non-impacted areas)	Chansang et al. (1981)
Thailand	Phuket	1986–87	Dredging of 1.3 million m^3 by hydraulic dredgers (9-months dredging & disposal operation)	30% Reduction in coral cover and a decline in species diversity for up to 1 year; maximum conc. 286 mg/l; rapid recovery in 22 months	Brown et al. (1990)
Singapore	coastline	1970s–90s	Coastal reclamation and dredging along almost the entire shoreline of Singapore	Loss of approx. 60% of Singapore's coral reefs; remaining reefs subjected to sediment impact	Hilton and Manning (1995) and Chou (2006)
Singapore	Southwest Islands	2006	Dredging and reclamation (9 million m^3)	No detectable impacts 300 m outside direct impact area; used adaptive monitoring & management approach	Doorn-Groen (2007)

(*continued on next page*)

Table 1 (*continued*)

Country	Location	Year	Activity/purpose	Scale of impact/damage	References
UK	Diego Garcia, Chagos	1980	Dredging	Coral diversity unaffected by dredging	Sheppard, 1980
UK	Castle Harbor, Bermuda	1941–1943	Extensive dredging and filling for construction of Kindley Airfield (US navy base)	Mass coral mortality due to dredging in harbor area major shift in nearby reef community structure towards more tolerant coral species	Dodge and Vaisnys (1977) and Flood et al. (2005)
USA	Johnston Atoll	1966	Dredging (440 ha)	Reduction of living corals by up to 40%; reduction in reef fish abundance & development of blue-green on dead coral	Brock et al. (1965)
USA	Kaneohe Bay, Hawaii	1974	Dredging	Up to 30% of corals died & overgrown with algae	Banner (1974)
USA	Johnston Atoll	1976	Airfield construction activities	40% Reduction in coral cover due to siltation from airfield construction activities	Amerson and Shelton (1976)
USA	Miami Beach, Florida	1977	Large-scale dredging operations	1 cm sediment cover on nearby reef surface in <2 h; partial mortality & paling of affected corals; up to 32% of corals exhibiting signs of stress; small colonies displayed tissue mortality	Marszalek (1981)
USA	Southeast Florida	1995	Dredge & fill (350,000 m^3) for beach widening	Burial & loss of 5 ha of nearshore hard-bottom habitat; 30× drop in fish density, 10× drop in fish diversity	Lindeman and Snyder (1999)
USA	Florida	1985–2004	26 Projects involving filling and dredging for beach nourishment and port development	217 Acres of reef impacted by cumulative effects	PBS&J, (2008)
USA	Florida	2005–06	Dredging for Broward County beach nourishment (10.9 km of beach with 1.5×10^6 m^3 of sand)	Increased sedimentation during construction, no effects on %cover; minor to moderate coral stress; rapid post-dredging recovery	Fisher et al. (2008)
USA	Key West (Florida)	2006	Key West harbour dredging project	No significant effects on % live coral cover; some paling & bleaching	CSA (2007)

(Schlapak and Herbich, 1978; Maharaj, 2001). From the freshly broken surface, very fine silt and colloidal material can be released into the water, creating milky white "clouds". These fine sediment clouds are difficult to control, as they can remain in suspension for prolonged periods and thus spread over large areas under the action of currents, wind and waves. It is therefore imperative to minimise the need for dredging coral material and to exercise great care and accuracy when dredging in coral reef environments. Some excellent guidelines on best management practices for dredging and port construction near coral reefs were published recently (PBS&J, 2008; PIANC, 2010). In the case of contaminated sediment, dredging may also lead to deleterious effects on water quality and reef-associated biota by the release of contaminants (Brown and Holley, 1982; Lay and Zsolnay, 1989; Esslemont et al., 2004). Dredgers and port engineers possess a wide range of tools to reduce their impact on the environment either by design or by choice of low-impact building methods (Bray, 2008). Various environmental regulatory agency permitting processes are intended to give engineers the information required to maintain any given project's impacts within the legally required, or otherwise agreed-upon, limits. Given the potential for adverse effects of dredging on sensitive marine habitats such as coral reefs, the management and monitoring of those activities that elevate turbidity and sediment-loading is critical. In practice, however, this has proved difficult as the development of water quality threshold values, upon which management responses are based, are subject to a large number of physical and biological parameters that are spatially and temporally specific (Sofonia and Unsworth, 2010).

It should be noted here that many coral reef environments demonstrate substantial natural variability in background turbidity due to resuspension as a result of metocean conditions such as tides, wind, waves, storms, cyclones, tsunamis and river floods, which in some areas can increase the suspended-sediment concentrations to levels similar to those occurring during dredging (Harmelin-Vivien, 1994; Schoellhamer, 2002; Anthony et al., 2004; Larcombe and Carter, 2004; Orpin et al., 2004; Storlazzi et al., 2004; Ogston et al., 2004; Kutser et al., 2007; Jouon et al., 2008).

It is almost impossible to predict levels and patterns of increased turbidity and sedimentation during dredging operations without sophisticated numerical modelling of site-specific hydrodynamic and sediment transport processes (Winterwerp, 2002; Hardy et al., 2004; Aarninkhof and Luijendijk, 2010). Total suspended sediment (TSS) concentrations experienced at a given distance from a dredging operation may vary by up to two orders of magnitude depending on the scale of the operation, the techniques used, background water quality conditions and the nature of the substrate that is dredged (or disposed of). Kettle et al. (2001) recorded suspended-sediment concentrations of >150 mg L^{-1} to be laterally confined to within about 100 m of a dredger in Cleveland Bay (Townsville, Australia). Plumes exceeding 20 mg L^{-1} extended for up to about a kilometre from the actual dredging or placement operation (Kettle et al., 2001). Thomas et al. (2003) reported a general regime of suspended-sediment concentrations >25 mg L^{-1} (90% of the time) for several months during dredging operations over fringing coral reefs at Lihir island (Papua New Guinea) with regular (short-term) peak increases above 1000 and 500 mg L^{-1} (in severe and transitional impact zones) in an area that normally experience background TSS concentrations of <5 mg L^{-1}. In contrast, Stoddart and Anstee (2005) recorded suspended-sediment concentrations above 10 mg L^{-1} for 42% of monitoring days at impacted coral reef sites (within 1 km of dredging locations, occasionally peaking to ~60 mg L^{-1}) during dredging operations in Mermaid Sound (Dampier, Western Australia) against a low background level of ~4 mg L^{-1} at reference sites.

A poor understanding of responses of corals to sediment disturbances can result in inappropriate management of dredging projects that may lead to preventable coral mortality or unnecessarily high costs from down-time and delays in dredging operations. There are many examples of dredging operations near coral reefs where inadequate management has contributed to significant damage to reefs and mortality of corals (Table 1). Conversely, exaggerated (over-conservative) thresholds used for predicting levels of coral mortality from dredging can lead to unrealistically high levels of predicted coral mortality over large areas of presumed impact. A review of ten recent (large) capital dredging projects near coral reefs in the Pilbara region (Western Australia) described how conditions governing environmental controls and monitoring requirements have become increasingly comprehensive, prescriptive and onerous since 2003 (Hanley, 2011). However, in none of these case studies was there evidence of any breach (non-compliance) of the permitted levels of impacts on corals. In fact, observed mortality of corals in these projects typically was far below predictions and could in many cases be attributed to other factors not related to dredging (e.g. cyclonic events and thermal bleaching). The review warned about the consequences of such routine overestimation of dredging impacts to corals, including the misinformation of the public, unrealistically large offset packages and unnecessarily large monitoring and baseline programs to areas well outside the real range of impacts (Hanley, 2011). These examples from Western Australia, along with the various case studies summarised in Table 1, clearly demonstrate the need for strengthening capacity in predicting and managing impacts of dredging through thorough literature reviews, a critical evaluation of past dredging projects near corals, and targeted experimental research (Lavery and McMahon, 2009).

The main effects of dredging and port construction on corals—besides direct physical removal, damage or burial—include temporarily increased turbidity and enhanced sedimentation. In order to understand how corals are affected by enhanced turbidity and sedimentation, it is important to first gain some basic understanding on how corals function.

3. The impacts of sediment disturbance on corals

With the exception of free-living species, corals—once settled—are sessile organisms (Hoeksema, 1988, 1993; Hubmann et al., 2002; Hoeksema and de Voogd, 2012). As they cannot move away from unfavourable conditions, growth-form and physiological changes regulate their interactions with the environment. Much of the success of reef-building corals relies on symbiotic, unicellular algae called zooxanthellae, which live as symbionts inside the coral tissue (primarily the gastrodermis) and produce the majority of the coral's energy requirements through photosynthesis. Because of this symbiosis, most corals require light to survive (Achituv and Dubinsky, 1990). The major problems arising from turbidity and sedimentation derived from coastal construction and dredging are related to the shading caused by decreases in ambient light and sediment cover on the coral's surface, as well as problems for the feeding apparatus under a sediment blanket and energetic costs associated with mucus production, sediment clearance and impaired feeding. Suspended sediments, especially when fine-grained, decrease the quality and quantity of incident light levels, resulting in a decline in photosynthetic productivity of zooxanthellae (Falkowski et al., 1990; Richmond, 1993). Non-photosynthetic corals are an exception to this but while they may not suffer from light reduction, they can be impacted by high loads of suspended sediment through clogging and smothering. Many corals are primarily light-traps and thus their growth form is not necessarily optimised for sediment-shedding. As a result, certain morphologies are prone to collect more sediment from the water column than the coral is able to clear (Hubbard and Pocock, 1972; Bak and Elgershuizen, 1976; Dodge and Vaisnys, 1977; Rogers, 1983; Stafford-Smith, 1993; Sanders and Baron-Szabo, 2005). Turbidity reduces ambient photosynthetically active radiation (PAR) and leads to a decrease in zooxanthellae productivity which can result in starvation. Sediment settling on coral tissue causes additional shading and smothering, and in this way contributes to a further decrease of the photosynthetic activity by zooxanthellae and can even lead to coral bleaching (Glynn, 1996; Brown, 1997).

High turbidity and sedimentation rates may depress coral growth and survival due to attenuation of light available to symbiotic zooxanthellae and redirection of energy expenditures for clearance of settling sediments. Thus, the potential effects of sediment input not only include direct mortality, but also involve

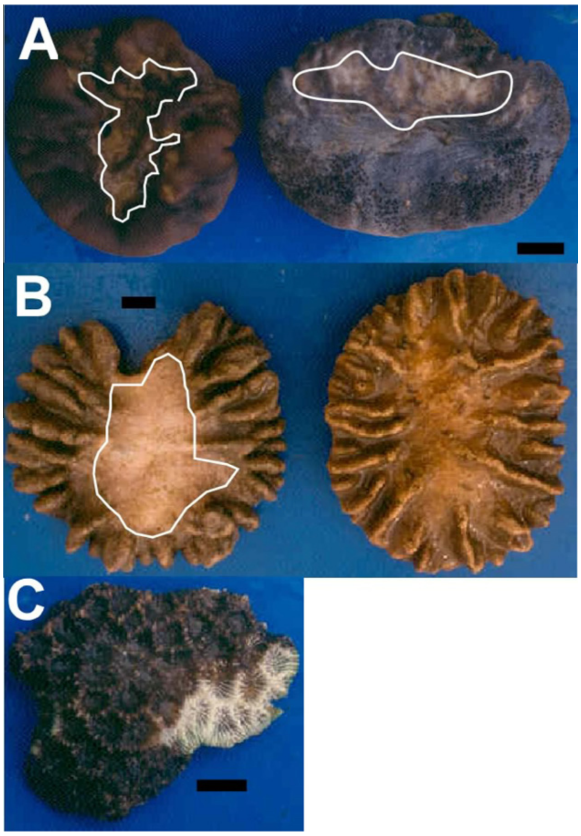

Fig. 1. Sublethal effects of sedimentation on corals. (A) After two weeks of intense sedimentation, large tissue necroses appeared on these *Lobophytum depressum* (left) and *Lobophytum patulum* (right). (B) At the same time *Sinularia dura* colonies were bleached where the sand had rested on them (left experimental animal, right control animal). (C) tissue necrosis on *Favites pentagona* after four weeks of sedimentation.

sublethal effects such as reduced growth, lower calcification rates and reduced productivity, bleaching, increased susceptibility to diseases, physical damage to coral tissue and reef structures (breaking, abrasion), and reduced regeneration from tissue damage (Fig. 1). Sediment disturbance can also affect coral recruitment and have impacts on other (non-coral) reef-dwelling organisms. As pointed out by Johannes (1975), selective mortality of corals results in the migration or death of other fauna, suggesting that the environmental tolerances of the associated reef community are unlikely to exceed those of the component corals. As the stress level caused by enhanced turbidity and sedimentation increases, the response of corals shifts from photo-physiological effects, changes in polyp activity and mucus production at the level of individual coral polyps, to colour changes, bleaching and partial tissue necrosis of coral colonies (Meesters et al., 1992; Stafford-Smith, 1993; Riegl, 1995; Riegl and Branch, 1995; Fabricius, 2005). Ultimately, severe and long-lasting stress from sustained sediment disturbances may result in wide-spread coral mortality, changes in community structure and major decreases in density, diversity and coral cover of entire reef systems (Table 2; adapted from Gilmour et al., 2006).

The risk and severity of impacts from dredging on corals is directly related to the intensity, duration and frequency of exposure to increased turbidity and sedimentation (Newcombe and MacDonald, 1991; McArthur et al., 2002). Very high sediment stress levels over relatively short periods may well result in sublethal and/or lethal effects on corals, while long-lasting chronic exposure

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Table 2
Schematic cause-effect pathway for the response of corals and coral communities to sedimentation and turbidity. Level of stress increasing from top to bottom (adapted from Gilmour et al., 2006).

	Sedimentation	Turbidity
Stress		
Photophysiological stress	• Reduced photosynthetic efficiency of zooxanthellae and autotrophic nutrition to coral	• Reduced photosynthetic efficiency of zooxanthellae and autotrophic nutrition to coral; switch to heterotrophic feeding, ingestion of sediment particles
Changes in polyp activity	• Extrusion of mesenterial filaments following severe stress • Increased ciliary or polyp activity, and tissue expansion in some species, to remove sediment	• Increased ciliary or polyp activity to feed
Mucus production	• Increased mucus production or sheeting to remove sediment	• Evidence of mucus production
Severe stress		
Sediment accumulation	• Accumulation of sediment on tissue of susceptible growth forms due to failure of mechanisms of rejection	
Change in coral colour	• Change in coral colour arising from changes in the density of zooxanthellae and photosynthetic pigments • Paling of coral due to partial bleaching	• Change in coral colour arising from changes in the density of zooxanthellae and photosynthetic pigments • Darkening of coral in response to reduced light due to photoacclimation
Bleaching	• Considerable whitening of corals due to the expulsion of a large proportion of zooxanthellae from the colony	• Not known
Partial mortality	• Injury to coral tissue, loss of polyps and partial mortality of the colony • Decrease in (live) coral cover	• Injury to coral tissue, loss of polyps and partial mortality of the colony • Decrease in (live) coral cover
Mortality	• Mortality of small-sized colonies and partial mortality of large corals • Mortality of susceptible species and size classes. • Decreased density, diversity and coral cover • Changes in community structure • Wide-spread mortality of corals • Major decreases in density, diversity and coral cover • Dramatic changes in community structure, and shifts towards the dominance of non-coral species, such as sponges and algae	• Mortality of susceptible species and size classes • Decreased density, diversity and coral cover • Changes in community structure • Wide-spread mortality of corals • Major decreases in density, diversity and coral cover • Dramatic changes in community structure, and shifts towards the dominance of non-coral species, such as sponges and algae

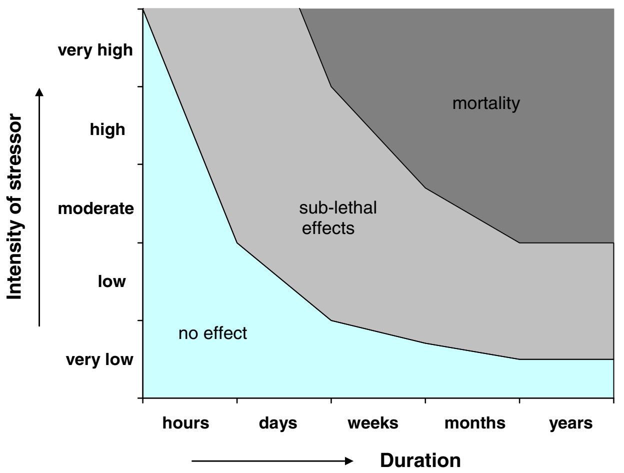

Fig. 2. Conceptual relationship between the intensity and duration of a stress event and the risk of sublethal and lethal effects on corals. This graph shows the general relationship between the magnitude of an increase in turbidity or sedimentation above background levels (vertical axis), how long it lasts (horizontal axis) and the onset of (sub)lethal effects on corals. Actual thresholds will vary by location based on typical ambient conditions, sediment properties (e.g. grain-size) and the sensitivity of the coral species.

to moderate levels of sediment stress may induce similar effects (Fig. 2). Repetitive stress events could result in deleterious effects much sooner if corals have not been allowed sufficient time to recover between consecutive disturbances (McArthur et al., 2002). Excessive sedimentation from land runoff and dredging events superimposed on other stresses from natural processes and anthropogenic activities can cause substantial impacts on coral health and dramatic declines in live coral cover (Field et al., 2000). It should be noted, however, that a number of studies have demonstrated the occurrence of coral reefs (often with high live coral cover) in areas of high and fluctuating turbidity and sedimentation, for example from the inner shelf of the Great Barrier Reef (Mapstone et al., 1989; Hopley et al., 1993; Larcombe et al., 1995; Anthony and Larcombe, 2000). Tolerance of corals to increased turbidity and sedimentation may vary seasonally and geographically, similar to what has been demonstrated for thermal thresholds (Weeks et al., 2008).

In this section we provide a brief overview of the main impacts of sediment disturbance on corals by first examining turbidity (light for photosynthesis), then sedimentation (feeding and respiration), then effects on sexual recruitment (larval survival and settlement) and, finally, the impact of associated nutrients and contaminants.

3.1. Turbidity and light for photosynthesis

Turbidity and light availability in the marine environment are measured and expressed in a number of different ways. Common measures for turbidity include concentration of total suspended solids (TSS, in milligrams per litre), suspended-sediment concentration (SSC, in milligrams per litre), nephelometric turbidity units (NTU), Secchi disc readings (in centimetres), and attenuation coefficient (k_d). Conversion factors between these different measures are site-specific, depending on various local factors, including particle-size distribution, contribution of phytoplankton and organic content (Gray et al., 2000; Thackston and Palermo, 2000). Light availability is generally measured directly in micromole photons per square metre per day, or expressed as a relative measure (minimum light requirement) in percentage of surface irradiance (% SI). Photosynthetically active radiation (PAR) is most commonly taken as being between 400 and 700 nm, which corresponds approximately to visible light (Kirk, 1977). At any depth, the underwater light field is highly variable and exactly how much light reaches any particular habitat will depend on factors such as orientation of the sun, the weather, shading, reflection, and refraction (Weinberg, 1976; Falkowski et al., 1990). The amount of light an organism will be exposed to is also contingent upon its vertical angle and compass direction (Weinberg, 1976; Falkowski et al., 1990; Dunne and Brown, 2001).

Light reduction is probably the most important of all sediment-related effects on corals. Light decreases exponentially with depth due to a process of attenuation (extinction), i.e. the absorption and scatter of light by water molecules, particulate solids, and dissolved matter (Weinberg, 1976; Falkowski et al., 1990). Maximal growth and development of reef corals usually occurs down to 30% to 40% of subsurface irradiance (SI) and rarely is any significant reef formation found below 10% SI (Achituv and Dubinsky, 1990). Photosynthetic carbon fixation by zooxanthellae in *Montastrea annularis* (a species with one of the widest depth distributions) was found to decrease by more than 93% between 0.5 and 50 m depth (Battey and Porter, 1988). Available light was found to be the primary factor responsible for monthly variations in growth of three hermatypic coral species in Curaçao (Bak, 1974). Shading by large *Acropora hyacinthus* table corals (causing light levels to fall exponentially to ~1% of outside values as a light meter was moved under the table) was found to significantly reduce "understorey" coral density, cover and diversity beneath the table corals compared with adjacent unshaded areas (Stimson, 1985). Shading of a 20 m^2 area of San Cristobal Reef off south-western Puerto Rico for five weeks altered community structure, decreased net reef productivity and caused bleaching and death of several hard coral species (Rogers, 1979).

As a response to lower light levels, most mesophotic reef corals often exhibit flat, plate-like morphologies to maximise light capture and may also utilise different symbionts (Bongaerts et al., 2010, 2011). Such plate-like morphology, however, more easily traps sediment, and although this increased susceptibility to sedimentation is normally not problematic due to the relatively lower rates of sedimentation on the deeper reef, increased sediment levels can result in large-scale mortality among mesophotic corals (Bak et al., 2005; Bongaerts et al., 2010).

Even in clear tropical waters, light intensity is reduced by 60% to 80% in the top 10 m of water (Kinzie, 1973) but attenuation increases in turbid waters (Kirk, 1977). Concordantly, the total energy available for the life processes of autotrophs is also reduced (Thurman, 1994), affecting coral distribution (Roy and Smith, 1971; Jaubert and Vasseur, 1974; Titlyanov and Latypov, 1991) as well as photosynthesis and respiration (Rogers, 1979; Telesnicki and Goldberg, 1995). Decreases in algal productivity causes a drop in the nutrition, growth, reproduction, calcification rate and depth distribution of corals. In some coral species, this drop in productivity can eventually result in the coral starving (Richmond, 1993). In Singapore, chronic levels of sedimentation over the last 30–40 years has resulted in underwater visibility being reduced from 10 m recorded in the early1960s to a contemporary average of 2 m (Chou, 1996). Chuang (1977) found only 10% of surface light reached down to 8 m depth, 5% to 10 m depth and 0.35% to 16 m depth at two sampling stations, whereas Todd et al. (2004a) found <0.6% surface PAR reaching 8.9 m at one of their "best" sampling sites. There is very little coral cover around Singapore beyond 8 m depth. Wave-driven resuspension of bottom sediments in shallow areas and/or tidal currents transporting material off corals may also be important, preventing direct negative effects of sedimentation on reefs in such marginal environments (Chou, 1988; Bak and Meesters, 2000).

Results of field studies on coral distributions have indicated a negative correlation between suspended sediment loads and hard coral abundance (Rice and Hunter, 1992). Coral communities are generally better developed, are more diverse and have greater coral cover and rates of coral growth the lower the sediment load (Rogers, 1990; Fabricius, 2005). Long-term exposure to elevated levels of suspended sediment can cause reduced coral growth and reduced reef development (Rice and Hunter, 1992), although recent studies from nearshore reefs in the Great Barrier Reef would argue against this, where there is evidence of spatially relevant and temporally persistent reef-building having occurred over millennial timescales (Larcombe et al., 1995; Anthony and Larcombe, 2000).

Monitoring data from the west coast of Barbados indicated a 20% reduction in the annual growth rate of *Montastraea annularis* in response to a 28% increase in average long-term background suspended-sediment levels (Hawker and Connell, 1989). Coral cover and diversity are greatly reduced near sources of terrigenous sediment input and runoff (e.g. rivers) and tend to increase with distance from the river mouth (Acevedo et al., 1989; Hoeksema, 1990; van Katwijk et al., 1993; Kleypas, 1996; Woolfe and Larcombe, 1999; Nugues and Roberts, 2003; Fabricius, 2005; Dikou and Van Woesik, 2006a; Cleary et al., 2006, 2008; Golbuu et al., 2008; Hennige et al., 2010; van der Meij et al., 2010). In the geological record, increased turbidity has been implicated as a major factor in the demise of several coral reefs in the western Atlantic (Adey et al., 1977; Lighty et al., 1978; Macintyre, 1988; Achituv and Dubinsky, 1990; Kleypas, 1996). At larger spatial scales, however, increased terrigenous sediment supply due to human impacts on catchments may not necessarily lead to increased turbidity or sedimentation at reefs further offshore and corals can indeed survive well in some turbid environments (Larcombe and Woolfe, 1999; Perry and Larcombe, 2003; Perry, 2005; Perry and Smithers, 2010).

There is some indication that elevated turbidity can reduce thermal bleaching damage to reefs, suggesting a photo-protective effect during thermal anomalies making shallow-water corals in turbid waters less susceptible to bleaching than those in clear waters (Phongsuwan, 1998; Piniak and Storlazzi, 2008) but this requires further study.

3.2. Sedimentation: feeding and respiration

Sedimentation and burial in the marine environment are measured and expressed in a number of different ways. Sedimentation (sometimes also called "siltation" or "deposition") is usually expressed as a rate (in mg cm^{-2} d^{-1}) or in thickness (mm) of the sediment layer (instantaneous, or accumulating over time). Water turbidity and sedimentation correlate only in part because increased turbidity does not necessarily lead to increased sediment deposition (Larcombe and Woolfe, 1999). A range of methods is available for field measurements of sediment accumulation or sediment elevation change in underwater environments, all of which have merits and shortcomings (Thomas and Ridd, 2004). Despite their widespread use in this setting, sediment traps do not provide quantitative information about "net" sedimentation on coral surfaces (Storlazzi et al., 2011). Sediment traps can, however, yield useful information about the relative magnitude of sediment dynamics in different areas, as long as trap deployment standards are used for trap height, trap-mouth diameter, height of trap mouth above the substrate and spacing between traps (Jordan et al., 2010; Storlazzi et al., 2011).

Sedimentation on coral reefs may cause smothering of coral polyps (Fig. 3; Fabricius and Wolanski, 2000), inhibiting photosynthetic production and increasing respiration as well as creating a diffusion barrier. In a study by Abdel-Salam and Porter (1988), daytime photosynthesis in corals exposed to sediments decreased, while at night-time respiration increased. Stafford-Smith (1993) measured a drop in photosynthesis to respiration (P:R) ratios for

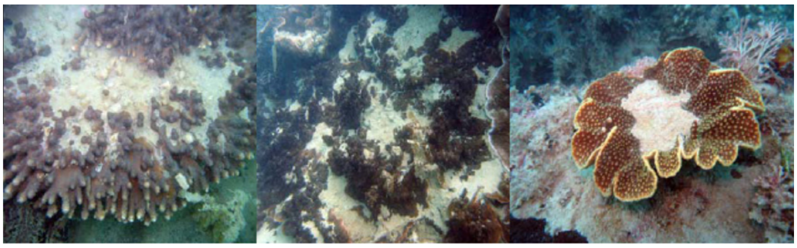

Fig. 3. Partial coverage of corals with sediment transported by plume and currents from nearby dredging works (Photo courtesy: Tony Ayling).

smothered corals. Corals will attempt to clean themselves of this sediment by a combination of ciliary action and the production and sloughing off of mucus sheets. This, however, is expensive in energy and can lead to exhaustion of mucus-producing cells (Peters and Pilson, 1985; Riegl and Bloomer, 1995; Riegl and Branch, 1995). At the individual (colony) level, energy diverted to clearing the colony surface of sediment can lead to growth inhibition and a reduction in other metabolic processes (Dodge and Vaisnys, 1977; Rogers, 1983; Edmunds and Davies, 1989). At the population level, increased sedimentation may inhibit sexual population recruitment, cause changes in the relative abundance of species, decrease live coral cover and reduce the abundance and diversity of corals and other reef fauna, including fish (Brock et al., 1965; Amesbury, 1981; Rogers, 1990; Gilmour, 1999; Bray and Clark, 2004). It may also, however, cause increased rates of asexual reproduction in free-living corals that show partial mortality (Gilmour, 2002, 2004).

Furthermore, cover by sediment interferes with the coral's feeding apparatus, by causing polyps to retract and tentacular action to cease. Sufficient sediment overburden may make it completely impossible for corals to expand their polyps and thus can inhibit the coral compensating for its losses in autotrophic food production by heterotrophic activity. While some corals are able to ingest sediment particles in turbid conditions and derive some nutritional value from them (Rosenfeld et al., 1999; Anthony et al., 2007) or even build up higher lipid energy reserves (Anthony, 2006), most corals cease activity when confronted with heavy sediment loads.

Corals can withstand a certain amount of settling sediment, as this occurs naturally (Rogers, 1977, 1990; Perry and Smithers, 2010). Many species have the ability to remove sediment from their tissues, either passively (through their growth form) or actively (by polyp inflation or mucus production, for example). Sediment rejection is a function of morphology, orientation, growth habit and behaviour of the coral and the amount and type of sediment (Bak and Elgershuizen, 1976). Corals growing in areas where they typically experience strong currents or relatively high wave energy generally have no need for effective (active) sediment rejection mechanisms, as the turbulence of the water assists in the passive cleaning of any sediment that may have accumulated on the coral tissue (Riegl et al., 1996; Hubmann et al., 2002; Sorauf and Harries, 2010). Many branching corals appear very effective in passive rejection of sediment because of their colony morphology, but they may suffer from reduced light levels. Massive and plating coral colonies, on the other hand, though usually more tolerant of turbid conditions, are more likely to retain sediment because of their shape and a lack of sediment rejection capabilities and thus tend to have a relatively low tolerance to sedimentation (Brown and Howard, 1985).

Various species of free-living mushroom corals that live on reef flats and slopes can occur on a range of substrata, whereas those that live deeper on the sandy reef bases usually live on sediment (Hoeksema and Moka, 1989; Hoeksema, 1990, 1991b). As juveniles, mushroom corals live attached and only after a detachment process do they become free-living and mobile (Hoeksema, 1989, 2004; Hoeksema and Yeemin, 2011). Some free-living mushroom coral species show a large detachment scar and their juveniles remain relatively long in the attached anthocaulus phase. A possible reason for postponed detachment is to avoid burial of the juvenile coral, especially if the coral remains vertically oriented so that sediment can more easily be shed than in a horizontal position (Chadwick-Furman and Loya, 1992). The evolutionary development of additional mouths over the upper surface in mushroom corals has resulted in the growth of larger coralla but also in a greater chance of survival during sedimentation—if one mouth is blocked by sediments, others remain intact (Hoeksema, 1991a; Gittenberger et al., 2011). In free-living mushroom corals, budding or fragmentation in combination with regeneration and mobility facilitates continuous growth and may result in large and dense accumulations of specimens on sandy surfaces (Pichon, 1974; Littler et al., 1997; Hoeksema, 2004; Hoeksema and Gittenberger, 2010; Hoeksema and Waheed, 2011).

3.3. Effects on sexual recruitment, larval survival and settlement

Sedimentation and turbidity not only influence the survival of adult corals, but also their reproductive success and probability of recruitment, as well as the survival and settlement of coral larvae (Babcock and Smith, 2000; Birrell et al., 2005). Sedimentation at a level that only partially covers the substrate and that is not directly harmful to adult colonies, and even suspended sediment, can significantly reduce larval recruitment by inhibiting settlement and reducing larval survival in the water column (Gilmour, 1999; Babcock and Smith, 2000; Birrell et al., 2005; Goh and Lee, 2008) although this is not always detectable in field studies (Fisk and Harriott, 1989). Settlement rates are near-zero on sediment-covered surfaces, and sedimentation tolerance in coral recruits is at least one order of magnitude lower than for adult corals (Fabricius, 2005).

Babcock and Davies (1991) evaluated effects on settlement rates of *Acropora millepora* larvae in aquaria under 0.5–325 mg cm^{-2} d^{-1} sedimentation. Higher sedimentation rates reduced the number of larvae settling on upper surfaces, but total numbers of settled larvae were not significantly affected by sedimentary regime. This was, however, likely an artefact since, in the field, accumulation of sediment on upward-facing surfaces would indeed greatly reduce the overall amount of suitable substratum available. Hodgson (1990b) investigated the larval settlement rate of *Pocillopora damicornis* on bare glass and on glass covered with measured amounts and area of fine sediment finding significant reduction due to sediment. Sediment cover of 95% completely prevented settlement. There was no increase in settlement when sediment cover was reduced from 90% to 50% of the glass surface area. In highly turbid conditions (>100 mg L^{-1}, which would not be unusual at sites in close proximity to a dredging operation), significant numbers of settled planulae of *Pocillopora damicornis* underwent reversed metamorphosis ("polyp bail-out"), indicating conditions were not appropriate for continued growth and development (Te, 1992). Chronic exposure to sedimentation rates of 10–15 mg cm^{-2} d^{-1} caused a 50% decrease in fecundity in *Acropora palifera* in Papua New Guinea (Kojis and Quinn, 1984).

Elevated levels of suspended sediment (50 mg L^{-1}, 100 mg L^{-1}) affected fertilisation, larval survival, and larval settlement in *Acropora digitifera* (Gilmour, 1999). While post-fertilisation embryonic development was not inhibited by suspended sediments, larval survival and larval settlement were significantly reduced. Significant declines in fertilisation success were reported for *Acropora millepora* at suspended-sediment levels $\geqslant$100 mg L^{-1} compared with lower levels ranging from 0 to50 mg L^{-1} with approximately 36% fertilisation at the highest tested suspended-sediment levels of 200 mg L^{-1} (Humphrey et al., 2008). Elevated concentrations of suspended sediment (43 mg L^{-1}, 159 mg L^{-1}) also significantly reduced fertilisation success in *Pectinia lactuca* compared with controls (Erftemeijer et al., 2012).

These findings imply that increased levels of suspended sediment and/or sedimentation due to dredging operations—especially when coinciding with the main spawning season of corals—may affect their reproductive success, compromise coral recruitment and thereby compromise the recovery of degraded reefs (Erftemeijer et al., 2012). The same issues are probably relevant in naturally or episodically turbid (higher stress) settings.

3.4. Nutrients and contaminants

The mucus coat that surrounds corals, which is moved off the coral by ciliary action and is replaced repeatedly, acts as their primary defence against precipitated sediment particles. A potentially problematic by-product of this abundant mucus production can be fertilisation of the nearby water potentially causing population explosions of bacteria (Mitchell and Chet, 1975; Coffroth, 1990; Ritchie and Smith, 2004; Brown and Bythell, 2005; Klaus et al., 2007). The metabolism of these bacteria can lead to local anoxic conditions and concomitant death of coral tissue in the immediate vicinity. Furthermore, high nutrient contents of silt can lead to microbial activity, eventually causing the underlying coral tissue to become necrotic (Weber et al., 2006; Hodgson, 1990a). Conversely, some coral species have been observed to exploit nutrient-rich suspended particles as a food source, thereby compensating for the stress caused by sedimentation (Fabricius and Wolanski, 2000).

Numerous kinds of terrestrial pollutants, including those from sewage and agricultural runoff, make their way into nearshore sediments that can be resuspended by dredging operations and subsequently cause eutrophication of coastal waters (Kenchington, 1985; Grigg and Dollar, 1990; San Diego-McGlone et al., 2008; Todd et al., 2010). As corals generally grow in oligotrophic waters, elevated nutrient levels can lead to a range of negative effects on coral health (Hawker and Connell, 1989), reduced fertilisation success (Harrison and Ward, 2001) and settlement rates (Hunte and Wittenberg, 1992). Increased phytoplankton concentrations reduce light penetration to the symbiotic zooxanthellae and increased organic sediment loads can smother corals (Bell, 1992). Eutrophication can also increase the severity of diseases (Bruno et al., 2003) and lead to competitive advantage for macroalgae that respond by rapid growth, smothering corals or blocking light (Lapointe, 1997; Walker and Ormond, 1982), although evidence for different trajectories also exists (McCook, 1999a, 1999b). Sediments that are influenced by outflow from industrial areas can contain relatively high levels of lead, cadmium, copper, tin, nickel and iron (Amin et al., 2009; Todd et al., 2010). In particular, copper is known to inhibit coral recruitment, fertilisation and development (Reichelt-Brushett and Harrison, 2005; Negri and Hoogenboom, 2011).

4. Responses among and within coral species

4.1. Responses to turbidity

Light-enhanced calcification is responsible for most of the skeletal growth of reef-building corals (Goreau, 1959). Low light decreases calcification in zooxanthellate scleractinian corals, being approximately three times lower in darkness than in light (Kawaguti and Sakumoto, 1948; Gattuso et al., 1999). Titlyanov (1991), however, noted that enhanced utilisation of light by zooxanthellae in three stony corals can result in stable levels of primary production in a wide light range (20–90% PAR). Low light levels may also inhibit the development of coral larvae (Rogers, 1990). Similar patterns of photo-acclimation (through photophysiological adaptations) across gradients of increased turbidity have been demonstrated by Hennige et al. (2008, 2010).

Although certainly also related to a variety of other environmental factors, species diversity of corals generally tends to decrease sharply with increasing (chronic) turbidity (Rogers, 1990; Becking et al., 2006; Cleary et al., 2008). Long-term turbidity stress can shift the species composition of reefs through the death of more light demanding corals and the subsequent replacement by usually deeper-living, more shade-tolerant ones at certain depths (Pastorok and Bilyard, 1985). Dikou and van Woesik (2006b) noted in Singapore the occurrence of deeper-water genera such as *Merulina*, *Pachyseris* and *Mycedium* found in relatively shallow (3–4 m) depths was most likely due to high turbidity levels. Also in Singapore, Goh et al. (1994) considered the sediment-impacted light environment to be the main factor controlling coral colony form. Foliose forms tended to dominate the shallow reef with more massive and encrusting forms found deeper.

4.2. Responses to sedimentation

Corals can react either actively or passively to sediments, which in many ways defines their capability to withstand prolonged sedimentation. Passive shedding refers to corals taking advantage primarily of their shape to allow increased runoff of sediment, to maintain parts of the corallum above sediment, or to use water currents to remove accumulated sediment (Stafford-Smith and Ormond, 1992; Stafford-Smith, 1993; Riegl, 1995; Riegl et al., 1995; Sanders and Baron-Szabo, 2005). It has long been known that coral shape correlates well to the environment, and in particular in paleo-ecological studies, corallum shape has frequently been equated to sedimentation conditions (Plusquellec et al., 1999; Sanders and Baron-Szabo, 2005). Colony shape plays an obvious role in aiding sediment runoff and hemispherical to columnar species have been found to be efficient passive shedders (Bak and Elgershuizen, 1976; Dodge and Vaisnys, 1977; Stafford-Smith, 1993; Riegl, 1995). Branching species retain little sediment, and many poritids are indeed very sediment-tolerant; however, some acroporids are inefficient sediment rejecters and do not appear well adapted to sedimentation despite an apparently advantageous growth form (Stafford-Smith, 1993). Thin, stick forms such as *Madracis mirabilis* or *Acropora cervicornis* are ideally suited passive shedders. Both species have little surface available for sediment accumulation and staghorn corals have polyps that are widely separated, further reducing the chance of sediment clogging (Meyer, 1989). Another efficient design for passive sediment rejection is the thin, platy and upright growth habit exhibited by *Agaricia tenuifolia* in shallow water. Only a small area is present at the top of each plate for sediment accumulation. This form, coupled with an erect growth habit, is very effective in letting sediment slide passively from the colony (Meyer, 1989). Gorgonians (Octocorallia), especially sea whips, were found to be among the most tolerant species to sediment-loading and dredging-induced turbidity in Florida (Marszalek, 1981). Five species of gorgonians in the highly sedimented waters of Singapore showed growth rates ranging from 2.3 to 7.9 cm yr^{-1}, which are comparable to published growth rates from non-sedimented environments (Goh and Chou, 1995).

Riegl (1995), Riegl and Bloomer (1995) and Schleyer and Celliers (2003) found in zooxanthellate soft corals, which are generally inefficient and passive sediment shedders, that ridged morphology maintained sediment-free areas and thus maintained photosynthetic efficiency which allowed these corals to persist in relatively sand-laden environments. In scleractinian corals, calyx size, orientation, and degree of meandrisation have been found to correlate in some species with rejection efficiency (Hubbard and Pocock, 1972; Rogers, 1983; Johnson, 1992; Stafford-Smith, 1993; Philipp and Fabricius, 2003; Sanders and Baron-Szabo, 2005; Rachello-Dolmen and Cleary, 2007; Sorauf and Harries, 2010); however, such relationships appear to be dependent on sediment size (Riegl, 1995). A counter-intuitive mechanism of passive sediment rejection is that of funnel-shaped corals (*Acropora clathrata* and *Turbinaria peltata*) occurring in turbid, but also high-energy environments. Riegl et al. (1996) showed in field and laboratory experiments that funnel-opening angle and depth could control hydrodynamic clearance of sediment via generation of unstable vortices in the funnels under high-current (surge) conditions that efficiently removed sediment from corals.

Active sediment-shedding mechanisms include polyp inflation, tentacular action and polyp movement (Stafford-Smith and Ormond, 1992; Riegl, 1995; Bongaerts et al., 2012). The cue to this activity is likely irritation of surface receptors when ciliary motion alone is not capable of removing sediment. Tentacular motion can be coordinated to collect sediment, largely by the action of cilia on the tentacular surfaces, which is then pushed or made to slide off the polyp. In some species, sediment is moved to the centre of the oral disc and ingested. This may be correlated with the observed feeding for energy gain reported by Anthony (1999a, 2000). Tissue expansion is a regularly observed mechanism that consists either of expansion of the entire polyp with ensuing tentacular action, or of an inflation of the oral disc with retracted polyps. The first would be a reaction under light to moderate sediment load, the latter a reaction under heavier sediment load. The inflation of the polyp with retracted tentacles leads to the formation of a smooth colony surface, from which sediment can slide off easily. This mechanism is thus a combination of active and passive sediment-shedding.

In free-living stony corals, such as mushroom corals, tissue inflation can lead not only to the removal of sediments, but also to the relocation of the entire corallum which is capable of pushing itself over the substratum (Chadwick, 1988; Chadwick-Furman and Loya, 1992; Hoeksema and de Voogd, 2012), a dispersion mechanism leading to high densities of evenly distributed corals (Goreau and Yonge, 1968; Schuhmacher, 1979; Fisk, 1983; Hoeksema, 1988, 2004; Yamashiro and Nishihira, 1995). Furthermore, if a free-living mushroom coral is at risk of dying because of sedimentation, it may survive by budding, a mechanism of asexual reproduction in which an adult coral generates clonal polyps that continue to live after the parent coral's death. This mechanism may result in coral aggregations (Gilmour, 2002, 2004; Hoeksema, 2004), but high densities of free-living corals in sediment-rich habitats may also be the result of sexual reproduction to spread the risk of burial and subsequent mortality (Johnson, 1992).

Important for sediment rejection is the production of mucus sheets (Coffroth, 1990; Rogers, 1990; Stafford-Smith, 1993). Some corals produce copious amounts of mucus as their primary mechanism to remove silt (e.g. *Meandrina meandrites*), whereas other corals produce mucus more sparingly but then use additional clearing mechanisms such as ciliary action (*Montastraea annularis*) (Dumas and Thomassin, 1977). Mucocytes, the cells producing mucus, are common in all coral tissues, but particularly so on the oral surface (Brown and Bythell, 2005). Together with ciliary action, mucus is used to move accumulated sediment off the coral (Schuhmacher, 1977). Mucus production, however, uses up an important part of a coral's daily photosynthetic production and its frequent replacement can lead to excessive demands on energy and a decrease in the number of mucus cells (Riegl and Bloomer, 1995; Vargas-Angel et al., 2006). Under severe sedimentation and turbidity stress, more than three times a coral's daily energy production can be used up for mucus production (Riegl and Branch, 1995)—mucus that is then sloughed off with the adhering sediment. Continued chronic sedimentation as well as frequent, repeated exposure to intermittent pulses of high sedimentation will lead to exhaustion of the sediment-clearing ability of corals, eventually leading to tissue thinning, loss of cilia and mucosecretory cells, and ultimately death (Fig. 4).

4.3. Within-species variation

It is clear that differences exist among species in their ability to withstand the effects of increased sedimentation. Do these differences also occur within species? As not all growth forms will survive equally under sediment stress, some environment-morphology matching can be expected. Certainly, many corals display

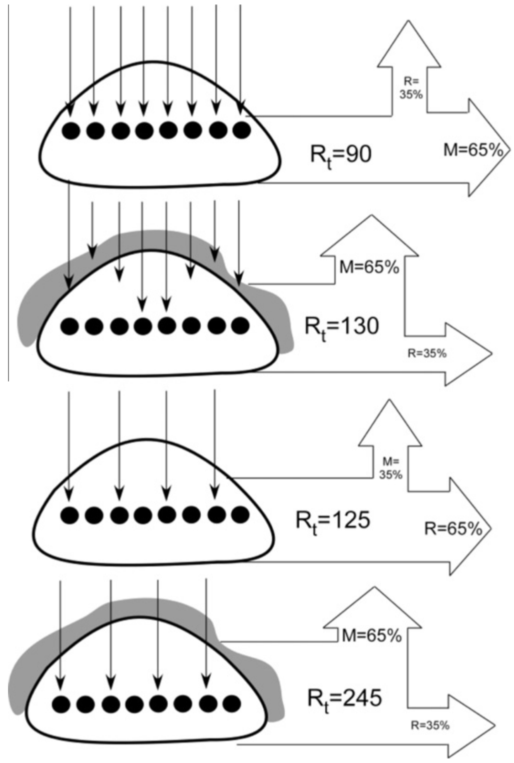

Fig. 4. Why corals starve to death when sedimented. Vertical arrows represent light, the black dots are zooxanthellae, the arrow coming from the coral represents energy use (measured by respirometry). Sediment is shown as grey cover on the coral. Under ~50% light (PAR_s) conditions, ~90% of productivity is respired, of which ~35% is due to mucus production and ~65% due to other metabolic functions. Under sedimentation, this is reversed and respiration due to mucus production now dominates. Also, more energy is respired than produced. Under increased turbidity (~25% PAR_s), the coral cannot function as autotroph anymore, and when sedimented uses more than two-days energy production in respiration, 65% of this for mucus alone. R_t = total respiration; M = share of respiration due to mucus production; R = share of respiration due to regular metabolic activity. Modified from Riegl and Branch (1995). By permission of Elsevier.

a high degree of intraspecific morphological variation. This can be due to genetic differentiation (polymorphism), environment-induced changes (phenotypic plasticity) or a combination of both (Foster, 1979; Todd et al., 2002a,b; Todd, 2008). Various studies have shown that the ambient light environment (both turbidity and depth-related) can be correlated to intraspecifc colony, corallite, and sub-corallite morphology, but little is known about the within-species differences in relation to settling sediments.

Examples of intraspecific morphological variation that has been related to light include Jaubert (1977) who showed that colonies of *Porites convexa* (as *Synaraea convexa*) were hemispherical with many short branches in high light, flatter with longer branches in medium light, and explanate in the lowest light conditions. Graus and Macintyre (1982) modelled calcification rates and photosynthesis in *Montastraea annularis* and demonstrated that light had the greatest effect on its morphogenesis. Computer models based on light diffusion and light shelter effects accurately matched the dendritic form of *Merulina ampliata* (Nakamori, 1988) via reciprocal transplant experiments, Muko et al. (2000) determined that platy colonies of *Porites sillimaniani* developed branches within eight months when transplanted to high light conditions. Beltran-Torres and Carricart-Ganivet (1993) concluded that light was the principal physical factor influencing corallite diameter and septal number variation in *Montastraea cavernosa*, and Wijsman-Best (1974) suggested light reduction to cause a decrease with depth of both corallites per unit area and number of septa in various faviids. Todd et al. (2004a) concluded that irradiance was the main factor driving small-scale plastic responses in the massive corals *Favia speciosa* and *Diploastrea heliopora* and suggested that this response may enhance light capture by increasing surface area. The corallite shape of *Goniastrea pectinata* also changes in relation to light and Ow and Todd (2010), through modeling light capture, showed this response to be an adaptive response to the immediate light environment.

Some morphologies, both at colony and corallite level, are believed to encourage sediment-shedding (Lasker, 1980; Rogers, 1983, 1990). Marshall and Orr (1931), after smothering various coral taxa with sand, concluded that corals with large polyps were better at removing sediment than those with small polyps. Small polyps equate to less tissue-distension potential and thus to a reduced ability to remove coarse grains. Stafford-Smith and Ormond (1992) found that active-rejection capability was positively correlated with calyx size and Hodgson (1993) concluded that large corallites and extensible polyps were advantageous in his tests on 50 species of coral. Corals that move larger grains tend to have more septa, high relief and numerous septa teeth. The shape of the calyx is also important to sediment-shedding, with V or U floors apparently beneficial for mechanical reasons (Hubbard and Pocock, 1972). Todd et al. (2001) hypothesised that these features in *Favia speciosa* may be advantageous to this species in Singapore's sedimented waters. Further, they found that *Favia speciosa* polyps were significantly larger at their most sediment-impacted study site (Todd et al., 2001). Riegl (1995) also found corallum shape to be important while Dodge (1982) found no clear trend. Gleason (1998) noted green and brown morphs of *Porites astreoides* had different sediment-shedding abilities even though small-scale morphologies were very similar. Even intra-colonial variation can have a great effect on sediment removal; for instance, small differences in colony convexity can lead to areas where sediments accumulate and create anoxic conditions (Stafford-Smith, 1992, 1993).

In the only study to date to specifically examine whether sediment can induce change in coral morphology, Todd et al. (2004b) found a slight increase in rugosity (the height of the wall measured from the outside of the corallite) in fragments exposed to sediment treatment compared with controls (*Favia speciosa* control = 1.36 mm, sediment treatment = 1.53 mm; *Diploastrea heliopora* control: 1.40 mm, sediment treatment = 1.54 mm). As passive rejection is enhanced by tall polyps with steep surfaces (Lasker, 1980), it is possible that this response would be beneficial to the two species tested. Any attempt to examine plastic responses of corals to chronic sediment is complicated by the reduction in light caused by sediment in the water. For instance, explanate *Porites sillimaniani* form branches under high light (Muko et al., 2000). It is easy to see how the branching form might be advantageous in high sediment conditions, but these are unlikely to develop as they require high light. Also, in *Turbinaria mesenterina*, convoluted forms (good for sediment rejection) became explanate (bad for sediment rejection) in low light and explanate forms became convoluted in high light conditions (Willis, 1985). The same problem also occurs at finer scales. Smaller corallites with fewer septa are likely related to decreased light in *Montastraea cavernosa* and some other faviids (Wijsman-Best, 1974; Beltran-Torres and Carricart-Ganivet, 1993) but the opposite traits are beneficial for sediment removal (Marshall and Orr, 1931; Hubbard and Pocock, 1972; Stafford-Smith and Ormond, 1992; Hodgson, 1993).

5. Tolerance levels and critical thresholds

All coral species are arranged along a gradient of relative tolerance to stress from sediment. Each coral species, therefore, has its own set of threshold values representing the concentrations of sediment which produce sublethal or lethal effects. After a certain maximum concentration, reduction of growth occurs due to smothering, reduced light levels and reduced zooxanthella photosynthesis. Ultimately, when sustained over a longer period, such concentrations can cause mortality.

5.1. Turbidity

There is a clear relationship between substratum cover by live corals and water transparency (K_{PAR}), which determines the compensation depth of corals (Yentsch et al., 2002). Values for the minimum light requirements of corals reported in the literature range from <1% to as much as 60% of surface irradiance (SI) (Table 3). Kleypas et al. (1999) suggested minimum light requirements to allow reef formation (40% SI) to differ from the minimum light requirements to allow survival of individual corals (10% SI). The sensitivity to reduced light is—at least in part—dependent on the growth form of corals, with branching species generally thriving only under at least 60% average SI, while most plocoid and meandroid massive species require only 20% average SI, and several platy corals can survive with as little as 0.15% (Jaap and Hallock, 1990). Typically, the reduced availability of light caused by increased turbidity is experienced more strongly by corals growing in deeper areas of a reef than by corals growing in shallower areas. Turbidity effects on corals depend on the grain size of the suspended sediment, with fine particles contributing most to light reduction while coarser particles may cause scouring and abrasion of coral tissue (PIANC, 2010).

Despite an impressive body of literature (see review by Hubbard, 1986), little quantitative information exists on the specific responses of reef organisms to suspended-sediment loading. There is a highly significant inverse relationship between coral growth rates and suspended-sediment yields (Miller and Cruise, 1995). Practical observations of coral mortality associated with turbidity plumes from dredging projects or increased runoff are inconsistent with laboratory experiments that have documented surprising tolerance by corals to high doses of sediment over short periods of time (Taylor and Saloman, 1978; Rogers, 1983). One of the factors responsible for this discrepancy may be the effect of the duration of exposure (Fig. 2). Tolerance limits of corals for total suspended

Table 3
Some published critical threshold of corals for light availability (% of surface irradiance SI).

Species/type of corals	Location	%SI	References
Plate corals	Florida,USA	0.15	Jaap and Hallock (1990)
Star corals	Curacao	1	Bak (1978)
Scleractinian corals	South China Sea	2–8	Titlyanov and Latypov (1991)
Individual corals	Worldwide	10	Achituv and Dubinsky (1990)
Star and brain corals	Florida, USA	20	Jaap and Hallock, 1990
Coral reefs	Worldwide	35	Achituv and Dubinsky (1990)
Branching corals	Florida, USA	60	Jaap and Hallock (1990)

matter (or suspended-sediment concentration) reported in the literature range from <10 mg L^{-1} in reef areas not subject to stresses from human activities to >100 mg L^{-1} in marginal reefs in turbid nearshore environments (Marshall and Orr, 1931; Roy and Smith, 1971; Mapstone et al., 1989; Hopley et al., 1993; Larcombe et al., 2001; Hoitink, 2003; Sofonia and Anthony, 2008) (Table 4). This wide range demonstrates that different coral species and corals in different geographic regions may respond differently to turbidity increases. Thermal tolerances in corals have also been reported to vary geographically (Weeks et al., 2008). Some corals have been shown to possess the ability to (temporarily) switch between autotrophy and heterotrophy or to make adjustments to their respiratory demands in response to episodic turbidity stress events (Telesnicki and Goldberg, 1995; Anthony and Fabricius, 2000) but these data are limited to a few coral species. Reduced photosynthetic capacity may lead to reduced energy reserves for maintenance and growth. Corals contain large lipid stores under normal (non-stressed conditions), but a recent study indicated that 30–50% depletion of those reserves may occur during stress events within a matter of weeks (Anthony et al., 2007).

In certain locations, coral reefs persist in highly turbid areas (Perry, 2005; Perry and Smithers, 2010). Larcombe et al. (1995) described the characteristics of suspended sediment concentrations of marine waters near inner-shelf fringing coral reefs in northern Australia and related these to the prevailing oceanographic and meteorological conditions. High temporal and spatial variation in near-bed SSCs corresponded to wind-generated swells, which, within 1 km of the reefs, produced near-bed SSCs of well over 200 mg L^{-1}. At the fringing coral reefs SSCs ranged from 5 mg L^{-1} to 40 mg L^{-1}. Flushing of these bays by tidal currents was important to prevent the build-up of suspended sediment in the water around the coral reefs. Other extremely turbid reefs were described by Anthony and Larcombe (2000) from Halifax Bay, Australia, where “coastal turbid-zone reefs” occur in water less than 4 m deep, with turbidity sometimes over 100 NTU (∼220 mg L^{-1}) as a result of wave-induced resuspension, and wind-driven longshore currents prevent accumulation of fine-grained sediment. In turbid situations, the key to sustained coral growth appears to be low sediment accumulation, frequently assured by strong tidal flushing, although recent studies from the GBR indicate that reefs in these settings can have quite high accretion rates. While reef growth was found to be possible under such conditions, these reefs hosted relatively moderate species numbers and sometimes had poorly consolidated frameworks (Hopley et al., 2007). Hoitink (2004) found that tidal currents around reefs in Indonesia resuspended sediments to give average Suspended-sediment concentrations between 2 and 10 mg L^{-1}, with maxima up to 50 mg L^{-1}. Riegl (1995) found surge-induced peak suspended-sediment concentrations of up to 389 mg L^{-1} in sandy gullies and 112 mg L^{-1} over coral on South African reefs; this, however, was local sediment stirred up and immediately re-deposited.

While the studies above demonstrate that coral reefs and turbidity/sedimentation can coexist, it also shows the danger of introducing sediment since it is likely to be remobilised repeatedly. All the reef systems discussed in the previous two paragraphs were clearly adapted to sedimentation and turbidity, with mostly low accretion rates demonstrated in South Africa (Ramsay and Mason, 1990; Riegl et al., 1995) and quite high accretion rates on inshore reefs from the Great Barrier Reef (Larcombe et al., 1995), comparable to those in “optimal” environments. Corals that are naturally exposed to high and variable background conditions of turbidity and sedimentation (e.g. due to storms and/or river influence) will show higher tolerances to short increases in turbidity or sedimentation caused by dredging (Nieuwaal, 2001). Corals from shallow-water environments, where they are frequently exposed to elevated temperatures, storms and wave action, are more likely to be tolerant of environmental stresses than corals in deeper waters (Brown and Howard, 1985; Hoeksema, 1991b; Hoeksema and Matthews, 2011).

A synthesis of literature data regarding the sensitivity of different coral species to turbidity is presented in Table 5. These data were reworked and related to a relative sensitivity index according to the response matrix presented in Table 6. Sensitivity classes were then given scores from 1 to 5, with 1 corresponding to “very tolerant” and 5 to “very sensitive”. The scores for individual coral species were subsequently related to their dominant growth form and mean calyx diameter. Analysis of these data (90 entries for 46 species) confirmed that there is a significant relationship (Kruskal–Wallis, $P < 0.05$) between the growth form of corals and their sensitivity to turbidity (Fig. 5a). Most soft corals and many massive coral species are relatively sensitive to turbidity while laminar, plating and tabular corals as well as some morphologically variable corals are relatively tolerant. There was no significant relationship between the calyx diameter of corals and their sensitivity to turbidity (Fig. 5b).

Table 4
Some published critical thresholds of corals (reefs) for Total Suspended Sediment (mg L^{-1}).

Description	Location	mg L^{-1}	References
Coral reefs	Great Barrier Reef (GBR), Australia	3.3	Bell (1990)
Coral reefs	Fanning lagoon, Florida, USA	10	Roy and Smith (1971)
Coral reefs	Caribbean	10	Rogers (1990)
Coral reefs	Papua New Guinea	15	Thomas et al. (2003)
Coral reefs	Florida, USA	20	Bogers and Gardner (2004)
Corals	Dominican Republic	20	Van der Klis and Bogers (2004)
Marginal reef environments	Banten Bay, Java, Indonesia	40	Hoitink (2003)
Marginal reef environments	Paluma Shoals, QLD Australia	40	Larcombe et al. (2001)
Nearshore fringing reefs	Magnetic Island, GBR, Australia	75–120	Mapstone et al. (1989)
Nearshore fringing reefs	Cape Tribulation, GBR, Australia	100–260	Hopley et al. (1993)
Seven resistant coral species	Florida, USA	165	Rice and Hunter (1992)

5.2. Sedimentation

Most coral species are sensitive to enhanced sedimentation, even in the order of a few centimetres per year (Rogers, 1990). Pastorok and Bilyard (1985) suggested that sedimentation rates of >50 mg cm^{-2} d^{-1} (equivalent to 500 g m^{-2} d^{-1}) may be considered catastrophic for some coral communities, while 10–50 mg cm^{-2} d^{-1}

Table 5
Sensitivity of different coral species for turbidity. Overview of the response of different species of corals to various levels of turbidity tested, as reported in the literature. Nomenclature of coral species was updated according to the most recent taxonomic revisions. Growth forms (as stated or inferred): B = branching; C = columnar (incl. digitate); E = encrusting; F = foliaceous; L = laminar (incl. plate & tabular); M = massive; S = solitary (free-living); So = soft corals & gorgonians. Calyx diameter measured on museum specimen, supplemented with data from Stafford-Smith and Ormond (1992).

Coral species	Turbidity level (tested)	Response	Growth form	Calyx (mm)	References
Acropora cervicornis (Lamarck, 1816)	Severe light reduction (shading) for 5 weeks	Mass bleaching (3 weeks), mortality/algal cover (7 weeks), no recovery (8 months)	B	1.0	Rogers (1979)
Acropora cervicornis (Lamarck, 1816)	50 mg/l (96 h)	No effect	B	1.0	Thompson (1980b)
Acropora cervicornis (Lamarck, 1816)	150 mg/l (96 h)	Polyp retraction, mucus production but no mortality	B	1.0	Thompson (1980b)
Acropora cervicornis (Lamarck, 1816)	476 mg/l (96 h)	Partial mortality after 96 h.	B	1.0	Thompson (1980b)
Acropora cervicornis (Lamarck, 1816)	Total shading (3 weeks)	Bleaching and mortality, no recovery	B	1.0	Quoted in Nieuwaal (2001)
Acropora cervicornis (Lamarck, 1816)	25 mg/l (drilling mud) (24 h)	62% Decrease in calcification rate	B	1.0	Kendall et al. (1983)
Acropora cervicornis (Lamarck, 1816)	100 mg/l (drilling mud) (24 h)	50% Decline in soluble tissue protein	B	1.0	Kendall et al. (1983)
Acropora cervicornis (Lamarck, 1816)	50 and 100 mg/l (kaolin, 24 h)	Reduced calcification rate and free amino acids at 100 mg/l (recovery in 48 h)	B	1.0	Kendall et al. (1985)
Acropora cervicornis (Lamarck, 1816)	1000 mg/l (for 65 h)	Mortality of colonies	B	1.0	Thompson and Bright (1980)
Acropora digitifera (larvae)	50–100 mg/l (lab and feld tests)	Adverse effects on fertilisation, larval survival and settlement			Gilmour (1999)
Acropora millepora (Ehrenberg, 1834)	1–30 mg/l SPM (hours)	Increased feeding capacity at high SPM concentrations	B	1.0	Anthony (1999a)
Acropora millepora (Ehrenberg, 1834)	1–30 mg/l SPM (days)	Increasing contribution of heterotrophy at high SPM conc.	B	1.0	Anthony (2000)
Acropora millepora (Ehrenberg, 1834)	1, 3, 10, 30 and 100 mg/l TSS (16 weeks)	Full colony mortality at 100 mg/l for 12 weeks (50% mortality after 4 weeks)	B	1.0	Negri et al. (2009) and Flores et al. (2011)
Acropora nobilis (Dana, 1846)	10 mg/l (42 days)	Increased survival from high temperature treatment compared to control	L	1.5	Anthony et al. (2007)
Acropora spp.	170 mg/l (hours) of marine snow/SPM	Mucus production in response to flocculation			Fabricius and Wolanski (2000)
Agaricia agaricites (Linnaeus, 1758)	Severe light reduction (shading) for 5 weeks	Partial bleaching after 5 weeks, recovery within weeks	L	5.0	Rogers (1979)
Agaricia agaricites (Linnaeus, 1758)	50 mg/l (96 h)	No effect	L	5.0	Thompson (1980b)
Agaricia agaricites (Linnaeus, 1758)	150 mg/l (96 h)	Polyp retraction, mucus production but no mortality	L	5.0	Thompson (1980b)
Agaricia agaricites (Linnaeus, 1758)	476 mg/l (96 h)	Mortality after 65 h	L	5.0	Thompson (1980b)
Agaricia agaricites (Linnaeus, 1758)	<1% SI (several days)	33% Decrease in calcification rate (for >1 month), but survival	L	5.0	Bak (1978)
Agaricia agaricites (Linnaeus, 1758)	1000 mg/l (for 65 h)	Mortality of colonies	L	5.0	Thompson and Bright (1980)
Cladocora arbuscula (Lesueur, 1812)	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival (10 d), minor bleaching (20 d)	B	4.0	Rice and Hunter (1992)
Colpophyllia natans (Houttuyn, 1772)	Severe light reduction (shading) for 5 weeks	Partial bleaching (5 weeks), limited recovery & some algal growth (15 weeks)	M	25.0	Rogers (1979)
Dichocoenia stokesi Milne Edwards & Haime, 1848	0–2 NTU and 7–9 NTU (weeks)	No effect on P:R ratio	M	11.0	Telesnicki and Goldberg (1995)
Dichocoenia stokesi Milne Edwards & Haime, 1848	14–16 NTU (weeks)	Mucus production, P:R ratio <1 after 6 days exposure	M	11.0	Telesnicki and Goldberg (1995)
Dichocoenia stokesi Milne Edwards & Haime, 1848	28–30 NTU (weeks)	Mucus production, P:R ratio <1 after 3 days exposure	M	11.0	Telesnicki and Goldberg (1995)
Dichocoenia stokesi Milne Edwards & Haime, 1848	50–150–476 mg/l (96 h)	No effect at 50 and 150 mg/l; extreme sublethal stress but survival at 476 mg/l	M	11.0	Thompson (1980b)
Dichocoenia stokesi Milne Edwards & Haime, 1848	1000 mg/l (for 65 h)	No mortality	M	11.0	Thompson and Bright (1980)
Diploria labyrinthiformis (Linnaeus, 1758)	Severe light reduction (shading) for 5 weeks	Substantial bleaching (5 weeks), no recovery & some algal growth (15 weeks)	M	8.0	Rogers (1979)
Eusmilia fastigiata (Pallas, 1766)	severe light reduction (shading) for 5 weeks	No visible effects	M	12.0	Rogers (1979)
Favia favus (Forskål, 1775)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	M	14.0	Riegl and Branch (1995)
Favites pentagona (Esper, 1794)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	M	7.0	Riegl and Branch (1995)
Fungiidae (mushroom corals)		Adapted to highly turbid environments			Dikou and Van Woesik, (2006)
Galaxea fascicularis (Linnaeus, 1767)	>40 NTU (c.40 d), at times up to 175 NTU	Shift from autotrophy to heterotrophy (reversible)	C	8.0	Larcombe et al. (2001)
Goniastrea retiformis (Lamarck, 1816)	Shading (equivalent to 16 mg/l) – 2 months	Increased particle feeding & heterotrophy; survival and tissue gains	M	4.0	Anthony and Fabricius (2000)

(*continued on next page*)

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Table 5 (*continued*)

Coral species	Turbidity level (tested)	Response	Growth form	Calyx (mm)	References
Goniastrea retiformis (Lamarck, 1816)	1–30 mg/l SPM (weeks)	Gained tissue & skeletal mass (all treatments); increasing heterotrophy	M	4.0	Anthony and Fabricius (2000)
Goniastrea retiformis (Lamarck, 1816)	1–16 mg/l suspended matter (8 weeks)	Increased growth rate as function of SPM concentration	M	4.0	Anthony (1999b)
Goniastrea retiformis (Lamarck, 1816)	Shading (equiv. 16 mg/l at 4 m) (8 weeks)	Significant reduction in growth rate	M	4.0	Anthony (1999b)
Gorgonia flabellum Linnaeus, 1758	Severe light reduction (shading) for 5 weeks	No visible effects	So		Rogers (1979)
Gorgonians & soft corals		Very tolerant to high turbidity			Fabricius and Dommisse (2000)
Gyrosmilia interrupta (Ehrenberg, 1834)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	M/E	16.0	Riegl and Branch (1995)
Isophyllia sinuosa (Ellis & Solander, 1786)	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival after 10 d, minor bleaching after 20 d	N	15.0	Rice and Hunter (1992)
Leptastrea sp.		Well adapted to turbid waters			Dikou and Van Woesik, (2006)
Lobophytum depressum Tixier-Durivault, 1966	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	So		Riegl and Branch (1995)
Lobophytum venustum Tixier-Durivault, 1957	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	So		Riegl and Branch (1995)
Madracis auretenra Locke, Weil & Coates, 2007	<1% SI (several days)	33% Decrease in calcification rate (for >1 month), but survival	B	1.0	Bak (1978)
Manicina areolata (Linneaus, 1758)	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival after 10 d, minor bleaching after 20 d	M	14.0	Rice and Hunter (1992)
Meandrina meandrites (Linnaeus, 1758)	0–2 NTU and 7–9 NTU (weeks)	No effect on P:R ratio	M/E	15.0	Telesnicki and Goldberg (1995)
Meandrina meandrites (Linnaeus, 1758)	14–16 NTU (weeks)	Mucus production, P:R ratio < 1 after 6 days exposure	M/E	15.0	Telesnicki and Goldberg (1995)
Meandrina meandrites (Linnaeus, 1758)	28–30 NTU (weeks)	Mucus production, P:R ratio < 1 after 3 days exposure	M/E	15.0	Telesnicki and Goldberg (1995)
Millepora alcicornis Linnaeus, 1758	Severe light reduction (shading) for 5 weeks	Partial bleaching (5 weeks), algal growth (6 weeks), no recovery of damaged tissue	B	0.5	Rogers (1979)
Montastraea annularis (Ellis & Solander, 1786)	Severe light reduction (shading) for 5 weeks	Substantial bleaching (5 weeks), partial recovery (6–8 weeks), some algae/mucus	M/E	5.0	Rogers (1979)
Montastraea annularis (Ellis & Solander, 1786)	50 mg/l (96 h)	No effect	M/E	5.0	Thompson (1980b)
Montastraea annularis (Ellis & Solander, 1786)	150 mg/l (96 h)	Polyp retraction, mucus production but no mortality	M/E	5.0	Thompson (1980b)
Montastraea annularis (Ellis & Solander, 1786)	476 mg/l (96 h)	Mortality after 65 h	M/E	5.0	Thompson (1980b)
Montastraea annularis (Ellis & Solander, 1786)	100 mg/l (6-weeks)	Major sublethal effects (photosynthesis, respiration, calcification & nutr.uptake)	M/E	5.0	Szmant-Froelich et al. (1981)
Montastraea annularis (Ellis & Solander, 1786)	1–10 mg/l (6 weeks)	Only (some) effect on feeding response	M/E	5.0	Szmant-Froelich et al. (1981)
Montastraea annularis (Ellis & Solander, 1786)	525 mg/l	Decreased net production & tissue Chl, increased respiration & mucus	M/E	5.0	Dallmeyer et al. (1982)
Montastraea annularis (Ellis & Solander, 1786)	1000 mg/l (for 65 h)	Mortality of colonies	M/E	5.0	Thompson and Bright (1980)
Montastraea cavernosa (Linnaeus, 1767)	Severe light reduction (shading) for 5 weeks	No visible effects	M	11.0	Rogers (1979)
Montipora aequituberculata Bernard, 1897		Common on shallow, turbid inshore fringing reefs	F	0.6	Stafford-Smith (1993)
Montipora aequituberculata Bernard, 1897	1, 3, 10, 30 and 100 mg/l TSS (16 weeks)	Full colony mortality at 30 mg/l after 12 weeks (50% mortality after 4 weeks)	F	0.6	Negri et al. (2009) and Flores et al. (2011)
Montipora capitata Dana 1846	Light reduction from 57 to 44% SI (field; hours)	Photophysiological sublethal response; 1.4 times lower rETR, higher F_v/F_m	B	1.0	Piniak and Storlazzi (2008)
Montipora digitata (Dana, 1846)	1–30 mg/l SPM (hours)	Increased feeding capacity at high SPM concentrations	B	1.0	Anthony (1999a)
Montipora digitata (Dana, 1846)	>95% shading (transplanted into caves)	Survival/acclimation, reduced photosynthetic rate	L	1.0	Anthony and Hoegh-Guldberg (2003)
Montipora digitata (Dana, 1846)	70% light reduction (permanent transplantation)	Complete photoacclimation within 3 weeks	L	1.0	Anthony and Hoegh-Guldberg (2003)
Montipora verrucosa (Lamarck, 1816)	8 and 20 mg/l (modelling)	Reduced photosynthesis at 8 mg/l; negative energy balance at 20 mg/l	M/L	1.0	Te (1998)
Montipora sp.		Well adapted to turbid waters			Dikou and Van Woesik, (2006)
Mussa angulosa (Pallas, 1766)	Severe light reduction (shading) for 5 weeks	No visible effects (1 colony showing minor bleaching after 8 weeks)	M	40.0	Rogers (1979)
Pectinia lactuca (Pallas, 1766) (larvae)	6, 43 and 169 mg/l (lab test)	Adverse effects on fertilisation success and embryo development			Erftemeijer et al. (2012)
Pectinia sp.		Well adapted to turbid waters			Dikou and Van Woesik, (2006)
Phyllangia americana Milne Edwards & Haime, 1849	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival after 10 d, minor bleaching after 20 d	E	9.0	Rice and Hunter (1992)

Table 5 (*continued*)

Coral species	Turbidity level (tested)	Response	Growth form	Calyx (mm)	References
Platygyra daedalea (Ellis & Solander, 1786)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	M	5.0	Riegl and Branch (1995)
Pocillopora damicornis (Linnaeus, 1758)	1–30 mg/l SPM (hours)	Increased feeding capacity at high SPM concentrations	B	1.1	Anthony (1999a)
Pocillopora damicornis (Linnaeus, 1758)	1–30 mg/l SPM (days)	Increasing contribution of heterotrophy at high SPM conc.	B	1.1	Anthony (2000)
Pocillopora damicornis (Linnaeus, 1758) (larvae)	10, 100, 1000 mg/l (modelling)	Reverse metamorphosis (reduced settlement success) at 100 and 1000 mg/l	B	1.1	Te (1998)
Pocillopora damicornis (Linnaeus, 1758)		Characteristic of turbid waters	B	1.1	Dikou and Van Woesik, (2006)
Porites astreoides Lamarck, 1816	50–150–476 mg/l (96 h)	No effect at 50 and 150 mg/l; extreme sublethal stress (but survival) at 476 mg/l	M/E	1.5	Thompson (1980b)
Porites astreoides Lamarck, 1816	<1% SI (several days)	Bleaching and mortality	M/E	1.5	Bak (1978)
Porites astreoides Lamarck, 1816	1000 mg/l (for 65 h)	No mortality	M/E	1.5	Thompson and Bright (1980)
Porites cylindrica Dana, 1846	Shading (equivalent to 16 mg/l) – 2 months	Energy deficiency/C-loss not compensated by particle feeding; sublethal stress	M	1.5	Anthony and Fabricius (2000)
Porites cylindrica Dana, 1846	1–30 mg/l SPM (weeks)	Skeletal growth sustained, tissue biomass decreased at high SPM	M	1.5	Anthony and Fabricius (2000)
Porites cylindrica Dana, 1846	1–30 mg/l SPM (hours)	Increased feeding capacity at high SPM concentrations	M	1.5	Anthony (1999a)
Porites cylindrica Dana, 1846	1–16 mg/l suspended matter (8 weeks)	No effect on growth rates	M	1.5	Anthony (1999b)
Porites cylindrica Dana, 1846	Shading (equiv. 16 mg/l at 4 m) (8 weeks)	Significant reduction in growth rate	M	1.5	Anthony (1999b)
Porites divaricata Lesueur, 1821	50–150–476 mg/l (96 h)	No effect at 50 and 150 mg/l; extreme sublethal stress (but survival) at 476 mg/l	B	1.2	Thompson (1980b)
Porites divaricata Lesueur, 1821	1000 mg/l (for 65 h)	No mortality	B	1.2	Thompson and Bright (1980)
Porites furcata Lamarck, 1816	50–150–476 mg/l (96 h)	No effect at 50 and 150 mg/l; extreme sublethal stress (but survival) at 476 mg/l	B	2.0	Thompson (1980b)
Porites furcata Lamarck, 1816	1000 mg/l (for 65 h)	No mortality	B	2.0	Thompson and Bright (1980)
Porites lobata Dana, 1846		Dominant in turbid waters			Stafford-Smith (1993)
Porites lutea Milne Edwards & Haime, 1851		Dominant in turbid waters	M	1.5	Stafford-Smith (1993)
Porites lutea Milne Edwards & Haime, 1851	Increased turbidity up to 286 mg/l (4 months)	Partial mortality of 25% of colonies, recovery within 22 months	M	1.5	Brown et al. (1990)
Porites porites (Pallas, 1766)	Significant light reduction due to eutrophication	Reduced reproductive success (ova maturation, larval development)	M	2.0	Tomascik and Sander (1987)
Porites sp.	General increase in SPM	Decreasing tissue thickness from nearshore to offshore			Barnes and Lough (1992)
Porites sp.	General increase in SPM	Decreasing skeletal density, linear extension, increasing calcification			Lough and Barnes (1992, 2000)
Porites sp.		Well adapted to turbid waters			Dikou and Van Woesik, (2006)
Sarcophyton glaucum (Quoy & Gaimard, 1833)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	So		Riegl and Branch (1995)
Scolymia cubensis (Milne Edwards & Haime, 1849)	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival after 10 d, minor bleaching after 20 d	S	91.0	Rice and Hunter (1992)
Scolymia cubensis (Milne Edwards & Haime, 1849)	49–199 mg/l (10 days)	Partial polyp death and partial bleaching (in some indivduals)	S	91.0	Rice (1984)
Siderastrea radians (Pallas, 1766)	49–199 mg/l (10 days)	Partial polyp death and partial bleaching (in some indivduals)	M/E'	5.0	Rice (1984)
Siderastrea siderea (Ellis & Solander, 1786)	Severe light reduction (shading) for 5 weeks	Partial bleaching after 5 weeks, partial recovery in 6–8 weeks	M	3.0	Rogers (1979)
Sinularia dura (Pratt, 1903)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	So		Riegl and Branch (1995)
Sinularia leptoclados (Ehrenberg, 1834)	Light reduced to 50% and 25% PAR (surface)	Severely diminished productivity, increased carbon loss and mucus	So		Riegl and Branch (1995)
Solenastrea hyades (Dana, 1846)	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival after 10 d, minor bleaching after 20 d	M	5.0	Rice and Hunter (1992)
Solenastrea hyades (Dana, 1846)	49–199 mg/l (10 days)	Partial polyp death and partial bleaching (in some individuals)	M	5.0	Rice (1984)
Stephanocoenia intersepta (Lamarck, 1816)	49, 101, 165 and 199 mg/l (10–20 days)	No effect on growth rate or survival after 10 d, minor bleaching after 20 d	M	3.0	Rice and Hunter (1992)
Stephanocoenia intersepta (Lamarck, 1816)	49–199 mg/l (10 days)	Partial polyp death and partial bleaching (in some individuals)	M	3.0	Rice (1984)
Turbinaria mesenterina (Lamarck, 1816)		Tolerant to high turbidity	L	1.5	Quoted in Nieuwaal (2001)
Turbinaria reniformis Bernard, 1896		Tolerant to high turbidity	L	2.0	Quoted in Nieuwaal (2001)
Turbinaria spp.		Most tolerant to high turbidity and sedimentation			Stoddart and Stoddart (2005)

Table 6
Response matrix ranking the relative sensitivity of corals according to their type of response to different levels of turbidity (mg L^{-1}). Severe shading, total shading and <1%SI were categorised as >100 mg L^{-1}, NTU values were categorised as follows: 0–2 NTU:<10 mg L^{-1}, 7–9 NTU: 10–20 mg L^{-1}, 14–16 NTU: 20–40 mg L^{-1}, 28–30 NTU: 40–100 mg L^{-1}, >40 NTU: >100 mg L^{-1}.

Response category	Turbidity level (mg L^{-1}) tested				
	<10	10–20	20–40	40–100	>100
No effect	(most spp.)	Intermediate	Tolerant	Very tolerant	Very tolerant
Sublethal effects (minor) (reduced growth/calcification, mucus production etc.)	Sensitive	Sensitive	Intermediate	Tolerant	Very tolerant
Sublethal effects (major) (bleaching, tissue damage)	Very sensitive	Sensitive	Intermediate	Tolerant	Tolerant
Lethal effects (partial mortality)	Very sensitive	Very sensitive	Sensitive	Intermediate	Tolerant
Major lethal effects (mass mortality)	Very sensitive	Very sensitive	Sensitive	Intermediate	(most spp.)

could be classified as moderate to severe. Other studies, however, revealed how many coral species and reefs are capable of surviving sedimentation rates as high as 100 mg cm^{-2} d^{-1} for several days to weeks without any major negative effects, while some (nearshore) reefs naturally experience sedimentation rates well over 200 mg cm^{-2} d^{-1} (Table 7). Nearshore fringing reefs in the Great Barrier Reef region that are characterised by high and variable sedimentation rates, ranging from 2 to 900 mg cm^{-2} d^{-1} (short-term rates) with long-term means of 50–110 mg cm^{-2} d^{-1}, were found to harbour highly diverse coral growth with a mean coral cover of 40–60% (Ayling and Ayling, 1991). A few coral species, such as *Montastraea cavernosa* and *Astrangia poculata*, can tolerate sedimentation rates as high as 600–1380 mg cm^{-2} d^{-1} (Lasker, 1980; Peters and Pilson, 1985). This wide range demonstrates that different coral

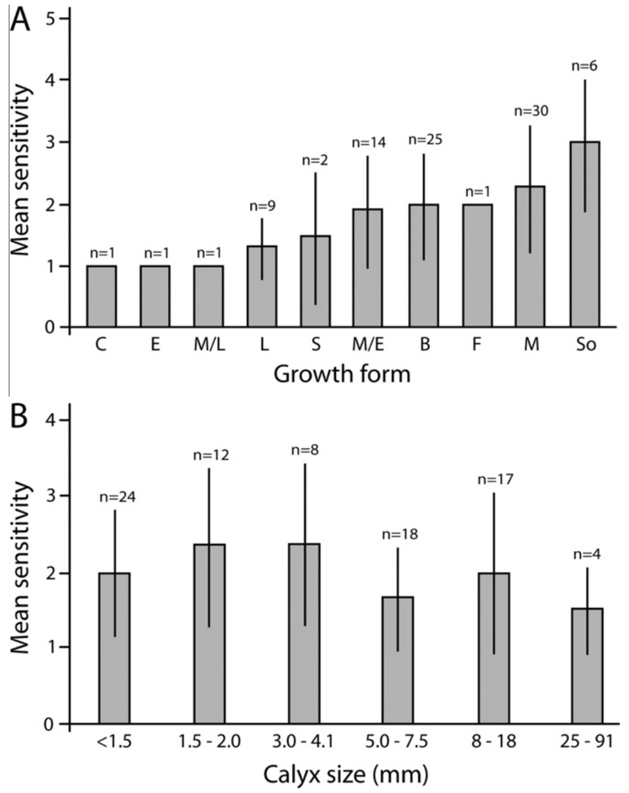

Fig. 5. Relationship between the sensitivity of corals to turbidity and [A] their growth form, and [B] their calyx size. Sensitivity (mean score ± SD) was determined by ranking corals according to their type of response to different levels of turbidity (see text and Table 6). Legend (growth forms): B = branching; C = columnar (incl. digitate); E = encrusting; F = foliaceous; L = laminar (incl. plate & tabular); M = massive; S = solitary (free-living); So = soft corals & gorgonians.

species and corals in different geographic regions may respond differently to increased amounts and rates of sedimentation.

Frequent short-term exposure to high sedimentation events or chronic (long-term) exposure to relatively high sedimentation rates results in increased mortality rates in populations of many coral species (Tomascik and Sander, 1985). If moderate levels of increased turbidity and sedimentation on a reef persist for particularly long periods of time (years or decades), the coral reef may undergo changes in diversity, with the most sensitive coral species (gradually) disappearing as can be seen on reefs in the proximity of big cities such as Singapore and Jakarta (Chou, 1988, 1996; Hoeksema and Koh, 2009; van der Meij et al., 2010; Hoeksema et al., 2011). These losses may also affect other species that depend on coral reefs, such as molluscs (van der Meij et al., 2009), especially if these live in close associations with specific coral hosts (Stella et al., 2011; Hoeksema et al., 2012). Such changes in species composition may cause (sometimes catastrophic) shifts in the coral reef ecosystem, resulting in a loss of ecological functions and ecosystem stability (Scheffer et al., 2001).

Stafford-Smith and Ormond (1992) summarised the conventional wisdom regarding sediment particle size and rejection, i.e. that silts and small particles are generally transported off the colony by ciliary currents whereas larger particles are moved by tissue expansion. Fine grain sizes flow off a colony more easily than coarse grains (Lasker, 1980) but nutrient-rich silts in calm waters can still be very stressful (Fabricius, 2005). Stafford-Smith and Ormond (1992) also explained the energetic costs of different sediment inputs, noting that sporadic downward fluxes of sediment are less costly than a continual light rain of particles. This is because short bursts of sediment leave accumulations in only a few colony areas, such as concave or flat surfaces, whereas a continual rain of particles affects a much larger expanse of tissue.

Some of the variation in sensitivity of corals to sedimentation reported in the literature may have been caused by differences in the particle size of sediments applied in the respective experiments, which calls for a more standardised approach in future experiments. Mud- and silt-sized sediments frequently have a more adverse impact than sand because of different physical and chemical properties (Thompson, 1980a,b; Weber et al., 2006; Piniak, 2007). Mud- and silt-sized sediments are more cohesive and colloidally bind nutrients better than sand. Therefore, a more active bacterial community is likely to develop in silt sheets causing damage to the corals. Ciliary action accompanies more or less all sediment-clearing activity, but is sensitive to grain size. Some of the fungiid corals and *Solenastrea hyades* appear to depend on ciliary action alone to rid the colony of fine sediment (Meyer, 1989). Tentacular action is especially effective for removing larger sediment particles. Surprisingly few coral species can use their tentacles to remove sediment, with *Porites porites* and *P. astreoides* being two notable exceptions (Meyer, 1989). Corals using ciliary action or mucus are more sensitive to continuous siltation. Some of these species simply quit their cleaning action after a short period of repeated sedimentation. A continuous rain of sediment

Table 7
Some published critical thresholds of coral reefs for sedimentation (mg cm^{-2} day^{-1}).

Species/type of corals	Location	mg cm^{-2} day^{-1}	References
Coral reefs	Worldwide (moderate to severe)	10	Pastorok and Bilyard (1985)
Coral reefs	Caribbean	10	Rogers (1990)
Coral reefs	Caribbean	37	Pastorok and Bilyard (1985)
Coral reefs	Worldwide (catastrophic)	50	Pastorok and Bilyard (1985)
Coral reefs	Puerto Rico	90	Miller and Cruise (1995)
Coral reefs	Indo-Pacific	228	Pastorok and Bilyard (1985)
Most coral species	Worldwide	300	Bak and Elgershuizen (1976)

temporarily exhausts both the mucus-secreting and ciliary drive for a period of one or two days. Recovery is possible only if siltation stops during the recovery period (Schuhmacher, 1977; Fortes, 2001).

Extreme sediment loads can lead to burial and eventual mortality (Rogers, 1983; Stafford-Smith, 1992). Wesseling et al. (1999) completely buried corals of the genera *Acropora, Porites, Galaxea* and *Heliopora* and found that, even after 68 h, all corals except *Acropora* eventually recovered. Rice and Hunter (1992) also determined that seven species near Florida were highly resistant to sediment burial. However, a heavy influx of sediment from a dredging operation resulted in complete or partial mortality in explanate colonies of *Porites astreoides* (Bak, 1978). Upland forest logging caused a nearly 100-fold increase in suspended sediment loads of Manlag River, resulting in prolonged sediment deposition at rates of 20 mg cm^{-2} d^{-1} in Bacuit Bay (Philippines), injuring and killing many of the ~50 coral species in the area, reducing species diversity, coral cover and average colony size (Hodgson, 1993; Birkeland, 1997; Hodgson and Dixon, 2000).

Heavy sedimentation is associated with fewer coral species, less live coral, lower coral growth rates, greater abundance of branching forms, reduced coral recruitment, decreased calcification, decreased net productivity of corals, and slower rates of reef accretion (Rogers, 1990). Tolerance of corals to high sediment loads varies considerably among species, with some corals being fairly resistant to low light levels and/or sedimentation effects (Rice and Hunter, 1992).

Field and laboratory experiments in Florida (USA) have shown that some of the most tolerant coral species in the Caribbean can survive complete burial with sediment for periods ranging from 7 to 15 days (Rice and Hunter, 1992) (Table 8). Burial with sediment of several Philippine corals caused sublethal effects (bleaching) and mortality within 20 to 68 h (Wesseling et al., 1999). Polyp inflation is an effective means of actively shedding sediment and corals with large inflation ratios are among the best sediment rejecters. Inflators are not only capable of (re)moving sediment continuously, but they also can endure siltation rates 5–10 times higher than regularly found on coral reefs. Many of these coral species are small forms, living attached or loose in sand bottoms, such as the Caribbean faviid *Manicina areolata* and the Pacific fungiid corals (Schuhmacher, 1977, 1979; Hoeksema, 1993; Johnson, 1992; Hubmann et al., 2002; Uhrin et al., 2005; Sorauf and Harries, 2010; Bongaerts et al., 2012).

A synthesis of literature data regarding sensitivity of different coral species to sedimentation is presented in Table 9. These data were reworked and related to a relative sensitivity index according to the response matrix presented in Table 10. Sensitivity classes

Table 8
Some examples of the duration coral species can survive very high sedimentation rates (burial).

Species	Survival characteristics	Reference
Porites sp.	90% Bleaching after 68 h burial, recovery within 4 weeks	Wesseling et al. (1999)
Acropora sp.	100% Mortality after 20 h burial, no recovery	Wesseling et al. (1999)
Galaxea sp.	Sublethal stress after 20–68 h burial, recovery within 3–4 weeks	Wesseling et al. (1999)
Heliopora coerule	Sublethal stress after 20–68 h burial, recovery within 3–4 weeks	Wesseling et al. (1999)
Scolomia cubensis	LT50 after 7 days (complete burial)	Rice and Hunter (1992)
Isophyllia sinuosa	LT50 after 7.2 days (complete burial)	Rice and Hunter (1992)
Manicina areolata	LT50 after 10 days (complete burial)	Rice and Hunter (1992)
Siderastrea radians	LT50 after 13.6 days (complete burial)	Rice and Hunter (1992)
Cladocora arbuscula	LT50 after 15 days (complete burial)	Rice and Hunter (1992)
Solenastrea hyades	LT50 after 15 days (complete burial)	Rice and Hunter (1992)
Stephanocoenia intersepta	LT50 after 16.2 days (complete burial)	Rice and Hunter (1992)

were then given scores from 1 to 5, with 1 corresponding to "very tolerant" and 5 to "very sensitive". The scores for individual coral species were subsequently related to their dominant growth form and mean calyx diameter. Analysis of these data (102 entries for 71 species) confirmed that there is a significant relationship (Kruskal–Wallis, $P < 0.05$) between the growth form of corals and their sensitivity to sedimentation (Fig. 6a). Free-living corals (such as mushroom corals), branching corals and many massive corals (especially with fleshy polyps) are quite tolerant to high rates of sedimentation, while laminar, plating and tabular corals as well as several soft corals are relatively sensitive. There was no significant relationship between the calyx diameter of corals and their sensitivity to sedimentation (Fig. 6b).

This relatively straightforward relationship (Figs. 5 and 6) can of course be complicated and altered by the interaction of several other factors such as active or passive sediment-clearing mechanisms, turbulence and exposure to wave action, colony orientation, morphological variability and adaptation within species, depth distribution, and the cumulative effects of extreme temperatures and salinities. However, despite some variability, complication by other factors and even some potential contradictions, it is clear from the overall findings that corals can indeed be roughly categorised according to their relative sensitivity to turbidity and sedimentation based on their growth form and morphology (Fig. 5 and 6).

6. Mitigating factors and potential for recovery

The sensitivity of corals to, and their ability to recover from, the impacts of dredging and related activities depends on a range of factors, including the ecological state or condition of the reef (e.g. degraded or pristine; dominated by algae, bio-eroders or reef-builders; level of fishing; and temperature anomalies), its resilience (species diversity; presence of keystone species; loss and replacement of keystone species; spatial heterogeneity; presence of refugia and connectivity to nearby unaffected reefs) and the

Table 9
Sensitivity of different coral species for sedimentation. Overview of the response of different species of corals to various sedimentation rates tested, as reported in the literature. Nomenclature of coral species was updated according to the most recent taxonomic revisions. Growth forms (as stated or inferred): B = branching; C = columnar (incl. digitate); E = encrusting; F = foliaceous; L = laminar (incl. plate & tabular); M = massive; S = solitary (free-living); So = soft corals & gorgonians. Calyx diameter taken from Stafford-Smith and Ormond (1992) supplemented with own measurements (BWH – Naturalis).

Coral species	Sedimentation rate (tested)	Response	Growth form	Calyx (mm)	References
Acropora cervicornis (Lamarck, 1816)	200 mg/m^2/d (daily for 45 days)	No effect (not even on growth rate) even after 45 days	B	1.0	Rogers (1979)
Acropora cervicornis (Lamarck, 1816)	200 mg cm^{-2} d^{-1} (daily)	No effect	B	1.0	Rogers (1990)
Acropora cervicornis (Lamarck, 1816)	430 mg cm^{-2} d^{-1} (>1 day)	Physiological stress	B	1.0	Bak and Elgershuizen (1976)
Acropora cervicornis (Lamarck, 1816)	Burial (10–12 cm of reef sand)	Sublethal stress within 12 h; 100% mortality within 72 h	B	1.0	Thompson (1980a)
Acropora formosa (Dana, 1846)	Up to 14.6 mg/m^2/d (fine silt) due to dredging	No effect on growth rate (in situ)	B	1.2	Chansang et al. (1992)
Acropora formosa (Dana, 1846)	200–300 mg cm^{-2} d^{-1} (up to 7 days)	Decreased growth	B	1.2	Simpson (1988)
Acropora millepora (Ehrenberg, 1834) (larvae)	0.5–325 mg cm^{-2} d^{-1} (2 days)	Reduction of larval settlement			Babcock (1991)
Acropora millepora (Ehrenberg, 1834)	83 mg cm^{-2} d^{-1} (up to 16 weeks)	Onset mortality after 4 weeks, full mortality after 12 weeks	B	1.0	Negri et al. (2009) and Flores et al. (2011)
Acropora palifera (Lamarck 1816)	Field site comparison (<1 versus 13.5 mg cm^{-2} d^{-1})	Reduced fecundity at site with higher sedimentation	L	2.0	Kojis and Quinn (1984)
Acropora palmata (Lamarck, 1816)	Up to 600 mg cm^{-2} d^{-1} (natural events)	Poor rejection ability; sediment accumulation	B	2.0	Abdel-Salam and Porter (1988)
Acropora palmata (Lamarck, 1816)	430 mg cm^{-2} d^{-1} (>1 day)	Physiological stress	B	2.0	Bak and Elgershuizen, 1976
Acropora palmata (Lamarck, 1816)	200 mg cm^{-2} d^{-1} (once)	Partial mortality	B	2.0	Rogers (1977)
Acropora palmata (Lamarck, 1816)	200 mg cm^{-2} d^{-1} (field application)	Death of underlying tissue	B	2.0	Rogers (1990)
Acropora palmata (Lamarck, 1816)	Burial (10–12 cm of reef sand)	100% mortality within 72 h	B	2.0	Thompson (1980a)
Acropora sp.	5 mg cm^{-2} d^{-1}	Massive mucus production (within 1 h), sublethal			Fabricius and Wolanski (2000)
Acropora sp.	Burial for 20 h	Mortality of all colonies			Wesseling et al. (1999)
Acropora spp.	39.6 mg cm^{-2} d^{-1} (for 2 weeks)	Partial bleaching (less affected)			Fabricius et al. (2007)
Agaricia agaricites (Linnaeus, 1758)	Heavy sedimentation event (>1 cm)	Reduced growth but survival	L	5.0	Bak (1978)
Agaricia agaricites (Linnaeus, 1758)	430 mg cm^{-2} d^{-1} (sand)	Mortality after 1 day	L	5.0	Bak and Elgershuizen (1976)
Agaricia agaricites (Linnaeus, 1758)	Burial (10–12 cm of reef sand)	60% Tissue loss within 24 h; 100% mortality after 72 h	L	5.0	Thompson (1980a)
Agaricia lamarcki Milne Edwards & Haime, 1851	140 mg/m^2/d (mean) for several weeks	Mass mortality (4 years after steep decline in growth)	L	8.0	van 't Hof (1983)
Agaricia sp.	30 mg/m^2/d (natural)	No effect; dominant species			Loya (1976)
Alveopora spp.		Can survive high sedimentation rates			Stafford-Smith and Ormond (1992)
Astrangia poculata (Ellis & Solander, 1786)	<600 mg cm^{-2} d^{-1}	Survival	S	6.0	Peters and Pilson (1985)
Catalaphyllia jardinei (Saville-Kent, 1893)		Survive high sedimentation rates	M	40.0	Stafford-Smith and Ormond (1992)
Cladocora arbuscula (Lesueur, 1812)	Complete burial	50% Survival after 15 days	B	4.0	Rice and Hunter (1992)
Ctenactis echinata (Pallas, 1766)	Continuously repeated burial (sand)	Tissue mortality and colony death after 24–72 h	S	200.0	Schuhmacher (1977)
Cycloseris costulata (Ortmann, 1889)	Continuously repeated burial (sand)	Survival (endurance with no apparent effect)	S	15.0	Schuhmacher (1977)
Cycloseris costulata (Ortmann, 1889)	40 mm3/cm^2/d	Maximum rate tolerated (field gradient)	S	15.0	Schuhmacher (1977)
Cycloseris distorta (Michelin, 1842)		Efficient sediment rejector (polyp inflation)	S	7.5	Schuhmacher (1977)
Cycloseris spp.		Can actively dig through overlying sediment			Stafford-Smith and Ormond (1992)
Danafungia horrida (Dana, 1846)	Continuously repeated burial (sand)	Tissue mortality and colony death after 24–72 h	S	215.0	Schuhmacher (1977)
Danafungia scruposa (Klunzinger, 1879)	Continuously repeated burial (sand)	Tissue mortality and colony death after 24–72 h	S	380.0	Schuhmacher (1977)
Dichocoenia stokesi Milne Edwards & Haime, 1848	430 mg cm^{-2} d^{-1} (sand + oil)	Mortality after 1 day	M	11.0	Bak and Elgershuizen (1976)
Diploastrea heliopora (Lamarck, 1816)	20 mg cm^{-2} d^{-1} (mixed sand)	Survival (4 months)	M	14.0	Todd et al. (2004a)
Diploria clivosa (Ellis & Solander, 1786)	Repeated application of 200 mg/cm^2	Extensive damage	M	9.0	Rogers (1983)
Diploria labyrinthiformis (Linnaeus, 1758)	High sedimentation rates (dredging)	Survival (no effect)	M	8.0	Dodge and Vaisnys (1977)
Diploria strigosa (Dana, 1846)	Up to 600 mg cm^{-2} d^{-1} (natural events)	High sediment clearing rate	M	8.0	Abdel-Salam and Porter (1988)
Diploria strigosa (Dana, 1846)	200 mg cm^{-2} d^{-1} (daily)	No effect	M	8.0	Rogers (1990)
Diploria strigosa (Dana, 1846)	High sedimentation rates (dredging)	Mass mortality (4 years after steep decline in growth)	M	8.0	Dodge and Vaisnys (1977)

Table 9 (*continued*)

Coral species	Sedimentation rate (tested)	Response	Growth form	Calyx (mm)	References
Diploria strigosa (Dana, 1846)	Burial (10–12 cm of reef sand)	Partial bleaching and sublethal stress within 24 h	M	8.0	Thompson (1980a)
Duncanopsammia axifuga (Milne Edwards & Haime, 1848)		Can survive high sedimentation rates	B	14.0	Stafford-Smith and Ormond (1992)
Echinopora spp.		Active sediment rejector			Stafford-Smith and Ormond (1992)
Echinopora mammiformis (Nemenzo, 1959)		Active sediment rejector	L	5.0	Stafford-Smith and Ormond (1992)
Euphyllia spp.		Can survive high sedimentation rates			Stafford-Smith and Ormond (1992)
Favia favus (Forskal, 1775)	200 mg cm^{-2} d^{-1} (6 weeks)	Minor tissue damage, mucus production, no bleaching	M	14.0	Riegl (1995) and Riegl and Bloomer (1995)
Favia speciosa (Dana, 1846)	20 mg cm^{-2} d^{-1} (mixed sand)	Survival (4 months)	M	12.0	Todd et al. (2004a)
Favia spp.	(0.9–1.3 mg/m^2/day)	Described as relatively 'sensitive' to sedimentation			McClanahan and Obura (1997)
Favia stelligera (Dana, 1846)	200 mg cm^{-2} d^{-1}	Mortality within 1–2 days	M	6.0	Stafford-Smith (1993)
Favites pentagona (Esper, 1794)	200 mg cm^{-2} d^{-1} (6 weeks)	Tissue damage, mucus production	M	7.0	Riegl (1995) and Riegl and Bloomer (1995)
Favites spp.	(between 1.3 and 4 mg cm^{-2} d^{-1}; not quoted)	tolerance to sedimentation described as 'intermediate'			McClanahan and Obura (1997)
Fungia fungites (Linnaeus, 1758)	Continuously repeated burial (sand)	Tissue mortality and colony death after 24–72 h	S	310.0	Schuhmacher (1977)
Fungia fungites (Linnaeus, 1758)	10 mm^3/cm^2/d	Maximum rate tolerated	S	310.0	Schuhmacher (1977)
Galaxea fascicularis (Linnaeus, 1767)	39.6 mg cm^{-2} d^{-1} (for 2 weeks)	Sublethal (sed.accum.), act.removal (polyp), recovery	M	8.0	Fabricius et al. (2007)
Galaxea fascicularis (Linnaeus, 1767)	Burial for 20 h	Tissue bleaching, recovery after 4 weeks	M	8.0	Wesseling et al. (1999)
Galaxea spp.	(4 mg/m^2/day)	Tolerance to sedimentation described as 'intermediate'			McClanahan and Obura (1997)
Gardineroseris planulata (Dana, 1846)	200 mg cm^{-2} d^{-1}	Partial mortality after 6 days	M	7.0	Stafford-Smith (1993)
Goniastrea retiformis (Lamarck, 1816)		Common on reefs affected by sedimentation	M	4.0	Brown and Howard (1985)
Goniopora lobata Milne Edwards & Haime, 1860		Active sediment rejector	c	4.0	Stafford-Smith and Ormond (1992)
Goniopora spp.		Survive high sedimentation rates			Stafford-Smith and Ormond (1992)
Gyrosmilia interrupta (Ehrenberg, 1834)	200 mg cm^{-2} d^{-1} (6 weeks)	Tissue damage, mucus production, no bleaching	M/E	16.0	Riegl (1995) and Riegl and Bloomer (1995)
Heliofungia actiniformis (Quoy & Gaimard, 1833)		Efficient sediment rejector (polyp inflation)	S	210.0	Schuhmacher (1977)
Heliopora coerulea (Pallas, 1766)	Burial for 20 h	Tissue bleaching, recovery after 4 weeks	B	0.8	Wesseling et al. (1999)
Heteropsammia cochlea (Spengler, 1783)		Obligate commensal sipunculid prevents burial	S	7.0	Stafford-Smith and Ormond (1992)
Hydnophora spp.	(4 mg/m^2/day)	Tolerance to sedimentation described as 'intermediate'			McClanahan and Obura (1997)
Isopora palifera (Lamarck, 1816)	10–15 mg cm^{-2} d^{-1}	50% Reduction in fecundity	C	2.0	Kojis and Quinn (1984)
Isophyllia sinuosa (Ellis & Solander, 1786)	Complete burial	50% Survival after 7.2 days	M	15.0	Rice and Hunter (1992)
Leptoria phrygia (Ellis & Solander, 1786)	25 mg cm^{-2} d^{-1}	Minor tissue damage within 3 weeks	M	4.1	Stafford-Smith (1992)
Leptoria phrygia (Ellis & Solander, 1786)	50–100 mg cm^{-2} d^{-1}	Major tissue damage and bleaching after 4 days	M	4.1	Stafford-Smith (1992)
Leptoria phrygia (Ellis & Solander, 1786)	100–200 mg cm^{-2} d^{-1}	Partial mortality and bleaching after 4 days	M	4.1	Stafford-Smith (1992)
Leptoria phrygia (Ellis & Solander, 1786)	>200 mg cm^{-2} d^{-1}	Mortality within 1–2 days	M	4.1	Stafford-Smith (1992, 1993)
Lobophytum depressum Tixier-Durivault, 1966	200 mg cm^{-2} d^{-1} (6 weeks)	Tissue damage, bleaching and partial mortality	So		Riegl (1995) and Riegl and Bloomer (1995)
Lobophytum venustum Tixier-Durivault, 1957	200 mg cm^{-2} d^{-1} (6 weeks)	Minor tissue damage and bleaching	So		Riegl (1995) and Riegl and Bloomer (1995)
Madracis auretenra Locke, Weil & Coates, 2007	Heavy sedimentation event (>1 cm)	Reduced growth but survival	B	1.0	Bak (1978)
Manicina areolata (Linneaus, 1758)	Complete burial	50% Survival after 10 days	M	23.0	Rice and Hunter (1992)
Meandrina meandrites (Linnaeus, 1758)		Produces copious amounts of mucus to remove silt	M	15.0	Dumas and Thomassin (1977)
Millepora spp.	(4 mg/m^2/day)	Tolerance to sedimentation described as 'intermediate'			McClanahan and Obura (1997)
Montastraea annularis (Ellis & Solander, 1786)		High sediment clearing rate	M/E	5.0	Abdel-Salam and Porter (1988)
Montastraea annularis (Ellis & Solander, 1786)	200 mg cm^{-2} d^{-1} (daily applications)	Tolerant for at least 38 days	L/E	5.0	Rogers (1979)
Montastraea annularis (Ellis & Solander, 1786)	400–800 mg cm^{-2} d^{-1} (single application)	Mortality	M	5.0	Rogers (1979)

(*continued on next page*)

Table 9 (*continued*)

Coral species	Sedimentation rate (tested)	Response	Growth form	Calyx (mm)	References
Montastraea annularis (Ellis & Solander, 1786)	19 mg cm^{-2} d^{-1} (permanent)	Reduced growth rate	M/E	5.0	Torres (1998)
Montastraea annularis (Ellis & Solander, 1786)	200 mg cm^{-2} d^{-1} (daily)	No effect	M/E	5.0	Rogers (1990)
Montastraea annularis (Ellis & Solander, 1786)	400 mg cm^{-2} d^{-1}	Temporary bleaching	M/E	5.0	Rogers (1990)
Montastraea annularis (Ellis & Solander, 1786)	800 mg cm^{-2} d^{-1}	Death of underlying tissue	M/E	5.0	Rogers (1990)
Montastraea annularis (Ellis & Solander, 1786)	800 mg cm^{-2} d^{-1} (single application)	Mortality	M/E	5.0	Rogers (1977)
Montastraea annularis (Ellis & Solander, 1786)	430 mg cm^{-2} d^{-1} (sand + oil)	Mortality after 1 day	L/M	5.0	Bak and Elgershuizen (1976)
Montastraea annularis (Ellis & Solander, 1786)	10 mg cm^{-2} d^{-1} (natural)	Reduced %cover	M	5.0	Torres and Morelock (2002)
Montastraea annularis (Ellis & Solander, 1786)	19 mg cm^{-2} d^{-1} (resuspended carbonate mud)	Reduced growth rate	M	5.0	Dodge et al. (1974)
Montastraea annularis (Ellis & Solander, 1786)	Burial (10–12 cm of reef sand)	40% Tissue loss within 24 h; 90% tissue loss within 72 h	M	5.0	Thompson (1980a)
Montastraea annularis (Ellis & Solander, 1786)		Produces little mucus; removes silt by by ciliary action	M	5.0	Dumas and Thomassin (1977)
Montastraea cavernosa (Linnaeus, 1767)	<1390 mg cm^{-2} d^{-1}	Survival	M	11.0	Lasker (1980)
Montastraea cavernosa (Linnaeus, 1767)	150 mg/m^2/d (natural)	Survival/dominance	M	11.0	Loya (1976)
Montastraea cavernosa (Linnaeus, 1767)	Burial (10–12 cm of reef sand)	30% Tissue loss after 72 h; remaining tissue in decay	M	11.0	Thompson (1980a)
Montipora aequituberculata Bernard, 1897	200 mg cm^{-2} d^{-1}	Bleaching after 6 days (but no mortality)	L	0.6	Stafford-Smith (1993)
Montipora aequituberculata Bernard, 1897	25 mg cm^{-2} d^{-1} (up to 16 weeks)	Onset mortality after 4 weeks, full mortality after 12 weeks	F	0.6	Negri et al. (2009) and Flores et al. (2011)
Montipora capitata Dana, 1846	Burial (2.2–2.8 g/cm^2 for 45 h)	sublethal effects after 30 h, little recovery after 90 h	B	2.0	Piniak (2007)
Montipora foliosa (Pallas, 1766)		Active sediment rejector	L	0.7	Stafford-Smith and Ormond (1992)
Montipora peltiformis Bernard, 1897	33–160 mg/cm^2 (silt) exposure for 36 h	Reduced photosynthesis within 12–60 h	F	1.0	Weber et al. (2006)
Montipora peltiformis Bernard, 1897	79–234 mg/cm2 (up to 36 h)	Signifcant decline in photosynthesis (quantum yield)	M/L	1.0	Philipp and Fabricius (2003)
Montipora spp.	(0.9–1.3 mg/m^2/day)	Described as 'sensitive' to sedimentation			McClanahan and Obura (1997)
Montipora verrucosa (Lamarck, 1816)	30 mg cm^{-2} d^{-1} (daily applications)	Survived (10 days of application)	M	1.5	Hodgson (1990a)
Mycetophyllia aliciae Wells, 1973	430 mg cm^{-2} d^{-1} (sand + oil)	Mortality after 1 day	L	14.0	Bak and Elgershuizen (1976)
Oxypora glabra Nemenzo, 1959	30 mg cm^{-2} d^{-1} (daily applications)	Total mortality within 10 days	L/E	5.0	Hodgson (1990a)
Pectinia lactuca (Pallas, 1766)		Active sediment rejector	L	18.0	Stafford-Smith and Ormond (1992)
Pectinia paeonia (Dana, 1846)		Active sediment rejector	L	15.0	Stafford-Smith and Ormond (1992)
Pectinia sp.		Active sediment rejector			Stafford-Smith and Ormond (1992)
Platygyra daedalea (Ellis & Solander, 1786)	200 mg cm^{-2} d^{-1} (6 weeks)	Minor tissue damage, mucus production, no bleaching	M	5.0	Riegl (1995) and Riegl and Bloomer (1995)
Platygyra sinensis (Milne Edwards & Haime, 1849)	Complete burial	Bleaching and tissue damage after 48 h	M	4.0	Wong (2001)
Platygyra spp.	(4 mg/m^2/day)	Tolerance to sedimentation described as 'intermediate'			McClanahan and Obura (1997)
Pleuractis granulosa (Klunzinger, 1879)	Continuously repeated burial (sand)	Survival (high endurance with no apparent effect)	S	185.0	Schuhmacher (1977)
Pleuractis granulosa (Klunzinger, 1879)	15 mm^3/cm^2/d	Maximum rate tolerated	S	185.0	Schuhmacher (1977)
Pleuractis moluccensis (Van der Horst, 1919)		Adapted to withstand considerable sedimentation rates	S	19.0	Schuhmacher (1977)
Pocillopora damicornis (Linnaeus, 1758)	50–95% sediment cover	Complete inhibition of larval settlement	B	1.0	Hodgson (1990b)
Pocillopora damicornis (Linnaeus, 1758)	67 and 186 mg cm^{-2} d^{-1} (fine silt; 83 days)	50–100% Mortality of transplanted fragments (esp. small)	B	1.0	Sakai et al. (1989)
Pocillopora damicornis (Linnaeus, 1758)	11–490 mg cm^{-2} d^{-1}ay (11 months)	Reduced growth rate of transplanted fragments	B	1.0	Piniak and Brown (2008)
Pocillopora meandrina Dana, 1846	30 mg cm^{-2} d^{-1} (daily applications)	Mortality within 10 days	B	1.0	Hodgson (1990a)
Pocillopora sp.	Increased sedimentation (dredging)	Considerable mortality			Hudson et al. (1982)

Table 9 (*continued*)

Coral species	Sedimentation rate (tested)	Response	Growth form	Calyx (mm)	References
Pocillopora spp.	(0.9–1.3 mg/m^2/day)	Described as 'sensitive' to sedimentation			McClanahan and Obura (1997)
Porites astreoides Lamarck, 1816	Heavy sedimentation event (>1 cm)	Mortality (inability to reject sediment)	L	1.5	Bak (1978)
Porites astreoides Lamarck, 1816		Abundant in heavly sedimented areas	M	1.5	Cortes and Risk (1985)
Porites astreoides Lamarck, 1816	430 mg cm^{-2} d^{-1} (sand)	Mortality after 1 day	M/E	1.5	Bak and Elgershuizen (1976)
Porites astreoides Lamarck, 1816	10 mg cm^{-2} d^{-1} (natural)	No effect	M/E	1.5	Torres and Morelock (2002)
Porites astreoides Lamarck, 1816	Burial (10–12 cm of reef sand)	Bleaching within 24 h; 70% tissue loss after 72 h	M/E	1.5	Thompson (1980a)
Porites lobata Dana, 1846	30 mg cm^{-2} d^{-1} (daily applications)	Mortality within 10 days	M	1.5	Hodgson (1990a)
Porites lobata Dana, 1846	Burial (1.5–1.6 g/cm^2 for 45 h)	Sublethal effects after 30 h, little recovery after 90 h	M	1.5	Piniak (2007)
Porites lobata Dana, 1846	200 mg cm^{-2} d^{-1}	Bleaching after 6 days (but no mortality)	M	1.5	Stafford-Smith (1993)
Porites lobata Dana, 1846	Complete burial (48 h)	Bleaching; complete recovery after sediment removal	M	1.5	Yeung (2000)
Porites lutea Milne Edwards & Haime, 1851	200 mg cm^{-2} d^{-1}	Bleaching after 6 days (but no mortality)	M	1.5	Stafford-Smith (1993)
Porites lutea Milne Edwards & Haime, 1851		Common on reefs affected by sedimentation	M	1.5	Brown and Howard (1985)
Porites lutea Milne Edwards & Haime, 1851	Increased sedimentation (dredging)	Survival	M	1.5	Hudson et al. (1982)
Porites lutea Milne Edwards & Haime, 1851	Up to 14.6 mg/m^2/d (fine silt) due to dredging	No effect on growth rate (in situ)	M	1.5	Chansang et al. (1992)
Porites porites (Pallas, 1766)		Uses tentacles to remove larger sediment particles	M	2.0	Meyer (1989)
Porites porites (Pallas, 1766) *forma* furcata	Burial (10–12 cm of reef sand)	90% bleaching within 24 h; 70% tissue loss after 72 h	B	2.0	Thompson (1980a)
Porites rus (Forskal, 1775)	39.6 mg cm^{-2} d^{-1} (for 2 weeks)	Massive mortality (anoxia)	M	0.5	Fabricius et al. (2007)
Porites sp.		Persists in areas of heavy sedimentation			Fabricius (2005)
Porites sp.	Burial for 6 h	No effect			Wesseling et al. (1999)
Porites sp.	Burial for 20 h	Discoloration & bleaching after 3 weeks			Wesseling et al. (1999)
Porites sp.	39.6 mg cm^{-2} d^{-1} (for 2 weeks)	Mucus production, survival (most tolerant)			Fabricius et al. (2007)
Porites spp.	(between 1.3 and 4 mg cm^{-2} d^{-1}; not quoted)	Tolerance to sedimentation described as 'intermediate'			McClanahan and Obura (1997)
Sarcophyton glaucum (Quoy & Gaimard, 1833)	200 mg cm^{-2} d^{-1}	Tissue damage and partial mortality within 6 weeks	So		Riegl (1995)
Scolymia cubensis (Milne Edwards & Haime, 1849)	Complete burial	50% Survival after 7 days	S	75.0	Rice and Hunter (1992)
Scolymia cubensis (Milne Edwards & Haime, 1849)	3 g of 3 grain-sizes: 62 µm, 250 µm, 2 mm (24 h)	Sediment-shedding efficiency related to calical angle	S	75.0	Logan (1988)
Siderastrea radians (Pallas, 1766)	Complete burial	50% Survival after 13.6 days	M/E	5.0	Rice and Hunter (1992)
Siderastrea radians (Pallas, 1766)	Total burial	Survival for more than 73 h	M/E	5.0	Mayer (1918)
Siderastrea radians (Pallas, 1766)	Burial (chronic)	Reduced growth and some mortality	M/E	5.0	Lirman et al. (2003)
Siderastrea siderea (Ellis & Solander, 1786)	10 mg cm^{-2} d^{-1} (natural)	No effect	M	3.0	Torres and Morelock (2002)
Siderastrea siderea (Ellis & Solander, 1786)	0.3–64 mg cm^{-2} d^{-1}	Partial mortality	M	3.0	Nugues and Roberts (2003)
Siderastrea siderea (Ellis & Solander, 1786)	Burial (10–12 cm of reef sand)	50% Bleaching and sublethal stress within 24 h	M	3.0	Thompson (1980a)
Sinularia dura (Pratt, 1903)	200 mg cm^{-2} d^{-1} (6 weeks)	Minor tissue damage and bleaching	So		Riegl (1995) and Riegl and Bloomer (1995)
Sinularia leptoclados (Ehrenberg, 1834)	200 mg cm^{-2} d^{-1} (6 weeks)	Minor tissue damage and bleaching	So		Riegl (1995), Riegl and Bloomer (1995)
Solenastrea hyades (Dana, 1846)	Complete burial	50% Survival after >15 days	M	5.0	Rice and Hunter (1992)
Stephanocoenia iniersepta (Lamarck, 1816)	Complete burial	50% Survival after 16.2 days	M	3.0	Rice and Hunter (1992)
Trachyphyllia geoffroyi (Audouin, 1826)		Actively dig through overlying sediment	S	45.0	Stafford-Smith and Ormond (1992)
Turbinaria mesenterina	110 mg/cm^2 (5 weeks)	No significant sublethal physiological effects	L	1.5	Sofonia and Anthony (2008)
Turbinaria (several spp.)		Active sediment rejector			Stafford-Smith and Ormond (1992)

typical ambient conditions experienced by the reef (McClanahan et al., 2002; Marshall and Schuttenberg, 2006). Reefs with effective management that minimises anthropogenic stresses are likely to have higher resilience than reefs that are already experiencing multiple stressors (West and Salm, 2003). Cumulative effects from or on related (adjacent) ecosystems such as mangroves and seagrass meadows (including effects from maintenance dredging cycles) may also have indirect consequences for the coral reef

Table 10
Response matrix ranking the relative sensitivity of corals according to their type of response to different rates of sedimentation.

Response category	Sedimentation rate (mg cm^{-2} d^{-1}) tested:				
	<10	10–50	50–200	>200	Complete burial
No effect	(most spp.)	Intermediate	Tolerant	Very tolerant	Very tolerant
Sublethal effects (minor)	Sensitive	Intermediate	Tolerant	Very tolerant	Very tolerant
Sublethal effects (major) (bleaching, tissue damage)	Sensitive	Sensitive	Intermediate	Tolerant	Tolerant
Lethal effects (partial mortality)	Very sensitive	Sensitive	Intermediate	Tolerant	Tolerant
Major lethal effects (mass mortality)	Very sensitive	Very sensitive	Sensitive	(most spp.)	(most spp.)

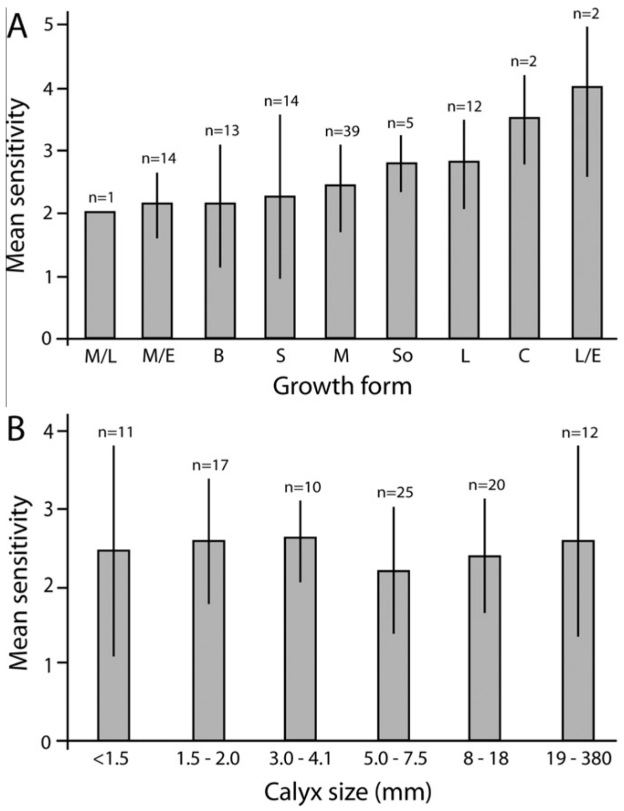

Fig. 6. Relationship between the sensitivity of corals to sedimentation and [A] their growth form, and [B] their calyx size. Sensitivity (mean score ± SD) was determined by ranking corals according to their type of response to different rates of sedimentation (see text and Table 10). Legend (growth forms): B = branching; C = columnar (incl. digitate); E = encrusting; L = laminar (incl. plate & tabular); M = massive; S = solitary (free-living); So = soft corals & gorgonians.

ecosystem. This is particularly so for ecological processes, functions and reef species that have important inter-linkages with mangrove and seagrass systems (Hemminga et al., 1994; Adams et al., 2006; Pollux et al., 2007). The timing of the dredging and construction activities may also affect the severity of impact, depending on the degree of seasonality and day–night cycles characterising the particular reef. Impacts during, or shortly prior to and after spawning events are of particular concern, since not only adult organisms may be negatively affected, but recruitment for the entire season may be jeopardised.

While sedimentation certainly is a major stressor that can lead to significant coral mortality, strong, isolated sediment pulses need not necessarily kill a reef. Many reefs, and certainly corals in most settings, can indeed survive repeated, even severe, sediment input (Browne et al., 2010). One of the most important factors mitigating against permanent damage is strong water motion, either by surge or by currents, that serves to re-suspend and remove the sediment from the corals (Stafford-Smith and Ormond, 1992; Riegl, 1995; Riegl et al., 1996; Schleyer and Celliers, 2003). As long as the coral's surface is free from sediment, regeneration is relatively easily achieved, even if damage occurred. A continuous cover of sediment on corals may lead to beginning tissue necrosis within 24 h in sensitive coral species, while in tolerant species there may still be no signs of necrosis after 14 days (Table 8). This process is particularly readily observed in soft corals. Once the sediment has been removed, however, even if tissue necroses have occurred, regeneration can take place in the space of only a few weeks (Meesters et al., 1992). Strong currents can aide passive sediment-clearing. Purely oscillating currents or surge, while temporarily cleaning colonies, may not help overall since sediments will build up around the corals and eventually smother them.

Provided that environmental conditions return to the pre-impact situation and that these conditions are not hampering recovery, time-scales for natural recovery of coral reefs are in the order of a few years to several decades, depending on the degree of damage, types of species affected, and possibilities for recruitment (Pearson, 1981; Moberg and Rönnbäck, 2003). Recovery of corals from sublethal stress can be rapid (weeks to months), while recovery from partial mortality takes several years. Reef recovery from mass mortality is generally slow and may take many years to decades, while in some cases recovery has not occurred at all. Few examples of recovery of coral reefs after severe sediment damage have been documented. Increased sedimentation is sometimes accompanied by other stresses, prolonging or inhibiting recovery, making it difficult to generalise or make predictions about recovery (Rogers, 1990). Of 65 examples for which sufficient data exist to make a judgment, coral cover recovered in 69% of cases after acute, short-term disturbances, but only in 27% of cases after chronic, long-term disturbance (Connell, 1997).

Wesseling et al. (1999) noted that the recovery time of corals following experimental short-term burial varied among coral species, ranging from several weeks to months, and also depended on the duration of the sedimentation event. In larger massive corals, sediment burial may cause bleaching and damaged patches, which—if larger than about 2 cm in diameter—do not recover, but will be colonised by algae or sponges preventing recovery of the coral (Hodgson, 1994). Brown et al. (1990) reported a 30% reduction in living coral cover 1 year after the start of dredging operations at Phuket (Thailand). After the dredging event had ceased, the reef recovered rapidly with coral cover values and diversity indices restored to former levels around 22 months after dredging began. The domination of this reef by massive coral species, which are physiologically adapted to intertidal living and which display partial rather than total colony mortality, may have contributed to its apparent resilience (Brown et al., 2002). Maragos (1972) estimated that 80% of the coral communities in the lagoon of Kaneohe Bay (Hawaii) died because of a combination of dredging, increased sedimentation and sewage discharge. Six years after discharge of sewage into Kaneohe Bay ceased, a dramatic recovery of corals and a decrease in the growth of smothering algae was reported (Maragos et al., 1985).

Coastal coral reefs adjacent to population centers often do not recover from disturbances, in contrast to remote reefs in relatively pristine environments, because chronic human influences have degraded water and substratum quality, thereby inhibiting recovery (McCook, 1999a; Wolanski et al., 2004). In the Seychelles, where corals had to recover from an intense bleaching event, *Acropora* species—usually the first to rapidly colonise new empty spaces—recovered substantially more slowly due to recruitment limitation, because these species were virtually eliminated throughout almost the entire Indian Ocean (Goreau, 1998). As a result, these species will not be able to re-establish themselves for many years or even decades. Poor water quality and excessive algal growth in some areas hampered recovery even when coral larvae were available (Goreau, 1998).

7. Management of dredging operations near coral reefs

For an overview of best practices for the management of dredging operations near coral reefs, reference is made to the recent PIANC report No. 108 (PIANC, 2010). Setting realistic and ecologically meaningful thresholds for model interrogation, as permit conditions to dredging contractors and for use as triggers in a reactive monitoring and management program, can be a challenge in coral reef environments. One of the problems encountered when trying to determine realistic thresholds for dredging near coral reefs includes a lack of knowledge, since only 10% of coral species has ever been studied with respect to their response to sediment disturbance. There is still a rather poor understanding of the relationship between sediment stress and the response of most corals. While meaningful sets of thresholds or criteria would ideally have to incorporate the intensity, duration and frequency of turbidity (or sedimentation) events generated by the dredging activities, actual values are difficult to determine with confidence and at present remain little more than estimates.

In some cases, uncertainties in model predictions of dredging plumes and a conservative approach by regulators applying the precautionary principle may have led to overestimation of impacts of dredging operations on corals while field monitoring suggested less coral mortality than predicted (Hanley, 2011). In other cases, the opposite situation may have led to unnecessary and avoidable damage on coral reefs. To prevent coral mortality, there is clearly a need for reliable sublethal coral health indicators as early warning for stress but the science for this is still in its infancy (Jameson et al., 1998; Vargas-Angel et al., 2006; Cooper and Fabricius, 2007; Cooper et al., 2009). Such bio-indicators, some of which can show remarkable temporal dynamics in response to variations in water quality (Cooper et al., 2008), require on-site validation before use in monitoring programs (Fichez et al., 2005).

Recently, some significant advances have been made in establishing reactive (feedback) monitoring programs that have proven a meaningful tool for minimising coral mortality during large-scale dredging operations in Singapore and Australia (Koskela et al., 2002; Doorn-Groen, 2007; Sofonia and Unsworth, 2010). The design of such monitoring programs should guarantee sufficient statistical power to detect a required effect size, which can be as much a challenge as the availability of suitable reference sites. Seasonal restrictions during mass coral spawning are sometimes placed on dredging programs, but the effectiveness of such mitigating measures on long-term coral reef resilience is not well understood. Given the wide variation in sensitivity among coral species, meaningful criteria to limit the extent and turbidity of dredging plumes and their effects on corals will always require site-specific evaluations. We emphasise the importance of taking into account the species assemblage present at any given site and understanding the dynamics of local ambient background conditions, including spatial and temporal variability of turbidity and sedimentation, before setting thresholds in any dredging operation near coral reefs. A combination of reactive (feedback) monitoring of water quality and coral health during dredging activities and spill-budget modelling of dredging plumes to guide decisions on when to modify (or even stop) dredging appears to be the most promising approach to effectively minimise negative impacts on corals and coral reefs.

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Annex 848

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Extraordinary diversity of reef corals in the South China Sea

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Abstract The South China Sea in the Central Indo-Pacific is a large marine region that spans an area of more than 3 million km^2 bounded by the coastlines of ten Asian nation states and contains numerous small islands. Although it abuts the western border of the Coral Triangle, the designated centre of maximum marine biodiversity, the South China Sea has received much less scientific and conservation attention. In particular, a consolidated estimate of the region's scleractinian reef coral diversity has yet to emerge. To address this issue, we assemble a comprehensive species distribution data set that comprises 16 reef areas spread across the entire South China Sea. Despite containing less than 17 % of the reef area as compared to the Coral Triangle, this region hosts 571 known species of reef corals, a richness that is comparable to the Coral Triangle's based on a standardised nomenclatural scheme. Similarity profile analysis and non-metric multidimensional scaling demonstrate that most areas are compositionally distinct from one another and are structured according

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to latitude but not longitude. More broadly, this study underscores the remarkable and unexpected diversity of reef corals in the South China Sea.

Keywords Coral reefs · Coral Triangle · Indo-Pacific · Latitudinal gradient · Scleractinia · Species richness

Introduction

The South China Sea (SCS) is a region in the Central Indo-Pacific marine realm (Spalding et al. 2007) covering an area of more than 3 million km^2 (Morton and Blackmore 2001; UNEP 2004). Its southwestern sector is situated on the shallow Sunda Shelf, while the central and northeastern areas consist of a deep basin reaching just over 5 km below sea level (Morton and Blackmore 2001; Xu and Malanotte-Rizzoli 2013). The coastlines of the surrounding major land masses and over 200 small islands within it (Ng and Tan 2000) provide suitable conditions for the growth and development of coral reefs (UNEP 2004). These include features such as Reed Bank, an extensive 100-km long barrier reef reaching 20 m below the surface that runs parallel to the Philippine island of Palawan (Taylor and Hayes 1983).

Many of the coral reefs fringing the major land masses are threatened by coastal development and overexploitation (McManus 1997; Kimura et al. 2008; Tun et al. 2008; Burke et al. 2011), while those of less inhabited island clusters such as the Spratly and Paracel islands are probably under less threat (but see McManus 1994; McManus and Meñez 1997). Initiatives are underway to protect healthy reefs and restore degraded ones (Pitcher et al. 2000; Aliño 2001; Ablan et al. 2002; Chou et al. 2009; Pernetta 2009; McManus et al. 2010; Vo et al. 2013), but thorough understanding of species richness patterns is an imperative for solving this biodiversity crisis. In recent years, the SCS has been receiving less conservation attention than the adjacent Coral Triangle (Clifton 2009; Burke et al. 2012; Napitupulu et al. 2012), mainly because spatial analyses generally show the latter to contain the world's highest numbers of reef corals, fishes and several other taxa (Allen and Werner 2002; Carpenter and Springer 2005; Hoeksema 2007; Allen 2008; Veron et al. 2009; Sanciangco et al. 2013). Not surprisingly, reef areas in the eastern SCS that are also part of the Coral Triangle, such as El Nido, have been on high priority for conservation action (Hodgson and Dixon 2000; Flower et al. 2013).

Many hurdles stand in the way of accurate diversity estimates for the SCS, including its areal vastness, its span of ten nation states, as well as overlapping territorial claims and conflicts (McManus 1994; Djalal 2000; Ng and Tan 2000; Talaue-McManus 2000; Morton and Blackmore 2001). Nevertheless, biodiversity studies have been carried out for many marine groups, including annelids (Paxton and Chou 2000), molluscs (Norman and Lu 2000; Sachidhanandam et al. 2000; Tan 2000), crustaceans (Jones et al. 2000; Komai 2000; Lowry 2000; Moosa 2000; Rahayu 2000), echinoderms (Lane et al. 2000), sponges (Hooper et al. 2000) and fish (Randall and Lim 2000), most of which document considerable proportions of global richness. For example, over 3,000 species of fish are known from the SCS (Randall and Lim 2000), a richness comparable to that of the Coral Triangle, estimated to be 3,000–4,000 (Burke et al. 2012).

Surprisingly, the diversity of scleractinian reef corals across the entire SCS is, as yet, unknown. UNEP (2004) estimates that the SCS supports about 20 % of Southeast Asia's reefs and more than half of its coral species. Species richness is reported to vary widely, from 12 to 351, across 50 locations with hotspots at Nha Trang (Vietnam) and El Nido (Palawan). Unfortunately, the UNEP report does not provide any species-level inventories for further analysis. The Coral Geographic database contributed by Veron et al. (2009, 2011) provides species records for the offshore reefs of the South China Sea ecoregion, and separately for the Gulf of Thailand, southern Vietnam, northern Vietnam, Hainan, Hong Kong and Taiwan, totalling 487 species. However, these do not take into account records from the southwestern and Philippines sectors of the SCS as well as numerous studies at the local scale (Table 1). As a result, the actual coral diversity of this region remains unclear.

These are exciting times for coral biodiversity research. Modern developments in phylogenetics have led to a multitude of taxonomic revisions, in many instances based on specimens collected from the SCS (Fukami et al. 2008; Huang et al. 2009a, 2011a, 2014; Stefani et al. 2011; Lin et al. 2011, 2012a, b; Benzoni et al. 2012a, 2014; Pichon et al. 2012; Keshavmurthy et al. 2013). New species are also being discovered (e.g., Latypov 2006; Hoeksema 2009, 2014; Licuanan and Aliño 2009; Benzoni et al. 2014) and new distribution records documented (e.g., Hoeksema 2009; Hoeksema and Koh 2009; Hoeksema et al. 2010). This study takes advantage of these developments by reviewing coral species records associated with various areas within the SCS (from published and grey literature), incorporating newly described species, and assembling a distributional data set based on current taxonomy. Such an approach can yield critical insights on biogeography and conservation, particularly for regions that until recently have been understudied for corals (e.g., Pichon 2007; Pichon and Benzoni 2007; Wafar et al. 2011; Obura 2012a, b). Therefore, we expect the data and analyses to further our understanding of the biodiversity in this large marine region.

Materials and methods

We consolidated species records of scleractinian reef corals from literature for various areas in the SCS (Table 1).

Table 1 South China Sea reef areas examined in this study

Code	Area	Richness	Sources
SG	Singapore	255	Huang et al. 2009b
MY	West Malaysia (Middle Rocks and eastern Peninsular Malaysia)	398	Harborne et al. 2000; Fenner 2001; Harding et al. 2003; Affendi et al. 2005, 2007; Yusuf and Affendi 2009; Affendi and Rosman 2012
TH	Thailand	264	Srithunya et al. 1981; Jiravat 1985; Sakai et al. 1986; Chou et al. 1991; Yeemin et al. 1994; Yeemin 2001, 2002, 2003; Putchim et al. 2002; Chankong 2006; Saenghaisuk and Yeemin 2009; Kongjandtre et al. 2010, 2012; Hoeksema et al. 2012; Wallace et al. 2012b
VN1	southwestern Vietnam	251	Latypov 1986, 2006, 2011; Vo and Hodgson 1997
VN2	southern Vietnam	398	Vo and Hodgson 1997; Vo and Phan 1997; Vo 1998; Vo et al. 2004; 1 Latypov 2006, 2011, 2012, 2013; Hoeksema et al. 2010; Phan 2012
VN3	central Vietnam	252	Vo and Hodgson 1997; Latypov 2006, 2011; Phan and Vo 2010; Vo and Nguyen 2010
VN4	northern Vietnam	176	Vo and Hodgson 1997; Latypov 2006, 2011
PA	Paracel Islands (Paracel Islands and Macclesfield Bank)	201	Wells 1935; Hoeksema 1989; Huang et al. 2006, 2011b; Shen et al. 2013
CN1	southern China (Weizhou, northwest Hainan, Sanya and Xuwen)	102	Huang et al. 2009c, 2011c, 2012b; Chen et al. 2010
CN2	southeastern China (Wanshan Islands, Hong Kong and Dongshan)	95	Ang et al. 2003; Huang et al. 2012a, c
BN	Brunei	391	Turak and DeVantier 2011
SA	western Sabah (Labuan, Pulau Tiga and Kota Kinabalu)	248	Nyanti and Johnston 1992; Waheed et al. 2012; Hoeksema 2014; Awang and Chan 2014; Waheed and Hoeksema 2014
SP	Spratly Islands	333	Dai and Fan 1996; Nguyen and Dang 2008; Latypov 2011; Huang et al. 2012d
PL	northern Palawan (El Nido)	398	Turak and DeVantier 2010
LZ	western Luzon (Batangas, Bolinao and Anda)	433	Licuanan 2009; DeVantier LM and Turak E, unpublished data
TW	Taiwan (Taiwan and Pratas Islands)	316	Dai 1991; Chen 1999; Li et al. 2000; Dai and Horng 2009a, b

Supraspecific taxonomy was based primarily on the species concepts of Veron (2000), with recent updates by Wallace et al. (2007), Dai and Horng (2009a, b), Licuanan (2009), Gittenberger et al. (2011), Benzoni et al. (2012a, b), Budd et al. (2012) and Huang et al. (2014). Species records were also standardised according to the synonymies defined by various workers (Yabe and Sugiyama 1932; Scheer and Pillai 1974; Veron et al. 1977; Veron and Pichon 1976, 1980, 1982; Veron and Wallace 1984; Sheppard 1987; Hoeksema 1989; Veron and Hodgson 1989; Wallace 1999; Veron 2000, 2002; Ditlev 2003; Dai and Horng 2009b; Benzoni et al. 2010; Arrigoni et al. 2012; Wallace et al. 2012a). The full data set and detailed list of synonyms are available as a supplementary Online Resource.

To explore the structure of reef coral diversity in the SCS, we first carried out a similarity profile analysis (SIMPROF; Clarke et al. 2008) on the presence/absence data. On the basis of the Bray-Curtis similarity index (Bray and Curtis 1957) computed among sites, we used the R package *clustsig* (Whitaker and Christman 2010) to generate 1,000 expected and simulated profiles each to test for the number of hierarchical clusters linking all the areas. No a priori groups were assumed.

Non-metric multidimensional scaling (NMDS; Kruskal 1964a, b; Minchin 1987) was then performed using the Bray-Curtis distances, allowing up to 10,000 random starts to find stable solutions. This was separately done in two and three dimensions. We also investigated the role of geographic location in structuring species distribution by fitting the areas' mid-point latitude and longitude as vectors onto the NMDS plots. Significance of the vectors was assessed using 10,000 random permutations. Ordination analyses were carried out in the R package *vegan* (Oksanen et al. 2013).

Finally, we computed sea surface and reef areas that are encompassed by the SCS and the adjacent (and marginally overlapping) Coral Triangle using base data published by Burke et al. (2011), in which reef locations were compiled as gridded data at a resolution of 500 m. Map projection was carried out following the original study—cylindrical equal-area projection by Lambert (1772) with central meridian at 160°W.

Results

The data set assembled here spans the entire geographic range of the SCS, from the lowest latitude reefs of Singapore to the northern and easternmost communities of Dongshan (southeastern China) and Taiwan (Fig. 1). Species records cover

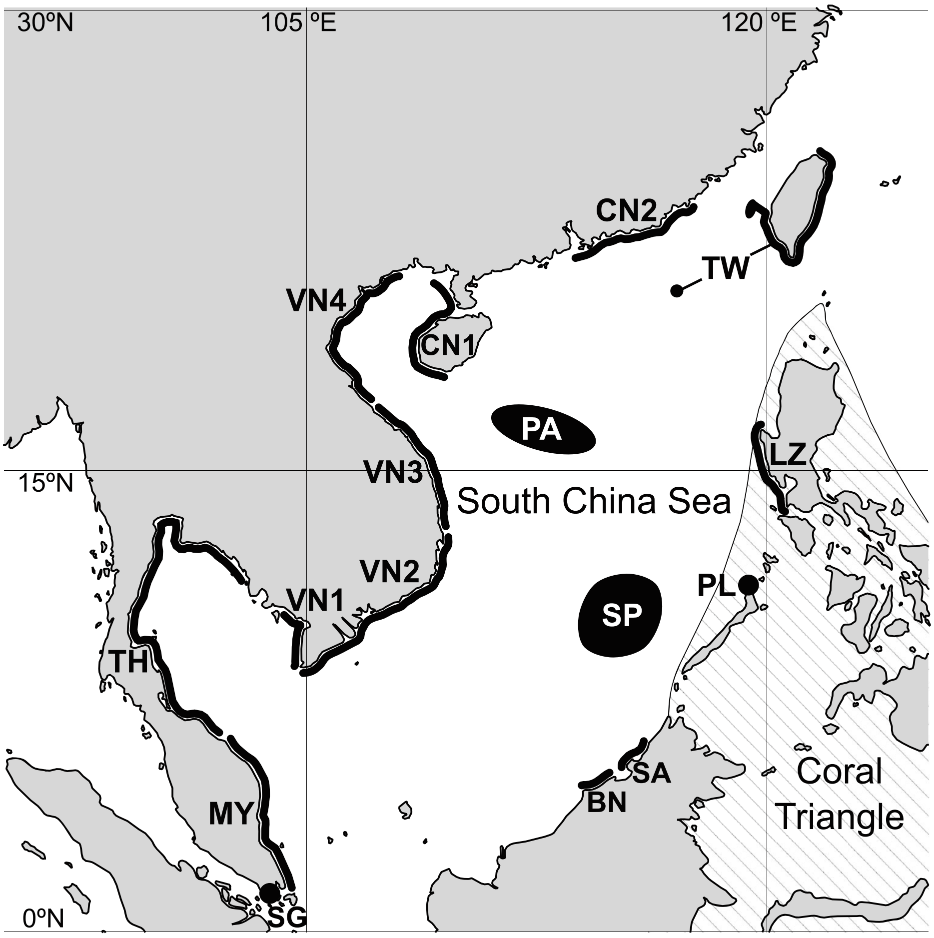

Fig. 1 Map of the South China Sea and part of the Coral Triangle, showing reef areas examined in this study as defined in Table 1

most of the western continental coast, but data are more patchy on the east side, comprising the northwest coast of Borneo and western shores of the Philippine islands. Notable gaps in species-level information include the coasts of Cambodia with a short coastline (~70 species according to Spalding et al. 2001), Sarawak with many large river outlets, southern Palawan, and northwestern Luzon.

The total number of reef coral species recorded in all of the areas is 571. Richness ranges from 95 at southeastern China, one of the northernmost areas, to 433 species in western Luzon (Table 1). Areas on the southeast Asian continent typically harbour moderate to high species counts (251–398 species) up to 17°N latitude (central Vietnam). From there, richness attenuates sharply northwards; pooling of all the Chinese mainland sites only results in 151 species. To the east, diversity remains moderate to high (≥ 248 species) in Brunei, western Sabah, Philippines, and even Taiwan (including Pratas Islands to its southwest). Note that data from Taiwan encompass records from the northeastern part of the main island, which is more often considered as part of the East China Sea. Nevertheless, they are included in this study, as its species composition closely resembles that of Penghu Islands in the Taiwan Strait (Chen 1999).

Because the richness gradient is inevitably influenced by the varying spatial scales of the examined areas, we focus on the similarity profile and ordination analyses to provide a more unbiased interpretation of the distributional patterns.

The SIMPROF analysis reveals 11 significantly distinct groups ($p<0.05$) from the 16 reef areas analysed (Fig. 2a). Only four groups form significant clusters ($p=1$); the Chinese pair of areas (CN1 and CN2) are spatially adjacent to each other, but not the southwest-central Vietnam (VN1 and VN3) and southern Vietnam-Spratlys (VN2 and SP) clusters. The Philippine pair of areas (PL and LZ) are grouped with Brunei (BN). Despite the distinctiveness among most reef areas, two general clusters at similarity index of ~40 have been recovered—the two Chinese areas, and all other areas. The species-poor, non-reef-building communities fringing the coastline of southern and southeastern China (Morton and Blackmore 2001) are characterised by a large proportion of generally massive species in the families Lobophylliidae, Merulinidae and Poritidae (46.4 % vs. 36.3 % for the entire SCS) with far fewer *Acropora* spp. (11.9 % vs. 17.2 % for the entire SCS)—

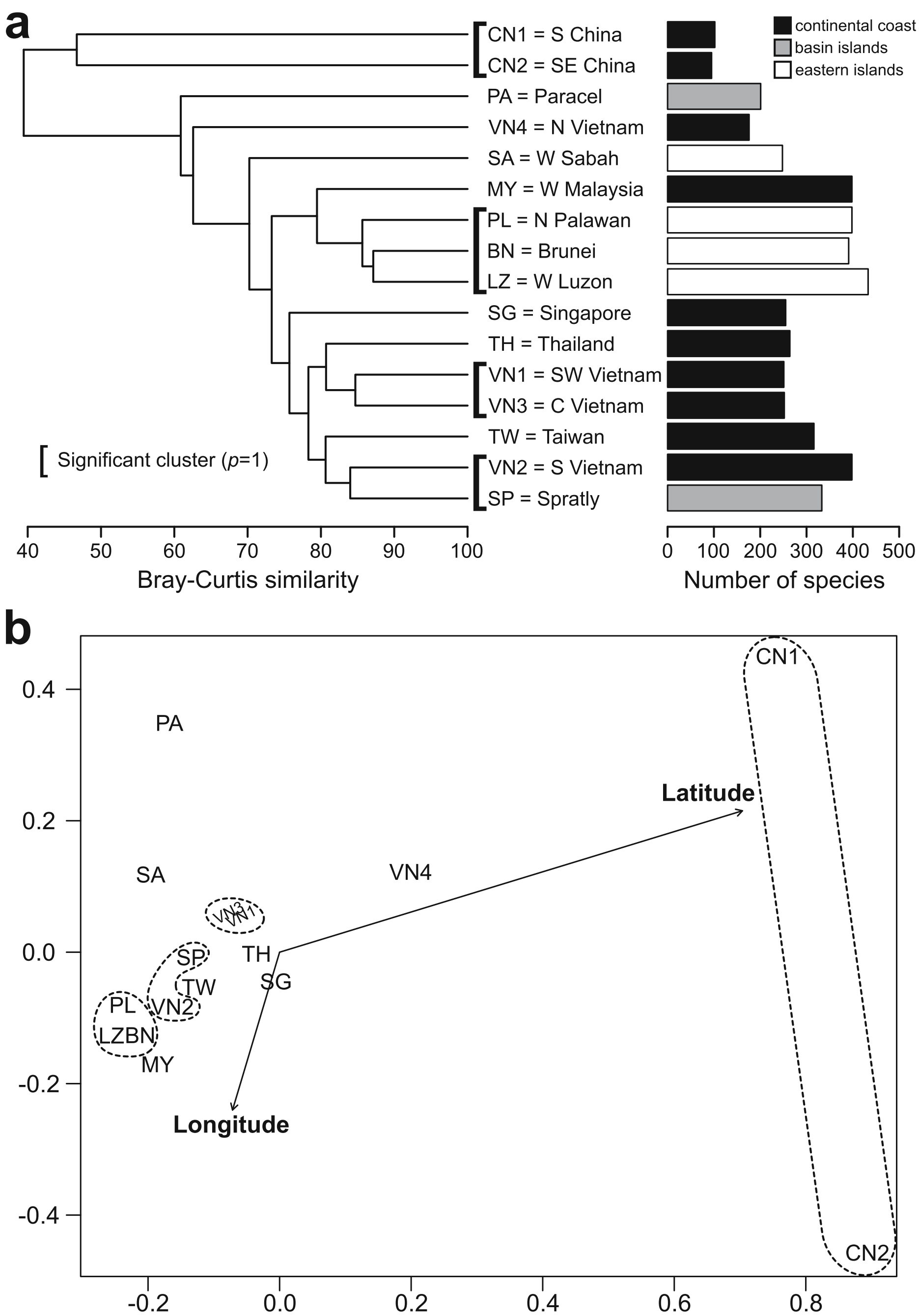

Fig. 2 **a** Similarity profile (SIMPROF) computed from coral presence/absence data for 16 reef areas along with their corresponding species richness, and **b** non-metric multidimensional scaling (NMDS) of reef areas showing effects of latitude (p=0.058) and longitude (p=0.82) in structuring the coral distribution

only 15 and five species in southern and southeastern China, respectively. The low number of species here and moderately high level of chaining confined to all other areas suggest that richness is an important determinant in the clustering pattern.

NMDS shows a broadly consistent picture with the SIMPROF results (Fig. 2b). The two-cluster pattern is clearly discernible on the two-dimensional and three-dimensional plots, which are qualitatively similar to one another even among various pairs of axes. The two-dimensional analysis found two convergent solutions with a good fit of stress 0.046 (Kruskal 1964a) after six attempts and without transforming the data. The three-dimensional scaling achieved an excellent fit of stress 0.024 (Kruskal 1964a) after 12 tries. The two-dimensional analysis found latitude to be a marginally significant vector in structuring the diversity among areas (p=0.058; three-dimensional scaling p=0.053). Longitude is not significant for both scalings ($p\geq$0.82), consistent with the richness similarity between the extreme eastern and western reef areas. It should be noted that most of the low latitude sites have low longitudes due to the shape of the region, although tests for a linear relationship between the two variables—with and without high-latitude areas CN1 and CN2—show non-significance ($p>0.14$). Furthermore, omission of the distinct areas CN1 and CN2 (Fig. 2a) does not recover longitude as a significant factor ($p=0.46$).

Geographically, the SCS has a total surface area of 3.4 million km^2, falling within the range of earlier estimates (Clark and Li 1993; Randall and Lim 2000; Morton and Blackmore 2001). This includes ~12,000 km^2 of reefs, or 4.7 % of the world's total reef surface area. We corroborate the computation by Burke et al. (2012) of the Coral Triangle reef area—nearly 73,000 km^2 (29 % of global)—contained within 5.5 million km^2 of sea surface.

Discussion

The present study assembles the most comprehensive coral data set of the SCS to illustrate its extraordinary richness. At 571 species, total diversity here rivals that of the Coral Triangle, which has been reported by the spatial database Coral Geographic to contain 605 species (Veron et al. 2009, 2011). In fact, subjecting the Coral Geographic to our taxonomic scheme reveals 566 species in the Coral Triangle (see detailed lists of Coral Triangle species and synonyms in the supplementary Online Resource). Herein lies the 'extraordinary' statistic, that the SCS, despite being six times smaller in reef area, is more coral-diverse than the Coral Triangle, the supposed centre of maximum marine biodiversity.

We note that the data used in our analysis are derived from various sources, being accumulated over time by various observers using different species concepts that could result in inflated species numbers. Some records are also not supported by museum collections that enable verification and minimise misidentifications. In contrast, during a survey of eastern Indonesia in the Coral Triangle, approximately 350 coral species were recorded and sampled from nine reef areas (Best et al. 1989). These numbers appear low in comparison to the SCS, but they were obtained after specimens were studied and compared by the same observers, effectively guaranteeing uniformity in species concepts among areas. It is therefore possible that actual species numbers in the SCS are lower than presently reported, as specimens identified as distinct species from different localities and environments become reconciled as ecotypes of the same species.

Total diversity aside, our analyses also uncover a high level of compositional variability within the SCS. At a maximum of 433 species in one area (western Luzon), and with most areas harbouring less than 300 species, including southeastern and southern China ($n=95$ and $n=102$ respectively), variation among areas is expected to be high. Indeed, the SIMPROF analysis recognises 11 distinct groups, with most areas being significantly dissimilar from one another. This variability is also high when comparing the seven ecoregions defined by Veron et al. (2009, 2011) that are fully contained within the SCS—coral faunas range from 94 species in Hong Kong to 435 species in their South China Sea ecoregion. In contrast, each of the 16 Coral Triangle ecoregions is reported to contain over 500 species (Veron et al. 2009, 2011), approaching the total richness. Thus the Coral Triangle has smaller margins for variation among ecoregions as compared to the SCS.

Our analyses demonstrate that latitude is a marginally significant factor in structuring the distribution of corals in the region. Previous analyses have shown that coral richness (Connolly et al. 2003; Obura 2012b) and composition (Bellwood and Hughes 2001) are well predicted by the latitudinal gradient across the Indo-Pacific domain (see Hughes et al. 2013). Results here provide support at a smaller scale within the SCS. Interestingly, species distribution exhibits no significant structure with respect to longitude, and richness is comparable between the extreme eastern and western reef areas. These findings strongly suggest that the general pattern of decreasing diversity with increasing distance from the Coral Triangle (e.g., Briggs 1974; Hughes et al. 2002; Bellwood and Meyer 2009) is modulated by local dynamics specific to the SCS.

Habitat area and diversity are known to play crucial roles in the spatial structuring of coral species (Done 1982; Karlson and Cornell 1998; Cornell and Karlson 2000; Bellwood and Hughes 2001). The coasts of the eastern islands Luzon and Palawan have some of the highest concentration of reefs, while parts of the Asian continental coastline are influenced by high freshwater and terrigenous inputs, and therefore have limited reef development (Morton and Blackmore 2001). The clustering of assemblages reflect this distinction in part, with the Philippine island areas and Brunei grouping together, though not with western Sabah (Fig. 2). However, this pattern belies the marked complexity of the diversity gradient within the SCS basin, as the Paracel and Spratly islands are significantly distinct in richness and composition, neither clustered with each other nor with adjacent reef areas.

Many hypotheses have been proposed to explain the high biodiversity in the Central Indo-Pacific realm, particularly the Coral Triangle region (Rosen 1988; Hoeksema 2007). The most compelling arguments generally involve planktonic larval dispersal via large-scale oceanic circulation. The North and South Equatorial Currents flow westward across the entire tropical Pacific Ocean, transporting larvae into the Central Indo-Pacific (Scheltema and Williams 1983; Scheltema 1986, 1988; Jokiel and Martinelli 1992). Upon arrival at the western Pacific, currents channel oceanic water mainly through the Coral Triangle region, generating complex local circulation patterns associated with the Indonesian Throughflow (Wyrtki 1961; Gordon and Fine 1996; Lukas et al. 1996; Gordon et al. 2003). Possibly coupled with eustatic fluctuations since the Pleistocene (Voris 2000; Siddall et al. 2003), these lead to changes in population subdivisions that ultimately drive the diversity gradient (Potts 1983; Rosen 1984; McManus 1985; Pandolfi 1992; Veron 1995; Wilson and Rosen 1998; Santini and Winterbottom 2002; Hoeksema 2007).

However, part of the full circulation that connects the western Pacific with the Indian Ocean also goes through the SCS between Vietnam and Borneo (Qu et al. 2005; Humphries and Webb 2008; Xu and Malanotte-Rizzoli 2013). Larvae carried into the SCS via this route are entrained within water masses in complex gyres that form over the Gulf of Thailand and eastern SCS (Qu 2000; Morton and Blackmore 2001; Fang et al. 2002; Xu and Malanotte-Rizzoli 2013), facilitating their settlement and supporting reef diversity (McManus 1994; McManus and Meñez 1997). Circulatory patterns used to explain the Coral Triangle diversity maximum can be invoked for our focal region. Indeed, with greater internal compositional variability and aggregate richness of corals within a considerably smaller reef area, there is reason to suggest that this physical forcing is more pertinent to coral distribution in the SCS than previously thought. This diversity is even more striking considering the relatively recent establishment of the present fauna. During the Late Pleistocene, sea levels were ≥ 40 m below current levels for more than 50 % of the time (Voris 2000; Hoeksema 2007). The Sunda Shelf was thereby exposed, cutting off the marine connection between the SCS and Java Sea, and drastically reducing habitable area in the region (Umbgrove 1947; Veron 1995; Hoeksema 2007). Following the Last Glacial Maximum, corals recolonised the SCS, eventually resulting in the modern distribution (Potts 1983; McManus 1985; Hanebuth et al. 2000; Renema et al. 2008; see also Wood et al. 2014).

Overall, our results do not diminish the biogeographical significance of the Coral Triangle. They certainly should not weaken the scientific justification for its conservation. After all, each of the Coral Triangle ecoregions does contain an exceptionally large number of coral species (> 500), with more records added when specific scleractinian families are targeted (Waheed and Hoeksema 2013). Rather, our goal is to highlight the remarkable diversity of reef corals in the adjacent SCS. Future research may find the western boundary of the Coral Triangle further west inside the SCS than presently established (Veron et al. 2009, 2011), which would be concordant with the delineation by Spalding et al. (2007). Previous richness estimates of the SCS have proven to be exceedingly low (e.g., UNEP 2004), yet we continue to underestimate its diversity because of spatial gaps in our data, such as the less-explored regions of the Spratly Archipelago and northwestern Luzon. Poorly known ecosystems, such as mesophotic reefs (> 40 m depth; see Kahng et al. 2010; Bridge et al. 2012) and caves, have been sources of new species discoveries in recent years (Kahng and Maragos 2006; Hoeksema 2012; Luck et al. 2013), but these have not been studied in the SCS. We thus hope that findings here will motivate scientific explorations that can provide further information relevant to the conservation of this large marine region.

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Annex 849

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RESEARCH ARTICLE

Extinction risk and conservation of the world's sharks and rays

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Abstract The rapid expansion of human activities threatens ocean-wide biodiversity. Numerous marine animal populations have declined, yet it remains unclear whether these trends are symptomatic of a chronic accumulation of global marine extinction risk. We present the first systematic analysis of threat for a globally distributed lineage of 1,041 chondrichthyan fishes—sharks, rays, and chimaeras. We estimate that one-quarter are threatened according to IUCN Red List criteria due to overfishing (targeted and incidental). Large-bodied, shallow-water species are at greatest risk and five out of the seven most threatened families are rays. Overall chondrichthyan extinction risk is substantially higher than for most other vertebrates, and only one-third of species are considered safe. Population depletion has occurred throughout the world's ice-free waters, but is particularly prevalent in the Indo-Pacific Biodiversity Triangle and Mediterranean Sea. Improved management of fisheries and trade is urgently needed to avoid extinctions and promote population recovery.
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eLife digest Ocean ecosystems are under pressure from overfishing, climate change, habitat destruction and pollution. These pressures have led to documented declines of some fishes in some places, such as those living in coral reefs and on the high seas. However, it is not clear whether these population declines are isolated one-off examples or, instead, if they are sufficiently widespread to risk the extinction of large numbers of species.

Most fishes have a skeleton that is made of bone, but sharks and rays have a skeleton that is made of cartilage. A total of 1,041 species has such a skeleton and they are collectively known as the Chondrichthyes. To find out how well these fish are faring, Dulvy et al. worked with more than 300 scientists around the world to assess the conservation status of all 1,041 species.

Based on this, Dulvy et al. estimate that one in four of these species are threatened with extinction, mainly as a result of overfishing. Moreover, just 389 species (37.4% of the total) are considered to be safe, which is the lowest fraction of safe species among all vertebrate groups studied to date.

The largest sharks and rays are in the most peril, especially those living in shallow waters that are accessible to fisheries. A particular problem is the 'fin trade': the fins of sharks and shark-like rays are a delicacy in some Asian countries, and more than half of the chondrichthyans that enter the fin trade are under threat. Whether targeted or caught by boats fishing for other species, sharks and rays are used to supply a market that is largely unmonitored and unregulated. Habitat degradation and loss also pose considerable threats, particularly for freshwater sharks and rays.

Dulvy et al. identified three main hotspots where the biodiversity of sharks and rays was particularly seriously threatened—the Indo-Pacific Biodiversity Triangle, Red Sea, and the Mediterranean Sea—and argue that national and international action is needed to protect them from overfishing.

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Introduction

Populations and species are the building blocks of the communities and ecosystems that sustain humanity through a wide range of services (***Mace et al., 2005***; ***Díaz et al., 2006***). There is increasing evidence that human impacts over the past 10 millennia have profoundly and permanently altered biodiversity on land, especially of vertebrates (***Schipper et al., 2008***; ***Hoffmann et al., 2010***). The oceans encompass some of the earth's largest habitats and longest evolutionary history, and there is mounting concern for the increasing human influence on marine biodiversity that has occurred over the past 500 years (***Jackson, 2010***). So far our knowledge of ocean biodiversity change is derived mainly from retrospective analyses usually limited to biased subsamples of diversity, such as: charismatic species, commercially-important fisheries, and coral reef ecosystems (***Carpenter et al., 2008***; ***Collette et al., 2011***; ***McClenachan et al., 2012***; ***Ricard et al., 2012***). Notwithstanding the limitations of these biased snapshots, the rapid expansion of fisheries and globalized trade are emerging as the principal drivers of coastal and ocean threat (***Polidoro et al., 2008***; ***Anderson et al., 2011b***; ***McClenachan et al., 2012***). The extent and degree of the global impact of fisheries upon marine biodiversity, however, remains poorly understood and highly contentious. Recent insights from ecosystem models and fisheries stock assessments of mainly data-rich northern hemisphere seas, suggest that the status of a few of the best-studied exploited species and ecosystems may be improving (***Worm et al., 2009***). However, this view is based on only 295 populations of 147 fish species and hence is far from representative of the majority of the world's fisheries and fished species, especially in the tropics for which there are few data and often less management (***Sadovy, 2005***; ***Newton et al., 2007***; ***Branch et al., 2011***; ***Costello et al., 2012***; ***Ricard et al., 2012***).

Overfishing and habitat degradation have profoundly altered populations of marine animals (***Hutchings, 2000***; ***Lotze et al., 2006***; ***Polidoro et al., 2012***), especially sharks and rays (***Stevens et al., 2000***; ***Simpfendorfer et al., 2002***; ***Dudley and Simpfendorfer, 2006***; ***Ferretti et al., 2010***). It is not clear, however, whether the population declines of globally distributed species are locally reversible or symptomatic of an erosion of resilience and chronic accumulation of global marine extinction risk (***Jackson, 2010***; ***Neubauer et al., 2013***). In response, we evaluate the scale and intensity of overfishing through a global systematic evaluation of the relative extinction risk for an entire lineage of exploited marine fishes—sharks, rays, and chimaeras (class Chondrichthyes)—using the Red List Categories and Criteria of the International Union for the Conservation of Nature (IUCN). We go on to identify, (i) the life history and ecological attributes of species (and taxonomic families) that render them prone to extinction, and (ii) the geographic locations with the greatest number of species of high conservation concern.

Chondrichthyans make up one of the oldest and most ecologically diverse vertebrate lineages: they arose at least 420 million years ago and rapidly radiated out to occupy the upper tiers of aquatic food webs (***Compagno, 1990***; ***Kriwet et al., 2008***). Today, this group is one of the most speciose lineages of predators on earth that play important functional roles in the top-down control of coastal and oceanic ecosystem structure and function (***Ferretti et al., 2010***; ***Heithaus et al., 2012***; ***Stevens et al., 2000***). Sharks and their relatives include some of the latest maturing and slowest reproducing of all vertebrates, exhibiting the longest gestation periods and some of the highest levels of maternal investment in the animal kingdom (***Cortés, 2000***). The extreme life histories of many chondrichthyans result in very low population growth rates and weak density-dependent compensation in juvenile survival, rendering them intrinsically sensitive to elevated fishing mortality (***Musick, 1999b***; ***Cortés, 2002***; ***García et al., 2008***; ***Dulvy and Forrest, 2010***).

Chondrichthyans are often caught as incidental, but are often retained as valuable bycatch of fisheries that focus on more productive teleost fish species, such as tunas or groundfishes (***Stevens et al., 2005***). In many cases, fishing pressure on chondrichthyans is increasing as teleost target species become less accessible (due to depletion or management restrictions) and because of the high, and in some cases rising, value of their meat, fins, livers, and/or gill rakers (***Fowler et al., 2002***; ***Clarke et al., 2006***; ***Lack and Sant, 2009***). Fins, in particular, have become one of the most valuable seafood commodities: it is estimated that the fins of between 26 and 73 million individuals, worth US$400-550 million, are traded each year (***Clarke et al., 2007***). The landings of sharks and rays, reported to the Food and Agriculture Organization of the United Nations (FAO), increased steadily to a peak in 2003 and have declined by 20% since (***Figure 1A***). True total catch, however, is likely to be 3–4 times greater than reported (***Clarke et al., 2006***; ***Worm et al., 2013)***. Most chondrichthyan catches are unregulated and often misidentified, unrecorded, aggregated, or discarded at sea, resulting in a lack of species-specific landings information (***Barker and Schluessel, 2005***; ***Clarke et al., 2006***; ***Iglésias et al., 2010***; ***Bornatowski et al., 2013***). Consequently, FAO could only be 'hopeful' that the catch decline is due to improved management rather than being symptomatic of worldwide overfishing (***FAO, 2010***). The reported chondrichthyan catch has been increasingly dominated by rays, which have made up greater than half of reported taxonomically-differentiated landings for the past four decades (***Figure 1B***). Chondrichthyan landings were worth US$1 billion at the peak catch in 2003, since then the value has dropped to US$800 million as catch has declined (***Musick and Musick, 2011***). A main driver of shark fishing is the globalized trade to meet Asian demand for shark fin soup, a traditional and usually expensive Chinese dish. This particularly lucrative trade in fins (not only from sharks, but also of shark-like rays such as wedgefishes and sawfishes) remains largely unregulated across the 86 countries and territories that exported >9,500 mt of fins to Hong Kong (a major fin trade hub) in 2010 (***Figure 1C***).

Results

Red List status of chondrichthyan species

Overall, we estimate that one-quarter of chondrichthyans are threatened worldwide, based on the observed threat level of assessed species combined with a modeled estimate of the number of Data Deficient species that are likely to be threatened. Of the 1,041 assessed species, 181 (17.4%) are classified as threatened: 25 (2.4%) are assessed as Critically Endangered (CR), 43 (4.1%) Endangered (EN), and 113 (10.9%) Vulnerable (VU) (***Table 1***). A further 132 species (12.7%) are categorized as Near Threatened (NT). Chondrichthyans have the lowest percentage (23.2%, n = 241 species) of Least Concern (LC) species of all vertebrate groups, including the marine taxa assessed to date (***Hoffmann et al., 2010***). Almost half (46.8%, n = 487) are Data Deficient (DD) meaning that information is insufficient to assess their status (***Table 1***). DD chondrichthyans are found across all habitats, but particularly on continental shelves (38.4% of 482 species in this habitat) and deepwater slopes (57.6%, ***Table 2***). Of the 487 DD species for which we had sufficient maximum body size (n = 396) and geographic distribution data (n = 378), we were able to predict that at least a further 68 DD species are likely to be threatened (***Table 3***, ***Supplementary file 1***). Accounting for the uncertainty in threat levels due to the number of DD species, we estimate that more than half face some elevated risk: at least one-quarter (n = 249; 24%) of chondrichthyans are threatened and well over one-quarter are Near Threatened (***Table 1***). Only 37% are predicted to be Least Concern (***Table 1***).

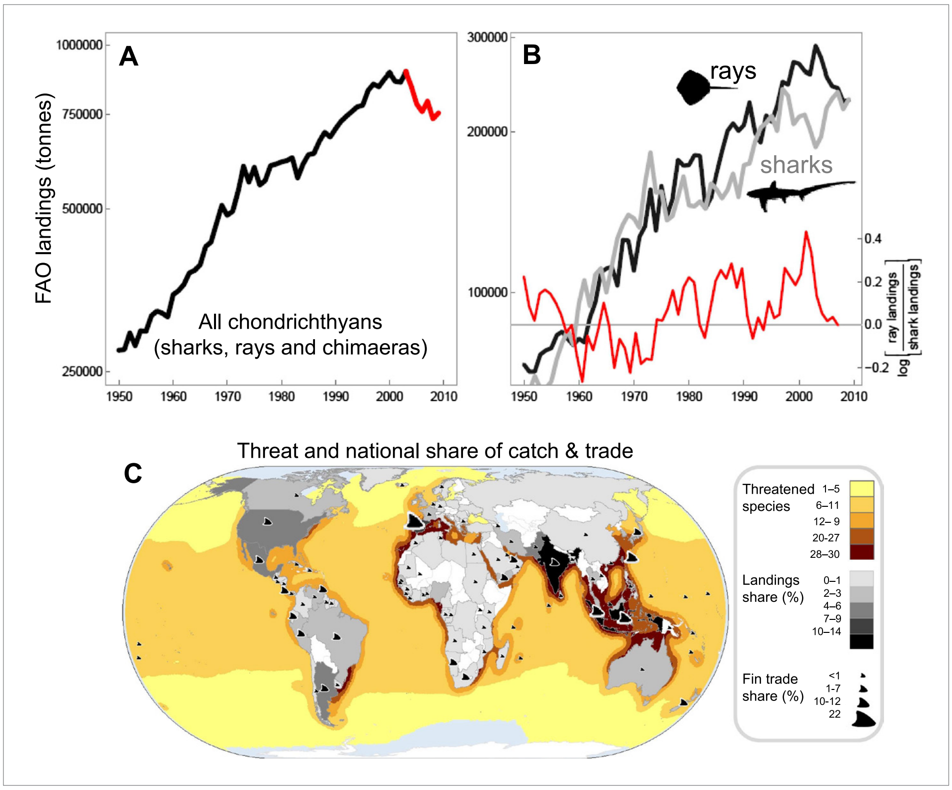

Figure 1. The trajectory and spatial pattern of chondrichthyan fisheries catch landings and fin exports. (**A**) The landed catch of chondrichthyans reported to the Food and Agriculture Organization of the United Nations from 1950 to 2009 up to the peak in 2003 (black) and subsequent decline (red). (**B**) The rising contribution of rays to the taxonomically-differentiated global reported landed catch: shark landings (light gray), ray landings (black), log ratio [rays/sharks], (red). Log ratios >0 occur when more rays are landed than sharks. The peak catch of taxonomically-differentiated rays peaks at 289,353 tonnes in 2003. (**C**) The main shark and ray fishing nations are gray-shaded according to their percent share of the total average annual chondrichthyan landings reported to FAO from 1999 to 2009. The relative share of shark and ray fin trade exports to Hong Kong in 2010 are represented by fin size. The taxonomically-differentiated proportion excludes the 'nei' (not elsewhere included) and generic 'sharks, rays, and chimaeras' category.

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Drivers of threat

The main threats to chondrichthyans are overexploitation through targeted fisheries and incidental catches (bycatch), followed by habitat loss, persecution, and climate change. While one-third of threatened sharks and rays are subject to targeted fishing, some of the most threatened species (including sawfishes and large-bodied skates) have declined due to incidental capture in fisheries targeting other species. Shark-like rays, especially sawfishes, wedgefishes and guitarfishes, have some of the most valuable fins and are highly threatened. Although the global fin trade is widely recognized as a major driver of shark and ray mortality, demand for meat, liver oil, and even gillrakers (of manta and other devil rays) also poses substantial threats. Half of the 69 high-volume or high-value sharks and rays in the global fin trade are threatened (53.6%, n = 37), while low-value fins often enter trade as well, even if meat demand is the main fishery driver (***Supplementary file 2A***). Coastal species are more exposed to the combined threats of fishing and habitat degradation than those offshore in pelagic and deepwater ecosystems. In coastal, estuarine, and riverine habitats, four principal processes of habitat degradation (residential and commercial development, mangrove destruction, river engineering, and pollution) jeopardize nearly one-third of threatened sharks and rays (29.8%, n = 54 of 181, ***Supplementary file 2B***). The combined effects of overexploitation and habitat degradation are most acute in freshwater, where over one-third (36.0%) of the 90 obligate and euryhaline freshwater chondrichthyans are threatened.

Table 1. Observed and predicted number and percent of chondrichthyan species in IUCN Red List categories

Taxon	Species number (%)	Threatened species number (%)	CR	EN	VU	NT	LC	DD
Skates and rays	539 (51.8)	107 (19.9)	14 (1.3)	28 (2.7)	65 (6.2)	62 (6.0)	114 (11.0)	256 (24.6)
Sharks	465 (44.7)	74 (15.9)	11 (1.1)	15 (1.4)	48 (4.6)	67 (6.4)	115 (11.0)	209 (20.1)
Chimaeras	37 (3.6)	0	0	0	0	3 (0.3)	12 (1.2)	22 (2.1)
All observed	1041	181 (17.4)	25 (2.4)	43 (4.1)	113 (10.9)	132 (12.7)	241 (23.2)	487 (46.8)
All predicted		249 (23.9)	–	–	–	312 (29.9)	389 (37.4)	91 (8.7)

CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; DD, Data Deficient. Number threatened is the sum total of the categories CR, EN and VU. Species number and number threatened are expressed as percentage of the taxon, whereas the percentage of each species in IUCN categories is expressed relative to the total number of species.

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Their plight is exacerbated by high habitat-specificity and restricted geographic ranges (***Stevens et al., 2005***). Specifically, the degradation of coastal, estuarine and riverine habitats threatened 14% of sharks and rays: through residential and commercial development (22 species, including river sharks *Glyphis* spp.); mangrove destruction for shrimp farming in Southeast Asia (4 species, including Bleeker's variegated stingray *Himantura undulata*); dam construction and water control (8 species, including Mekong freshwater stingray *Dasyatis laosensis*), and pollution (20 species). Many freshwater sharks and rays suffer multiple threats and have narrow geographic distributions, for example the Endangered Roughnose stingray *(Pastinachus solocirostris)* that is found only in Malaysian Borneo and Indonesia (Kalimantan, Sumatra and Java). Population control of sharks, in particular due to their perceived risk to people, fishing gear, and other fisheries has contributed to the threatened status of at least 12 species (***Supplementary file 2B***). Sharks and rays are also threatened due to capture in shark control nets (e.g. Dusky shark *Carcharhinus obscurus*), and persecution to minimise: damage to fishing nets (e.g. Green sawfish *Pristis zijsron*); their predation on aquacultured molluscs (e.g. Estuary stingray *Dasyatis fluviorum*); interference with spearfishing activity (e.g. Grey nurse shark *Carcharias taurus*), and the risk of shark attack (e.g. White shark *Carcharodon carcharias*). So far the threatened status of only one species has been directly linked to climate change (New Caledonia catshark *Aulohalaelurus kanakorum*, ***Supplementary file 2B***). the climate-sensitivity of some sharks has been recognized (***Chin et al., 2010***) and the status of shark and ray species will change rapidly in climate cul-de-sacs, such as the Mediterranean Sea (***Lasram et al., 2010***).

Correlates and predictors of threat

Elevated extinction risk in sharks and rays is a function of exposure to fishing mortality coupled with their intrinsic life history and ecological sensitivity (***Figures 2–6***). Most threatened chondrichthyan species are found in depths of less than 200 m, especially in the Atlantic and Indian Oceans, and the Western Central Pacific Ocean (79.6%, n = 144 of 181, ***Figure 2***). Extinction risk is greater in larger-bodied

Table 2. Number and percent of chondrichthyans in IUCN Red List categories by their main habitats

Habitat	Species (%)	Threatened (%)	CR (%)	EN (%)	VU (%)	NT (%)	LC (%)	DD (%)
Coastal and continental shelf	482 (46.3)	127 (26.3)	20 (4.1)	26 (5.4)	81 (16.8)	73 (15.1)	97 (20.1)	185 (38.4)
Neritic and epipelagic	39 (3.7)	17 (43.6)	0	3 (7.7)	14 (35.9)	13 (33.3)	5 (12.8)	4 (10.3)
Deepwater	479 (46.0)	25 (5.2)	2 (0.4)	6 (1.3)	17 (3.5)	45 (9.4)	133 (27.8)	276 (57.6)
Mesopelagic	8 (0.8)	0	0	0	0	0	4 (50.0)	4 (50.0)
Freshwater (obligate species only)	33 (3.2)	12 (36.4)	3 (9.1)	8 (24.2)	1 (3.0)	1 (3.0)	2 (6.1)	18 (54.5)
Totals	1041	181 (17.4)	25 (2.4)	43 (4.1)	113 (10.9)	132 (12.7)	241 (23.2)	487 (46.8)

CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern; DD, Data Deficient.

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Table 3. Summary of predictive Generalized Linear Models for life history and ecological correlates of IUCN status

Model	Model structure and hypothesis	Degrees of freedom, *k*	Log likelihood	AIC_c	ΔAIC	AIC weight	Accuracy (AUC)	R^2
1	~maximum length	2	−227.479	459	43.67	0.000	0.678	0.139
2	~ …+ minimum depth	3	−210.299	426.7	11.34	0.003	0.746	0.243
3	~ …+…+ depth range	4	−204.703	417.5	2.19	0.25	0.762	0.276
4	~ …+…+…+ geographic range	5	−202.578	415.3	0	0.748	0.772	0.298

Species were scored as threatened (CR, EN, VU) = 1 or Least Concern (LC) = 0 for n = 367 marine species. AIC_c is the Akaike information criterion corrected for small sample sizes and ΔAIC is the change in AIC_c. The models are ordered by increasing complexity and decreasing AIC weight (largest ΔAIC to lowest), coefficient of determination (R^2), and prediction accuracy (measured using Area Under the Curve, AUC).
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species found in shallower waters with narrower depth distributions, after accounting for phylogenetic non-independence (***Figures 3 and 4***). The traits with the greatest relative importance (>0.95) are maximum body size, minimum depth, and depth range. In comparison, geographic range (measured as Extent of Occurrence) has a much lower relative importance (0.79, ***Figure 3***), and in the predictive models it improved the variance explained by 2% and the prediction accuracy by 1% (***Table 3***). The probability that a species is threatened increases by 1.2% for each 10 cm increase in maximum body length, and decreases by 10.3% for each 50 m deepening in the minimum depth limit of species. After accounting for maximum body size and minimum depth, species with narrower depth ranges have a 1.2% greater threat risk per 100 m narrowing of depth range. There is no significant interaction between depth range and minimum depth limit. Geographic range, measured as the Extent of Occurrence, varies over six orders of magnitude, between 354 km^2 and 278 million km^2 and is positively correlated with body size (Spearman's $\rho = 0.58$), and hence is only marginally positively related to extinction risk over and above the effect of body size. Accounting for the body size and depth effects, the threat risk increases by only 0.5% for each 1,000,000 km^2 increase in geographic range (***Table 4***). The explanatory and predictive power of our life history and geographic distribution models increased with complexity, though geographic range size contributed relatively little additional explanatory power and a high degree of uncertainty in the parameter estimate (***Tables 3 and 4***). The maximum variance explained was 69% (***Table 4***) and the predictive models (without controlling for phylogeny) explained 30% of the variance and prediction accuracy was 77% (***Table 3***).

By habitat, one-quarter of coastal and continental shelf chondrichthyans (26.3%, n = 127 of 482) and almost half of neritic and epipelagic species (43.6%, n = 17 of 39) are threatened. Coastal and continental shelf and pelagic species greater than 1 m total length have a more than 50% chance of being threatened, compared to ~12% risk for a similar-sized deepwater species (***Figure 5***). While deepwater chondrichthyans, due to their slow growth and lower productivity, are intrinsically more sensitive to overfishing than their shallow-water relatives (***García et al., 2008***; ***Simpfendorfer and Kyne, 2009***) for a given body size they are less threatened—largely because they are inaccessible to most fisheries (***Figure 5***).

As a result of their high exposure to coastal shallow-water fisheries and their large body size, sawfishes (Pristidae) are the most threatened chondrichthyan family and arguably the most threatened family of marine fishes (***Figure 6***). Other highly threatened families include predominantly coastal and continental shelf-dwelling rays (wedgefishes, sleeper rays, stingrays, and guitarfishes), as well as angel sharks and thresher sharks; five of the seven most threatened families are rays. Least threatened families are comprised of relatively small-bodied species occurring in mesopelagic and deepwater habitats (lanternsharks, catsharks, softnose skates, shortnose chimaeras, and kitefin sharks, ***Figure 6***, ***Figure 6—source data 1***).

Geographic hotspots of threat and conservation priority by habitat

Local species richness is greatest in tropical coastal seas, particularly along the Atlantic and Western Pacific shelves (***Figure 7A***). The greatest uncertainty, where the number of DD species is highest, is centered on four areas: (1) Caribbean Sea and Western Central Atlantic Ocean, (2) Eastern Central Atlantic Ocean, (3) Southwest Indian Ocean, and (4) the China Seas (***Figure 7B***). The megadiverse China Seas face the triple jeopardy of high threat in shallow waters (***Figure 7CD***), high species richness (***Figure 7A***), and a large number of threatened endemic species (***Figure 8***), combined with high risk due to high uncertainty in status (large number of DD species, ***Figure 7B***). Whereas the distribution of

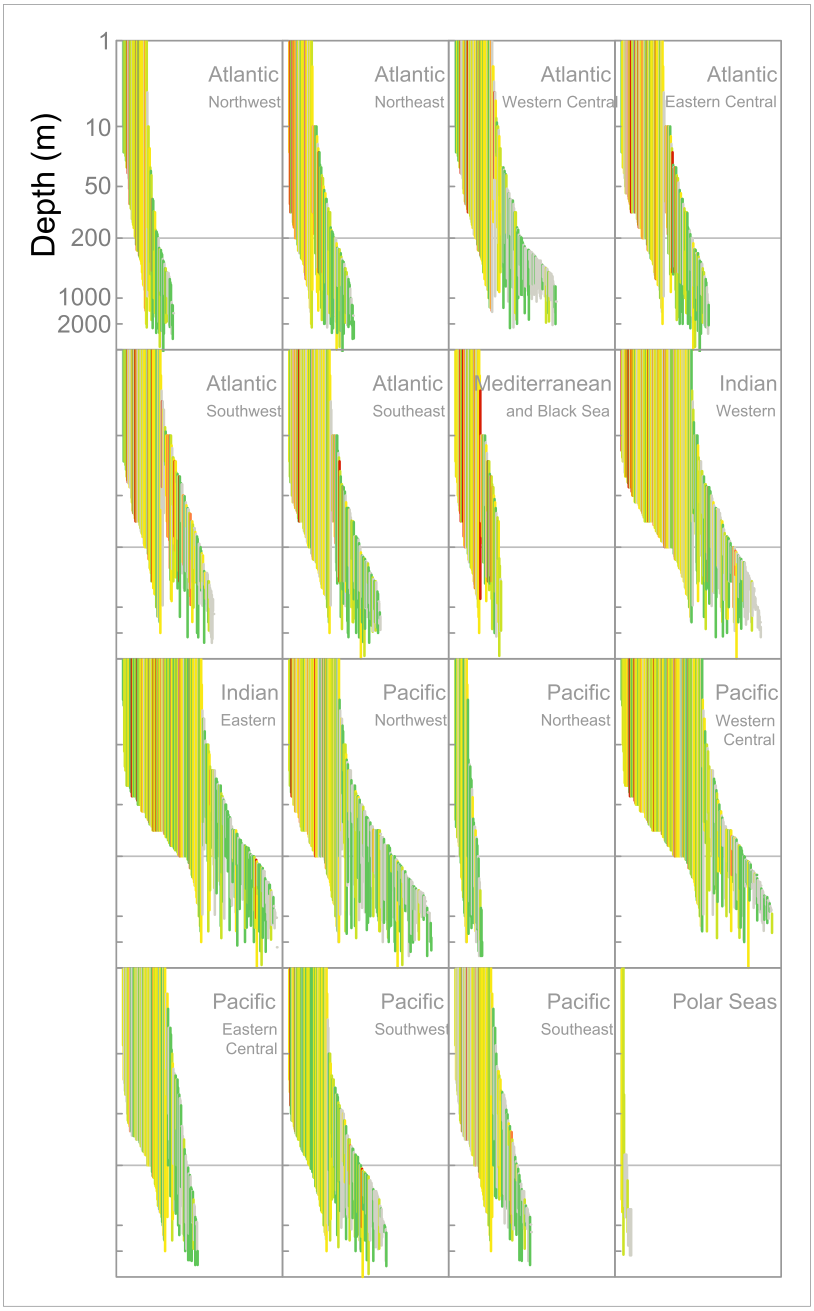

Figure 2. IUCN Red List Threat status and the depth distribution of chondrichthyans in the FAO Fishing Areas of the Atlantic, Indian and Pacific Oceans, and Polar Seas. Each vertical line represents the depth range (surface-ward minimum to the maximum reported depth) of each species and is colored according to threat status: CR (red), EN (orange), VU (yellow), NT (pale green), LC (green), and DD (gray). Species are ordered left to right by increasing median depth. The depth limit of the continental shelf is indicated by the horizontal gray line at 200 m. The Polar Seas include the following FAO Fishing Areas: Antarctic–Atlantic (Area 48), Indian (Area 58), Pacific (Area 88), and the Arctic Sea (Area 18).

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Figure 2. Continued on next page

Figure 2. Continued

The following figure supplements are available for figure 2:

Figure supplement 1. Map of Food and Agriculture Organization of the United Nations Fishing Areas and their codes: 18, Arctic Sea; 21, Atlantic, Northwest; 27, Atlantic, Northeast; 31, Atlantic, Western Central; 34, Atlantic, Eastern Central; 37, Mediterranean and Black Sea; 41, Atlantic, Southwest; 47, Atlantic, Southeast; 48, Atlantic, Antarctic; 51, Indian Ocean, Western; 57, Indian Ocean, Eastern; 58, Indian Ocean, Antarctic and Southern; 61, Pacific, Northwest; 67, Pacific, Northeast; 71, Pacific, Western Central; 77, Pacific, Eastern Central; 81, Pacific, Southwest; 87, Pacific, Southeast; and, 88, Pacific, Antarctic.
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threat in coastal and continental shelf chondrichthyans is similar to the overall threat pattern across tropical and mid-latitudes, the spatial pattern of threat varies considerably for pelagic and deepwater species. Threatened neritic and epipelagic oceanic sharks are distributed throughout the world's oceans, but there are also at least seven threat hotspots in coastal waters: (1) Gulf of California, (2) southeast US continental shelf, (3) Patagonian Shelf, (4) West Africa and the western Mediterranean Sea, (5) southeast South Africa, (6) Australia, and (7) the China Seas (***Figure 7D***). Hotspots of deepwater threatened chondrichthyans occur in three areas where fisheries penetrate deepest: (1) Southwest Atlantic Ocean (southeast coast of South America), (2) Eastern Atlantic Ocean, spanning from Norway to Namibia and into the Mediterranean Sea, and (3) southeast Australia (***Figure 7E***).

Hottest hotspots of threat and priority

Spatial conservation priority can be assigned using three criteria: (1) the greatest number of threatened species (***Figure 7A***), (2) greater than expected threat (residuals of the relationship between total number of species and total number of threatened species per cell, ***Figure 9***), and (3) high irreplaceability—high numbers of threatened endemic species (***Figure 8***). Most threatened marine chondrichthyans (n = 135 of 169) are distributed within, and are often endemic to (n = 73), at least seven distinct threat hotspots (e.g., for neritic and pelagic species ***Figure 7D***). With the notable exception of the US and Australia, threat hotspots occur in the waters of the most intensive shark and ray fishing and fin-trading nations (***Figure 1C***). Accordingly these regions should be afforded high scientific and conservation priority (***Table 5***).

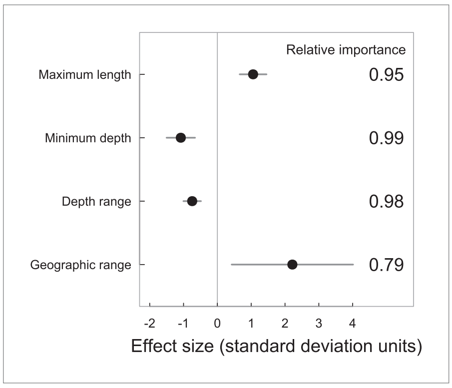

Figure 3. Standardized effect sizes with 95% confidence intervals from the two best explanatory models of life histories, geographic range and extinction risk in chondrichthyans. The data were standardized by subtracting the mean and dividing by one standard deviation to allow for comparison among parameters. The relative importance is calculated as the sum of the Akaike weights of the models containing each variable. Chondrichthyans were scored as threatened (CR, EN, VU) = 1 or Least Concern (LC) = 0 for n = 367 marine species. Threat status was modeled using General Linear Mixed-effects Models, with size, depth and geography treated as fixed effects and taxonomy hierarchy as a random effect to account for phylogenetic non-independence.
DOI: 10.7554/eLife.00590.009

The greatest number of threatened species coincides with the greatest richness (***Figure 7A vs 7C–E***); by controlling for species richness we can reveal the magnitude of threat in the pelagic ocean and two coastal hotspots that have a greater than expected level of threat: the Indo-Pacific Biodiversity Triangle and the Red Sea. Throughout much of the pelagic ocean, threat is greater than expected based on species richness alone, species richness is low (n = 30) and a high percentage (86%) are threatened (n = 16) or Near Threatened (n = 10). Only four are of Least Concern (Salmon shark *Lamna ditropis*, Goblin shark *Mitsukurina owstoni*, Longnose pygmy Shark *Heteroscymnoides marleyi*, and Largetooth cookiecutter shark *Isistius plutodus*) (***Figure 9***). The Indo-Pacific Biodiversity Triangle, particularly the Gulf of Thailand, and the islands of Sumatra, Java, Borneo, and Sulawesi, is a hotspot of greatest residual threat especially for coastal sharks and rays with 76 threatened species (***Figure 9***). Indeed, the Gulf of Thailand large marine ecosystem has

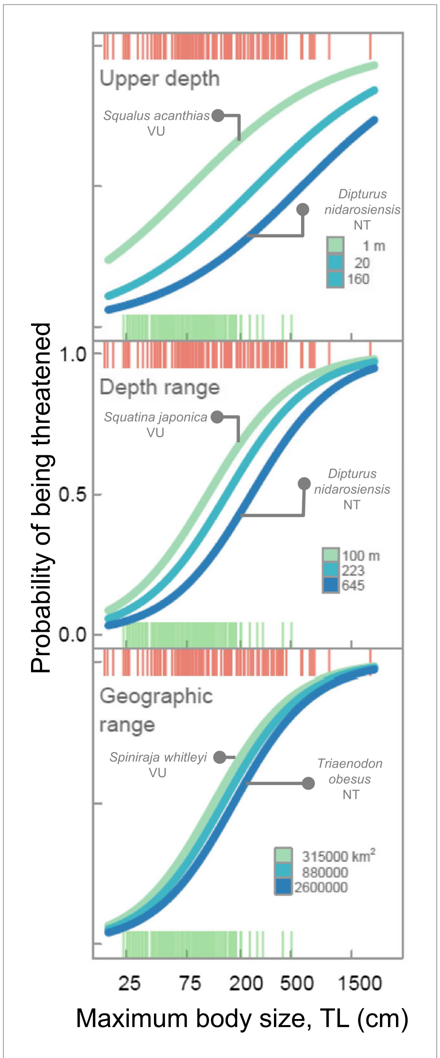

Figure 4. Life history sensitivity, accessibility to fisheries and extinction risk. Probability that a species is threatened due to the combination of intrinsic life history sensitivity (maximum body size, cm total length, TL) and accessibility to fisheries which is represented as minimum depth limit, depth range, and geographic range size (Extent of Occurrence). The lines represent the variation in body size-dependent risk for the upper quartile, median, and lower quartile of each range metric. The examplar species are all of similar maximum body length and the difference in risk is largely due to differences in geographic distribution. Chondrichthyans were scored as threatened (CR, EN, VU) = 1 or Least Concern (LC) = 0 for n = 366 marine species. The lines are the best fits from General Linear Mixed-effects Models, with maximum body size and geographic

Figure 4. Continued on next page

the highest threat density with 48 threatened chondrichthyans in an area of 0.36 million km^2. The Red Sea residual threat hotspot has 29 threatened pelagic and coastal species (***Figure 9***). There are 15 irreplaceable marine hotspots that harbor all 66 threatened endemic species (***Figure 8***; ***Supplementary file 2C***).

Discussion

In a world of limited funding, conservation priorities are often based on immediacy of extinction, the value of biodiversity and conservation opportunity (***Marris, 2007***). In this study, we provide the first estimates of the threat status and hence risk of extinction of chondrichthyans. Our systematic global assessment of the status of this lineage that includes many iconic predators reveals a risky combination of high threat (17% observed and 23.9% estimated), low safety (Least Concern, 23% observed and >37% estimated), and high uncertainty in their threat status (Data Deficient, 46% observed and 8.7% estimated). Over half of species are predicted to be threatened or Near Threatened (n = 561, 53.9%, ***Table 1***). While no species has been driven to global extinction—as far as we know—at least 28 populations of sawfishes, skates, and angel sharks are locally or regionally extinct (***Dulvy et al., 2003***; ***Dulvy and Forrest, 2010***). Several shark species have not been seen for many decades. The Critically Endangered Pondicherry shark (*Carcharhinus hemiodon*) is known only from 20 museum specimens that were captured in the heavily-fished inshore waters of Southeast Asia: it has not been seen since 1979 (***Cavanagh et al., 2003***). The now ironically-named and Critically Endangered Common skate (*Dipturus batis*) and Common angel shark (*Squatina squatina*) are regionally extinct from much of their former geographic range in European waters (***Cavanagh and Gibson, 2007***; ***Gibson et al., 2008***; ***Iglésias et al., 2010***). The Largetooth sawfish (*Pristis pristis*) and Smalltooth sawfish (*Pristis pectinata*) are possibly extinct throughout much of the Eastern Atlantic, particularly in West Africa (***Robillard and Séret, 2006***; ***Harrison and Dulvy, 2014***).

Our analysis provides an unprecedented understanding of how many chondrichthyan species are actually or likely to be threatened. A very high percentage of species are DD (46%, 487 species); that is one of the highest rates of Data Deficiency of any taxon to date (***Hoffmann et al., 2010***). This high level of uncertainty in status further elevates risk and presents a key challenge for future assessment efforts. We outline a first step through our estimation that 68 DD species are likely to be

Figure 4. Continued

distribution traits treated as fixed effects and taxonomy hierarchy as a random effect to account for phylogenetic non-independence. Each vertical line in each of the 'rugs' represents the maximum body size and Red List status of each species: threatened (red) and LC (green).
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threatened based on their life histories and distribution. Numerous studies have retrospectively explained extinction risk, but few have made a priori predictions of risk (***Dulvy and Reynolds, 2002***; ***Davidson et al., 2012***). Across many taxa, extinction risk has been shown to be a function of an extrinsic driver or threat (***Jennings et al., 1998***; ***Davies et al., 2006***) and the corresponding life history and ecological traits: large body size (low intrinsic rate of population increase, high trophic level), small geographic range size, and ecological specialization. Maximum body size is an essential predictor of threat status, we presume because of the close relationship between body size and the intrinsic rate of population increase in sharks and rays (***Smith et al., 1998***; ***Frisk et al., 2001***; ***Hutchings et al., 2012***). Though we note that this proximate link may be mediated ultimately through the time-related traits of growth and mortality (***Barnett et al., 2013***; ***Juan-Jordá et al., 2013***). Our novel contribution is to show that depth-related geographic traits are more important for explaining risk than geographic range per se. The shallowness of species (minimum depth limit) and the narrowness of their depth range are important risk factors (***Figure 3***). We hypothesize that this is so because shallower species are more accessible to fishing gears and those with narrower depth ranges have lower likelihood that a proportion of the species distribution remains beyond fishing activity. For example, the Endangered Barndoor skate (*Dipturus laevis*) was eliminated throughout much of its geographic range and depth distribution due to bycatch in trawl fisheries, yet may have rebounded because a previously unknown deepwater population component lay beyond the reach of most fisheries (***Dulvy, 2000***; ***Kulka et al., 2002***; ***COSEWIC, 2010***). We find that geographic range (measured as Extent of Occurrence) is largely unrelated to extinction risk. This is in marked contrast to extinction risk patterns on land (***Jones et al., 2003***; ***Cardillo et al., 2005***; ***Anderson et al., 2011a***) and in the marine fossil record (***Harnik et al., 2012a***, ***2012b***), where small geographic range size is the principal correlate of extinction risk. We suggest that this is because fishing activity is now widespread throughout the world's oceans (***Swartz et al., 2010***), and even species with the largest ranges are exposed and often entirely encompassed by the footprint of fishing activity. By contrast, with a few exceptions (mainly eastern Atlantic slopes, ***Figure 7E***), fishing has a narrow depth penetration and hence species found at greater depths can still find refuge from exploitation (***Morato et al., 2006***; ***Lam and Sadovy de Mitcheson, 2010***).

The status of chondrichthyans is arguably among the worst reported for any major vertebrate lineage considered thus far, apart from amphibians (***Stuart et al., 2004***; ***Hoffmann et al., 2010***). The percentage and absolute number of threatened amphibians is high (>30% are threatened), but a greater percentage are Least Concern (38%), and uncertainty of status is lower (32% DD) than for chondrichthyans. Our discovery of the high level of threat in freshwater chondrichthyans (36%) is consistent with the emerging picture of the intense and unmanaged extinction risk faced by many freshwater and estuarine species (***Darwall et al., 2011***).

Our threat estimate is comparable to other marine biodiversity status assessments, but our findings caution that 'global' fisheries assessments may be underestimating risk. The IUCN Global Marine Species Assessment is not yet complete, but reveals varying threat levels among taxa and regions (***Polidoro et al., 2008***, ***2012***). The only synoptic summary to-date focused on charismatic Indo-Pacific coral reef ecosystem species. Of the 1,568 IUCN-assessed marine vertebrates and invertebrates, 16% (range: 12–34% among families) were threatened (***McClenachan et al., 2012***). This is a conservative estimate of marine threat level because although they may be more intrinsically sensitive to extinction drivers, charismatic species are more likely to garner awareness of their status and support for monitoring and conservation (***McClenachan et al., 2012***). The predicted level of chondrichthyan threat (>24%) is distinctly greater than that provided by global fisheries risk assessments. These studies provide modeled estimates of the percentage of collapsed bony fish (teleost) stocks in both data-poor unassessed fisheries (18%, ***Costello et al., 2012***) and data-rich fisheries (7–13%, ***Branch et al., 2011***). This could be because teleosts are generally more resilient than elasmobranchs (***Hutchings et al., 2012***), but in addition we caution that analyses of biased geographic and taxonomic samples may be underestimating risk of collapse in global fisheries, particularly for species with less-resilient life histories.

Our work relies on consensus assessments by more than 300 scientists. However, given the uncertainty in some of the underlying data that inform our understanding of threat status, such as

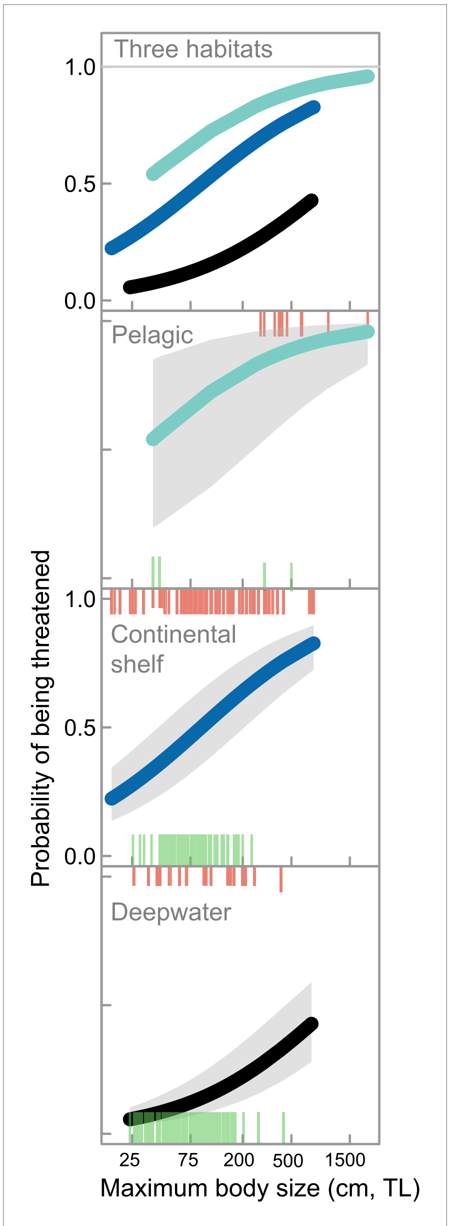

Figure 5. Life history, habitat, and extinction risk in chondrichthyans. IUCN Red List status as a function of maximum body size (total length, TL cm) and accessibility to fisheries in marine chondrichthyans in three main habitats: coastal and continental shelf <200 m ('Continental shelf'); neritic and oceanic pelagic <200 m ('Pelagic'); and, deepwater >200 m ('Deepwater'), n = 367 (threatened n = 148; Least Concern n = 219). The upper and lower 'rug' represents the maximum
Figure 5. Continued on next page

fisheries catch landings data, it is worth considering whether these uncertainties mean our assessments are downplaying the true risk. While there are methods of propagating uncertainty through the IUCN Red List Assessments (***Akcakaya et al., 2000***), in our experience this approach was uninformative for even the best-studied species, because it generated confidence intervals that spanned all IUCN Categories. Instead it is worth considering whether our estimates of threat are consistent with independent quantitative estimates of status. The Mediterranean Red List Assessment workshop in 2005 prompted subsequent quantitative analyses of catch landings, research trawl surveys, and sightings data. Quantitative trends could be estimated for five species suggesting they had declined by 96% to >99.9% relative to their former abundance suggesting they would meet the highest IUCN Threat category of Critically Endangered (***Ferretti et al., 2008***). By comparison the earlier IUCN regional assessment for these species, while suggesting they were all threatened, was more conservative for two of the five species: Hammerhead sharks (*Sphyrna* spp.)—Critically Endangered, Porbeagle shark (*Lamna nasus*)—Critically Endangered, Shortfin mako (*Isurus oxyrinchus*)—Critically Endangered, Blue shark (*Prionace glauca*)—Vulnerable, and Thresher shark (*Alopias vulpinus*)—Vulnerable.

We can also make a complementary comparison to a recent analysis of the status of 112 shark and ray fisheries (***Costello et al., 2012***). The median biomass relative to the biomass at Maximum Sustainable Yield (B/B_{MSY}) of these 112 shark and ray fisheries was 0.37, making them the most overfished groups of any of the world's unassessed fisheries. Assuming B_{MSY} occurs at 0.3 to 0.5 of unexploited biomass then the median biomass of shark and ray fisheries had declined by between 81% and 89% by 2009. These biomass declines would be sufficient to qualify all of these 112 shark and ray fisheries for the Endangered IUCN category if they occurred within a three-generation time span. By comparison our results are considerably more conservative. Empirical analyses show that an IUCN threatened category listing is triggered only once teleost fishes (with far higher density-dependent compensation) have been fished down to below B_{MSY} (***Dulvy et al., 2005***; ***Porszt et al., 2012***). Hence, our findings are consistent with only around one-quarter of chondrichthyan species having been fished down below the B_{MSY} target reference point. While there may be concern that expert assessments may overstate declines and threat, it is more likely that our con-

Figure 5. Continued

body size and Red List status of each species: threatened (upper rugs) and Least Concern (lower rugs). The lines are best fit using Generalized Linear Mixed-effects Models with 95% confidence intervals (***Table 9***).

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servative consensus-based approach has understated declines and risk in sharks and rays.

For marine species, predicting absolute risk of extinction remains highly uncertain because, even with adequate evidence of severe decline, in many instances the absolute population size remains large (***Mace, 2004***). There remains considerable uncertainty as to the relationship between census and effective population size (***Reynolds et al., 2005***). Therefore, Red List categorization of chondrichthyans should be interpreted as a comparative measure of *relative* extinction risk, in recognition that unmanaged steep declines, even of large populations, may ultimately lead to ecosystem perturbations and eventually biological extinction. The Red List serves to raise red flags calling for conservation action, sooner rather than later, while there is a still chance of recovery and of forestalling permanent biodiversity loss.

Despite more than two decades of rising awareness of chondrichthyan population declines and collapses, there is still no global mechanism to ensure financing, implementation and enforcement of chondrichthyan fishery management plans that is likely to rebuild populations to levels where they would no longer be threatened (***Lack and Sant, 2009***; ***Techera and Klein, 2011***). This management shortfall is particularly problematic given the large geographic range of many species. Threat increased only slightly when geographic range is measured as the Extent of Occurrence; however, geographic range becomes increasingly important when it is measured as the number of countries (legal jurisdictions) spanned by each species. The proportion of species that are threatened increases markedly with geographic size measured by number of Exclusive Economic Zones (EEZs) spanned; one-quarter of threatened species span the EEZs of 18 or more countries (***Figure 10***). Hence, their large geographic ranges do not confer safety, but instead exacerbates risk because sharks and rays require coherent, effective international management.

With a few exceptions (e.g., Australia and USA), many governments still lack the resources, expertise, and political will necessary to effectively conserve the vast majority of shark and rays, and indeed many

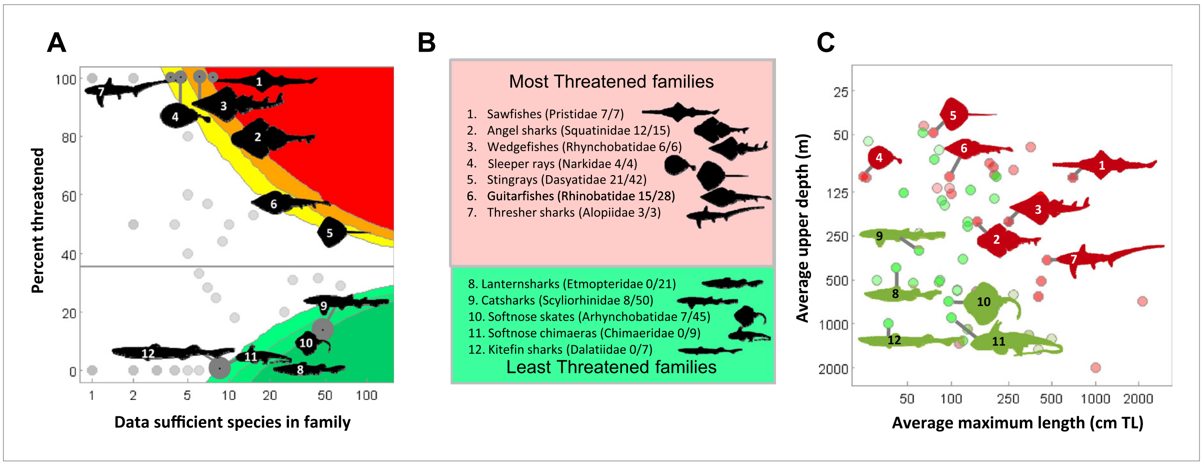

Figure 6. Evolutionary uniqueness and taxonomic conservation priorities. Threat among marine chondrichthyan families varies with life history sensitivity (maximum length) and exposure to fisheries (depth distribution). (**A**) Proportion of threatened data sufficient species and the richness of each taxonomic family. Colored bands indicate the significance levels of a one-tailed binomial test at p=0.05, 0.01, and 0.001. Those families with significantly greater (or lower) than expected threat levels at p<0.05 against a null expectation that extinction risk is equal across families (35.6%). (**B**) The most and least threatened taxonomic families. (**C**) Average life history sensitivity and accessibility to fisheries of 56 chondrichthyan families. Significantly greater (or lower) risk than expected is shown in red (green).

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The following source data are available for figure 6:

Source data 1. Number and IUCN Red List status of chondrichthyan species in IUCN Red List categories by family (alphabetically within each order).

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Table 4. Summary of explanatory Generalized Linear Mixed-effect Models of the life history and geographic distributional correlates of IUCN status

Model structure and hypothesis	Degrees of freedom, *k*	Log likelihood	AIC_c	ΔAIC	AIC weight	R^2GLMM(*m*) of fixed effects only	R^2GLMM(*c*) of fixed and random effects
~ maximum length	5	−197.06	404.3	28.31	0.000	0.32	0.58
~ …+ minimum depth	6	−187.013	386.3	10.29	0.005	0.48	0.65
~ …+…+ depth range	7	−182.139	378.6	2.62	0.212	0.49	0.66
~ …+…+…+ geographic range	8	−179.785	376.0	0	0.784	0.69	0.80

Species were scored as threatened (CR, EN, VU) = 1 or Least Concern (LC) = 0 for n = 367 marine species. AIC_c is the Akaike information criterion corrected for small sample sizes; ΔAIC is the change in AIC_c. The models are ordered by increasing complexity and decreasing AIC weight (largest ΔAIC to lowest). R^2GLMM(*m*) is the marginal R^2 of the fixed effects only and R^2GLMM(c) is the conditional R^2 of the fixed and random effects.

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other exploited organisms (***Veitch et al., 2012***). More than 50 sharks are included in Annex I (Highly Migratory Species) of the 1982 Law of the Sea Convention, implemented on the high seas under the 1992 Fish Stocks Agreement, but currently only a handful enjoy species-specific protections under the world's Regional Fishery Management Organizations (***Table 6***), and many of these have yet to be implemented domestically. The Migratory Sharks Memorandum of Understanding (MoU) adopted by the Parties to the Convention on Migratory Species (CMS) so far only covers seven sharks, yet there may be more than 150 chondrichthyans that regularly migrate across national boundaries (***Fowler, 2012***). To date, only one of the United Nations Environment Programme's Regional Seas Conventions, the Barcelona Convention for the Conservation of the Mediterranean Sea, includes chondrichthyan fishes and only a few of its Parties have taken concrete domestic action to implement these listings. Despite two decades of effort, only ten sharks and rays had been listed by the Convention on International Trade in Endangered Species (CITES) up to 2013 (***Vincent et al., 2014***). A further seven species of shark and ray were listed by CITES in 2013—the next challenge is to ensure effective implementation of these trade regulations (***Mundy-Taylor and Crook, 2013***). OSPAR (the Convention for the Protection of the marine Environment of the North-East Atlantic) lists many threatened shark and ray species, but its remit excludes fisheries issues. Many chondrichthyans qualify for listing under CITES, CMS, and various regional seas conventions, and should be formally considered for such action as a complement to action by Regional Fisheries Management Organizations (RFMOs) (***Table 6***).

Bans on 'finning' (slicing off a shark's fins and discarding the body at sea) are the most widespread shark conservation measures. While these prohibitions, particularly those that require fins to remain attached through landing, can enhance monitoring and compliance, they have not significantly reduced shark mortality or risk to threatened species (***Clarke et al., 2013***). Steep declines and the high threat levels in migratory oceanic pelagic sharks suggest raising the priority of improved management of catch and trade through concerted actions by national governments working through RFMOs *as well as* CITES, and CMS (***Table 7***).

A high proportion of catch landings come from nations with a large number of threatened chondrichthyans and less-than-comprehensive chondrichthyan fishery management plans. Future research is required to down-scale these global Red List assessments and analyses to provide country-by-country diagnoses of the link between specific fisheries and specific threats to populations of more broadly distributed species (***Wallace et al., 2010***). Such information could be used to focus fisheries management and conservation interventions that are tailored to specific problems. There is no systematic global monitoring of shark and ray populations and the national fisheries catch landings statistics provide invaluable data for tracking fisheries trends in unmanaged fisheries (***Newton et al., 2007***; ***Worm et al., 2013***). However, the surveillance power of such data could be greatly improved if collected at greater taxonomic resolution. While there have been continual improvements, catches are underreported (***Clarke et al., 2006***), and for those that are reported only around one-third is reported at the

Annex 849

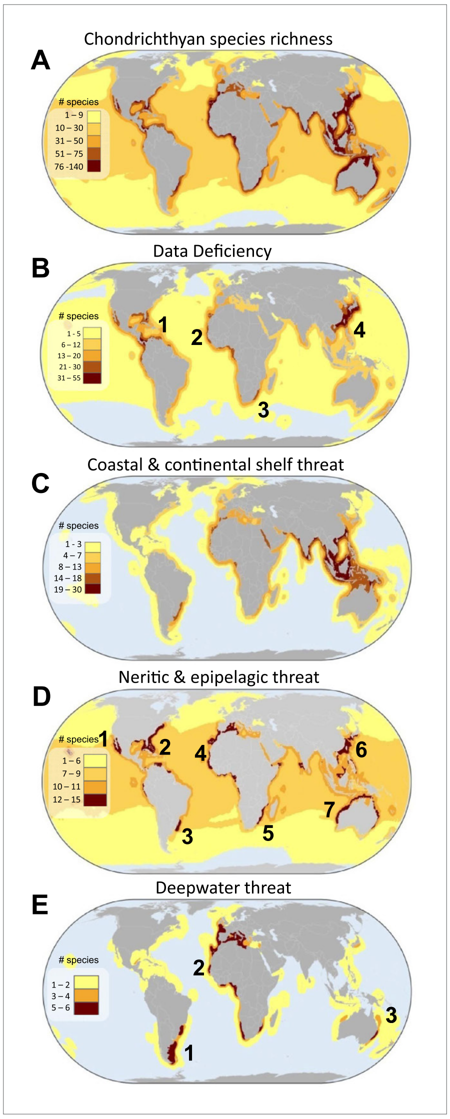

Figure 7. Global patterns of marine chondrichthyan diversity, threat and knowledge. (**A**) Total chondrichthyan richness, (**B**) the number of Data Deficient and threat by major habitat: (**C**) coastal and continental shelf (<200 m depth), (**D**) neritic and epipelagic (<200 m depth), and (**E**) deepwater slope and abyssal plain (>200 m) habitats. Numbers expressed as the total number of species in each 23,322 km^2 cell. The numbers are hotspots refereed to in the text.
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species level (***Fischer et al., 2012***). To complement improved catch landings data, we recommend the development of repeat regional assessments of the Red List Status of chondrichthyans to provide an early warning of adverse changes in status and to detect and monitor the success of management initiatives and interventions. Aggregate Red List Threat indices for chondrichthyans, like those available for mammals, birds, amphibians, and hard corals (***Carpenter et al., 2008***) would provide one of the few global scale indicators of progress toward international biodiversity goals (***Walpole et al., 2009***; ***Butchart et al., 2010***).

Our global status assessment of sharks and rays reveals the principal causes and severity of global marine biodiversity loss, and the threat level they face exposes a serious shortfall in the conservation management of commercially-exploited aquatic species (***McClenachan et al., 2012***). Chondrichthyans have slipped through the jurisdictional cracks of traditional national and international management authorities. Rather than accept that many chondrichthyans will inevitably be driven to economic, ecological, or biological extinction, we warn that dramatic changes in the enforcement and implementation of the conservation and management of threatened chondrichthyans are urgently needed to ensure a healthy future for these iconic fishes and the ecosystems they support.

Methods

IUCN Red List Assessment process and data collection

We applied the Red List Categories and Criteria developed by the International Union for Conservation of Nature (IUCN) (***IUCN, 2004***) to 1,041 species at 17 workshops involving more than 300 experts who incorporated all available information on distribution, catch, abundance, population trends, habitat use, life histories, threats, and conservation measures.

Some 105 chondrichthyan fish species had been assessed and published in the 2000 Red List of Threatened Species prior to the initiation of the Global Shark Red List Assessment (GSRLA). These assessments were undertaken by correspondence and through discussions at four workshops (1996—London, UK, and Brisbane, Australia; 1997—Noumea, New Caledonia, and 1999—Pennsylvania, USA). These assessments applied earlier versions of the IUCN Red List Criteria and, where possible, were subsequently reviewed and updated according to version 3.1 Categories and Criteria during the GSRLA. The IUCN Shark Specialist Group (SSG) subsequently held a series of 13 regional and thematic Red List workshops in nine countries around the world (***Table 8***). Prior to the workshops, each

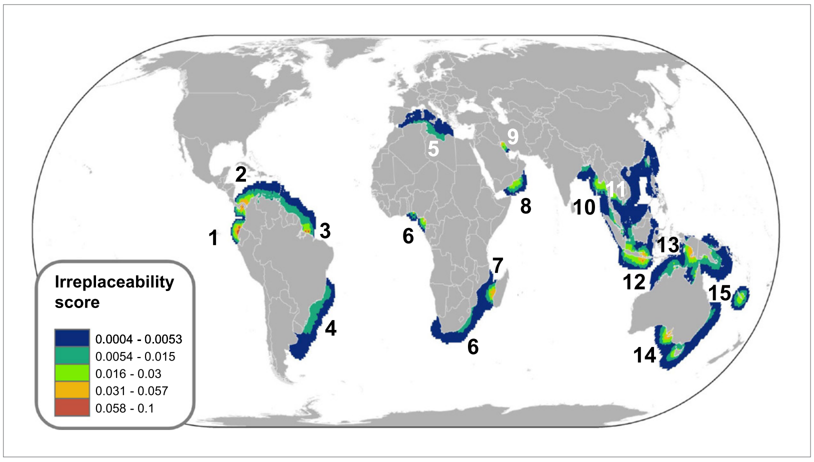

Figure 8. Irreplaceability hotspots of the endemic threatened marine chondrichthyans. Endemics were defined as species with an Extent of Occurrence of <500,000 km^2 (n = 66). Irreplaceable cells with the greatest number of small range species are shown in red, with blue cells showing areas of lower, but still significant irreplaceability. Irreplaceability is the sum of the inverse of the geographic range sizes of all threatened endemic species in the cell. A value of 0.1 means that on average a single cell represents one tenth of the global range of all the species present in the cell. The numbers are hotspots referred to in the text.
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participant was asked to select species for assessment based on their expertise and research areas. Where possible, experts carried out research and preparatory work in advance, thus enabling more synthesis to be achieved during each workshop. SSG Red List-trained personnel facilitated discussion and consensus sessions, and coordinated the production of global Red List Assessments for species in each region. For species that had previously been assessed, participants provided updated information and assisted in revised assessments. Experts completed assessments for some wide-ranging, globally distributed species over the course of several workshops. In total, 302 national, regional, and international experts from 64 countries participated in the GSRLA workshops and the production of assessments. All Red List Assessments were based on the collective knowledge and pooled data from dedicated experts

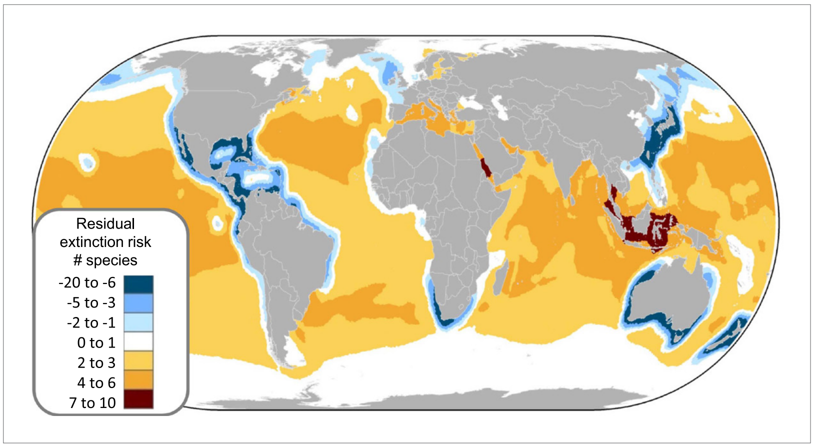

Figure 9. Spatial variation in the relative extinction risk of marine chondrichthyans. Residuals of the relationship between total number of data sufficient chondrichthyans and total number of threatened species per cell, where positive values (orange to red) represent cells with higher threat than expected for their richness alone.
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Table 5. Scientific and conservation priority according to threat, knowledge and endemicity by FAO Fishing Area

FAO Fishing Area (ranked priority)	Threatened species (% of total, n = 181)	Data Deficient species (% of total, n = 487)	Number of endemic species (threatened endemics)	Threatened endemic species
(1) Indian, Eastern	67 (37.0)	69 (14.2)	58 (5)	*Atelomycterus baliensis, Himantura fluviatilis, Zearaja maugeana, Trygonorrhina melaleuca, Urolophus orarius*
(2) Pacific, Western Central	76 (42.0)	81 (16.6)	51 (14)	*Glyphis glyphis, Aulohalaelurus kanakorum, Hemitriakis leucoperiptera, Brachaelurus colcloughi, Hemiscyllium hallstromi, H. strahani, Himantura hortlei, H. lobistoma, Pastinachus solocirostris, Aptychotrema timorensis, Rhinobatos jimbaranensis, Rhynchobatus* sp. nov. A, *Rhynchobatus springeri, Urolophus javanicus*
(3) Pacific, Northwest	48 (26.5)	116 (23.8)	80 (6)	*Benthobatis yangi, Narke japonica, Raja pulchra, Squatina formosa, S. japonica, S. nebulosa*
(4) Indian, Western	61 (33.7)	104 (21.4)	62 (8)	*Carcharhinus leiodon, Haploblepharus kistnasamyi, H. favus, H. punctatus, Pseudoginglymostoma brevicaudatum, Electrolux addisoni, Dipturus crosnieri, Okamejei pita*
(5) Atlantic, Western Central	32 (17.7)	81 (16.6)	62 (4)	*Diplobatis colombiensis, D. guamachensis, D. ommata, D. pictus*
(6) Pacific, Southwest	34 (18.8)	49 (10.1)	28	
(7) Atlantic, Southwest	52 (28.7)	52 (10.7)	37 (19)	*Galeus mincaronei, Schroederichthys saurisqualus, Mustelus fasciatus, M. schmitti, Atlantoraja castelnaui, A. cyclophora, A. platana, Rioraja agassizii, Sympterygia acuta, Benthobatis kreffti, Dipturus mennii, Gurgesiella dorsalifera, Rhinobatos horkelii, Zapteryx brevirostris, Rhinoptera brasiliensis, Squatina argentina, S. guggenheim, S. occulta, S. punctata*
(8) Atlantic, Southeast	37 (20.4)	51 (10.5)	13	
(9) Atlantic, Eastern Central	42 (23.2)	44 (9.0)	6	
(10) Pacific, Southeast	26 (14.4)	67 (13.8)	32 (3)	*Mustelus whitneyi, Triakis acutipinna, T. maculata*
(11) Pacific, Eastern Central	20 (11.0)	52 (10.7)	19 (2)	*Urotrygon reticulata, U. simulatrix*
(12) Atlantic, Northeast	33 (18.2)	23 (4.7)	8	
(13) Atlantic, Northwest	22 (12.2)	17 (3.5)	3 (1)	*Malacoraja senta*
(14) Mediterranean & Black Sea	34 (18.8)	16 (3.3)	3 (1)	*Leucoraja melitensis*
(15) Pacific, Northeast	9 (5.0)	11 (2.3)	0	
(16) Indian, Antarctic	1 (0.6)	4 (0.8)	2	
(17) Atlantic, Antarctic	1 (0.6)	4 (0.8)	2	
(18) Pacific, Antarctic	0	3 (0.6)	0	
(19) Arctic Sea	0	0	0	

Endemics were defined as those species found only within a single FAO Fishing Area. FAO Fishing Areas were ranked according to greatest species richness, percent threatened species, percent Data Deficient species, number of endemic species and number of threatened endemic species.

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across the world, ensuring global consultation and consensus to achieve the best assessment for each species with the knowledge and resources available ('Acknowledgements'). Any species assessments not completed during the workshops were finalized through subsequent correspondence among experts.

The SSG evaluated the status of all described chondrichthyan species that are considered to be taxonomically valid up to August 2011 (see "Systematics, missing species and species coverage" below). Experts compiled peer-reviewed Red List documentation for each species, including data on: systematics, population trends, geographic range, habitat preferences, ecology, life history, threats, and conservation measures. The SSG assessed all species using the IUCN Red List Categories and Criteria version 3.1 (***IUCN, 2001***). The categories and their standard abbreviations are: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), and Data Deficient (DD). Experts further coded each species according to the IUCN Habitats, Threats and Conservation Actions Authority Files, enabling analysis of their habitat preferences, major threats and conservation action requirements. SSG Program staff entered all data into the main data fields in the IUCN Species Information Service Data Entry Module (SIS DEM) and subsequently transferred these data into the IUCN Species Information Service (SIS) in 2009.

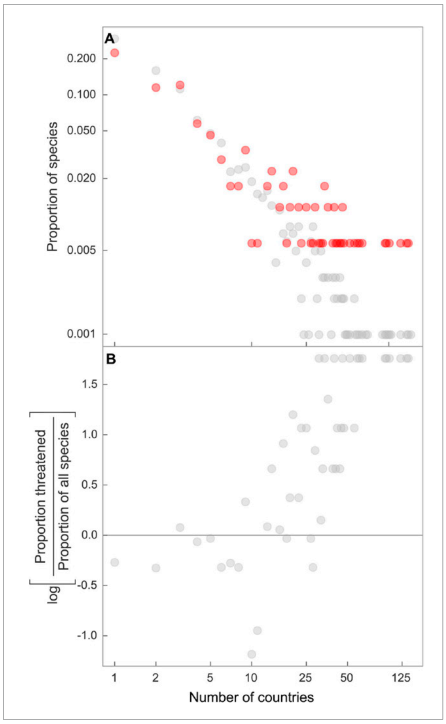

Figure 10. Elevated threat in chondrichthyans with the largest geographic ranges, spanning the greatest number of national jurisdictions. Frequency distribution of number of jurisdictions spanned by all chondrichthyans (black, n = 1,041) and threatened species only (red, n = 174), for (**A**) country EEZs, and (**B**) the overrepresentation of threatened species spanning a large number of country EEZs, shown by the log ratio of proportion of threatened species over the proportion of all species. The proportion of threatened species is greater than the proportion of all species where the log ratio = 0, which corresponds to range spans of 16 and more countries.
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Systematics, missing species and species coverage

The SSG collated data on order, family, genus, species, taxonomic authority, commonly-used synonyms, English common names, other common names, and taxonomic notes (where relevant). For taxonomic consistency throughout the species assessments, the SSG followed Leonard J V Compagno's 2005 Global Checklist of Living Chondrichthyan Fishes (***Compagno, 2005***), only deviating from this where there was extensive opposing consensus with a clear and justifiable alternative, as adjudicated by the IUCN SSG's Vice Chairs of Taxonomy, David E Ebert and William T White.

Keeping pace with the total number of chondrichthyans is a challenging task, especially given the need to balance immediacy against taxonomic stability. One-third of all species have been described in the past thirty years. Scientists have described a new chondrichthyan species, on average, almost every 2–3 weeks since the 1970s (***Last, 2007***; ***White and Last, 2012***). Since Leonard V J Compagno completed the global checklist in 2005, scientists have recognized an additional ~140 species (mostly new) living chondrichthyan species. This increase in the rate of chondrichthyan descriptions in recent years is primarily associated with the lead up to the publication of a revised treatment of the entire chondrichthyan fauna of Australia (***Last and Stevens, 2009***), requiring formal descriptions of previously undescribed taxa. In particular, three CSIRO special publications published in 2008 included descriptions of 70 previously undescribed species worldwide (***Last et al., 2008a***, ***2008b***, ***2008c***). The number of new species described in 2006, 2007 and 2008 was 21, 23, and 81, respectively, with all but nine occurring in the Indo–West Pacific. Additional nominal species of chondrichthyans are also included following resurrection of previously unrecognized species such as the resurrection of *Pastinachus atrus* for the Indo–Australian region, previously considered a synonym of *P. sephen* (**Last and Stevens, 1994**). Scientists excluded some nominal species of dubious taxonomic validity from this assessment. Thus, the total number of chondrichthyan species referred to in this paper (1,041) does not include all recent new or resurrected species, which require future work for their inclusion in the GSRLA.

Many more as yet undescribed chondrichthyan species exist. The chondrichthyan faunas in several parts of the world (e.g., the northern Indian Ocean) are poorly known and a large number of species are likely to represent complexes of several distinct species that require taxonomic resolution, for example some dogfishes, skates, eagle rays, and stingrays (**Iglésias et al., 2010**; **White and Last, 2012**). Many areas of the Indian and Pacific Oceans are largely unexplored and, given the level of micro-endemism documented for a number of chondrichthyan groups, it is likely that many more species will be discovered in the future (**Last, 2007**; **Naylor et al., 2012**). For example, recent surveys of Indonesian fish markets revealed more than 20 new species of sharks out of the approximately 130 recorded in total (**White et al., 2006**; **Last, 2007**; **Ward et al., 2008**).

Table 6. Progress toward regional and international RFMO management measures for sharks and rays

1. Bans on 'finning' (the removal of a shark's fins and discarding the carcass at sea) through most RFMOs (**Fowler and Séret, 2010**);
2. North East Atlantic Fisheries Commission (NEAFC) bans on directed fishing for species not actually targeted within the relevant area (Spiny dogfish [*Squalus acanthias*], Basking shark [*Cetorhinus maximus*], Porbeagle shark [*Lamna nasus*]) (**NEAFC, 2009**);
3. Convention on the Conservation of Antarctic Marine Living Resources bans on 'directed' fishing for skates and sharks and bycatch limits for skates (**CCMLR, 2011**);
4. A Northwest Atlantic Fisheries Organization (NAFO) skate quota (note: this has consistently been set higher than the level advised by scientists since its establishment in 2004) (**NAFO, 2011**);
5. International Commission for the Conservation of Atlantic Tunas (ICCAT) bans on retention, transshipment, storage, landing, and sale of Bigeye Thresher (*Alopias superciliosus*), and Oceanic whitetip shark (*Carcharhinus longimanus*), and partial bans (developing countries excepted under certain circumstances) on retention, transshipment, storage, landing, and sale of most hammerheads (*Sphyrna* spp.), and retention, transshipment, storage, and landing (but not sale) of Silky shark (*Carcharhinus falciformis*) (**Kyne et al., 2012**);
6. An Inter-American Tropical Tuna Commission (IATTC) ban on retention, transshipment, storage, landing, and sale of Oceanic whitetip sharks (**IATTC, 2011**);
7. An Indian Ocean Tuna Commission (IOTC) ban on retention, transshipment, storage, landing, and sale of thresher sharks-with exceptionally low compliance and reportedly low effectiveness (**IOTC, 2011**); and,
8. A Western and Central Pacific Fisheries Commission ban on retention, transshipment, storage, and landing (but not sale) of Oceanic whitetip sharks (**Clarke et al., 2013**).

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Distribution maps

SSG experts created a shapefile of the geographic distribution for each chondrichthyan species with GIS software using the standard mapping protocol for marine species devised by the IUCN GMSA team (http://sci.odu.edu/gmsa/). The map shows the Extent of Occurrence of the species cut to one of several standardized basemaps depending on the ecology of the species (i.e., coastal and continental shelf, pelagic and deepwater). The distribution maps for sharks are based on original maps provided by the FAO and Leonard JV Compagno. Maps for some of the batoids were originally provided by John McEachran. New maps for recently described species were drafted where necessary. The original maps were updated, corrected, or verified by experts at the Red List workshops or out-of-session assessors and SSG staff and then sent to the GMSA team who modified the shapefiles and matched them to the distributional text within the assessment.

Occurrence and habitat preference

SSG assessors assigned countries of occurrence from the 'geographic range' section of the Red List documentation and classified species to the FAO Fishing Areas (http://www.iucnredlist.org/technical-documents/data-organization) in which they occur (***Figure 2—figure supplement 1***). Each species was coded according to the IUCN Habitats Authority File (http://www.iucnredlist.org/technical-documents/classification-schemes/habitats-classification-scheme-ver3). These categorizations are poorly developed and often irrelevant for coastal and offshore marine animals. For the purposes of analysis presented here we assigned chondrichthyans to five unique habitat-lifestyle combinations (coastal and continental shelf, pelagic, meso- and bathypelagic, deepwater,

Table 7. Management recommendations: the following actions would contribute to rebuilding threatened chondrichthyan populations and properly managing associated fisheries

Fishing nations and regional fisheries management organizations (RFMOs) are urged to:
1. Implement, as a matter of priority, scientific advice for protecting habitat and/or preventing overfishing of chondrichthyan populations;
2. Draft and implement Plans of Action pursuant to the International Plan Of Action (IPOA–Sharks), which include, wherever possible, binding, science-based management measures for chondrichthyans and their essential habitats;
3. Significantly increase observer coverage, monitoring, and enforcement in fisheries taking chondrichthyans;
4. Require the collection and accessibility of species-specific chondrichthyan fisheries data, including discards, and penalize non-compliance;
5. Conduct population assessments for chondrichthyans;
6. Implement and enforce chondrichthyan fishing limits in accordance with scientific advice; when sustainable catch levels are uncertain, set limits based on the precautionary approach;
7. Strictly protect chondrichthyans deemed exceptionally vulnerable through Ecological Risk Assessments and those classified by IUCN as Critically Endangered or Endangered;
8. Prohibit the removal of shark fins while onboard fishing vessels and thereby require the landing of sharks with fins naturally attached; and,
9. Promote research on gear modifications, fishing methods, and habitat identification aimed at mitigating chondrichthyan bycatch and discard mortality.
National governments are urged to:
10. Propose and work to secure RFMO management measures based on scientific advice and the precautionary approach;
11. Promptly and accurately report species-specific chondrichthyan landings to relevant national and international authorities;
12. Take unilateral action to implement domestic management for fisheries taking chondrichthyans, including precautionary limits and/or protective status where necessary, particularly for species classified by IUCN as Vulnerable, Endangered or Critically Endangered, and encourage similar actions by other Range States;
13. Adopt bilateral fishery management agreements for shared chondrichthyan populations;
14. Ensure active membership in Convention on International Trade in Endangered Species (CITES), Convention for the Conservation of Migratory Species (CMS), RFMOs, and other relevant regional and international agreements;
15. Fully implement and enforce CITES chondrichthyan listings based on solid non-detriment findings, if trade in listed species is allowed;

Table 7. Continued on next page

and freshwater) mainly according to depth distribution and, to a lesser degree, position in the water column. The pelagic group includes both neritic (pelagic on the continental shelf) and epipelagic oceanic (pelagic in the upper 200 m of water over open ocean) species. Species habitats were classified based on the findings from the workshops combined with a review of the primary literature, FAO fisheries guides and field guides (**Cavanagh et al., 2003**; **Cavanagh and Gibson, 2007**; **Cavanagh et al., 2008**; **Gibson et al., 2008**; **Camhi et al., 2009**; **Kyne et al., 2012**). Species habitat classifications tended to be similar across families, but for some species the depth distributions often spanned more than one depth category and for these species habitat was assigned according to the predominant location of each species throughout the majority of its life cycle (**Compagno, 1990**). This issue was mainly confined to coastal and continental shelf species that exhibited distributions extending down the continental slopes (e.g., some *Dasyatis*, *Mustelus*, *Rhinobatos*, *Scyliorhinus*, *Squalus*, and *Squatina*). We caution that some of the heterogeneity in depth distribution or unusually large distributions may reflect taxonomic uncertainty and the existence of species complexes (**White and Last, 2012**). We defined the deep sea as beyond the continental and insular shelf edge at depths greater than or equal to 200 m. Coastal and continental shelf includes predominantly demersal species (those spending most time dwelling on or near the seabed), and excluded neritic chondrichthyans. Pelagic species included macrooceanic and tachypelagic ocean-crossing epipelagic sharks with circumglobal distributions as well as sharks suspected of ocean-crossing because they exhibit circumglobal but disjunct distributions, for example Galapagos shark (*Carcharhinus galapagensis*).

Our classification resulted in a total of 33 obligate freshwater and 1,008 marine and euryhaline chondrichthyans of which 482 species were found predominantly in coastal and continental shelf, 39 in pelagic, 479 in deepwater, and eight in meso- and bathypelagic habitats. To evaluate whether the geographic patterns of threat are robust to alternate unique or multiple habitat classifications we considered two alternate classification schemes, one where species were classified into a single habitat and another where species were classified in one or more habitats. The alternate unique classification scheme yielded 42 pelagic (**Camhi et al., 2009**), and 452 deepwater chondrichthyans (**Kyne and Simpfendorfer, 2007**), leaving 517 coastal and continental shelf and 33 obligate freshwater species (totaling 1,044, based on an

Table 7. Continued

16. Propose and support the listing of additional threatened chondrichthyan species under CITES and CMS and other relevant wildlife conventions;
17. Collaborate on regional agreements and the CMS migratory shark Memorandum of Understanding (***CMS, 2010***), with a focus on securing concrete conservation actions; and,
18. Strictly enforce chondrichthyan fishing and protection measures and impose meaningful penalties for violations.

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older taxonomic scheme). When species were classified in more than one habitat this resulted in 513 species in the coastal and continental shelf, 564 in deepwater, 54 in pelagic, and 13 meso- and bathypelagic habitats. We found the geographic pattern of threat was robust to the choice of habitat classification scheme, and we present only the unique classification (482 coastal and continental shelf, 39 pelagic, 479 deepwater habitat species).

Major threats

SSG assessors coded each species according to the IUCN Major threat Authority File (http://www.iucnredlist.org/technical-documents/classification-schemes/habitats-classification-scheme-ver3). We coded threats that appear to have an important impact, but did not describe their relative importance for each species.

The term 'bycatch' and its usage in the IUCN Major threat Authority File do not capture the complexity and values of chondrichthyan fisheries. Some chondrichthyans termed 'bycatch' are actually caught as 'incidental or secondary catch' as they are used to a similar extent as the target species or are sometimes highly valued or at least welcome when the target species is absent. 'Unwanted bycatch' refers to cases where the chondrichthyans are not used and fishers would prefer to avoid catching them (Clarke, S personal communication, Sasama Consulting, Shizuoka, Japan). If the levels of unwanted bycatch are severe enough, chondrichthyans can be actively persecuted to avoid negative and costly gear interactions—such as caused the near extirpation of the British Columbian population of Basking shark (*Cetorhinus maximus*) (***Wallace and Gisborne, 2006***).

Red List Assessment

We assigned a Red List Assessment category for each species based on the information above using the revised 2001 IUCN Red List Categories and Criteria (version 3.1; http://www.iucnredlist.org/technical-documents/categories-and-criteria). We provided a rationale for each assessment justifying the classification along with a description of the relevant criteria used in the designation. Data fields also present the reason for any change in Red List categories from previous assessments (i.e., genuine change in status of species, new information on the species available, incorrect data used in previous assessments, change in taxonomy, or previously incorrect criteria assigned to species); the current population trend (i.e., increasing, decreasing, stable, unknown); date of assessment; names of assessors and evaluators (effectively the peer-reviewers); and any notes relevant to the Red List category. The Red List documentation for each species assessment is supported by references to the primary and secondary literature cited in the text.

Data entry, review, correction, and consistency checking

Draft regional Red List Assessments and supporting data were collated and peer-reviewed during the workshops and through subsequent correspondence to produce the global assessment for each species. At least one member of the SSG Red List team was present at each of the workshops to facilitate a consistent approach throughout the data collection, review and evaluation process. Once experts had produced draft assessments, SSG staff circulated summaries (comprised of rationales, Red List Categories and Criteria) to the entire SSG network for comment. As the workshops took place over a >10-year period, some species assessments were reviewed and updated at subsequent workshops or by correspondence. Each assessment received a minimum of two independent evaluations as a part of the peer-review process, either during or subsequent to the consensus sessions (a process involving 65 specialists and experts across 23 participating countries) prior to entry into the database and submission to the IUCN Red List Unit.

SSG Red List-trained personnel undertook further checks of all assessments to ensure consistent application of the Red List Categories and Criteria to each species, and the then SSG Co-chair Sarah L Fowler, thoroughly reviewed every assessment produced from 1996 to 2009. Following the data review and evaluation process, all species assessments were entered in the Species Information Service database and checked again by SSG Red List Unit staff. IUCN Red List Program staff made the final check prior to the acceptance of assessments in the Red List database and publication of assessments and data online (http://www.iucnredlist.org/).

Subpopulation and regional assessments

We included only global species assessments in this analysis. In many cases, subpopulation and regional assessments were developed for species before a global assessment could be made. For very wide-ranging species, such as the oceanic pelagic sharks, a separate workshop was held to combine these subpopulation or regional assessments (**Table 8**). A numerical value was assigned to each threat category in each region where the species was assessed, and where possible these values were then averaged to calculate a global threat category (**Gärdenfors et al., 2001**). Hence, the Red List categories of some species may differ regionally; for example, porbeagle shark (*Lamna nasus*) is classified as VU globally, but CR in the Northeast Atlantic and Mediterranean Sea. Often population trends were not available across the full distribution of a species. In these cases, the degree to which the qualifying threshold was met was modified according to the degree of certainty with which the trend could be extrapolated across the full geographic range of a species. The calculation of the overall Red List category for globally distributed species is challenging, particularly when a combination of two or more of the following issues occurs: (1) trend data are available only for a part of the geographic range; (2) regional trend data or stock assessments are highly uncertain; (3) the species is data-poor in some other regions; (4) the species is subject to some form of management in other regions; and, (5) the species is moderately productive (**Dulvy et al., 2008**). This situation is typified by the Blue shark (*Prionace glauca*) that faces all of these issues. The best abundance trend data come from the Atlantic Ocean, but the different time series available occasionally yield conflicting results; surveys of some parts of the Atlantic exhibit declines of 53–80% in less than three generations (**Dulvy et al., 2008**; **Gibson et al., 2008**), while a 2008 stock assessment conducted for the International Commission for the Conservation of Atlantic Tuna (ICCAT) indicate, albeit with substantial uncertainty, that the North Atlantic Blue shark population biomass is still larger than that required to generate Maximum Sustainable Yield (B_{MSY}) (**Gibson et al., 2008**). The Blue shark is one of the most productive of the oceanic pelagic sharks, maturing at 4–6 years of age with an annual rate of population increase of ~28% per year and an approximate B_{MSY} at ~42% of virgin biomass, B_0 (**Cortés, 2008**; **Simpfendorfer et al., 2008**). While the available data may support the regional listing of the Atlantic population of this species in a threatened category, the assessors could not extrapolate this to the global distribution because the species may be subject to lower fishing mortality in other regions. Hence the Blue shark was listed as NT globally. Further details on this issue and additional data requirements to improve the assessment and conservation of such species are considered elsewhere (**Gibson et al., 2008**; **Camhi et al., 2009**).

Red Listing marine fishes

We assessed most threatened chondrichthyans (81%, n = 148 of 181) using the Red List population reduction over time Criterion A. Only one of the threatened species, the Skate (*Dipturus*) was assessed under the higher decline thresholds of the A1 criterion, where 'population reduction in the past, where the causes are clearly reversible AND understood AND have ceased'. The remaining threatened species were assessed using the IUCN geographic range Criterion B (n = 29) or the small population size and decline Criterion C (n = 4: Borneo shark *Carcharhinus borneensis*, Colclough's shark *Brachaelurus colcloughi*, Northern river shark *Glyphis garricki*, and Speartooth shark *Glyphis glyphis*). The Criterion A decline assessments were based on statistical analyses and critical review of a tapestry of local catch per unit effort trajectories, fisheries landings trajectories (often at lower taxonomic resolution), combined with an understanding of fisheries selectivity and development trajectories.

We assessed most chondrichthyans using the Red List criterion based on population reduction over time (Criterion A). The original thresholds triggering a threatened categorization were Criterion A1: VU 20%; EN 50%; and CR 80% decline over the greater of the past (A1) or future (A2) 10 years or three generations (IUCN Categories and Criteria version 2.3). IUCN raised these thresholds in 2001 to VU, ≥30%; EN, ≥50%; and CR, ≥80% decline over the greater of 10 years or three generations in the past (A2), future (A3) and ongoing (A4), and changed A1 to a reduction over the past 10 yrs or 3 generations of VU ≥50%; EN ≥70%; CR ≥90%, where the causes of reduction are understood AND have ceased AND are reversible. This was in response to concerns that the

Table 8. The locations, dates, number of participants and the number of countries represented at each of the SSG Red List workshops, along with unique totals

Red List workshop	Location	Date	Participants	Countries
Australia and Oceania	Queensland, Australia	March 2003	26	5
South America	Manaus, Brazil	June 2003	25	8
Sub-equatorial Africa	Durban, South Africa	September 2003	28	9
Mediterranean	San Marino	October 2003	29	15
Deep sea sharks	Otago Peninsula, New Zealand	November 2003	32	11
North and Central America	Florida, USA	June 2004	55	13
Batoids (skates and rays)	Cape Town, South Africa	September 2004	24	11
Expert Panel Review	Newbury, UK	March 2005	12	5
Northeast Atlantic	Peterborough, UK	February 2006	25	9
West Africa	Dakar, Senegal	June 2006	25	12
Expert Panel Review	Newbury, UK	July 2006	9	12
Pelagic sharks	Oxford, UK	February 2007	18	11
Northwest Pacific/ Southeast Asia	Batangas, Philippines	June/July 2007	23	13
		Totals	227	57

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original thresholds were too low for managed populations that are being deliberately fished down to MSY (typically assumed to be 50% of virgin biomass under Schaeffer logistic population growth) (***Reynolds et al., 2005***). This revision was designed to improve consistency between fisheries limit reference points and IUCN thresholds reducing the likelihood of false alarms—where a sustainably exploited species incorrectly triggers a threat listing (***Dulvy et al., 2005***; ***Porszt et al., 2012***). Empirical testing shows that this has worked and demonstrates that a species exploited at fishing mortality rates consistent with achieving MSY (F_{MSY}) would lead to decline rates that would be unlikely to be steep enough to trigger a threat categorization under these new thresholds (***Dulvy et al., 2005***).

It is incontrovertible that a species that has declined by 80% over the qualifying time period is at a greater relative risk of extinction than another that declined by 40% (in the same period). Regardless, there may be a wide gap in the population decline trajectory between the point at which overfishing occurs and the point where the absolute risk of extinction becomes a real concern (***Musick, 1999a***). In addition, fisheries scientists have expressed concern that decline criteria designed for assessing the extinction risk of a highly productive species may be inappropriate for species with low productivity and less resilience (***Musick, 1999a***), although this was addressed with the use of generation times to rescale decline rates to make productivity comparable (***Reynolds et al., 2005***; ***Mace et al., 2008***). In response to concerns that IUCN decline thresholds are too low and risk false alarms, the American Fisheries Society (AFS) developed alternate decline criteria (***Musick, 1999a***) to classify North American marine fish populations (***Musick et al., 2000***). This approach only categorizes species that have undergone declines of 70–99% over the greater of three generations or 10 years. Nonetheless, most of the species so listed by AFS also appear on the relevant IUCN Specialist Group lists and vice versa, although the risk categories are slightly different. The reason for the concordance is that in most instances the decline had far exceeded 50% over the appropriate timeframe long before it was detected. Consequently, SSG scientists generally agreed in assigning threat categories to species that had undergone large declines, but many were reluctant to assign a VU classification to species that were perceived to be at or near 50% virgin population levels and presumably near B_{MSY}. In practice, the latter were usually classified as NT unless other circumstances (highly uncertain data, combined with widespread unregulated fisheries) dictated a higher level of threat according to the precautionary principle.

Statistical analysis

Modeling correlates of threat

Vulnerability to population decline or extinction is a function of the combination of the degree to which intrinsic features of a species' behavior, life history and ecology (sensitivity) may reduce the capacity of a species to withstand an extrinsic threat or pressure (exposure). We tested the degree to which intrinsic life histories and extrinsic fishing activity influenced the probability that a chondrichthyan species was threatened. Threat category was modeled as a binomial response variable; with LC species assigned a score of 0, and VU, EN & CR species assigned a 1. We used maximum body length (cm), geographic range size (Extent of Occurrence, km^2), and depth range (maximum–minimum depth, m) as indices of intrinsic sensitivity, and minimum depth (m) and mean depth (maximum–minimum depth/2) as a measure of exposure to fishing activity. All variables were standardized to *z*-scores by subtracting the mean and dividing by the standard deviation to minimize collinearity (variance inflation factors were less than 2). Mean depth was not included in model evaluation as it was computed from, and hence, correlated to minimum depth (Spearman's $\rho = 0.52$). We fitted Generalized Linear Mixed-effect Models with binomial error and a logit link to model the probability of a species being threatened, using taxonomic structure as a nested random effect (e.g., order/family/genus) to account for phylogenetic non-independence. The probability of a species *i* being threatened was assumed to be binomially distributed with a mean p_i, such that the linear predictor of p_i was:

$$\log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_{i,j}X_{i,j} + \beta_{i,k}X_{i,k}, \tag{2}$$

where $\beta_{i,j}$ and $\beta_{i,k}$ are the fitted coefficients for life history or geographic range traits *j* and *k*, and $X_{i,j}$ and $X_{i,k}$ are the trait values of *j* and *k* for species *i* (***Tables 4 and 9***). The effect of a one standard deviation increase in the coefficient of interest was computed as:

$$1/\left(1+\exp\left(\beta_0+\beta_1\right)\right)-1/\left(1+\exp\left(\beta_0+(\beta_1*2)\right)\right), \tag{3}$$

following (***Gelman and Hill, 2006***). Models were fitted using the lmer function in the R package lme4 (***Bates et al., 2011***). The amount of variance explained by the fixed effects only and the combined fixed and random effects of the binomial GLMM models was calculated as the marginal R^2GLMM(*m*) and conditional R^2GLMM(*c*), respectively, using the methods described by ***Nagakawa and Schlielzeth (2012)***.

Estimating the proportion of potentially threatened DD species

We predicted the number of Data Deficient species that are potentially threatened based on the maximum body size and geographic distribution traits (***Table 3***; ***Supplementary file 1***). Specifically, based on the explanatory models described above, all variables were $\log_{10}$ transformed and we fitted generalized linear models of increasing complexity assuming a binomial error and logit link (***Equation 2***; ***Table 3***). Model performance was evaluated using Receiver Operating Characteristics by comparing the predicted probability that the species was threatened *p*(THR) against the true observed status (Least Concern = 0, and threatened [VU, EN & CR] = 1) (***Sing et al., 2005***; ***Porszt et al., 2012***). The prediction accuracy was calculated as the Area Under the Curve (AUC) of the relationship between false positive rates and true positive rates, where a false positive is a model prediction of ≥0.5 and true observed status is 0 (or <0.5 and 1) and a true positive is a prediction of ≥0.5 and true observed status is 1 (or <0.5 and 0). True and false positive rates, and accuracy (AUC) were calculated using the R package ROCR (***Sing et al., 2005***). The probability that a DD species was threatened $p(THR)_{DD}$ was predicted based on the available life history and distributional traits. DD species with $p(THR)_{DD} \geq 0.5$ were classified as threatened and <0.5 as Least Concern. This optimum classification threshold was confirmed by comparing accuracy across the full range of possible thresholds (from 0 to 1). We fitted models using the gls function and calculated pseudo-R^2 using the package rms.

With these models we can estimate the number and proportion of species in each category (***Table 1***). We estimated that 68 of 396 DD species are potentially threatened, and hence the remainder (396–68 = 328) is likely to be either Least Concern or Near Threatened. Assuming these species are distributed between these categories according to the observed ratio of NT:LC species of

0.5477 this results in a total of 312 (29.9%) Near Threatened species (132 known + 180 estimated) and 389 (37.4%) Least Concern species (241 known +148 estimated). After apportioning the DD species among threatened (68), NT (312), and LC (389), only 91 (8.7%; 487–396) are likely to be Data Deficient (***Table 1***).

Spatial analysis

The SSG and the GMSA created ArcGIS distribution maps as polygons describing the geographical range of each chondrichthyan depending on the individual species' point location and depth information. Pelagic species distribution maps were digitized by hand from the original map sources. For spatial analyses, we merged all species maps into a single shapefile. We mapped species using a hexagonal grid composed of individual units (cells) that retain their shape and area (~23,322 km^2) throughout the globe. Specifically, we used the geodesic discrete global grid system, defined on an icosahedron and projected to the sphere using the inverse Icosahedral Snyder Equal Area (ISEA) (***Sahr et al., 2003***). A row of cells near longitude 180°E/W was excluded, as these interfered with the spatial analyses (***Hoffmann et al., 2010***). Because of the way the marine species range maps are buffered, the map polygons are likely to extrapolate beyond known distributions, especially for any shallow-water, coastal species, hence not only will range size itself likely be an overestimate, but so will the number of hexagons.

We excluded obligate freshwater species from the final analysis as their distribution maps have yet to be completed. The maps of the numbers of threatened species represent the sum of species that have been globally assessed as threatened, in IUCN Red List categories VU, EN or CR, existing in each ~23,322 km^2 cell. We caution that this should not be interpreted to mean that species existing within that grid cell are necessarily threatened in this specific location, rather that this location included species that are threatened, on average, throughout their Extent of Occurrence. The number of threatened species was positively related to the species richness of cells ($F_{1,\ 14,846}$ = 1.5 e^5, p<0.001, r^2 = 0.91). To remove this first-order effect and reveal those cells with greater and lower than expected extinction risk, we calculated the residuals of a linear regression of the number of threatened species on the number of non-DD species (referred to as data sufficient species). Cells with positive residuals were mapped to show areas of greater than expected extinction risk compared to cells with equal or negative residuals. Hexagonal cell information was converted to point features and smoothed across neighboring cells using ordinary kriging using a spherical model in the Spatial Analyst package of ArcView. Such smoothing can occasionally lead to contouring artefacts, such as the yellow wedge west of southern Africa in ***Figure 7D***, and we caution against over-interpreting marginal categorization changes.

We identified hotspots of threatened endemic chondrichthyans to guide conservation priorities. To describe the potential cost of losing unique chondrichthyan faunas, we calculated irreplaceability scores for each cell. Irreplaceability scores were calculated for each species as the reciprocal of its area of occupancy measured as the number of cells occupied. For example, for a species with an Extent of Occurrence spanning 100 hexagons, each hexagon in its range would have an irreplaceability 1/100 or 0.01 in each of the 100 hexagons of its Extent of Occurrence. The irreplaceability of each cell was calculated by averaging $\log_{10}$ transformed irreplaceability scores of each species in each cell. Averaging irreplaceability scores controls for varying species richness across cells. We calculated irreplaceability both for all chondrichthyans and for threatened species only. Irreplaceability was also calculated using only endemic threatened species, whereby endemicity was defined as species having an Extent of Occurrence of <50,000, 100,000, 250,000 or 500,000 km^2. Different definitions of endemicity gave similar patterns of irreplaceability and we present the results of only the largest-scale definition of endemicity. Hence the irreplaceability of threatened species and particularly the threatened endemic chondrichthyans represents those locations or 'hotspots' (***Myers et al., 2000***) at greatest risk of losing the most unique chondrichthyan biodiversity.

Fisheries catch landings and shark fin exports to Hong Kong

We extracted chondrichthyan landings reported to FAO by 146 countries and territories from a total of 128 countries (as some chondrichthyan fishing nations are overseas territories, unincorporated territories, or British Crown Dependencies) from FishStat (***FAO, 2011***). We categorized landings into 153 groupings, comprised of 128 species-specific categories (e.g., *angular roughshark*, *piked dogfish*, *porbeagle*, *Patagonian skate*, *plownose chimaera*, *small-eyed ray*, etc) and 25 broader *nei* (nei = not elsewhere included) groupings (e.g., such as *various sharks nei*, *threshers sharks nei*, *ratfishes nei*, *raja rays nei*). For each country, all chondrichthyan landings in metric tonnes (t) were averaged over the decade 2000–2009. Landings reported as '<0.5' were assigned a value of 0.5 t. Missing data reported as '.' were

Table 9. Parameter estimates for General Linear Mixed-effects Models testing the probability that a species is threatened p(THR) given either categorical habitat class or continuous measure of depth distribution and maximum size

(A) Habitat category

p(THR) = maximum length + habitat category, random effect = Order/Family/Genus			
Fixed effects	**Standardized coefficient**	**Standard error**	**p-value**
Intercept (Coastal and continental shelf)	0.27	0.33	0.4
Deepwater	−2.01	0.39	<0.001
Pelagic	−0.46	0.94	0.62
Maximum length	2.59	0.69	<0.001
marginal R^2GLMM(*m*) of fixed effects only = 0.40.			
conditional R^2GLMM(*c*) of fixed and random effects = 0.60.			
ΔAIC without taxonomic inclusion = −18.7.			
ΔAIC for differing threat metrics: binomial THR (CR + EN + VU + NT) = −165.7; categorical = −975.6.			

(B) Minimum depth

p(THR) = maximum length + minimum depth, random effect = Order/Family/Genus			
Fixed effects	**Standardized coefficient**	**Standard error**	**p-value**
Intercept	−0.74	0.31	0.015
Minimum depth	−2.73	0.78	<0.001
Maximum length	2.46	0.61	0.002
marginal R^2GLMM(*m*) of fixed effects only = 0.48.			
conditional R^2GLMM(*c*) of fixed and random effects = 0.64.			
ΔAIC without taxonomic inclusion = −12.9.			
ΔAIC for differing threat metrics: binomial THR (CR + EN + VU + NT) = −153.4; categorical = −985.8.			

(C) Maximum depth

p(THR) = maximum depth + maximum length, random effect = Order/Family/Genus			
Fixed effects	**Standardized coefficient**	**Standard error**	**p-value**
Intercept	−0.60	0.28	<0.001
Maximum depth	−2.35	0.54	<0.001
Maximum length	3.03	0.63	<0.001
marginal R^2GLMM(*m*) of fixed effects only = 0.45.			
conditional R^2GLMM(*c*) of fixed and random effects = 0.63.			
ΔAIC without taxonomic inclusion = −17.2.			
ΔAIC for differing threat metrics: binomial THR (CR + EN + VU + NT) = −156.7; categorical = −981.7.			

(D) Depth range

P(THR) = median depth + maximum length, random effect = Order/Family/Genus			
Fixed effects	**Standardized coefficient**	**Standard error**	**p-value**
Intercept	−0.51	0.26	0.002
Depth range	−1.82	0.50	<0.001
Maximum length	3.17	0.64	<0.001
marginal R^2GLMM(*m*) of fixed effects only = 0.42.			
conditional R^2GLMM(*c*) = 0.62.			
ΔAIC without taxonomic inclusion = −22.3.			
ΔAIC for differing threat metrics: binomial THR (CR + EN + VU + NT) = −158.7; categorical = −982.3.			

Table 9. Continued on next page

Table 9. Continued

(E) Geographic range (Extent of Occurrence)			
p(THR) = geographic range + maximum length, random effect = Order/Family/Genus			
Fixed effects	**Standardized coefficient**	**Standard error**	**p-value**
Intercept	−0.50	0.52	0.33
Geographic range	5.22	3.7	0.12
Maximum length	2.16	0.75	0.004
marginal R^2GLMM(m) of fixed effects only = 0.65.			
conditional R^2GLMM(c) = 0.81.			
ΔAIC without taxonomic inclusion = −25.8.			
ΔAIC for differing threat metrics: binomial THR (CR + EN + VU + NT) = −156.5; categorical = −982.9.			

The improvement of model fit by inclusion of phylogenetic random effect was calculated as the difference in AIC (ΔAIC) between the GLMM (with phylogenetic random effect) and a GLM as ΔAIC = AIC(GLMM)-AIC(GLM). *p*(THR) was binomially distributed assuming species that were CR, EN or VU were threatened (1) and LC species were not (0). We present ΔAIC for two other threat classifications, assuming: THR also includes NT species, or THR was a continuous categorical variable ranging from LC = 0 to CR = 5.

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assigned a zero. Total annual chondrichthyan landings are underestimated as data are not reported for 1,522 out of a total count of 13,990 entries in the dataset. Therefore, 11% of chondrichthyan landings reported to the FAO over the 10-year period are 'data unavailable, unobtainable'. We mapped FAO chondrichthyan landings as the national percent share of the average total landings from 2000 to 2009.

For the analysis of landings over time we removed the aggregate category 'sharks, rays, skates, etc' and all nine of the FAO chimaera reporting categories. The 'sharks, rays, skates, etc' FAO reported category comprised 15,684,456 tonnes of the reported catch from all countries during 1950–2009, which is a total of 45% of the total reported catch for this time period. However, the proportion of catch in this category has declined from around 50% of global catch to around 35%, presumably due to better reporting of ray catch and as sharks have declined or come under stronger protection (***Figure 1***). The nine chimaera categories make up a small fraction of the global catch, 249,404.5 tonnes from 1950 to 2009, representing 0.72% of the total catch.

Hong Kong has long served as one of the world's largest entry ports for the global shark fin trade. While fins are increasingly being exported to Mainland China where species-specific trade data is more difficult to obtain, each year (from 1996 to 2001) Hong Kong handled around half of all fin imports (***Clarke et al., 2006***). Data on shark fin exports to Hong Kong were requested directly from the Hong Kong Census and Statistics Department (***Hong Kong Special Administrative Region Government, 2011***). We mapped exports to Hong Kong as the proportion of the summed total weight of the four categories of shark fin exported to Hong Kong in 2010: (1) shark fins (with or without skin), with cartilage, dried, whether or not salted but not smoked (trade code: 3055950), (2) shark fins (with or without skin), without cartilage, dried, whether or not salted but not smoked (3055930), (3) shark fins (with or without skin), without cartilage, salted or in brine, but not dried, or smoked (3056940), and (4) shark fins (with or without skin), with cartilage, salted or in brine, but not dried or smoked (3056930). We could not correct the difference in weight due to product type. To identify the threat classification of the chondrichthyan species in the fin trade, we included records of the most numerous species used in the Hong Kong fin trade as well as those species with the most-valued fins (***Clarke et al., 2006***, ***2007***; ***Clarke, 2008***).

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Author contributions

NKD, SLF, Conception and design, Acquisition of data, Analysis and interpretation of data, Drafting or revising the article, Contributed unpublished essential data or reagents; JAM, CG, Acquisition of data, Drafting or revising the article; RDC, Conception and design, Acquisition of data, Analysis and interpretation of data, Drafting or revising the article; PMK, LRH, SV, Acquisition of data, Analysis and interpretation of data, Drafting or revising the article; JKC, LNKD, MPF, GHB, SRL, Analysis and interpretation of data, Drafting or revising the article; SVF, JCS, JDS, Analysis and interpretation of data, Drafting or revising the article, Contributed unpublished essential data or reagents; CMP, Acquisition of data, Analysis and interpretation of data; CAS, Conception and design, Analysis and interpretation of data, Drafting or revising the article; KEC, Analysis and interpretation of data, Contributed unpublished essential data or reagents; LJVC, Acquisition of data, Drafting or revising the article, Contributed unpublished essential data or reagents; DAE, MRH, WTW, Drafting or revising the article, Contributed unpublished essential data or reagents

Additional files

Supplementary files

• Supplementary file 1. The Data Deficient chondrichthyan species that are potentially threatened.
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• Supplementary file 2. (**A**) IUCN Red List status of chondrichthyans in the fin trade, including (i) families with the most-valued fins, and (ii) the most prevalent species utilized in the Hong Kong fin trade. (**B**) Chondrichthyan species threatened by (i) control measures, and (ii) habitat destruction and degradation, pollution or climate change with the corresponding IUCN threat classification (***Salafsky et al., 2008***). (**C**) Irreplaceable: the 66 threatened endemic sharks and rays ordered in decreasing irreplaceability.
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Major datasets

The following dataset was generated:

Author(s)	Year	Dataset title	Dataset ID and/or URL	Database, license, and accessibility information
The International Union for Conservation of Nature	2013	The IUCN Red List of Threatened Species	http://www.iucnredlist.org/	Publicly available.

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Annex 850

John McManus, "Offshore coral reef damage, overfishing and paths to peace in the South China Sea", *The South China Sea: An International Law Perspective*, Conference Papers (6 Mar. 2015)

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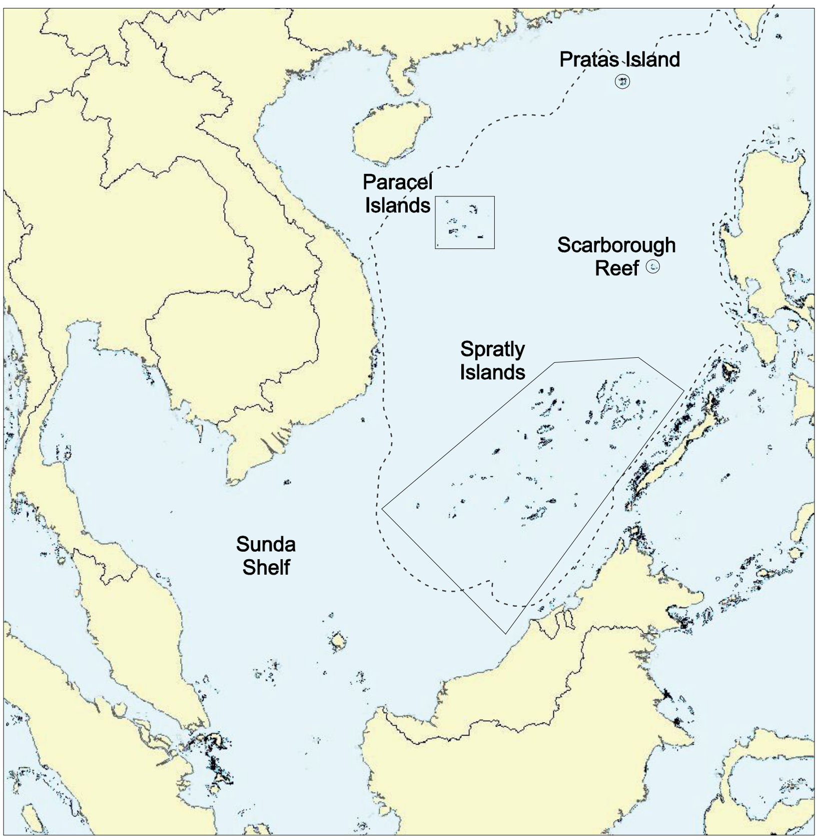
Offshore Coral Reef Damage, Overfishing and Paths to Peace in the South China Sea

John W. McManus, PhD



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Abstract

Offshore coral reefs of the South China Sea are subject to complex overlapping sovereignty claims by up to six regional nations. Escalating tensions have led to widespread structural reinforcement of military outposts on many reefs via dredging and filling. Analysis of satellite images indicated at least 140 km^2 of coral reef damage, including 17 km^2 in essentially permanent damage from filling and channel/harbor dredging, and 123 km^2 of decadal-scale damage from dredging for building materials. This will exacerbate the growing regional overfishing problem. Options to protect resources and lessen tensions include (1) the establishment of a Greater Spratly Islands Peace Park, and (2) the collaborative management of fisheries, the environment and mineral resources across the entire Sea. Both options require freezes on extant claims and activities in support of claims. No matter how it is achieved, regional peace would greatly enhance fisheries stability and economic growth among all claimant nations.

Keywords

coral reef atolls; Spratly Islands; Paracel Islands; Scarborough Reef; tying hands signaling

Introduction

Offshore coral reefs in the South China Sea (SCS), here defined as beyond 50 km from major land masses, include Pratas and Scarborough Atolls, and numerous reefs within the Spratly and Paracel island groups (Figure 1). Each of these reef systems is subject to overlapping sovereignty claims by two or more of the regional coastal nations, including the People's Republic of China (PRC), Republic of China (Taiwan), the Philippines, Brunei, Malaysia and Vietnam. Other offshore coral reefs include many that do not rise to within 5-10 m of the surface, including many poorly known reefs scattered across the numerous banks and continental shelf areas.[1]

Rising tensions in the South China Sea have led to the reinforcement of substrates supporting military outposts on many of the offshore coral reefs which have features near, at, or above tidal levels[2]. The dredging and filling operations conducted in support of this have raised concerns over potential damage to important ecosystems and associated fisheries. These concerns have in turn escalated regional tensions[3].

Much of the tension recently has been associated with activities by the PRC, including the construction and military buildup of seven sand islets[4]. One response has been a diplomatic unification of the Philippines and Vietnam against PRC[5], joined to a limited degree by

[1] J.W. McManus, 'Coral reefs of the ASEAN Region: status and management' (1988) 17(3) *Ambio* 189-193.
[2] Island Tracker, Asia Maritime Transparency Initiative. Available at http://amti.csis.org/island-tracker/; accessed 11 August 2015.
[3] Anon., 'PH tells UN: South China Sea disputes of global concern' (2015) *InterAksion*. Available at http://www.interaksyon.com/article/112369/ph-tells-un-south-china-sea-disputes-of-global-concern; accessed 11 August 2015.
[4] D. Watkins, 'What China Has Been Building in the South China Sea' (2015) *The New York Times*. Available at http://www.nytimes.com/interactive/2015/07/30/world/asia/what-china-has-been-building-in-the-south-china-sea.html?_r=0; accessed 11 August 2015.
[5] C. Thayer, 'The Philippines and Vietnam Forge a Strategic Partnership' (2015) *The Diplomat*. Available at http://thediplomat.com/2015/03/the-philippines-and-vietnam-forge-a-strategic-partnership/; accessed 11 August 2015.

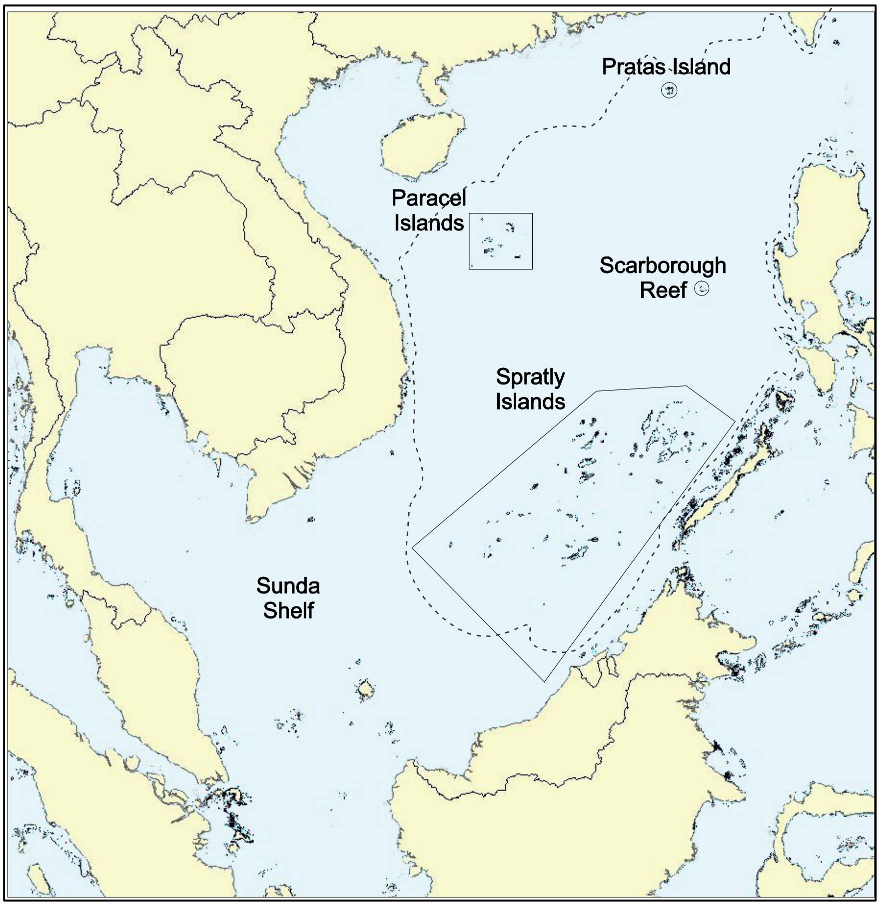

Figure 1. Map of offshore near-surface coral reefs in the South China Sea. Not shown are numerous coral reefs which are several meters below the surface such as those on the Macclesfield Bank and Truro Shoal between the Paracels and Scarborough, the Reed Bank north of the Spratly area, and numerous reefs scattered across the Sunda Shelf. Dashed line indicates shelf areas. (Map modified from one generated by ReefBase.org, by the WorldFish Center, UNEP, WCMC and the Institute for Marine Remote Sensing).

Malaysia[6], and supported by Japan, the United States, and other extra-regional nations[7]. In July, 2015, hearings began at the Permanent Court of Arbitration on a case filed by the Philippines to invalidate the claims by the PRC to areas of the Spratly Islands and Scarborough Reef claimed by the Philippines[8]. At the time of this writing, the PRC has refused to participate in those hearings. This strongly indicates that no resolution is currently possible in the form of a division of sovereignty. Thus, there is a need to consider other options which do not involve such a division. In all cases, compliance – and preferably initiation – by PRC is crucial. This paper will consider a broad range of factors associated with the regional tensions, leading to suggestions for steps toward their easement.

Some General Economic Factors

Shipping

The area between the Spratly Islands and PRC serves as a vital shipping route. Approximately USD 5.3 trillion worth of international trade passes through each year, including up to half of the world's oil shipments[9]. This includes approximately 80% of the shipping trade with PRC[10] and a large part of the shipping trade connecting Europe, Africa and Asia with Japan, Hawaii and the Americas. Serious armed conflict in this area could temporarily close down or delay this shipping, potentially creating losses on the order of USD 14.5 billion dollars per day[11], while ships are redirected around the large island of Borneo or elsewhere. This could have a substantial impact on the world economy, but particularly on that of PRC.

Trade and investment relationships

A clear national priority of each claimant country is economic growth. This is particularly important to policy in the PRC, which is taking steps to establish itself as a leading economic power. One major national goal is the establishment of a 'Maritime Silk Road' involving enhanced trade among nations, including those along a route linking its heavy investments in Africa to mainland China[12]. Despite some successes with the establishment of a new

[6] J. NG and T. Moss, 'Malaysia Toughens Stance with Beijing Over South China Sea' (2015) *The Wall Street Journal*. Available at file:///C:/Users/John/Documents/Websites/Malaysia%20Toughens%20Stance%20With%20Beijing%20Over%20South%20China%20Sea%20-%20WSJ.html; accessed 11 August 2015.

[7] O. Holmes, ''We have short memories': Japan unites with former foes to resist China's empire of sand' (2015) *The Guardian*. Available at http://www.theguardian.com/world/2015/jun/26/we-have-short-memories-japan-unites-with-former-foes-to-resist-chinas-empire-of-sand; accessed 11 August 2015.

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[9] T.M. Cronk, 'Pacom Chief: China's Land Reclamation Has Broad Consequences' (2015) *U.S. Department of Defense News*. Available at http://www.defense.gov/news/newsarticle.aspx?id=129348; accessed 11 August 2015.

[10] W. Englund, 'How the South China Sea could help Beijing level the nuclear playing field' (2015) *The Washington Post*. Available at https://www.washingtonpost.com/news/worldviews/wp/2015/05/14/how-the-south-china-sea-could-be-beijings-path-to-greater-dominance-in-the-pacific/; accessed 11 August 2015.

[11] Calculated as 5.3 trillion divided by 365 days

[12] W. Yale, 'China's maritime silk road' (2015) *The Diplomat*. Available at http://thediplomat.com/2015/04/chinas-maritime-silk-road-gamble/; accessed 12 August 2015.

international bank and other related actions[13], the tensions in the South China Sea continue to work against these economic goals. As this is being written, China is experiencing a major fall in the stock market[14]. The expensive building of islands in the Spratly area and associated military buildup to defend its claims represents a considerable direct economic loss, and the tensions it has inflated add further to instability in the economy and growth of China.

Fisheries

The waters of the South China Sea are heavily overfished. Figure 2 shows a simple Gordon-Schaefer bioeconomic model which illustrates some basic principles. As fishing effort (e.g. number of boats, total tonnage of fishing craft, etc.) in a new fishery increases over time, the yield and gross income from the fishery initially climbs and then falls as parent fish become too scarce to replace previous losses. In an unrealistically ideal ecosystem with a constant environment and level of other predation, the theoretical maximum for yield vs. fishing effort is the top of the curve, known as the 'maximum sustainable yield (MSY)'. In the real world, variability makes the region in the vicinity of MSY unstable for fish stocks. The further to the right of MSY the level of fishing becomes (increasing fishing effort), the more likely a fishing collapse will occur – a wild fluctuation leading to extremely low abundances or local extinction. This is true both for single species fisheries and those with many species[15].

We illustrate the total cost of fishing by the fishing society as a line which increases as fishing effort increases. The difference vertically from this 'loss' line to the gross income curve represents net income. The cost line includes both the direct costs associated with gear, fuel, boat-maintenance, salaries, etc., as well as taxes, payments to investors, and any opportunity costs of spending time fishing as opposed to earning salaries from other jobs. For example, a fisher who is giving up working at a job paying ten dollars per hour has an additional cost to go fishing of ten dollars per hour. In an 'open access' fishery, people increasingly enter the fishery, provided they can meet the necessary start-up costs, until the average person or boat is making no net profit. This point, the 'scramble point', 'bionomic equilibrium' or 'open-access equilibrium' is the only equilibrium point in most unregulated fisheries. It is achieved at the cost of driving fish stocks to where they are greatly reduced in the wild and often very likely to collapse unexpectedly[16]. Thus, fisheries must always be regulated in order to be sustainable.

In unregulated fisheries with low entry costs (e.g. small boats) in areas of coastal crowding and widespread poverty (near zero opportunity costs), the overfishing tends to rapidly progress from population level overfishing (beyond optimal) to ecosystem overfishing (causing unfavorable ecological shifts among local species), to Malthusian overfishing. In the latter condition, a state of desperation and heavy competition with compatriots and outsiders leads to increasing use of fishing gear types that are dangerous, such as air-hose based 'hookah' diving,

[13] Y. Sun, 'How the International Community Changed China's Asian Infrastructure Investment Bank' (2015) *The Diplomat*. Available at http://thediplomat.com/2015/07/how-the-international-community-changed-chinas-asian-infrastructure-investment-bank/; accessed 12 August 2015.

[14] P. Sweeney and L. Jianxin, 'China lets yuan fall further, fuels fears of 'currency war'' (2015) *Reuters*. Available at http://www.reuters.com/article/2015/08/12/us-china-markets-yuan-idUSKCN0QG04U20150812; accessed 12 August 2015.

[15] J.W. McManus, C. Nañola, R. Reyes, and K. Kesner, *Resource Ecology of the Bolinao Coral Reef System* (ICLARM Studies and Reviews 22, 1992) 50-56. Available (free with registration) at http://www.reefbase.org/resource_center/publication/pub_19712.aspx; accessed 12 August 2015.

[16] *Ibid*

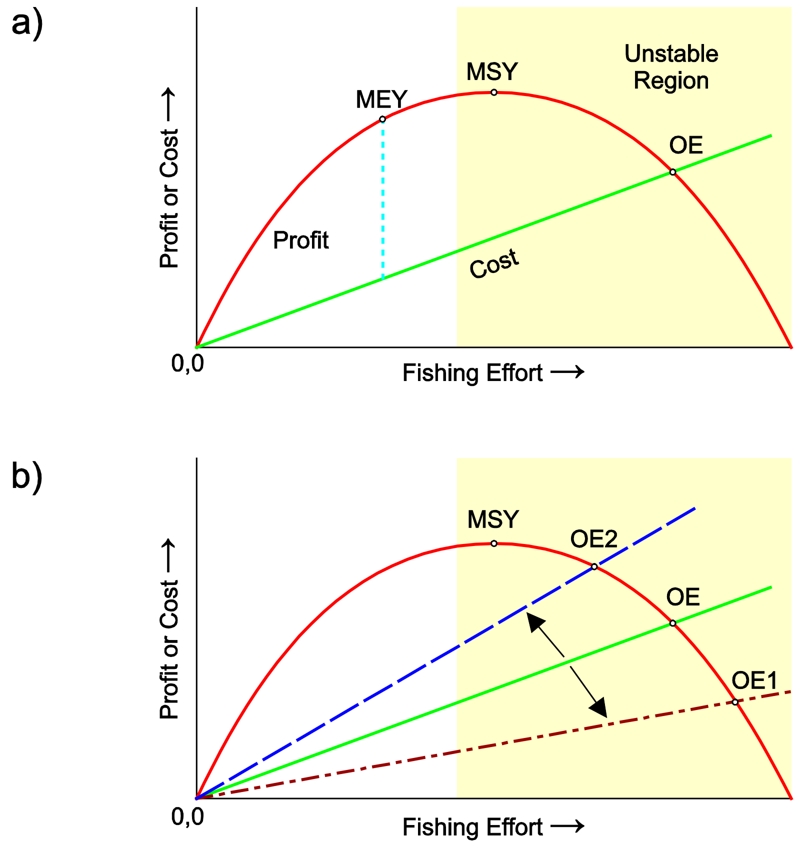

Figure 2. Gordon-Schaefer bioeconomic model. As fishing effort increases along the x-axis, the total cost of the effort increases roughly linearly (straight line). Profits initially increase and then decrease as fish stocks become too sparse to maintain healthy populations (curved line). Shaded areas indicate increasingly unstable stocks as effort increases. MSY at the top of the curve is the traditional 'maximum sustainable yield' point which, due to unpredictability in various factors, is unstable. OE is the 'open-access equilibrium', the point at which the average fisher makes no net income. In the absence of controls and alternative incomes, people tend to enter a fishery (adding effort) up to this point. In (a), MEY represents the greatest net profit to society (dotted line), which is a target point for fishery management. In (b), the cost of fishing can be lowered by means such as blast-fishing or subsidies, making the equilibrium drop (OE1), decreasing societal profit and further destabilizing stocks. Increasing the costs of fishing, such as via taxes or increasing opportunity costs, raises the equilibrium (OE2), improving overall production and helping to stabilize stocks.

and destructive to the fishery, such as poisoning and blast-fishing[17]. Often, the MSY point is used as a 'limit reference point', a point at which one should take strong action to reduce fishing pressure. An appropriate 'target reference point' is the 'Maximum Economic Yield (MEY)' point[18]. At this point, society is getting the optimal net profit from a fishery, and the effort is low enough to keep the fish stocks healthy.

Once a fishery is at the open access equilibrium point, the goal should be to reduce fishing effort until the MEY level is achieved. In the unrealistically ideal case, that would entail a reduction of the fishing effort by 50%. In the real world, because of natural variability and unsymmetrical yield (profit) curves, the reduction goal should be set at 60%[19]. However, there are very few cases in which such reductions have been possible.

The state of Malthusian overfishing is often easy to recognize. People living at near-zero net income tend to have extremely poor housing, few possessions, and often relatives in menial jobs in distant cities sending funds home. Fish in village markets tend to be small – often with a median fish length of 8 - 25 cm or so[20]. This describes the condition along most of the coastline of the South China Sea. Exceptions include the small coastlines of Taiwan and Brunei, where truly poor fishing populations are limited. Thus, it is reasonable to infer that, in general, the coastlines of the South China Sea are fished at more than twice the level at which they should be. This helps to explain why fishers in areas such as the Philippines and Vietnam will often risk going to distant offshore reefs in unsafe craft, often loaded with blasting fishing devices so as to make the risk as worthy as possible.

The Gordon-Schaefer model roughly describes the dynamics of more modern fishing fleets as well. For larger vessels, a means to push the open access equilibrium to the left is to impose taxes, often justified as covering the cost of enforcing fishing regulations. This raises the cost of fishing, and moves the equilibrium appropriately. However, for small-scale fishing, taxation is often impractical. For these situations, the emphasis is often on the development of alternative livelihoods, thereby raising the opportunity cost of fishing. In such fisheries, the use of destructive fishing methods is a way to lower the cost. This moves the equilibrium point to the right, where fish stocks become even more unstable – particularly with the added instabilities associated with damaged fish habitat. In the general case, the cost is lowered via the introduction of more efficient fishing gear, fish-tracking sonar, etc., or via government subsidies such as low-cost loans or subsidized fuel. All of these push the equilibrium to the right, further reducing wild fish stocks to dangerously low levels. Fishing regulation is generally crucial to maintaining sustainability, whereas fishing subsidies generally reduce sustainability.

A 2002 study of the major commercial fisheries of the South China Sea, focused primarily on offshore fishing, indicated that fish stocks at trophic levels three and above, such as tuna, mackerel, jacks, and sharks, underwent a reduction of more than 50% from 1960 to 2000. The exception was Brunei, where fishing is prohibited around the numerous oil rigs and

[17] *Ibid*; D. Pauly, 'On Malthusian overfishing' (1990) 13(1) *Naga, ICLARM Quarterly* 3–4. Available at http://aquaticcommons.org/9417/1/na_2839.pdf; accessed 12 August 2015.

[18] J.F. Caddy and R. Mahon, *Reference points for fisheries management* (FAO Fisheries Technical Paper. No. 347. Rome, FAO, 1995) Chapter 2. Available at www.fao.org/docrep/003/v8400e/v8400e00.HTM; accessed 12 August 2015.

[19] McManus *et al*., *op. cit.* ref. 15.

[20] J.W. McManus, L.A.B. Meñez, K.N. Kesner-Reyes, S.G. Vergara, and M.C. Ablan, 'Coral reef fishing and coral-algal phase shifts: implications for global reef status' (2000) 57(3) *ICES Journal of Marine Science* 572–578.

interconnecting pipes which act as no-fishing reserves. This demonstrates the effectiveness of large marine protected areas in this region[21].

PRC has attempted to unilaterally impose regulations on South China Sea fisheries, including seasonal closures[22] and a mandate for non-PRC fishers to request permission to fish in the Sea[23], presumably aimed at reducing fishing effort. While these regulations are entirely valid means to improve fishery sustainability, their unilaterally imposed nature caused them to backfire. Both Vietnam and the Philippines have responded by encouraging their fishers to increase their fishing effort in protest, and as a means to reinforce claims of national sovereignty[24]. For its part, China has outfitted approximately 50,000 of its marine fishing fleet with location and communications devices to keep them in touch with their military when needed, and is subsidizing fuel for long distance travel[25]. Vietnam is also subsidizing its fishers by funding the construction of improved vessels[26]. This combination of fisheries effort enhancement and subsidy are driving the regional fisheries into a much worse state than the poor state that market forces alone would have induced. Additionally, the occasional arrests of fishers from PRC by the Philippines for harvesting protected species such as sea turtles[27], and the harassment of fishers from the Philippines[28] and Vietnam[29] by PRC, continue to keep regional tensions high.

There have been various proposals to convert portions of the Spratly Island area into protected areas[30]. Others have proposed that the whole of the Spratly Islands be converted to a

[21] V. Christensen, L. R. Garces, G.T. Silvestre and D. Pauly, 'Fisheries Impact on the South China Sea Large Marine Ecosystem: A Preliminary Analysis using Spatially-Explicit Methodology' in G. Silvestre, L. Garces, I. Stobutzki, M. Ahmed, R.A. Valmonte-Santos, C. Luna, L. Lachica-Aliño, P. Munro, V. Christensen and D. Pauly (eds), *Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries* (WorldFish Center Conference Proceedings (67) 51-62. Available at http://www1.worldfishcenter.org/trawl2/publications/assessment/pdf/Chapter-03-FA.pdf; accessed 13 August 2015.

[22] C. Xieyuan (ed), 'South China Sea Fishing Ban Lifted' (2015) *CRIEnglish.com News*. Available at http://english.cri.cn/12394/2015/08/01/4161s889863.htm; accessed 13 August 2015.

[23] G. Cabacungan, R.D. Anda, T. Quismundo, 'Kalayaan mayor urges PH fishers to defy China' (2014) *Inquirer.net*. Available at http://globalnation.inquirer.net/96275/kalayaan-mayor-urges-ph-fishers-to-defy-china; accessed 14 August 2015.

[24] *Ibid*; A. Dien, 'Vietnam lambastes China for fishermen harassment, island building' (2015) *Thanh Nien News*. Available at http://www.thanhniennews.com/politics/vietnam-lambastes-china-for-fishermen-harassment-island-building-47155.html; accessed 14 August 2015.

[25] H.J. Kazianis, 'China's 50,000 Secret Weapons in the South China Sea' (2015) *The National Interest*. Available at http://nationalinterest.org/feature/china%E2%80%99s-50000-secret-weapons-the-south-china-sea-10973; accessed 14 August 2015.

[26] A. Dien, *op. cit.* ref. 24.

[27] Anon., 'Philippines orders nine Chinese fishermen freed after poaching conviction in disputed Spratlys' 9 June 2015 *South China Morning Post*. Available at http://www.scmp.com/news/asia/diplomacy/article/1819283/philippines-orders-nine-chinese-fishermen-freed-after-poaching; accessed 14 August 2015.

[28] S. Lannin, 'South China Sea: Escalating tensions threatening livelihoods of local fishermen' 3 June 2015 *ABC News Online* (Australia). Available at http://www.abc.net.au/news/2015-06-02/fishermen-say-south-china-sea-dispute-threatening-their-livelih/6516138; accessed 14 August 2015.

[29] A Dien *op. cit.* ref. 24.

[30] A. White, 'Priority areas for marine resource management' in J.P. Morgan and M.J. Valencia (eds), *Atlas for Marine Policy in Southeast Asian Seas* (University of California Press, Berkeley, 1983); M.J. Valencia, J.M. Van Dyke, and N.A. Ludwig, *Sharing the Resources of the South China Sea* (University of Hawaii Press, 1999) 187-190.

single international protected area or peace park[31]. During a seven-year intensive study of the coral reef fisheries of Bolinao, Philippines, on the South China Sea, it was noted that heavy Malthusian overfishing tended to drive many species to local rarity or extinction[32]. Every few years, however, the stocks would be temporarily rejuvenated. Because the coastline in both directions for hundreds of miles was likely to be overfished to the same extreme levels, as predicted by the open access equilibrium, attention turned to offshore reefs as a potential source of fish larvae. A compilation of known larval drift times for coral reef fish indicated that the average fish was likely to drift with ocean currents for about a month prior to settling out on a reef. A set of six vector current charts created from records of ship drift were obtained, each representing current patterns typical of a given alternate month. In an early form of particle tracking inter-reef connectivity, hypothetical larvae were initiated within the Spratly Island area, and their likely motions were tracked from vector to vector – accounting for direction, speed and the passage of time. Because of the reversing monsoons and other weather factors, the currents of the South China Sea vary radically over the year, sometimes reversing directions. Thus, the tracking in each alternate monthly case provided different results. At times, the fish could resupply much of the western Philippines. At others, they could supply parts of Brunei, Malaysia and Vietnam. They could also resupply the Paracel Island area and Scarborough Reef, from where a second generation of fish could reach much of Taiwan and mainland China. It was shown that this dense group of offshore reefs could explain why targeted fish species along all of these coastlines do not go extinct amidst the heavy levels of overfishing. This result led to the suggestion in 1992 and 1993 for a Spratly Island International Marine Park[33]. This concept was expanded on in 1995[34], 1997[35] and again in 2010[36], the latter paper using the term Peace Park. The results of the simple initial connectivity study were largely confirmed in terms of the prevention of local extinction by a team in 2011 employing state-of-the-art computer models[37]. Region-wide genetic studies of three reef fish species (the false Moorish idol *Heniochus acuminatus*, the six bar wrasse *Thallasoma hardwickii*, and the threespot dascyllus *Dascyllus trimaculatus*) confirmed that South China Sea connectivity was very high, but indicated that there seem to be some population differences among north-central, western, and southern

[31] J.W. McManus, 'The Spratly Islands: a marine park alternative' (1992) 15(3) *Naga, ICLARM Quarterly* 4-8; J.W. McManus, 'The Spratly Islands: A Marine Park?' (1994) 23(3) *Ambio* 181-186.

[32] McManus *et al., op. cit.* ref. 15.

[33] McManus 1992 and 1993, *op. cit.* ref. 31.

[34] J.W. McManus, 'Large and Small-Scale Marine Protected Areas __ Planning, Investment and Intergenerational Quality of Life' in A.J. Hooten and M.E. Hatziolos (eds), *Sustainable Financing Mechanisms for Coral Reef Conservation: Proceedings of a Workshop. Environmentally Sustainable Development Proceedings Series No. 9* (World Bank, Washington D.C., 1995) 60-71.

[35] J.W. McManus and L.A.B Meñez, 'The proposed Spratly Island international marine park: biological considerations'. Proceedings of the 8th International Coral Reef Symposium, Volume 2 (1997) 1943-1948.

[36] J.W. McManus, K.T. Shao, S.Y. Lin, 'Toward establishing a Spratly Islands International Marine Peace Park: ecological importance and supportive collaborative activities with an emphasis on the role of Taiwan' (2010) 41 *Ocean Development and International Law* 270-280. The term 'Peace Park' was used in this context the previous year by the authors in a presentation at the International Conference on Issues in the South China Sea, 19-20 August 2009 in Taipei, Taiwan, on which the paper was based.

[37] J.T. Kool, C.B. Paris, P.H. Barber, and R.K. Cowen, 'Connectivity and the development of population genetic structure in Indo-West Pacific coral reef communities' (2011) 20 *Global Ecology and Biogeography* 695-706.

subareas. The results suggested that the divisions may be anchored within portions of the Spratly area subject to differing current patterns[38].

At the Philippines-Vietnam Joint Permanent Working Group on Maritime and Ocean Concerns (JPWG-MOC), held in Vietnam in 2007[39], representatives from the Philippines proposed that the Spratly Islands area be converted to a transboundary peace park. This suggestion was reiterated the following year by participants in the Conference on the Results of the Philippines-Vietnam JOMSRE-SCS (JOMSRE I to IV), also in Vietnam[40]. Philippine Ambassador Alberto Encomienda also called for a similar action in 2008 as an implementation of Part IX of the United Nations Convention on the Law of the Sea. This was strongly supported by former Philippine Secretary of the Environment Angel Alcala in 2011[41]. The call for a Spratly Island Peace Park has been supported among the discussions and conclusions in several other scientific papers, including at least one with a PRC co-author[42] and one from a team of PRC scientists[43].

Biodiversity

The South China Sea is a region of very high marine species diversity. Because of a recent emphasis on surveys by the Philippines, Vietnam, PRC and Taiwan, no up-to-date compilation of known species yet exists. Some preliminary species numbers are found in a 2010 compilation of multiple biodiversity surveys[44]. In general, the Philippines and adjacent areas have species numbers which are roughly five to ten times those in a given biotic group to those found in the Caribbean or Hawaii. For example, the Caribbean has approximately 61 species of reef-building corals, while the Philippines and neighbors to the south have more than 600 species. While Hawaii has approximately 420 species of reef fish, the Philippines and southern neighbors have more than 2,200 species (37% of the world's reef fish species)[45]. A recent study has indicated that coral reefs globally may have roughly 830,000 multicellular species, of which 620,000 (about 75%) have yet to be identified[46]. The biogeographic gradient in invertebrate species tends to be higher than that of fish. However, via conservative first order estimation, 37% of the

[38] M.C.A. Ablan, J.W. McManus, C.A. Chen, K.T. Shao, J.D. Bell, A.S. Cabanban, V.S. Tuan and I.W. Arthana, 'Meso-scale transboundary units for the management of coral reefs in the South China Sea Area' (2002) 25(3-4) *NAGA, The WorldFish Center Quarterly* 4-9; C.A. Chen, M.C.A. Ablan, J.W. McManus, J.D. Bell, V.S. Tuan, A.S. Cabanban and K.T. Shao, (2004) 'Population structure and genetic variability of six bar wrasse (*Thallasoma hardwicki*) in northern South China Sea revealed by mitochondrial control region sequences' *Marine Biotechnology* 6 (4): 312-326.

[39] Y.H. Song, 'A marine biodiversity project in the South China Sea: joint efforts made in the SCS Workshop Process' (2011) 26 *The International Journal of Marine and Coastal Law* 119–149.

[40] *Ibid*.

[41] A.C. Alcala, 'A transboundary Peace Park in the Spratlys' (2011) *Dumaguete Metro Post*. Available at http://dumaguetemetropost.com/a-transboundary-peace-park-in-the-spratlys-p1743-98.htm; accessed 18 August 2015.

[42] T.P. Hughes, H. Huang, M.A.L. Young, 'The wicked problem of China's disappearing coral reefs' (2013) 27 *Conservation Biology* 261–269.

[43] M.X. Zhao, K.F. Yu, Q. Shi, T.R. Chen, H.L. Zhang, and T.G. Chen, 'Coral communities of the remote atoll reefs in the Nansha Islands, southern South China Sea' (2013) 185(9) *Environmental monitoring and assessment* 7381-7392.

[44] See McManus *et. al.*, *op. cit.* ref. 36.

[45] The Coral Triangle Atlas online at http://ctatlas.reefbase.org/coraltriangle.aspx; accessed 14 August 2015.

[46] R. Fisher, R.A. O'Leary, S. Low-Choy, K. Mengersen, N. Knowlton, R.E. Brainard, and M.J. Caley, 'Species richness on coral reefs and the pursuit of convergent global estimates' 25 *Current Biology* 500–505.

830,000 reef species globally would lead us to expect that the southern reefs of the South China Sea to hold more than 307,000 multicellular coral reef species. Given the sparse nature of studies in the area, coupled with the isolation of some portions, it would be reasonable to expect that the majority of these have yet to be identified, and a large number of them will be new to science. This indicates that the potential for new medical ‘drugs from the sea’ from these offshore reefs is particularly high.

Parts of the South China Sea are encompassed within the boundaries of the ‘Coral Triangle’, a region of anomalously high marine species diversity extending from the Solomon Islands to eastern Java, Indonesia and northwards to encompass the Philippines. This area is the focus of a major biodiversity conservation effort, the Coral Triangle Initiative. The latter is a partnership among the Philippines, Malaysia, Indonesia, Timor-Leste, Papua New Guinea, and the Solomon Islands, aimed at protecting and managing coral reefs and tuna, and concurrently at helping to alleviate coastal poverty. It has been endorsed and funded by Australia, the United States, the Asia Development Bank, the Global Environment Facility, the Nature Conservancy, the World Wildlife Fund, and others[47]. The actual center of highest marine species diversity is located in the Central Philippines, practically adjacent to the South China Sea[48]. Based on connectivity studies[49], as well as of migration routes of wide-ranging fish including tuna[50], the Spratly Island area may improve the sustainability of fisheries in the Philippines and those as far south as Indonesia. Clearly, environmental damage to the Spratly Islands is inconsistent with this major international cooperative effort. Additionally, it works specifically against regional environmental protection agreements such as Agenda 21 and the Biodiversity Convention, and regional efforts associated with international organizations including the Association of South East Asian Nations, the Southeast Asian Fisheries Development Center, the Coordinating Body for the Seas of Southeast Asia, the World Fish Center, the World Bank, the United Nations Environment Programme, the United Nations Development Programme, the United Nations Food and Agriculture Organization, and other United Nations organizations with coastal activities in the area.

Tourist Potential

There are at least a hundred surface and subsurface coral reefs in the Greater Spratly Islands, and another twenty or so amid the Paracel Islands that would offer world class tourist diving if a peaceful climate were to prevail. In past decades, there had been visits to the Spratly Islands by muro-ami ships[51], in which hundreds of fishers would damage coral while driving fish into nets with weighted ropes[52]. However, this practice has nearly died out. Fishers using blasting

[47] The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF). Available at http://www.coraltriangleinitiative.org/; accessed 16 August 2015.

[48] K.E. Carpenter and V.G. Springer, 'The center of the center of shore fish biodiversity : The Philippine Islands' (2005) 72 Environmental Biology of Fishes 467-480.

[49] McManus (1992) *op. cit.,* ref. 31; Kool *et al., op. cit. ref.* 37.

[50] Valencia *et al. op. cit.* ref. 30 pg. 265.

[51] C.R. Wilkinson and R.W. Buddemeier, 'Global Climate Change and Coral Reefs: Implications for People and Reefs' *Report of the UNEP-IOC-ASPEI-IUCN Global Task Team on the Implications of Climate Change on Coral Reefs*, (IUCN, Gland, Swizerland, 1994) 77. Available at https://cmsdata.iucn.org/downloads/climchng.pdf; accessed 18 August 2015.

[52] J.W. McManus, 'Social and economic aspects of reef fisheries and their management' in N. Polunin and C. Roberts (eds.), *Coral Reef Fisheries*. (Chapman and Hall, London, 1996) 249-181.

devices[53] and poisons still show up in arrests by various claimant countries. However, these methods are rarely used in waters below ten meters of depth, lest many of the fish sink or drift away because of the increasingly difficult task of collecting them in deepening waters. A single blast of a typical ‘bottle bomb’ typically kills coral within a 0.5-1.5 m radius[54], leaving coral in that spot to recover over roughly a 5-10 year period. The near absence of organic pollutants of these far off-shore reefs (except near potentially polluting military outposts) will lead to relatively rapid recovery rates compared to those alongside major land masses, because alongside populated coastlines excessive nutrients make seaweed more likely to outcompete coral following a disturbance[55]. Levels of damage by destructive fishing devices tend to be less in situations where fish are very abundant, because boats become quickly loaded with fish. This means that one need not damage as much habitat to reach one’s harvesting capacity. Given that surface and near surface coral reef area in the Spratly area cover roughly 1,150 square kilometers[56], and the fact that fishing by all gears on those reefs is orders of magnitude sparser than along the coastlines of major regional landmasses, one can be confident that near pristine reefs are easily found. Exceptions will include the areas immediately adjacent to the more than 50 military outposts, in which the troops and associated people will fish quite heavily so as to minimize fuel costs. Additionally, the reefs from which sand has been dredged or on which new islets or islet extensions rest will be severely damaged. Because of their high value, certain easily captured, shallow water species will likely be largely absent across the region, such as certain species of giant clams[57]. Sea turtles, sharks, and large groupers and wrasses have been specifically targeted, especially for markets in PRC, and so their populations are likely much lower now than they were a few decades ago. For example, the nine fishermen from PRC recently released from custody by the Philippines were arrested at Half Moon Shoal with a harvest of 555 sea turtles[58].

Fortunately, recovery for local extinctions of such species is often possible. For instance, giant clams have been restored to many regional reefs[59]. Sea turtle populations in the Hainan are

[53] J. Akamine 'Who is to be blamed? Socio-cultural notes on blast fishing in the Spratly Islands' in Proceedings of the 10th International Coral Reef Symposium (Okinawa, International Society for Reef Studies, 2006) 1427-1433. Available at http://www.reefbase.org/resource_center/publication/icrs.aspx; accessed 18 August, 2015.

[54] J.W. McManus, C.L. Nañola, and R.B. Reyes, 'Effects of some destructive fishing methods on coral cover and potential rates of recovery' (1997) 21(1) *Environmental Management* 69-78; S.B. Saila, L.J. Kocic and J.W. McManus, 'Modelling the effects of destructive fishing practices on tropical coral reefs' (1993) 94 *Marine Ecology Progress Series* 51-60.

[55] J.W. McManus and J.F. Polsenberg, 'Coral-Algal Phase-Shifts on Coral Reefs: Ecological and Environmental Aspects' (2004) 60 *Progress in Oceanography* 263–279.

[56] M. Spalding, C. Ravilious, and E.P. Green, *World Atlas of Coral Reefs* (University of California Press, Berkeley, CA, 2001).

[57] E.D. Gomez, 'Destroyed reefs, vanishing giant clams'. (2015) *Philippine Daily Inquirer*. Available at http://opinion.inquirer.net/84595/destroyed-reefs-vanishing-giant-clams; accessed 20 August, 2015.

[58] Associated Press in Manila op. cit. ref. 27.

[59] E.D. Gomez, S. Mingoa-Licuanan, 'Achievements and lessons learned in restocking giant clams in the Philippines' (2006) 80(1) *Fisheries Research* 46-52.

being restored via rescue and release practices[60]. Large predatory fish have been shown to recover quite well when fishing pressures on them are alleviated for long periods of time[61].

An excellent example of such recovery has been within the very similar coral reef atolls of the Tubbataha Reefs World Heritage Site, directly south of the Spratly area near the center of the Sulu Sea. Two decades ago, they were in a state similar to many of the Spratly reefs most readily accessible shore – low on sharks and other high trophic level species. Now, after more than a decade of protection by rangers living in a structure on pilings on one of the reefs, the fish populations are unusually high[62]. Ecologists have come to understand that most truly pristine reefs in past centuries had more biomass in predatory fish than in their prey, such as herbivorous and plankitvorous fish. This currently very rare situation was enabled by the fact that the prey fish tend to have much higher rates of turn-over than the predators. By 2015, it had become apparent that this state was being approached at Tubbataha. Amidst the massive schools of jacks and other species of predators, there are currently relatively dense populations of sharks, including tiger sharks[63] which are particularly high in the trophic web.

If the existing military outposts of the Spratly and Paracel areas were to support trained park rangers, a substantial amount of natural reef restoration would be possible. Giant clams and other absent shallow water species could be restored via transplantation. The only current resort in the Spratly area is the Malaysian resort at Swallow Reef. Part of its economic success is undoubtedly due to its location in the relatively peaceful southwest, away from the threat of intervention by other claimant nations. The PRC base of Sansha (Woody Island) in the Paracels and the Taiwanese-occupied islands of Taiping (Itu Aba Island) in the northern Spratlys and the Dongsha Islands are being prepared for increasing tourism – with much planning concentrated on protecting the environment[64]. Taiping is notable for its solar power conversion initiative[65], setting the stage for similar ecologically friendly developments among other Spratly Island bases. However, one can achieve much less impact by limiting visitors to live-aboard vessels, as is being done at Tubbataha. Some of the costs of securing the reefs in that case come from entry fees[66]. However, the total economic impact includes the income received at airports from tourists flying in, at the hotels where they stay, at the taxis, shops and restaurants they use, at the dive tour operators, and so forth. A peaceful South China Sea would greatly enhance tourist income across the region. Additionally, it would be a boost to the yacht building and maintenance industry. China ranks eighth among the world's superyacht builders. However, most of the

[60] A. Ruggeri, 'The unlikely sea turtle saviour' (2015) *BBC Travel*. Available at http://www.bbc.com/travel/story/20150521-in-china-saving-sea-turtles-from-soup; accessed 27 August 2015.

[61] G.R. Russ and A.C. Alcala, 'Marine reserves: long-term protection is required for full recovery of predatory fish populations' (2004) 138(4) *Oecologia* 622-627.

[62] M. Dygico, C. Salao, A.B. Honasan, *Tubbataha Reefs: A marine protected area that works* (WWF-Philippines, Quezon City, Philippines, 2006).

[63] B. Gacad, 'Expedition Shark: Why we need to protect these predators: A team of scientists from the Philippines, Europe, and America conduct a 10-day expedition in the Tubbataha Reef' (2015) *Rappler*. Available at: http://www.rappler.com/science-nature/environment/98766-expedition-shark-tubbataha-lamave-marine-conservation; accessed 29 August, 2015.

[64] Han Bin, 'Sansha: youngest Chinese city fast developing' (2015) *CCTV com English*. Accessible at http://english.cntv.cn/2015/07/23/VIDE1437637923545130.shtml; accessed 29 August 2015.

[65] R. Jennings, 'Taiwan's eco-friendly islet in troubled South China Sea: someone big Is watching' (2015) *Forbes*. Accessible at http://www.forbes.com/sites/ralphjennings/2015/07/19/taiwans-eco-friendly-islet-in-troubled-south-china-sea-someone-big-is-watching/; accessed 29 August 2015.

[66] R.F. Subade, 'Mechanisms to capture economic values of marine biodiversity: the case of Tubbataha Reefs UNESCO World Heritage Site, Philippines' (2007) 31 *Marine Policy* 135-142.

yachts are purchased to be used in other parts of the world[67]. Easing unrest in the region would lead to a rise of the yachting industry – another means to boost the regional economy.

Coral Reef Wave Protection and Sea Level Rise

The offshore shallow coral reef atolls of the South China Sea often have a characteristic zonation which includes a wave-breaking reef crest (Figure 3). In areas such as this wherein major typhoons are common, the protection afforded by the reefs from large waves is the major reason why construction of any kind is possible, including military outposts built on pilings. All of the islets in the area are protected by wave-breaking reef structures such as crests or long rows of shallow reef spurs, and none would be likely to exist without them.

Surface breaking coral reefs tend to reduce wave energy by 97%. Of this, 86% is attributed to the wave crest alone, and of what remains, 65% is dissipated along the reef flats behind the crest[68]. The crest is generally about the height of the tides, while usually staying slightly underwater at normal high tides[69]. In this region, the tides range generally to a meter in height or less. Thus, the most significant part of the reef for many purposes is a small elongated 'bump' of a crest, about meter high. Upon these bumps rest not only the futures of any islets and manmade structures in the South China Sea, but also the futures of many coastal populations throughout the tropical and subtropical world. Remarkably little is understood about how these structures grow and maintain themselves amid the constant forces of wave erosion and breakdown by organisms living within the crests. The shallow, wave impacted portions of a geomorphologically significant coral reef grow together as a unit – a highly efficient self-assembling machine which converts wave energy into relatively horizontal water currents, in the process directing these mechanical sources of energy and sunlight into the conversion of oceanic plankton into the most biodiverse ecosystems on Earth. Any significant interference with these processes, particularly involving changes in water flow, runs the risk of disabling the wave protection capacity of the reef. Even in the case that the effects are not visible within a decade or two, they will certainly become important as sea-level rise accelerates within the coming half century or so.

The development of an offshore atoll can take many millions of years. The calcium carbonate reef limestone has built up gradually over time, suffering through periods of exposure to air, rain and land vegetation during low stands of sea level, but generally keeping up (or catching up) with local sea level during periods of rapid rise and/or subsiding sea floors[70]. The Spratly area is replete with examples of reef structures that failed to keep up – the subsurface reef systems. Many groups of shallow atolls in the area sit upon much larger subsurface atolls as small sections that kept up while the rest fell behind, reforming into small atolls. Although many subsurface reef sections are visible through the clear offshore waters on satellite imagery, such as that on Google Earth, these losing reefs may be tens of meters deep at their shallowest. Other

[67] T.L. Wilkinson, 'Why China's ultra-rich haven't warmed to superyachts' (2015) *Fortune*. Accessible at http://fortune.com/2015/02/10/chinas-ultra-rich-superyachts/; accessed 29 August 2015.

[68] F. Ferrario, M.W. Beck, C.D. Storlazzi, F. Micheli, C.C. Shepard and L. Airoldi, 'The effectiveness of coral reefs for coastal hazard risk reduction and adaptation' (2013) 5 (3794) *Nature Communications*. Available at http://www.nature.com/ncomms/2014/140513/ncomms4794/abs/ncomms4794.html; accessed 29 August 2015.

[69] H.J. Wiens, *Atoll environment and ecology* (Yale University Press, New Haven, Connecticut, 1962) 57-58.

[70] J.W. McManus, 'Coral Reefs' in J.H. Steele, S.A. Thorpe and K.K. Turekian (eds), *Encyclopedia of Ocean Sciences* (Academic Press, London, 2001) 524-534.

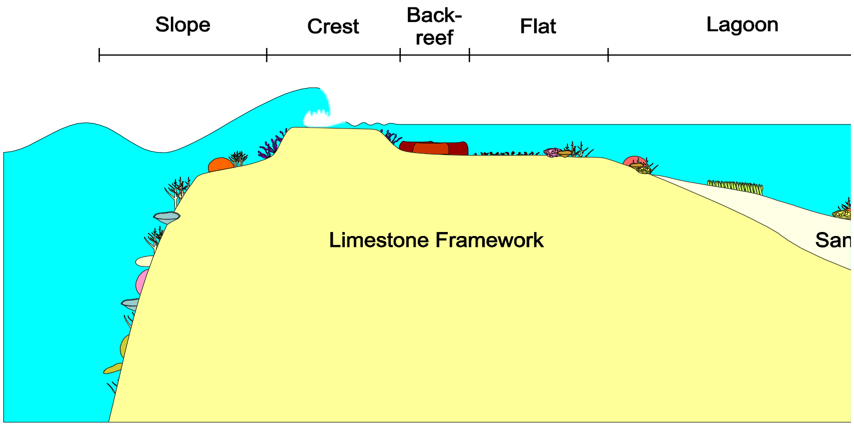

Figure 3. Zones of a typical atoll. Approaching from deep waters, one often encounters a reef slope with prominent coral colonies, a wave-breaking reef crest flanked and covered with various types of algae, a back-reef zone with truncated boulder-shaped corals ('microatolls'), and a reef flat and lagoon with patches of algae, coral, and seagrass amid a plethora of sand-dwelling species such as giant clams and sea cucumbers. All of these habitats support dense assemblages of fish in their natural states. The reef crest is generally the height of the normal tidal range, which is often less than a meter in the South China Sea.

subsurface reefs are scattered along the large regional shelf areas including the Sunda Shelf north of Borneo[71]. Still others probably exist which fell behind in deeper areas below sufficient light levels to grow with reasonable speed and became 'give-up' reefs[72] or even dropped into areas with scarce or absent sunlight and became devoid of characteristic shallow coral reef life as 'drowned reefs'[73].

The development of a typical atoll is illustrated in Figure 4. An oceanic mountain (or mountainous ridge) becomes surrounded by coral and associated organisms, many of whose calcareous parts coalesce as they die and become covered with new organisms, eventually forming a fringing reef. As the mountain 'sinks' due to subsidence and/or rising sea level, the reef tends to grow straight upwards. The outer portions of the reef are very efficient at using up plankton and oxygen flowing inwards, and so reef development lags behind generally a few hundred meters behind the wave-breaking reef crest. As this inner area deepens, a barrier reef is formed around the remaining mountain. Calcareous sand and gravel produced by reef organisms collect within the lagoon, with deeper layers slowly turning into hard reef substrate via complex processes. Once the mountain has disappeared, a ring-shaped coral reef atoll remains, with a lagoon over a sand floor supported by reef limestone[74]. Figure 4 (j) shows how waves are transformed into currents, which flow across the reef zones and out through channels. Figure 4 (f-g) shows a hypothetical case wherein an artificial island interferes with these patterns of interacting waves, currents and ecological growth. This interference reduces the ratio of growth to erosion, reducing the capacity of the wave-breaking portions of the reef to keep up with rising sea level. For example, the removal of hard corals from the wave-striking side of the reef crest may reduce its wave-buffering capacity[75]. Additionally, sediment can inhibit the growth of crustose coralline algae and various components of the micro-ecosystem of the reef crest, which are crucial to its accretionary processes. Once the reef crest is no longer primarily intertidal, wave erosion increases, along with various ecological shifts which further result in a breakdown of the reef crest and other shallow reef zones[76]. This breakdown is likely to continue at least until the reef is safely below the range of heavy impact of most storm waves, which can be 10 or more meters deep[77]. Because reef growth rates decline at depth due to reduced light levels (required to

[71] J.W. McManus, 'Coral reefs of the ASEAN Region: status and management' (1988) 17(3) *Ambio* 189-193; J.W. McManus, 'Tropical marine fisheries and the future of coral reefs: a brief review with emphasis on Southeast Asia'. (1997) 16 Suppl. *Coral Reefs* S121-S127 (especially Fig. 3).

[72] A.C. Neumann and I. Macintyre, 'Reef response to sea level rise: keep–up, catch–up or give–up' in C. Gabrie, J.L. Toffart and B. Salvat (eds), Proceedings of the 5th International Coral Reef Congress, Volume 3: Symposia and Seminars A. (Antenne Museum-Ephe, Moorea, French Polynesia, 1985) 105–110. Available at http://www.reefbase.org/resource_center/publication/pub_24184.aspx; accessed 30 August 2015.

[73] P. Blanchon and D. Blakeway, 'Are catch-up reefs an artefact of coring?' (2003) 50 *Sedimentology* 1271–1282.

[74] P. Blanchon, M. Granados-Corea, E. Abbey, J.C. Braga, C. Braithwaite, D.M. Kennedy, T. Spencer, J.M. Webster and C.D. Woodroffe, 'Postglacial Fringing-Reef to Barrier-Reef conversion on Tahiti links Darwin's reef types' (2014) 4(4997) *Scientific Reports*. Available at http://www.nature.com/articles/srep04997; accessed 30 August 2015.

[75] C. Sheppard, D.J. Dixon, M. Gourlay, A. Sheppard, and R. Payet, 'Coral mortality increases wave energy reaching shores protected by reef flats: examples from the Seychelles' (2005) 64 *Estuarine, Coastal and Shelf Science* 223–234.

[76] R.R. Graus and I.G. MacIntyre, 'Global warming and the future of Caribbean coral reefs' (1998) 13(1) *Carbonates & Evaporites* 43-47.

[77] This author observed in the late 1980's that concrete blocks used to mark study sites on the Bolinao fringing reef along northwestern Luzon, Philippines weighing approximately 260 kg each at depths up to 20 m sometimes moved horizontally a meter or more during strong typhoons.

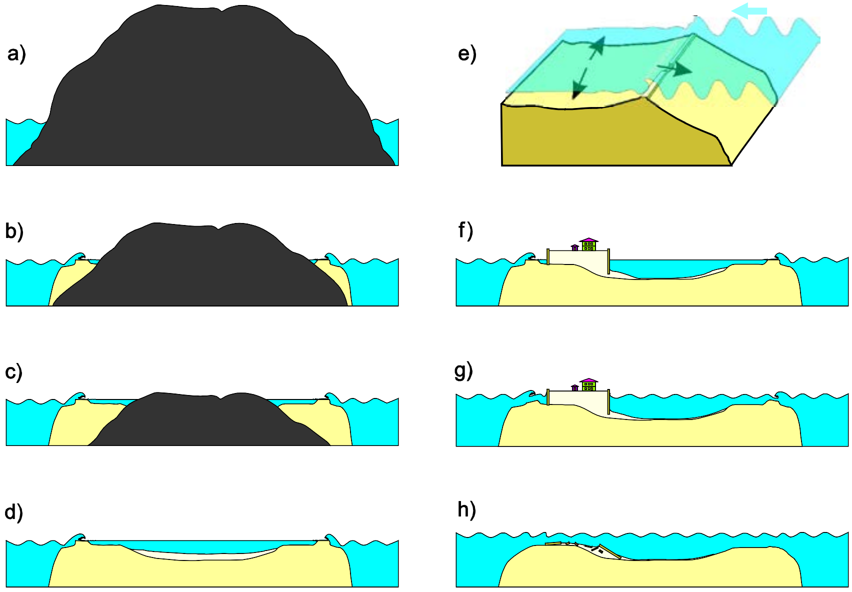

Figure 4. Cross-section diagrams of an atoll showing its origins as fringing reefs around a mountain (a, b). As the mountain sinks and/or sea level rises, the reef often grows vertically forming lagoons within a barrier reef (c), and finally an atoll with a sand-filled lagoon (d). The upper reef slope, crest, back-reef and flat areas together forms a highly efficient 'machine' which converts on average 97% of wave energy into horizontal currents, of which approximately 87% is due to the reef crest (e). Human-built structures are often well-protected by healthy reef crests (f). However, reef crests which are damaged enough to result in net erosion or are unable to keep up with sea-level rise or seafloor sinking are likely to break down (g), ultimately losing their ability to protect human structures from storm waves.

fuel symbiotic algae in calcium carbonate producing corals, giant clams and foraminiferans), the reef may fall further behind rising sea levels.

We are in a period of rapidly accelerating sea-level rise. The Intergovernmental Panel on climate Change (IPCC) in 2013 published anticipated rates of this acceleration under four potential scenarios[78]. Figure 5 shows these accelerating rates in contrast to a relatively fast rate of coral reef growth of 6.7 mm/yr[79]. Each curve is subject to considerable uncertainty, and those associated with the year 2100 are indicated at the right for each scenario. Under the worst case scenario, known as the 'business as usual' scenario, even the most undisturbed coral reefs are likely to fall behind sea level rise substantially prior to 2100. In this case, interference with reef processes by humans is likely only to accelerate the subsequent tear-down processes. However, under any of the scenarios in which effective action is taken to reduce global emissions, many healthy coral reefs may be able to keep up. This assumes that some processes of concern, such as increasing frequencies of coral bleaching (loss of symbiotic algae due to abnormally high water temperatures), intensification of cyclonic storms and the increasing acidity of the ocean do not substantially slow down reef growth – issues now under widespread investigation and debate. Ideally, well-protected reefs may permit continued human habitation in reef-protected areas around the world, at least in cases where not all land has been submerged. Clearly, however, any anthropogenic activities which substantially and chronically damage reef processes will almost certainly lead to a loss of reef protection from waves.

Damage Assessment of Offshore Reefs in the South China Sea

A great deal of concern has been raised concerning the building of artificial islands on coral reefs in the South China Sea. This concern is well-justified – the loss of regional reef area to burial within a few years of construction activities constitutes the most rapid nearly permanent loss of coral reef area in human history. The near-permanence here must be emphasized. Most coral reef degradation around the world has been characterized by a loss of hard coral covering the substrate due to coral death from unusually high seawater temperatures, disease, thin layers of sediment, or the replacement of corals by seaweed because of excessive nutrients and/or a reduction of herbivores by overfishing or disease[80]. In those cases, there is usually a reasonable chance that some years after the disturbance has been alleviated, the coral will return to its former dominance[81] -- especially for reefs in the Indo-Pacific Region (as opposed to the less resilient Caribbean reefs)[82]. However, once a portion of a coral reef has been buried under tons

[78] J.A. Church, P.U. Clark, A. Cazenave, J.M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifield, G.A. Milne, R.S. Nerem, P.D. Nunn, A.J. Payne, W.T. Pfeffer, D. Stammer and A.S. Unnikrishnan, 'Sea Level Change' in T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2013) 1137-1216, at p. 1181.

[79] D. Hubbard, E. Gischler, P. Davies, L. Montaggioni, G. Camoin, W.-C. Dullo, C. Storlazzi, M. Field, C. Fletcher, E. Grossman, C. Sheppard, H. Lescinsky, D. Fenner, J.W. McManus and S. Scheffers, 'Island outlook: Warm and swampy' (2014) 345(6203) *Science* 1461.

[80] L. Burke, K. Reytar, M. Spalding, A. Perry, *Reefs at Risk Revisited* (World Resources Institute, Washington, DC, 2011) 3.

[81] P.J. Mumby, R.S. Steneck, and A. Hastings 'Evidence for and against the existence of alternate attractors on coral reefs' (2013) 122 *Oikos* 481−491.

[82] G. Roff and P.J. Mumby 'Global disparity in the resilience of coral reefs' (2012) 27 *Trends in Ecology and Evolultion* 404–413.

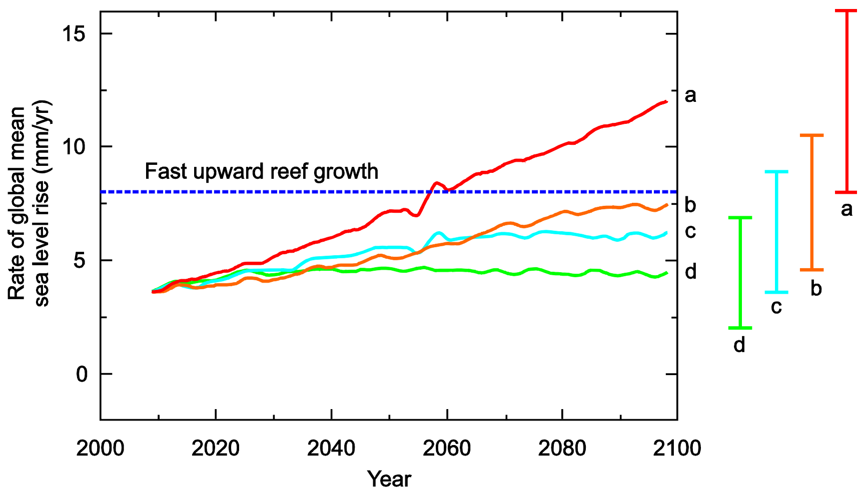

Figure 5. Graphs of projected rates of sea-level rise and vertical reef growth against time. The horizontal dashed line indicates an unusually fast-growing coral reef from fossil records (7.89 mm/y). The highest curve indicates anticipated rates of sea-level rise in the absence of global action to reduce emissions – the 'business-as-usual' scenario. Other curves indicate projections from various degrees of emission reduction. The uncertainty of each projection at 2100 is represented on the right. In the absence of global action, most reefs will fall below sea level in coming decades. However, under any of the scenarios of global action, particularly healthy reef crests may remain at the surface. Reefs with substantial functional disruption will generally fall behind.

of sand and gravel, that portion will be devoid of coral reef species for as long as the sediment rests upon it. These are not temporary islands, but rather intended to remain in place for generations. As discussed above, the combined effects of reduction in wave-breaking capacity, negative impacts of climate change on coral reefs generally and accelerating sea level rise may make it impossible to maintain these islands against strengthening typhoons within a few decades. Even then, the vast quantities of piled-up sand and gravel are likely to continue to prevent growth for long periods even once the areas have sunk below sea level, and to spread out to damage other areas of the reefs. The damage from these artificial islands is thus essentially permanent, within the time range of many decades.

Island-building has been by no means the only form of destruction carried out within the offshore reefs of the South China Sea. The most widespread issue has been overfishing, which, by favoring the growth of fleshy algae over calcareous species of plants and animals, has likely reduced the growth capacities of the reefs[83]. This problem continues to grow, and will do so until a proper management and enforcement plan is in place. Given proper management actions, this problem is theoretically reversible. However, the presence of the extended and new islands will undoubtedly lead to increased fishing pressure in their vicinities as settled fishing populations increase and transient fishers stay nearby for safety reasons.

A more recent and very widespread problem which has been largely unidentified to date is that of shallow-water dredging. The channels and harbors that have been dredged in conjunction with the island building and extension, here referred to as 'deep dredging', have not produced enough material to create the new land masses. Because of this, widespread dredging of calcareous sand and gravel (the latter from living and dead hard corals) has occurred on reef flats and lagoons on reef systems both adjacent to and distant from the island construction and reinforcement. This 'shallow dredging', while not causing quite as permanent and catastrophic a loss as the filling operations, is still far more devastating over a term of a decade or longer than overfishing or destructive fishing in the area has been – as elucidated below.

Figure 6 shows Google Earth satellite images of shallow dredging (top) and island building with deep dredging of a harbor (bottom). Note that in both cases, large plumes of sand and silt are created, which coat nearby sections of coral reef. Both shallow and deep dredging directly remove reef flat, lagoon, and in some cases reef crest and fore-reef ecosystems, while causing drastic changes to the geomorphology and hydrodynamic regimes. The deep dredging cuts through thousands of years of reef limestone. Because of the draughts of the military and civilian ships (typically 3.5 to 12 m) for which the dredging has been done, as well as a depth safety factor, the final depth will in most cases be 5 to 10 meters beyond existing natural depths. The resulting areas will likely have to be dredged out regularly to keep them from filling in. These basins and channels are not part of the naturally self-assembling machine of the reef, and so will generally be subject to sediment deposition. The changes in currents and new openings for waves to enter unimpeded will have complex consequences for the ecological communities across the reef. The periodic dredging to clear built-up sediments will prevent most reef organisms from settling, and will likely create a chronic problem of sand and silt plumes for surrounding marine ecological zones.

The shallow dredging of calcareous sand and gravel will have both long-term (many decades) and medium-term (a few years or decades) impacts. In the case on non-chronic

[83] J.W. McManus, L.A.B. Meñez, K.N.K Reyes, S.G. Vergara and M.C. Ablan, 'Coral reef fishing and coral-algal phase shifts: implications for global reef status' (2000) 57(3) *ICES Journal of Marine Science* 572–578.

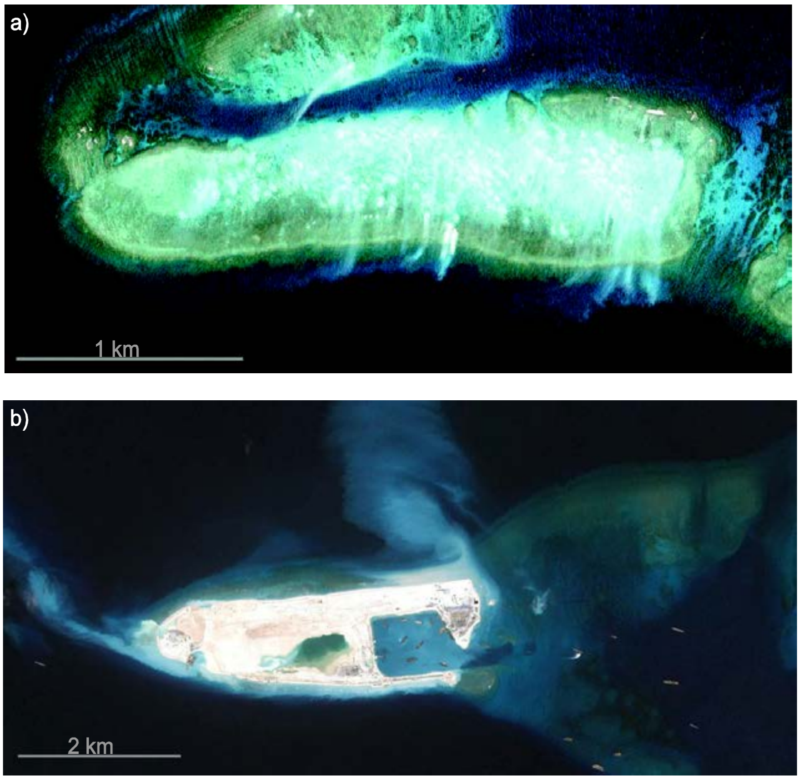

Figure 6. Two satellite images from the Spratly area. a) Two partial atolls rising above a larger subsurface atoll, and subject to shallow dredging to extract sand for island building. The resulting plumes of sand spread out from the lagoons to other reef zones. Dredging and transport vessels are seen at right-center. b) Fiery Cross Reef with all shallow portions of the atoll now buried by sand except for a dredged harbor. Subsurface portions of a larger underlying atoll are visible on the right. Large dredging ships exceeding 100m in length are accompanied by various transport vessels.

dredging, many of the lagoon and reef flat ecosystems will gradually return to a near natural state, though with differences because of different depths and, in some cases for reef flats, a loss of semi-consolidated and patchy hard substrate in return for sand from other areas. A few meters in depth of both lagoon sands and reef flat substrate represent a thousand years or more of production by the reef[84].

Although sand and silt production are natural processes within a reef, misplacement of these materials due to dredging and construction activities can have serious consequences for the zones on which they land[85]. Many benthic (bottom-dwelling) organisms will be simply buried and die. Resuspension of this displaced material by waves can keep the silt-sized materials in the water column long enough to deprive light to reef-building encrusting algae and a myriad of other reef organisms. These sediments are particularly hazardous to soft and hard corals. They can reduce growth rates, cause lesions, and inhibit sexual reproduction[86]. The weakened corals may become susceptible to diseases[87]. As sand is picked up by waves and fast currents, it can scour living tissue from corals[88]. If the damage is not chronic, the relatively resilient Indo-Pacific reefs may recover all but the larger coral colonies within a few decades to half a century, although substantial changes in species composition may result[89]. However, over-fishing for herbivorous fish can result in a post-damage phase shift toward dominance by fleshy algae, delaying recovery for long periods of time depending on the chronic nature and intensity of this over-fishing[90]. In the vicinity of a military settlement, the associated organic pollution can further enhance this impact. As storms damage the newly filled areas of artificial islands and island extensions, further shallow dredging will likely be necessary. Thus, in some areas the shallow dredging itself may become as chronic a problem as that of the filled areas and deep dredged areas. Thus, while the damage associated with the shallow dredging is on average of less concern than the filling and deep dredging, some areas of the shallow dredging subject to periodic repetition will be damaged for just as long -- near-permanently. Because these disruptions will tend to inhibit the reef from keeping up with sea level, the affected reefs will likely be submerged within a few decades, altering the reef permanently and thus, in a sense, constituting permanent damage.

A preliminary compilation of areas of shallow offshore reefs impacted by shallow dredging, deep dredging and filling across the South China Sea was conducted primarily using high resolution satellite images available online on Google Earth. The areas were identified on

[84] K.-F. Yu, J.-X. Zhao, P.-X. Wang, Q. Shi, Q.-S. Meng, K.D. Collerson, T.-S. Liue, 'High-precision TIMS U-series and AMS 14C dating of a coral reef lagoon sediment core from southern South China Sea' (2006) 25 *Quaternary Science Reviews* 25.

[85] X.-B. Li, H. Huang, J.-S. Lian, S. Liu, L.-M. Huang, J.-H. Yang, 'Spatial and temporal variations in sediment accumulation and their impacts on coral communities in the Sanya Coral Reef Reserve, Hainan, China' (2013) 96 *Deep-Sea Research II* 88–96.

[86] P.L.A. Erftemeijer, B. Riegl, B.W. Hoeksema, P.A. Todd, 'Environmental impacts of dredging and other sediment disturbances on corals: a review' (2012) 64 *Marine Pollution Bulletin* 1737-1765.

[87] F.J. Pollock, J.B. Lamb, S.N. Field, S.F. Heron, B. Schaffelke B, G. Shedrawi, D.G. Bourne, B.L. Willis, 'Sediment and Turbidity Associated with Offshore Dredging Increase Coral Disease Prevalence on Nearby Reefs' (2014) 9(7) *PLoS ONE* e102498. doi:10.1371/journal.pone.0102498.

[88] Wiens *op. cit.* ref. 69 p. 128; R.C. Highsmith, A.C. Riggs and C.M. D'Antonio, 'Survival of Hurricane-Generated Coral Fragments and a Disturbance Model of Reef Calcification/Growth Rates' (1980) 46(3) *Oecologia* 322-329.

[89] M.X. Zhao, K. F. Yu, Q. M. Zhang, Q. Shi, G. Roff, 'Age structure of massive *Porites lutea* corals at Luhuitou fringing reef (northern South China Sea) indicates recovery following severe anthropogenic disturbance' (2014) 33 *Coral Reefs* 39–44.

[90] McManus and Polsenberg *op. cit.* ref. 55.

current or historical images based on a combination of comparisons with historical or neighboring images, in conjunction with experience from several decades of coral reef field and image analyses by this author. Quantification was done with the use of the area estimation tool in Google Earth Pro. Shallow dredging areas were identified by nested arching patterns in the sediments characteristic of the impact of suction dredges as the dredging vessel swings back and forth sucking up sand and gravel while the vessel progresses forward. This procedure (often used when dredging rivers, coasts or estuaries) is facilitated by the use of a pair of 'spuds' (long spike-like structures) mounted on opposing corners of the vessel at the stern, which are lowered and raised alternately. The vessel swings on the axis of the lowered spud during the suction process occurring at the bow. This results in the opposite side of the stern moving forward. Then the opposite spud is lowered and the previous spud is raised for the next swing of the vessel in the opposite direction. This results in a 'walking' motion, and a progression of arching dredging marks on the bottom[91]. More than 110 offshore shallow reef sites were investigated across the region. English reef names were gathered from Valencia et. al.[92] and plotted on Google Earth Pro, with corrections to locations based on matching descriptions of reefs to images. Although nearly all of these named shallow reef sites were represented in images from within the last year or so, and many unnamed sites were located and analyzed, an additional ten or so sites with primarily unnamed reefs were represented only in low-resolution imagery or not at all (based on numerous charts), and so were not properly analyzed. Thus, the quantification is in terms of 'at least' this much damage.

For the seven artificial islands rapidly constructed in the Spratly area by China, it was important to use very current information. Because the Asia Maritime Transparency Initiative (AMTI) website of the CSIS Think Tank had better assess to current imagery than the author, their island estimates were used herein. The author measured each new island based on older imagery with some corrections for subsequent changes visible in later images from the AMTI website other sources. However, they were close enough to the published AMTI website to serve as validation, and the more precise AMTI values were used. The deep dredging was completed early enough that Google Earth Imagery was useable directly.

Each occupied feature was identified as to claimant nation by reference to Valencia et al.[93] and various news sources, and closely examined as to building style, types of adjacent watercraft, etc. to validate that the occupation information was current. Fortunately, each claimant had employed a limited range of very characteristic military base construction styles. For unoccupied reefs which showed signs of shallow dredging, identification of the responsible party was inferred via distance to the nearest occupied reefs on which filling had occurred. Overall, the assignment of damage area responsibility to countries is believed to be at least 90% correct.

The results of this analysis are shown in Table 1. More than 140 square kilometers of coral reef area showed serious signs of damage from dredging and/or filling. No obvious damage to coral reef area was visible for Taiwan-occupied Pratas Reef (Dongsha). With total filling covering 14.5 km^2 of reef ecosystem, and another 2.5 km^2 of channel and harbor dredging, it is

[91] J.B. Herbich, 'River Dredging, Section 1'in J.B. Herbich (ed), Handbook of Dredging Engineering, Second Edition (McGraw-Hill, New York, 2000) 8.4-8.10.
[92] Valencia *et al., op. cit.* ref. 30 Appendix 1 227-234.

[93] *Ibid*.

apparent that the world had lost at least 17 km^2 of its more highly diverse and fishery productive coral reefs, essentially permanently. While not as permanent and severe, the additional of shallow dredging of reef flats and lagoons for building materials had seriously disrupted 123 km^2 of important ecosystems within these valuable reefs, with impacts that may last for many decades. The PRC is responsible for more than 90% of the overall damage from dredging and filling among offshore coral reefs in the South China Sea.

In the Spratly area per se (excluding Scarborough Reef), unlike within the Parcels, there is a clear and distinct difference between the shallow surface-breaking reefs and deeper subsurface reefs, wherein no part of the reef extends to near the surface. The satellite-derived and empirically measured validation depths published by Hu et al. for North Danger Reefs suggest that these subsurface reefs are generally at about 8 - 20 m or so in depth, and so are not among the reefs known widely as mesophotic reefs (where light is considerably reduced), nor the true deep reefs (below the photic zone). The total area of shallow reefs in the Spratly area is 1,150 km^2. When deep reefs are included, the total becomes 3,821 km^2 [94]. The 103 km^2 of damaged shallow reef in this area represents approximately 9% of the total shallow reef area, and roughly 3% of the total reef area at depths visible to areal and satellite images. Within the Paracels, the 37 km^2 of damage represents about 8% of the total area of reef of 481 km^2 [95].

There are some differences in species composition between the shallow and subsurface reefs in the Spratly area, so a loss of shallow water reef area may reduce populations of certain species not found in deeper areas. Many species of oceanic migratory fish (including tuna, jacks, mackerel, etc.) swim through reef areas to feed on dense schools of reef fishes, often in shallow waters. The loss of 8-9% of the shallow reef area in these two reef groups may have a significant impact on regional fisheries, both in terms of direct reef fisheries and migratory oceanic fish harvests. Demonstrating this impact would require multiple years of data, because fish stocks vary annually due to many factors. However, the further expansion of dredged reef area, especially in conjunction with continued overfishing, would clearly pose an increasingly serious problem for regional fisheries sustainability.

Fossil Fuel and Hydrates Issues

In the early 1990's when the idea of an International Spratly Islands International Marine Park was proposed[96], much of the opposition to it was centered on the possibility of substantial amounts of fossil fuels being present[97]. Although it is conceivable that licenses to drill for oil and gas could be issued by a park management organization, there was the concern that the park status would inhibit exploration and development of these reserves. However, in 2013, the U.S. Energy Administration Agency published a map on its website which indicates that there are likely to be no significant oil reserves in the Spratly area outside of the Sunda Shelf, and that gas reserves in the Spratly area are much lower per area than on many surrounding shelf areas. Reserves of these are similarly low at Scarborough Reef and within the Paracel Islands. There

[94] M.D. Spalding, *op. cit.* ref. 56.

[95] Personal communication from Mark Spalding, Senior Marine Scientist, Global Marine Team, The Nature Conservancy (University of Cambridge, UK), based on measurements by the Marine Science Institute of the University of the Philippines as part of regional reef area assessments in Burke *et al., op. cit.* ref. 56.

[96] McManus *et al., op. cit.* ref. 31.

[97] M.J. Valencia, 'Oil and the lack of it in the South China Sea.(includes reply)(response to article by Ian Townsend-Gault, Contemporary Southeast Asia, vol 20, no 2, Aug 1998)' (1999) 21(1) *Contemporary Southeast Asia* 153-154.

Table 1. Areas of damage to offshore coral reefs in the South China Sea in square kilometers. These are minimal values, as they were primarily based on available satellite imagery on Google Earth as of 10 September 2015 and a few reefs may not have been visible. Filled areas incorporated values for Spratly Chinese bases from the AMTI website of CSIS to that date with measured values from other bases. Shallow dredging was for coral reef sand and gravel to use for fill, and would have necessarily included living hard coral and other organisms. Overall accuracy is believed to exceed 90%.

	Filling	Dredging		Row Sums	% of Total GSI
		Channel	Shallow		
Greater Spratly islands (GSI)					
People's Republic of China	12.82	1.38	79.21	93.41	91%
Philippines	0.06	---	6.09	6.15	6%
Vietnam	0.26	0.21	2.68	3.15	3%
Malaysia	0.35	0.04	---	0.39	<1%
Taiwan	0.04	0.04	---	0.08	<1%
Total, GSI	**13.53**	**1.66**	**87.99**	**103.18**	
Paracel Islands					
People's Republic of China	1.00	0.86	35.02	36.89	
Total, South China Sea	**14.54**	**2.52**	**123.01**	**140.07**	

are, however, likely to be very significant reserves in areas adjacent to the Paracel Islands[98]. There are likely to be substantial methane hydrate reserves within the deep waters between the atolls of the Spratly Island area[99], but the means to safely exploit this highly explosive, greenhouse gas producing, potential energy source have yet to be developed[100].

National Aspirations and Precedents

The building of artificial islands has unified the Philippines and Vietnam in opposition to the PRC's actions in the South China Sea[101]. They appear to be largely supported in this by many extra-regional nations, including the United States, Japan[102], Australia[103], the United Kingdom[104] and others. In an effort to ease regional tensions, Taiwan has called for an expansion of joint scientific research and environmental protection of the Sea[105]. Previous presidents of both Taiwan and the Philippines have spoken in favor of the establishment of a Peace Park or similar designation within the Spratly Islands[106]. Clearly, the most important factor in any such natural resource protective strategy would be support from the PRC.

There are precedents involving the PRC which may be helpful. In 2007, the World Conservation Monitoring Center and the International Union for the Conservation of Nature published a list of transboundary protected areas[107]. Of 227 such areas, the PRC was shown to be a partner in 17, including one which involved three other nations. While these all involved borders on land, they demonstrate that such cooperation is not beyond the realm of consideration

[98] Anon., 'Contested areas of South China Sea likely have few conventional oil and gas resources' (2013) *Independent Statics and Analysis, U.S. Energy Administration Agency*. Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=10651#; accessed 10 September 2015.

[99] N.N. Trung, 'The gas hydrate potential in the South China Sea' (2012) 88–89 *Journal of Petroleum Science and Engineering* 41–47; H. Liu, Y. Yao, and H. Deng, 'Geological and Geophysical Conditions for Potential Natural Gas Hydrate Resources in Southern South China Sea Waters' (2011) 22(6) *Journal of Earth Science* 718–725.

[100] W. Pentland, 'Energy's Most Dangerous Game' (2008) *Forbes*. Available at http://www.forbes.com/2008/08/29/energy-methane-hydrates-biz-energy-cx_wp_0902gashydrates.html; accessed 10 September 2015.

[101] N.P. Calleja, 'Philippines, Vietnam close to signing cooperation pact on South China Sea' (2015) *Inquirer.net*. Available at http://globalnation.inquirer.net/128054/philippines-vietnam-close-to-signing-cooperation-pact-on-south-china-sea; accessed 10 September 2015.

[102] Y. Hayashi and C. Tsuneoka, 'Japan open to joining U.S. in South China Sea patrols' (2015) *The Wall Street Journal*. Available at http://www.wsj.com/articles/japan-may-join-u-s-in-south-china-sea-patrols-1435149493; accessed 10 September 2015.

[103] R. Taylor, 'Australia to Continue Military Patrols in South China Sea' (2015) *The Wall Street Journal*. Available at http://www.wsj.com/articles/australia-to-continue-patrolling-south-china-sea-1433046154; accessed 10 September 2015.

[104] M. Martina, 'Britain calls for freedom of navigation in South China Sea' (2015) *Reuters World*. Available at http://uk.reuters.com/article/2015/08/12/uk-southchinasea-china-britain-idUKKCN0QH1HO20150812; accessed 10 September 2015.

[105] Anon., 'South China Sea Peace Initiative' *Ministry of Foreign Affairs, Republic of China (Taiwan)* (2015). Available at http://www.mofa.gov.tw/News_Content.aspx?n=604CBAA3DB3DDA11&sms=69594088D2AB9C50&s=4589151C339E71C5; accessed 10 September 2015.

[106] McManus *et al., op. cit.* ref. 36.

[107] I. Lysenko, C. Besançon, and C. Savy, *2007 UNEP-WCMC Global List of Transboundary Protected Areas* (United Nations Environment Programme and World Conservation Monitoring Center, Cambridge, U.K., 2007). Available at: http://www.tbpa.net/docs/78_Transboundary_PAs_database_2007_WCMC_tbpa.net.pdf; accessed 12 September 2015.

by the PRC. There is also a significant marine-based transboundary fisheries management agreement between Vietnam and the PRC, governing the fisheries of the Gulf of Tonkin[108]. While there have been issues with its implementation, particularly with the perception of bilateral equity in decision-making[109], it clearly represents a step forward.

The 'Tied-Hands' Dilemma

In political science theory, a nation which expects to be taken seriously in a stand-off must find an effective means with which to signal that it will not back down[110]. These signals are often most effective when they involve substantial investment of one type or another, which will lead to a major loss if the nation was to capitulate. Signaling may be most effective when these losses are likely to lead to the populace forcing a major change in government. Fearon classified these signaling investments as either 'sunk costs' or 'tied hands'[111]. In a recent analysis of the Spratly Islands tension within this framework, Haotian Qi showed that sunk costs would include military buildup and the recent development of artificial islands. Of at least equal concern, however, is the ubiquitous tied hands strategy in play across the region[112]. Each major claimant nation, but particularly the PRC, the Philippines and Vietnam, have conducted major information campaigns primarily aimed at ensuring that the general populace within each country strongly believes that its claims are the only legal and justified ones. An example is the recent three-part series, shown on television in the Philippines and available on the Internet, entitled 'Kalayaan, Karapatan sa Karagatan'[113]. Kalayaan is the name for the Philippine claim in the Spratly Islands, and the rest of the title refers to ocean rights. This well-produced series makes the PRC in particular seem like it is hoarding valuable resources away from their rightful owners, the Philippines. It is clear that if any of these three nations were to concede territory to the others, the periodic street demonstrations already happening in some of these countries would intensify considerably, potentially leading to the ouster of the extant government. Indeed, this threat of ouster is an important part of the signaling via the tied hands investment.

It is becoming increasingly unlikely that the nations involved in overlapping claims in the South China Sea will agree to any settlement which leads to a reduction of perceived sovereignty. Thus, any potential path to peace must maintain each nation's claims as they currently stand.

[108] L. Jianwei and C. Pingpingm, 'China-Vietnam fishery cooperation in the gulf of tonkin revisited' (2011) Second International Workshop, November 2010, East Sea (South China Sea) Studies (Ho Chi Minh City, Vietnam, EastSeaStudies.org, 2011). Available at http://nghiencuubiendong.vn/en/conferences-and-seminars-/second-international-workshop/594-china-vietnam-fishery-cooperation-in-the-gulf-of-tonkin-revisited-by-li-jianwei-a-chen-pingping; accessed 12 September 2015.

[109] M. Lerner, 'Outcry over China's global fishing practices' (2015) *Blouin News*. Available at http://blogs.blouinnews.com/blouinbeatbusiness/2015/05/20/outcry-over-chinas-global-fishing-practices/; accessed 12 September 2015.

[110] J.D. Fearon, 'Signaling Foreign Policy Interests: tying hands versus sinking costs' (1997) 41(1) *Journal of Conflict Resolution* 68-90.

[111] *Ibid*.

[112] H. Qi, 'The Line That America Shouldn't Cross in the South China Sea' (2015) *The National Interest*. Available at http://nationalinterest.org/feature/the-line-america-shouldnt-cross-the-south-china-sea-13138; accessed 13 September 2015.

[113] *Kalayaan, Karapatan sa Karagatan* (Three-part video in Tagalog, Philippine Department of Foriegn Affairs, Manila, Philippines, 2015). Available at https://www.youtube.com/results?search_query=Kalayaan%2C+Karapatan+sa+Karagatan; accessed 13 September 2015.

Steps toward Peace

General

It is widely understood that the nonbinding Declaration of a Code of Conduct adopted by the Foreign Ministers of ASEAN and the People's Republic of China at the 8th ASEAN Summit in Cambodia in 2002 was insufficient to protect the region's natural resources and ensure political stability. Thus, there are moves to develop a new, binding Code of Conduct[114]. In this process, it must be clearly understood that regional stability is indivisibly bound to sustainable fisheries exploitation and the protection of critical fish habitats including coral reefs. The latter environmental protection can be strongly reinforced by the development of ecologically sustainable tourism. Tourism can only grow in the absence of military threat. Thus, increasing profit from, and economic dependence on, tourism can help to reduce regional militarization.

One reason for the failure to agree on a draft of a Code of Conduct implementation in 2012 was the inclusion of references to Exclusive Economic Zones (EEZ) and sovereignty by the Philippines over Scarborough Reef[115]. It is likely that any similar references in future drafts which amount to losses of claimed territory or perceived exclusive resource rights by one or another country will also lead to failed adoption.

Essentials for a Binding Code of Conduct

The success of any binding regional agreement for political and military stability across the South China Sea must include as a minimum:

1. **A freeze on claims**. A point in time must be chosen prior to the development of the agreement beyond which no changes in declared sovereignty can take place. It must be clear, however, that the agreement itself does not reinforce those claims.

2. **A freeze on claim-supportive activities**. It must be agreed that no actions during the period of effect of an agreement will be used in any future efforts to strengthen a case for sovereignty. This will immediately remove the motivations behind much of the militarization and environmental damage currently underway, such as the occupation of barely habitable islets mainly for purposes of demonstrating administrative control.

3. **A reduction in offshore military facilities**. Heavily armed military bases lead to widespread unease and potentially to attempts to balance military potential via an arms race. Given the high investments recently placed in the offshore bases, it may be necessary to make this a gradual phase-down. Military bases are excessively expensive,

[114] A. Panda, 'For the ASEAN-China South China Sea Code of Conduct, ninth time isn't the charm' (2015) *The Diplomat*. Available at http://thediplomat.com/2015/08/for-the-asean-china-south-china-sea-code-of-conduct-ninth-time-isnt-the-charm/; accessed 13 September 2015.

[115] C.A. Thayer 'ASEAN'S Code of Conduct in the South China Sea: A Litmus Test for Community-Building?' (2012) The Asia-Pacific Journal: Japan Focus. Available at http://www.japanfocus.org/-carlyle_A_-Thayer/3813/article.html; accessed 13 September 2015.

and so a period of lessening need for their maintenance will create pressures to reduce the maintenance expenditures.

4. **Reinforcement of encounter protocols**. There are well developed protocols governing actions associated with encounters at sea and in the air of both military and civilian craft. These must be recognized as features inherent to the new agreement.

5. **A regional body to oversee resources**. Because of the combination of highly-migratory species and high degree of larval connectivity for less mobile species, the South China Sea must be seen as a common pool of fisheries resources. Achieving sustainability, optimal harvest and rational benefit distributions for these highly complex fisheries will require cutting-edge fisheries analysis and careful selection of management protocols. Environmental protection must a priority concern, in support of fisheries, tourism, and the broader values of these unique offshore ecosystems. Environmental impact analysis and mitigation procedures must be held to standards which are consistent regionally, instead of variable among nations. The exploitation of fossil fuels must be regulated in concert with efforts to protect the environment, but also overseen so as to ensure rational benefit distribution. The regional body which will oversee all resources in the South China Sea will require regional buy-in and so must include government representation. However, it must also be led by the highest possible quality of science. This is generally not possible when approached solely in terms of national representation. Thus, the intergovernmental body of representation must share responsibility with an international body of thematic experts. These, in turn should work with independent international organizations with responsibility for South China Sea resources, such as various UN agencies, regional resource bodies such as SEAFDEC, and the WorldFish Center, with the inclusion of experts and focused research efforts tapping the global pool of scientists. Data sharing and archiving must be mandatory, so as to make optimal use of research expenditures.

6. **Well-defined inspection, arbitration and enforcement procedures**. 'Binding' implies enforceable. There must be transparency throughout the offshore South China Sea, with the unrestricted freedom of visits to any research or development activity by all signatories. There must be clear arbitration procedures for various classes of dispute, and clear actions associated with disregard for essential agreement provisions.

The Antarctic Treaty[116] is a starting point for much of the development of a binding Code of Conduct. It was formulated based on problems similarly arising from overlapping national claims, and as a means to protect the common heritage of humankind. It includes both a freeze on claims and a freeze on claim-supportive activities. There are reasonably clear procedures for site inspection and dispute arbitration, the latter including both committees specifically appointed from among the ratifying or signatory nations, as well as agreements to settle other issues within the Permanent Court of Arbitration[117]. There are important issues with this treaty to avoid in the Code of Conduct, such as the many gaps in environmental and fisheries protection which have

[116] 1959 Antarctic Treaty (Washington, D.C., 1 December 1959, in force 23 June 1961) 402 UNTS 71.
[117] *Ibid.*

been the focus of subsequent agreements and proposed actions[118]. However, it is a well-tested document to serve as a basis on which to build and improve.

The Transboundary Peace Park Option

'Marine protected areas' (MPA) are marine areas which are afforded special environmental protection because of the unusual importance of these areas to humankind. The term 'marine park' is used as a form of MPA. The definition of such a park varies case-to-case, but usually refers to an MPA under a central administration which allows tourism activities and often fishing in specific areas. Other areas within a large marine park or marine reserve may include 'no-fishing reserves' or other classified areas intended to help with the mission of making resources sustainable across generations. Transboundary Peace Parks are parks on land or across areas of water whose mission of protecting the environment are combined with that of reducing tensions associated with disputed national boundaries. The first specifically designated peace park was the Waterton-Glacier International Peace Park established in 1932, which includes the United States and Canada in joint management of natural resources in an area where the national boundaries were unsettled. Since then, a large number of transboundary peace parks have been initiated, particularly in Africa. A marine example is the Red Sea Peace Park involving Israel and Jordan[119]. As discussed previously, there have been multiple proposals to include part or all of the Spratly Islands into a transboundary park or network of parks.

The establishment of the Greater Spratly Islands Peace Park, including Scarborough Reef, would be a major step in not only helping to stabilize fish stocks across the South China Sea, but in promoting tourism and regional political stability. The administration of the Park could be handled by an independent contracted agency, under the supervision of a panel consisting of claimant nations and with an advisory panel made up of thematic experts of global stature.

A second area for consideration as a Peace park would be the Paracel Islands. Given the strongly entrenched nature of the PRC within this archipelago, it may be difficult to establish such as Peace Park until such time as Vietnam challenges the PRC for sovereignty rights. Should the PRC's position as the legal administrators of the Paracels be challenged in arbitration, then perhaps a Paracels Peace Park could be considered as an alternative to the unlikely option of the PRC abandoning the island group.

Concluding Remarks

The very large, highly speciose offshore coral reef structures of the South China Sea are part of the common heritage of humankind. They are irreplaceable components of the total package of resources that current generations must pass on to later generations. Their importance

[118] S.L. Chown, J.E. Lee, K.A. Hughes, J. Barnes, P.J. Barrett, D.M. Bergstrom, P. Convey, D.A. Cowan, K. Crosbie, G. Dyer, Y. Frenot, S.M. Grant, D. Herr, M.C. Kennicutt, M. Lamers, A. Murray, H.P. Possingham, K. Reid, M.J. Riddle, P.G. Ryan, L. Sanson, J.D. Shaw, M.D. Sparrow, C. Summerhayes, A. Terauds, D.H. Wall, Challenges to the Future Conservation of the Antarctic (2012) 337 *Science* 158-159.

[119] M.P. Crosby *et al.,* "The Red Sea Marine Peace Park: Early Lessons Learned from a Unique Trans-boundary Cooperative Research, Monitoring and Management Program," in Proceedings of the IUCN/WCPA-EA-4 Taipei Conference (Taipei, Taiwan, IUCN/WCPA, 2002).

extends far beyond the confines of the South China Sea. Were the offshore reefs of either the Greater Spratly Islands or Parcel Islands comfortably within the undisputed regime of a single nation, they would certainly qualify as World Heritage Sites. In these ways, they are similar to the resources of Antarctica. In the latter case, only 12 nations had originally registered claims to the area. However, there are currently 52 nations which are parties to the Treaty[120]. This Treaty can serve as a starting point for either an offshore South China Sea treaty, or a more geographically restricted Greater Spratly Islands Peace Park, or both. It may be necessary for the immediate future, in order for progress to be made, to keep negotiations and ratification limited to the nations surrounding the South China Sea, plus perhaps other members of the ASEAN organization. However, ultimately the global nature of the problems may necessarily lead to an expansion of ratification to a global level.

[120] Anon., 'Parties' *Secretariat of the Antarctic Treaty*. Available at http://www.ats.aq/devAS/ats_parties.aspx?lang=e; accessed 13 September 2015.

Annex 851

C.H. Ainsworth & P.J. Mumby, "Coral-algal phase shifts alter fish communities and reduce fisheries production", *Global Change Biology* (9 July 2014)

Global Change Biology

Global Change Biology (2014), doi: 10.1111/gcb.12667

Coral–algal phase shifts alter fish communities and reduce fisheries production

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Abstract

Anthropogenic stress has been shown to reduce coral coverage in ecosystems all over the world. A phase shift towards an algae-dominated system may accompany coral loss. In this case, the composition of the reef-associated fish assemblage will change and human communities relying on reef fisheries for income and food security may be negatively impacted. We present a case study based on the Raja Ampat Archipelago in Eastern Indonesia. Using a dynamic food web model, we simulate the loss of coral reefs with accompanied transition towards an algae-dominated state and quantify the likely change in fish populations and fisheries productivity. One set of simulations represents extreme scenarios, including 100% loss of coral. In this experiment, ecosystem changes are driven by coral loss itself and a degree of habitat dependency by reef fish is assumed. An alternative simulation is presented without assumed habitat dependency, where changes to the ecosystem are driven by historical observations of reef fish communities when coral is lost. The coral–algal phase shift results in reduced biodiversity and ecosystem maturity. Relative increases in the biomass of small-bodied fish species mean higher productivity on reefs overall, but much reduced landings of traditionally targeted species.

Keywords: acidification, bleaching, coral disease, coral reefs, Ecopath with Ecosim, ecosystem-based management, Raja Ampat, reef fish

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Introduction

Coral reefs are assailed by an array of anthropogenic stressors rapidly intensifying with the growth of human populations and the expansion of human industry. Climate change, including global warming and ocean acidification, and indirect impacts like disease and corallivore outbreaks may come to rival overexploitation and pollution as the major drivers of coral loss (Hoegh-Guldberg *et al*., 2007; Frieler *et al*., 2012). As we project these effects to intensify, we may expect further loss of coral structure and reduced abundance of numerous reef-associated species (Wilson *et al*., 2006), many of which support reef fisheries (Pratchett *et al*., 2011). Tropical reef fisheries are an indispensable source of income in many communities of the developing world and critical for food security (McManus, 1997; Bell *et al*., 2011). In this article, we attempt to quantify in broad terms the likely impact that coral loss followed by a phase transition to an algae-dominated state may have on the reef fish assemblage and on fisheries productivity.

We select as a case study the Raja Ampat archipelago in Eastern Indonesia. Still relatively pristine, it is among the most biodiverse regions on Earth possessing over 75% of the world's coral species and almost a thousand species of reef fish (McKenna *et al*., 2002; Donnelly *et al*., 2003; Halim & Mous, 2006). Although the human population is low, the coral reef ecosystem faces numerous threats including overexploitation, destructive fishing practices (blast and cyanide fishing), coral mining, crown-of-thorn (*Acanthaster planci*) outbreaks and land-based pollution (Pet-Soede & Erdmann, 1998; Kaczmarsky *et al*., 2005).

It is difficult to estimate the amount of coral loss that has occurred historically in Raja Ampat. Blast fishing is present, but estimates of the frequency vary widely (e.g. Erdmann & Pet, 2002; McKenna *et al*., 2002; Donnelly *et al*., 2003), while the effects on coral reefs of disease and environmental stress remain poorly studied. As few empirical data are available with which to base the rate of loss, we engage here in simulation modelling that represents a wide range of possible futures.

We present simulations for a range of coral loss, up to 100%, from the Raja Ampat ecosystem. We refer to these as 'conjectural' simulations because the effect of coral loss lies outside of the observed historical range for any such large area (Raja Ampat model encompasses 45 000 km^2; Ainsworth *et al*., 2008b). However, similar losses of coral have been observed at the scale of individual reefs after coral bleaching events

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(Edwards *et al*., 2001; Mumby *et al*., 2001) and corresponding fish population impacts have been studied (Sano, 2004; Pratchett *et al*., 2008). We assume some degree of habitat dependency for reef fish species and drive ecosystem changes by removing coral from the model. We also assume space-limited growth by macroalgae.

A second set of simulations, more firmly grounded in empirical data, drives changes in the ecosystem not by coral loss directly, but by changes in the fish assemblage that result from coral loss (as documented by Wilson *et al*., 2006). In this case, model predictions are made concerning the wider fish community and we present overall ecosystem impacts as the combination of data from Wilson's observations and predictions made by the model. For comparison, it is worth noting that the assemblage changes presented by Wilson are driven, on average, by a 33.4% loss of coral relative to the initial (2012) coral biomass value (i.e. from 100% down to 66.6%). Thus, the Wilson simulation corresponds to a moderate change in coral reef status relative to the conjectural simulations.

Materials and methods

EwE models

Working with nongovernmental and academic partners, Ainsworth *et al*. (2008a,b) constructed a suite of ecosystem models using Ecopath with Ecosim (EwE: Christensen & Pauly, 1992; Walters *et al*., 1997) and Ecospace (Walters *et al*., 1998) representing various regions in Raja Ampat. Development of the models utilized field information from dive transects, fish stomach sampling, community interviews and coastal surveys. The models were tuned to historical catch and biomass data (1990–2006; including illegal removals, Varkey *et al*., 2010 and anecdotal biomass information Ainsworth *et al*., 2008c) and used to reconstruct the history of exploitation in the region and to answer practical management and conservation questions posed by the Indonesian Ministry of Marine Affairs and Fisheries (Departemen Kelautan dan Perikanan, DKP). A thorough technical description of the model, including all input data, assumptions, fits to observational data and diagnostic testing is available in Ainsworth *et al*., 2008b located at http://www.fisheries.ubc.ca/node/3755. Applications of the model include Varkey *et al*., 2012; Pitcher & Ainsworth, 2010 and Ainsworth *et al*., 2008a.

We employ the present-day Raja Ampat model (assumed representative of 2012), representing the entire archipelago bounded at the north-west coordinate 129°12′ E, 0°12′ N and the south-east coordinate 130°30′ E, 2°42′ S. This model is described in Ainsworth *et al*. (2008b), so we will present only the information most relevant to this study. The most important parameter is the degree of species' dependency on coral reefs, which we represent by use of EwE's mediation functions (Christensen *et al*., 2005). These can be used to represent changes in the vulnerability of prey to predator by some third mediating species group (e.g. Cox *et al*., 2002) or affect the productivity of a group according to the biomass of a mediating group (e.g. Okey *et al*., 2004). Ainsworth *et al*. (2008a,b) developed four mediation functions for the Raja Ampat models that affect prey vulnerability according to the biomass of a mediating group. These describe tuna facilitating small pelagic predation by birds, coral protection of fish and invertebrates, cleaner wrasse symbiosis with large reef fish and sea grass/mangrove protection of juvenile reef fish (Fig. 1). The protection effect from coral is particularly relevant to this study as it establishes the response of reef-associated fish to coral loss (an assumption relaxed under the Wilson simulation). The function is modelled so that the vulnerability of the prey species changes in inverse linear proportion to coral biomass. All predators are affected equally (effectively we assume a similar mode of attack). The vulnerabilities are free to increase to a maximum of 2× the baseline value during periods of low coral biomass and can decrease to near 1 during periods of high coral biomass. Note that in high complexity reefs, certain size classes of prey may be disproportionately affected by coral loss (Rogers *et al*., 2014).

These four functions are applied to appropriate species in the model (Table 1). In this study, we have added a fifth affecting benthic algal productivity (Fig. 2). As coral biomass declines, productivity of benthic algae increases. Adding this mediation effect is necessary to capture space-limited growth in algae as moderated by competitive exclusion by coral. Without the mediation effect, algal growth in EwE is moderated only by herbivory. Note that increased productivity is realistic with coral decline if fleshy macroalgae are replaced by fast-turnover benthic turfs (Hatcher, 1988) – our benthic algae group implicitly includes both. Although the potential for algal phase shifts are well documented (Done, 1992; Norström *et al*., 2009) and an important assumption in our modelling methodology, Carassou *et al*., 2013 note that macroalgae density is related to coral coverage only in degraded reef systems. However, due to the large spatial domain of the model (45 000 km^2; Ainsworth *et al*., 2008b), we represent here the net effect in a mosaic of degraded and healthy reefs.

Conjectural simulations

We force the biomass of coral to decline from 0% to −100% in eleven 20-year simulations (2012–2032). Results are presented at the end state of the simulations (in 2032). For each of the simulations, we estimated fisheries productivity in kg C km^{-2} yr^{-1} based on an annual catch rate and assuming a 1 : 20 dry to wet weight conversion ratio (Cushing *et al*., 1958) and Redfield element proportions C : N : P = 106 : 16 : 1 (Redfield, 1934). To calculate the productivity and biomass of the ecosystem under the most extreme coral decline scenario (−100%), we generated a new Ecopath model based on the end state of the simulation utilizing the .eii file input/output procedure available in EwE (Christensen *et al*., 2005). Ecosystem productivity is determined as the sumproduct of biomasses and production-per-unit-biomass (P/B) across species groups. A weighted average of biomass/production (B/P)

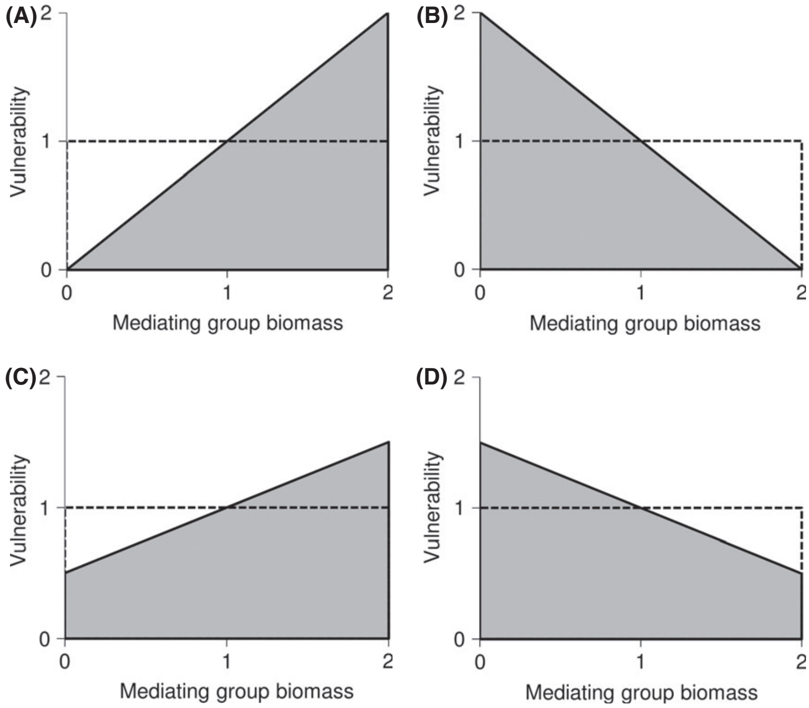

Fig. 1 Ecosim mediation functions. Vulnerability of prey vs. mediating group biomass: (A) tuna facilitating small pelagic predation by birds; (B) reef-building coral protection of reef fish and invertebrates; (C) cleaner wrasse symbiosis with large reef-associated fish; (D) sea grass and mangrove protection of juvenile reef fish. x- and y-axes are relative to model baseline values. Reproduced from Ainsworth *et al.*, 2008b.

Table 1 Assignment of mediation functions (Med.) in Raja Ampat EwE model. A, B, C and D are defined as in Fig. 1. Reproduced from Ainsworth *et al.*, 2008b

Prey group	Med.	Prey group	Med.	Prey group	Med.	Prey group	Med.
Ad groupers	B, C	Ad coral trout	B, C	Juv small reef assoc.	B, D	Ad eroding grazers	B, C
Sub groupers	B	Juv coral trout	B, D	Ad large planktivore	B, C	Juv eroding grazers	B, D
Juv groupers	B, D	Ad small pelagic	A	Juv large planktivore	B, D	Ad scraping grazers	B, C
Ad snappers	B, C	Juv small pelagic	A	Ad small planktivore	B	Juv scraping grazers	B, D
Sub snappers	B	Ad large reef assoc.	B, C	Juv small planktivore	B, D	Penaeid shrimps	D
Juv snappers	B, D	Juv large reef assoc.	B, D	Ad anchovy	A	Shrimps and prawns	D
Ad Napoleon wrasse	B, C	Ad medium reef assoc.	B, C	Juv anchovy	A	Octopus	B
Sub Napoleon wrasse	B	Juv medium reef assoc.	B, D	Ad macroalgal browsing	B, C	Small crabs	B
Juv Napoleon wrasse	B, D	Ad small reef assoc.	B	Juv macroalgal browsing	B, D		

(units: yr) is used as an indicator of ecosystem maturity after Odum (1969).

Wilson simulation

For the Wilson simulation, we force biomass of seven fish groups. Biomass change is based on Fig. 2 in Wilson *et al.* (2006), which provides biomass change at the species level relative to the change in coral cover. Wilson's species are aggregated (averaged) to the level of EwE functional groups and the absolute change in biomass is determined relative to the coral decline projected by the model. The coral decline amounts to an 8.3% loss over the 20 year simulation. This rate represents the effects of coral mining, blast fishing, cyanide fishing and corallivory by bioeroding fish and crown-of-thorns starfish and was set by Ainsworth *et al.*, 2008a to reflect trends in Raja Ampat (McKenna *et al.*, 2002). It is similar to the 7.4% decline observed in the Indo-Pacific over the same period by Bruno & Selig (2007). The programmed loss of coral in the model ensures that trophodynamic effects impacting species whose biomass is not forced are realistically portrayed. Based on this technique, the following biomass changes from Wilson

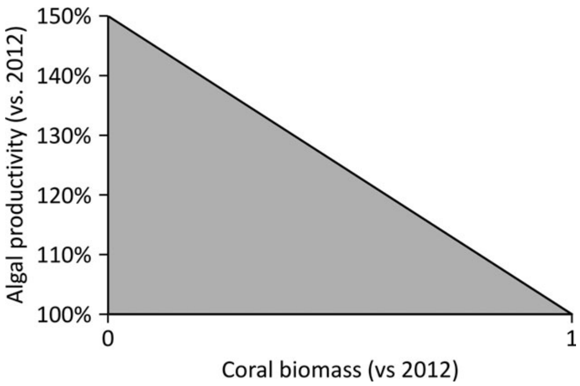

Fig. 2 Mediation function boosts algal productivity when coral biomass is low.

are inferred: butterflyfish −7.6%, cleaner wrasse −4.8%, large reef-associated fish +1.0%, medium reef-associated fish −1.5%, small reef-associated fish −5.0%, scraping grazers +1.8% and small planktivores −2.5%. We assume a linear increase or decrease in species group biomass leading to these values in the final year of a 20-year simulation (relative to initialization biomass). Biodiversity is assessed using two methods, the Shannon index (Shannon & Weaver, 1949), which measures evenness, and the Q90 index (Ainsworth & Pitcher, 2006), which measures evenness and richness. All simulations run from 2012 to 2032 and we assume that current (2012) fishing mortalities are maintained into the future.

Results

Detailed model results for conjectural and Wilson simulations are provided in the supplement. Tables S1 through S6 provide biomass, catch and catch value results; Tables S7 and S8 show changes in ecosystem trophic level; Table S9 shows mixed trophic impacts from Ecopath indicating net trophic effects for impacted-impacting group combinations (see Ulanowicz & Puccia, 1990 and Christensen *et al*., 2005). Table S10 shows changes in production rates for the conjectural simulation. Figures S1 through S6 show Shannon and Q90 biodiversity trajectories. Figure S7 shows average ecosystem biomass/production.

Conjectural simulations

Biomass trajectories for the conjectural simulations are presented in Fig. 3A. When coral is eliminated, the ecosystem shifts towards algal dominance. Herbivorous fish increase 14% and urchins increase 117% under the extreme coral loss scenario (relative to the 0% loss scenario). However, the reef fish groups' biomasses decrease on average by 46%, with some reef-dependent groups showing severe depletions

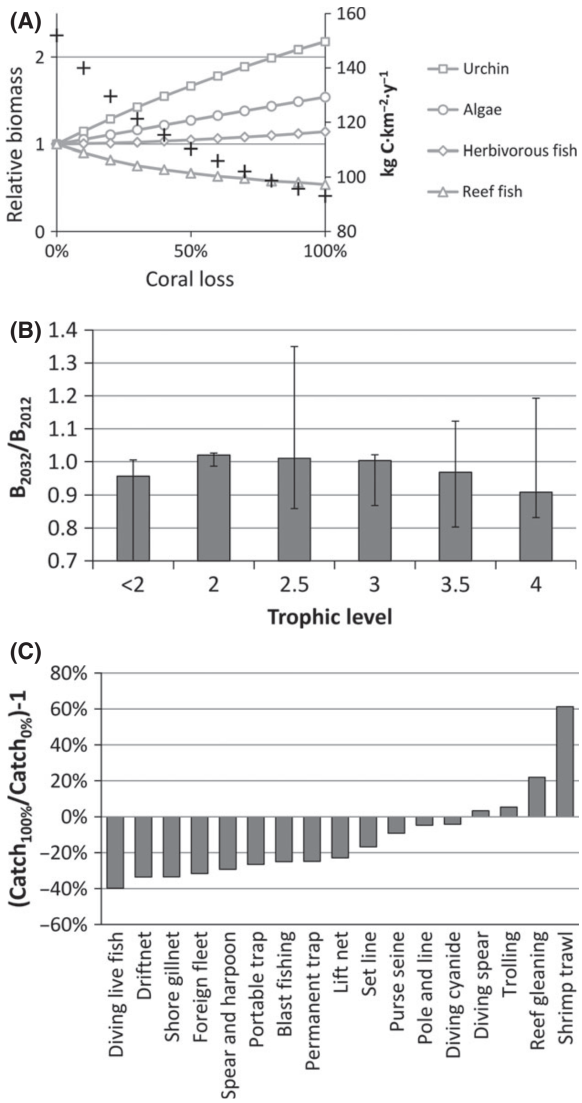

Fig. 3 Simulation results. (A) Transition from coral-dominated ecosystem (left) to algae-dominated ecosystem (right). Data represent end-points of 20-year simulations. Results are from the conjectural simulations (0%, 10% … 100% coral loss scenarios). Grey lines: biomass changes relative to initialization (2012) biomass; black hatches: reef fisheries productivity in kg C km^{-2} yr^{-1}. (B) Biomass changes per trophic level under the 100% coral loss scenario (all species groups). Error bars show the range for species groups within these trophic levels. (C) Fisheries catch by fleet under the 100% coral loss scenario relative to 0% loss scenario. Catch for the year 2032 is compared.

(small reef fish −97%, medium reef fish −61%, large planktivores −78%) (see Table S1). The total production rate of reef-associated groups increases by about 40% as high-turnover smaller species replace slow-growing larger species (Table S10). This finding is corroborated as mean ecosystem trophic level also

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drops from 1.62 to 1.56 between 2012 and 2032 (Table S8), reflecting a major structural change. Larger species tend to be higher trophic level, and we see a skewing of the trophic pyramid towards smaller-bodied consumers (Fig. 3B). In the 100% coral loss scenario, Shannon biodiversity decreases and then recovers incompletely (Figure S1), Q90 biodiversity decreases steadily (Figure S2).

When corals are removed, total ecosystem biomass increases 18.5% (Table S1). With trophic chains shortened, fewer trophic steps result in less energy lost through thermodynamic inefficiencies. However, the increased biomass does not occur in groups targeted by fisheries. Annual reef fish landings decline by 39%, from 152 to 93 kg C km^{-2} yr^{-1} [contrast this against Rogers *et al.* (2014) who estimated a 55% decline in predator productivity under similar conditions in the Caribbean]. Reef fish biomass has been halved from 373 to 202 kg C km^{-2} (Table S1). Midtrophic level species, which previously acted as a conduit for vertical energy flow, are reduced in biomass (small pelagic fish −45%, small reef fish −97%, anchovy −43%) (Table S1). This is from a combination of top-down and bottom-up effects (Table S9). Macroalgal grazers increase in biomass because of the abundance of algae in coral loss scenarios, yet they do not eat algae exclusively. A small fraction of their diet includes forage species (e.g. about 19% of predation mortality on small pelagic fish is due to this group) so there is increased predation from macroalgal grazers. There is also a decrease in availability of small herbivorous zooplankton, an important prey item for forage fish. This is due to a trophic cascade connecting herbivorous zooplankton to carnivorous zooplankton to reef-associated fish (Table S9).

Structural changes are further evidenced by a decrease in ecosystem maturity (Figure S7), with the greatest reduction in B/P occurring in the 100% coral loss scenario. The only fisheries that clearly benefit from the loss of coral structure are those targeting shrimp and other benthic invertebrates (Fig. 3C). Biomass increases in both the penaeid shrimp (+64%) and nonfished shrimp groups (+42%) (Table S1). The mixed trophic impacts routine (Ulanowicz & Puccia, 1990) suggests that this is due to a decrease in predation mortality by carnivorous macrobenthos, which is a result of coral loss (Table S9). A small increase in the availability of detritus may also contribute.

Wilson simulation

Forcing EwE with Wilson *et al.* biomass changes in reef fish leads to a 10–30% decline in biomass over 20 years in fished groups like large pelagic fish, groupers and snappers (Table S4). There is a steady decrease in ecosystem biodiversity from 2012 to 2032 according to the Shannon index, but the Q90 index decreases and then recovers (Figures S3 and S4). This disagreement between the metrics implies that evenness has been impacted, but ecosystem biomass eventually recovers (although not necessarily in the same groups as those that declined). Considering biodiversity within the reef fish assemblage, both biodiversity metrics indicate steady decline (Figures S5 and S6). As in the conjectural simulations, there is an increase in shrimp biomass (Fig. 4). Penaeid shrimp and nonfished shrimp increase 7% and 6% respectively (Table S4), while the shrimp trawl fleet benefits from a 9% increase in the annual catch rate (Table S6).

Discussion

The Raja Ampat ecosystem is exceptionally biodiverse and may serve as a sensitive test site for coral loss studies. In other ways, the ecosystem is typical of coral reef

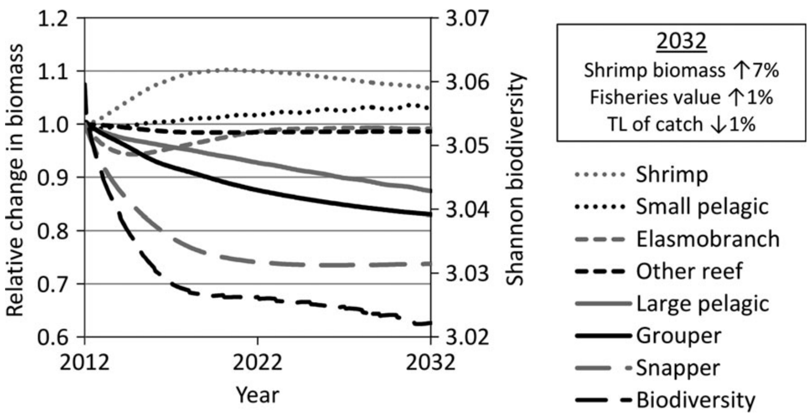

Fig. 4 Ecosystem biomass changes in Raja Ampat from 2012 to 2032 using Wilson *et al.*, 2006 biomass forcing.

areas: it endures a multitude of threats with environmental and human-related stressors on the rise. We have simulated in this article both a typical pattern of coral loss, similar to the recent world case studies summarized by Wilson *et al.* (2006), and more dramatic losses as may become common in years to come.

The conjectural simulations, in which up to 100% of coral biomass was removed, result in fundamental shifts in ecosystem structure and function. The ecosystem transitions from a coral-dominated state to an algal-dominated state, although these algae are primarily envisaged to be short turfs rather than fleshy macroalgae, and do not necessarily pose a threat to ecosystem recovery (sensu Arnold *et al*., 2010). This is consistent with evidence from the Indo-Pacific (Mumby *et al*., 2013).

The model predicts that transition towards algal dominance results in increases in herbivorous species and decreases in reef-associated fauna and high trophic level piscivorous species, the main targets of fisheries (Sano, 2004; Pratchett *et al*., 2008). Evidence for a herbivore numerical response may be ambiguous in the Indo-Pacific (Wismer *et al*., 2009; Carassou *et al*., 2013; Heenan & Williams, 2013) although some studies found indications of such (Cheal *et al*., 2008; Gilmour *et al*., 2013). Moreover, these relationships are common in the Caribbean (Williams *et al*., 2001; Mumby *et al*., 2005, 2006, Newman *et al*., 2006; Carpenter, 1990) and this lends credence to the model's behaviour. Food limitation in herbivorous fish contributes to the numerical response (Ainsworth *et al*., 2008b). A nonlinear effect may occur at low population sizes where herbivore fish response is decoupled from algal density (Hernández-Landa *et al*., 2014), but this is unlikely to affect our results as herbivore fish biomass remains relatively high in Raja Ampat (Ainsworth *et al*., 2008b). Differentiation within the herbivore guild is missed by our model due to species aggregation, so it is difficult to infer which functional roles (see Heenan & Williams, 2013) remain present after the phase shift and therefore implications for reef resiliency (Cheal *et al*., 2008).

The shift in biomass towards lower trophic level species indicates that trophic chains are shortened overall and the food web is simplified. The model predicts that less energy passes to the upper food web and through fewer conduits. This is indicated by a decrease in the average trophic level, reduced biomass in forage species (caused by simultaneous top-down and bottom-up effects), and reduced ecosystem biodiversity – a finding supported by observation (Jones *et al*., 2004; but see Cheal *et al*., 2008). Finally, ecosystem maturity decreases as long-lived species are replaced with high-turnover species.

Nonlinear or threshold effects may actually worsen this problem at low coral densities (Pratchett *et al*., 2014). We conclude that human communities relying on this depauperate ecosystem would likely be required to abandon traditional target species in favour of less valuable but more abundant species. As the EwE model we have employed does not consider opportunistic fishing behaviour or market effects, it is difficult to estimate the change in fisheries profitability. Despite great abundance, these high-turnover species of fish and invertebrates are likely to fluctuate with environmental variability more than the longer lived species that are the traditional mainstay of fisheries. This could carry implications for the consistency of fisheries benefits and food security.

The conjectural simulations and the Wilson simulation agree that loss of coral results in large decreases in reef-associated fauna, and that smaller reef-associated fish species are particularly impacted. This shift in size structure has been noticed empirically (Graham *et al*., 2007; Ledlie *et al*., 2007). Also, the conjectural simulations and the Wilson simulation agree that an increase in shrimp biomass and shrimp landings is likely when coral is depleted. This effect can be traced to reduced predation on shrimp by carnivorous macrobenthos, which are dependent on reefs, and a greater availability of detritus.

Qualitative agreement between the Wilson and conjectural simulations within the range of historically observed coral declines in this region lends credibility to the more extreme coral loss scenarios ventured by the conjectural simulations. However, one conspicuous disagreement is that the conjectural simulations predict a decrease in small midtrophic level fish with implications for vertical flow of energy to the upper food web. This behaviour is not present in the Wilson simulation. The (inputted) fish abundance data drawn from Wilson *et al.* (2006) does in fact include a 5% decrease in small reef-associated fish (one of the largest changes observed by those authors), but our simulation does not predict a similar decrease in small pelagic fish. Rather, it predicts a small increase in those groups leaving the pelagic forage assemblage intact. One possible explanation is that greater losses of coral are required to elicit this effect (more akin to the extreme scenarios tested in the conjectural simulations). An alternative explanation is that the conjectural simulations, which assumed a uniform effect of coral loss on different size categories of reef-associated fish, lost nuanced differences that were more properly represented by the Wilson simulation.

This study uses a combination of modelling the potential effects of major coral loss (conjectural simulations) with more empirically grounded simulations of the consequences of a modest decline in coral cover (the Wilson *et al.* simulations). In both cases, the productivity of reef fisheries declines severely. This is a concern for food security given the high dependence on fish protein that often exists in tropical coastal areas (Burke *et al.*, 2011).

Acknowledgements

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Conjectural simulation results (biomass by species group, all simulations).
Table S2. Conjectural simulation results (catch and value rates by species group, selected simulations).
Table S3. Conjectural simulation results (catch and value rates by fishery, selected simulations).
Table S4. Wilson simulation results (biomass by functional group).
Table S5. Wilson simulation results (catch and value rates by functional group).
Table S6. Wilson simulation results (catch and value by fishery).
Table S7. Trophic level at initialization (2012) and end state (2032) for Wilson simulation.
Table S8. Trophic level at initialization (2012) and end state (2032) for conjectural simulations.
Table S9. Mixed trophic impacts.
Table S10. Production rate in 2032 under 100% coral loss scenario.
Figure S1. Shannon biodiversity for conjectural simulations (0%, 50% and 100% coral loss scenarios).
Figure S2. Q90 biodiversity for conjectural simulations (0%, 50% and 100% coral loss scenarios).
Figure S3. Shannon biodiversity for Wilson simulation (all groups).
Figure S4. Q90 biodiversity for Wilson simulation (all groups).
Figure S5. Shannon biodiversity for Wilson simulation (reef fish groups).
Figure S6. Q90 biodiversity for Wilson simulations (reef fish groups).
Figure S7. Average group biomass/production ratios in the ecosystem.

Annex 852

"Strand", *Coral Reef Info*, *available at* http://www.coralreefinfo.com/coralglossary/glossary_s.htm (accessed 28 Nov. 2015)

strand - the narrow littoral marine zone including beach, foredune, and remaining sandy habitat up to the edge of stabilized dune or inland vegetation. Much of this zone is under the influences of salt spray, shifting and abrasive sand, severe storm surf and high tides. Strand occurs from tropical to temperate, even arctic, latitudes and along coastlines of continents and islands

Annex 853

"Physical Properties of Strand", *The Mildred E. Mathias Botanical Garden*, *available at* http://www.botgard.ucla.edu/html/botanytextbooks/worldvegetation/strand/physicalpropertiesofstrand.html (accessed 28 Nov. 2015)

Physical Properties of Strand.

1. Daily and annual solar radiation of the unobstructed beach environment can be relatively high, especially in the tropical, subtropical, and warm temperate zones. Full sun on a cloudless day can yield very high instantaneous values of intercepted light, because white sand has high albedo and, therefore, a substantial amount of solar radiation that strikes the white sand is reflected from the surface. On the other hand, coastal fog and overcast skies may also occur daily or seasonally, so that during much of the daytime leaves may be exposed to lower solar radiation than they would intercept in a cloudless, inland habitat at the same latitude.
2. Mean annual air temperature (also annual range) varies greatly along a gradient of tropical to arctic sites, but typically each is less extreme than for comparable inland sites from the same latitudes, because coastal temperature highs and lows (most sites have little or no freezing) are moderated by maritime conditions. Temperature at the surface of reflective, dry sand greatly exceeds air temperature during full-sun conditions, being significantly higher for leaves resting on the sand surface than several inches above the sand.
3. Daily land and sea breezes are typical for many beaches. Some strand sites receive calm to mild winds year-round, some regularly receive strong to moderate winds, and many are strongly affected by winds of violent, catastrophic storms. Wind reduces boundary layer thickness (i.e., unstirred air) next to leaf and sand, thereby increasing evapotranspiration while also decreasing leaf and sand temperature, if winds are strong enough. Strand may have markedly different wind microhabitats on windward and leeward sides of dunes and established plants.
4. In addition to the influence of high tides, strand plants obtain moisture (freshwater) from precipitation and fog drip (intercepted by shoots) and may as well benefit from moisture condensation (dew) on the shoot and sand surface. To be physiologically significant, the sand must be sufficiently wetted in the region used by roots.
5. Salt spray is a minute aerosol formed above heavy surf, generated when bubbles of saltwater break. Salt spray is therefore highest at water's edge and decreases dramatically inland. The vegetation on the ocean-facing edge consequently receives the highest concentrations of salts, but these levels are very weak. Vertical surfaces have much higher interception rates of salt spray than horizontal ones; linear surfaces higher than broad ones; structures high above the sand intercept substantially more than structures close to the sand.
6. The outer edge of vegetation will experience the greatest effects of physical buffeting and salinity from soaking high tides and swells during storm surges.
7. Dry surface sand is mobile. Plants can be damaged by sand blast, roots are sometimes exposed, and shoots frequently are buried by shifting sand, pushed by strong winds. To move sand grains, wind speed must be at least four meters per second.
8. Beach sand has a low capacitance to retain water and is nutrient-poor, with < AHREF="d0428tx.html">little organic matter. Surface sand, which experiences rapid wet-dry episodes, is a stressful environment for plant roots. Deep sands may remain moist, receiving and storing water while the surface sand stays dry much of the time. Roots and rhizomes can penetrate sand rapidly, in comparison with growth within heavy soils having clay.

[Return to Strand Main Menu]

Annex 854

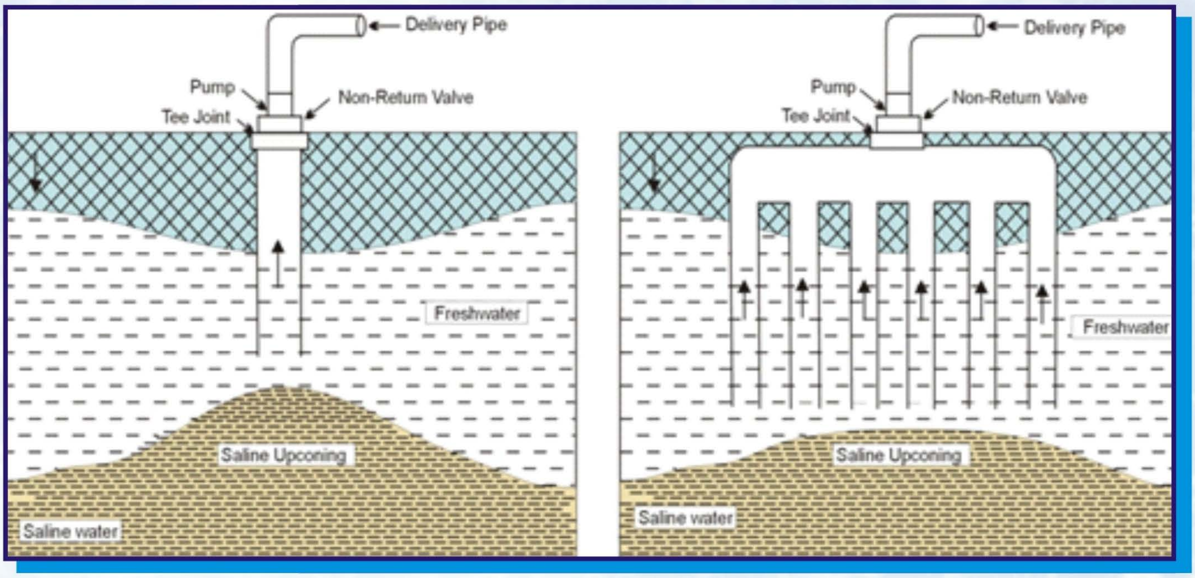
ICARDA/USDA, "Skimming Well Technologies for Sustainable Groundwater Management", *available at* http://uaf.edu.pk/directorates/water_management/brochures/Skimming%20Well%20(English)%20 brochure.pdf (accessed 28 Nov. 2015)

Watershed Rehabilitation and Irrigation Improvement in Pakistan

Skimming Well Technology for Sustainable Groundwater Management

What is skimming well

Skimming well is a technique employed with an intention to extract relatively freshwater from the upper zone of the fresh-saline aquifer. The skimming wells are low discharge (less than 28 l.p.s.) cluster of wells drawing groundwater from relatively shallow depth.



Single and multi strainer well

Need of skimming well

Exploitation of groundwater for agriculture, municipal and industrial uses is severely hampered in many parts of Punjab due to upcoming of brackish groundwater in response to freshwater withdrawals. The skimming wells are used:

- To get fresh water
- To manage root zone salinity
- To reduce energy requirement for low discharge tube wells

Delivery from a skimming well

Types of Skimming Wells

- Conventional single strainer well
- Multi-strainers wells
- Scavenger wells
- Radial collector wells
- Dug wells

How to install a skimming well?

- During drilling, take water samples at 3 intervals and measure electric conductivity (EC) of water
- At a depth, when EC of water sample is around 3 dS/m, stop further drilling. This depth may be assumed as fresh-saline water interface.
- Install well 40% penetration ratio. For example if water table is at 10 m depth and fresh-saline water interface is at 35 m, then water available for pumping is about 25 m. Therefore, skimming well may be installed at about 20 m from the soil surface
- Select number of strainers based on the freshwater available. Greater the freshwater thickness, lesser will be the number of strainers required
- The radial distance of strainers from pump should be less than 3 m
- Two skimming wells with a discharge of 28 lps (1 cusecs) should not be installed within a distance of 350 m from each other

How to operate a skimming well?

A skimming well should not be operated continuously. The well may be operated 4-12 hrs/day depending on the freshwater thickness and recharging sources.

A T used to join the well points with the pump

Benefit of skimming well

- Improved quality of pumping groundwater
- Availability of locally manufactured material
- Availability of local expertise for drilling, installation and maintenance
- Shallow water table which helps in use of centrifugal pump units
- Technically simple systems
- Economically viable
- Improves soil health and crop yields

Cost of Skimming well

Cost of skimming well depends upon discharge and brand of pump as well as the depth of fresh water layer. The cost of one cusec skimming well varies from Rs.1.5-3 lakh

For more information about skimming well technology contact:
Water Management Research Centre University of Agriculture Faisalabad
Phone: +92-41-9200201

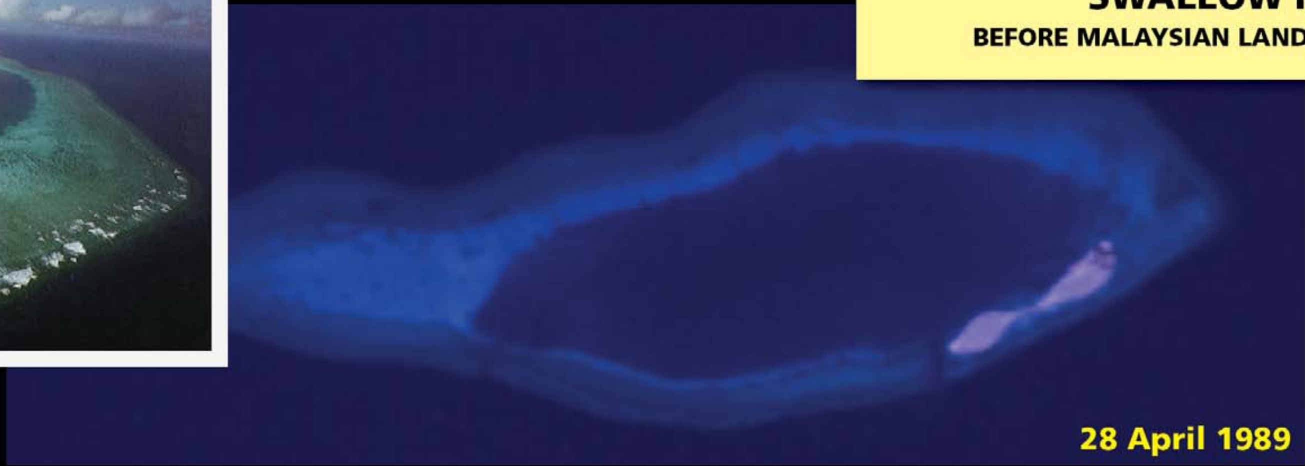
Annex 855

Slides Presented at Hearing on Merits by Prof. Clive Schofield, Ph.D. (30 Nov. 2015)

SWALLOW REEF

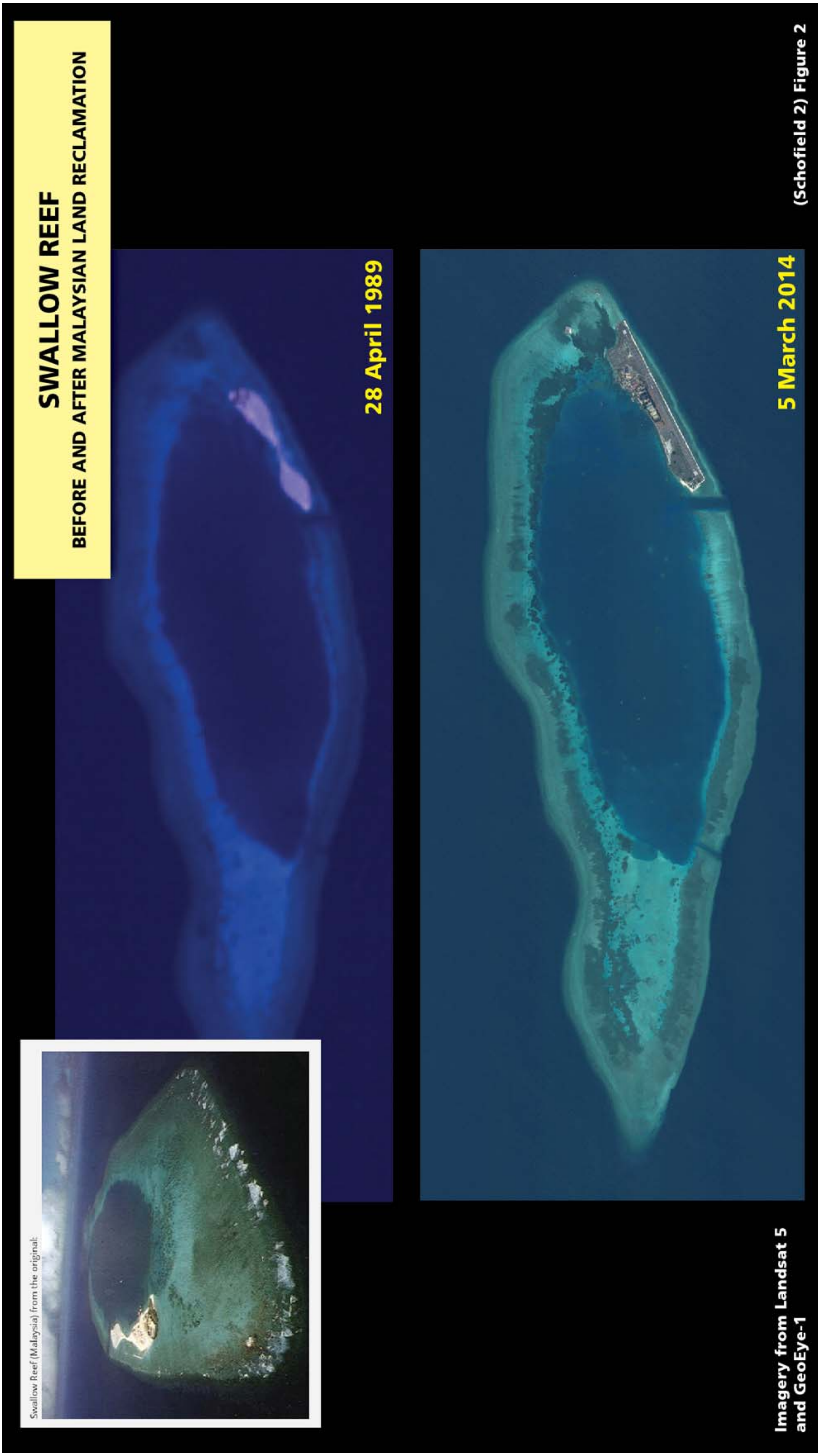
BEFORE MALAYSIAN LAND RECLAMATION

Swallow Reef (Malaysia) from the original:

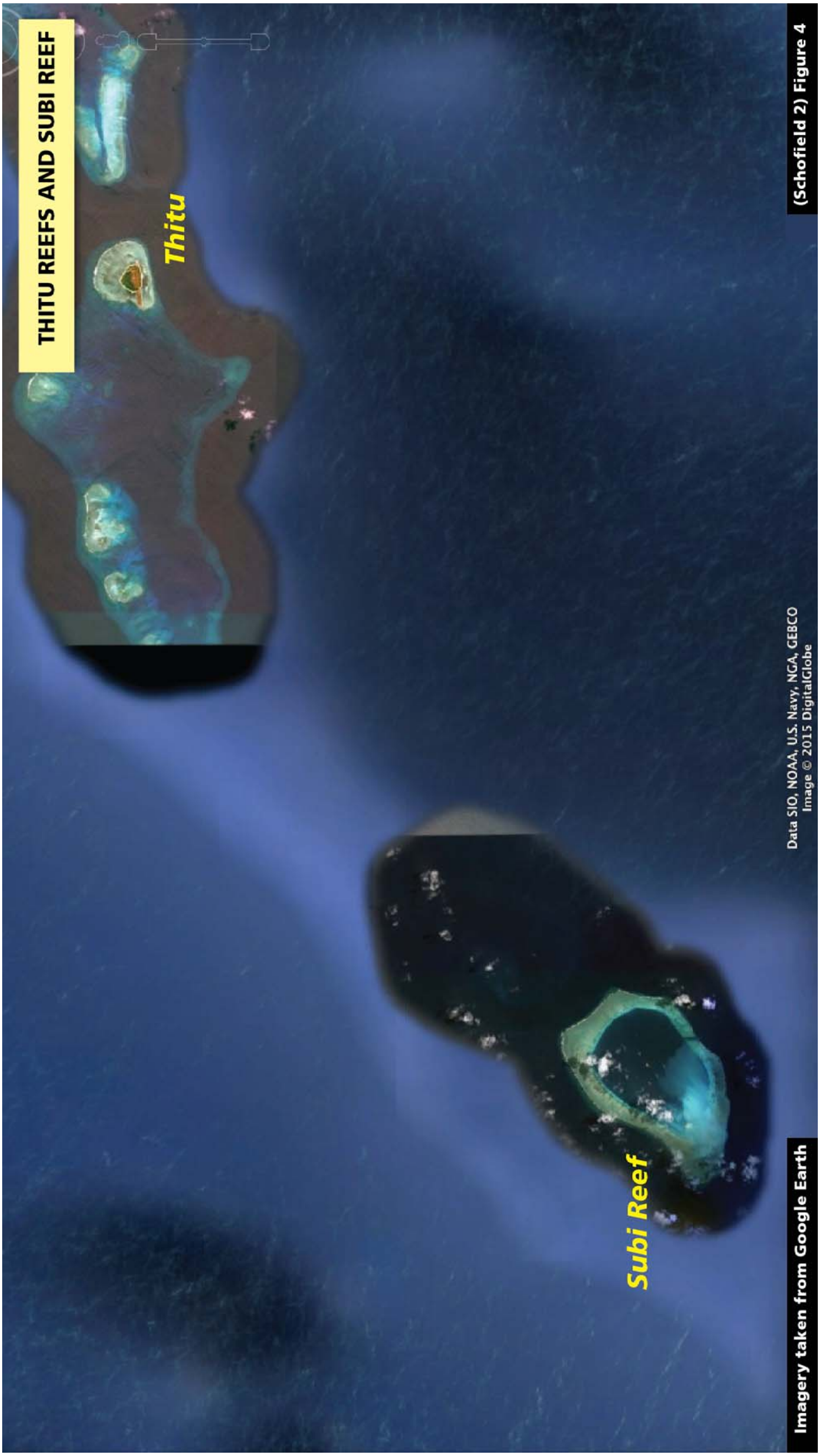


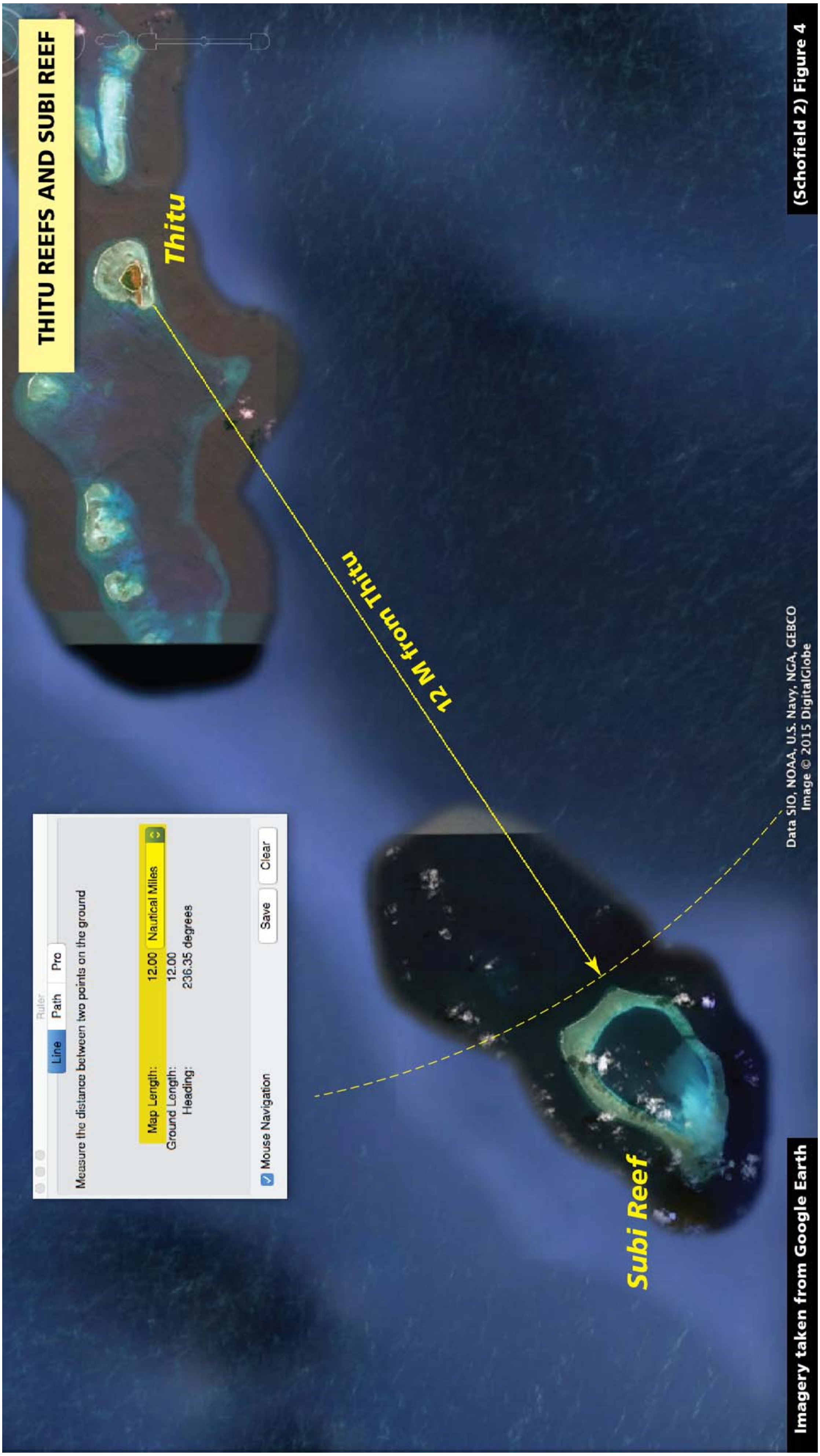
Imagery from Landsat 5
and GeoEye-1

(Schofield 2) Figure 2

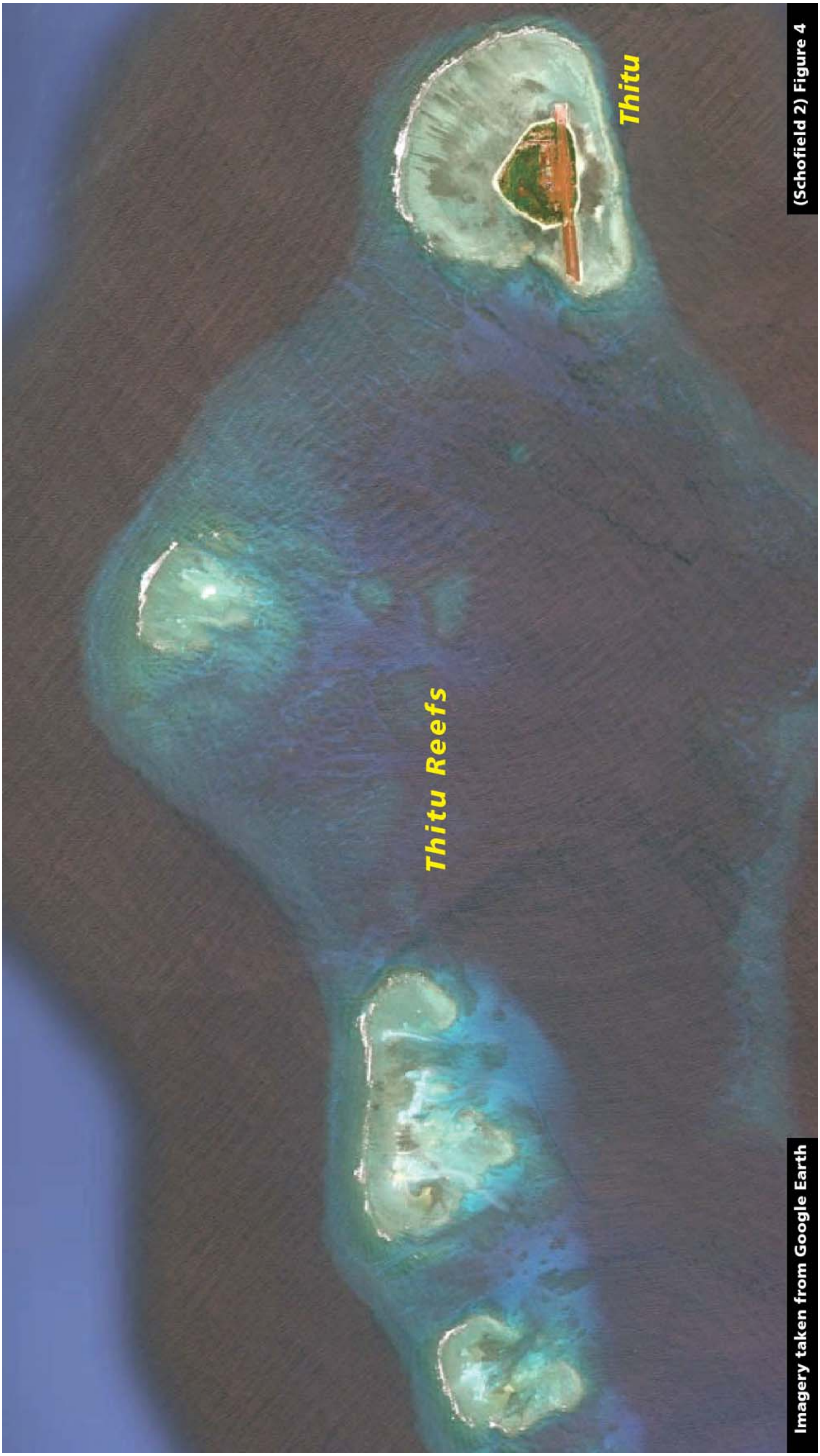

SWALLOW REEF
BEFORE AND AFTER MALAYSIAN LAND RECLAMATION
28 April 1989
5 March 2014
Swallow Reef (Malaysia) from the original:
Imagery from Landsat 5 and GeoEye-1
(Schofield 2) Figure 2


SUBI REEF
BEFORE AND AFTER RECENT CHINESE
ARTIFICIAL ISLAND BUILDING
8 August 2012
6 November 2015
Imagery acquired from Digitial Globe
(Schofield 2) Figure 3


THITU REEFS AND SUBI REEF
Thitu
Subi Reef
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2015 DigitalGlobe
Imagery taken from Google Earth
(Schofield 2) Figure 4



(Schofield 2) Figure 4


(Schofield 2) Figure 4
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Thitu Reefs
Imagery taken from Google Earth


(Schofield 2) Figure 4
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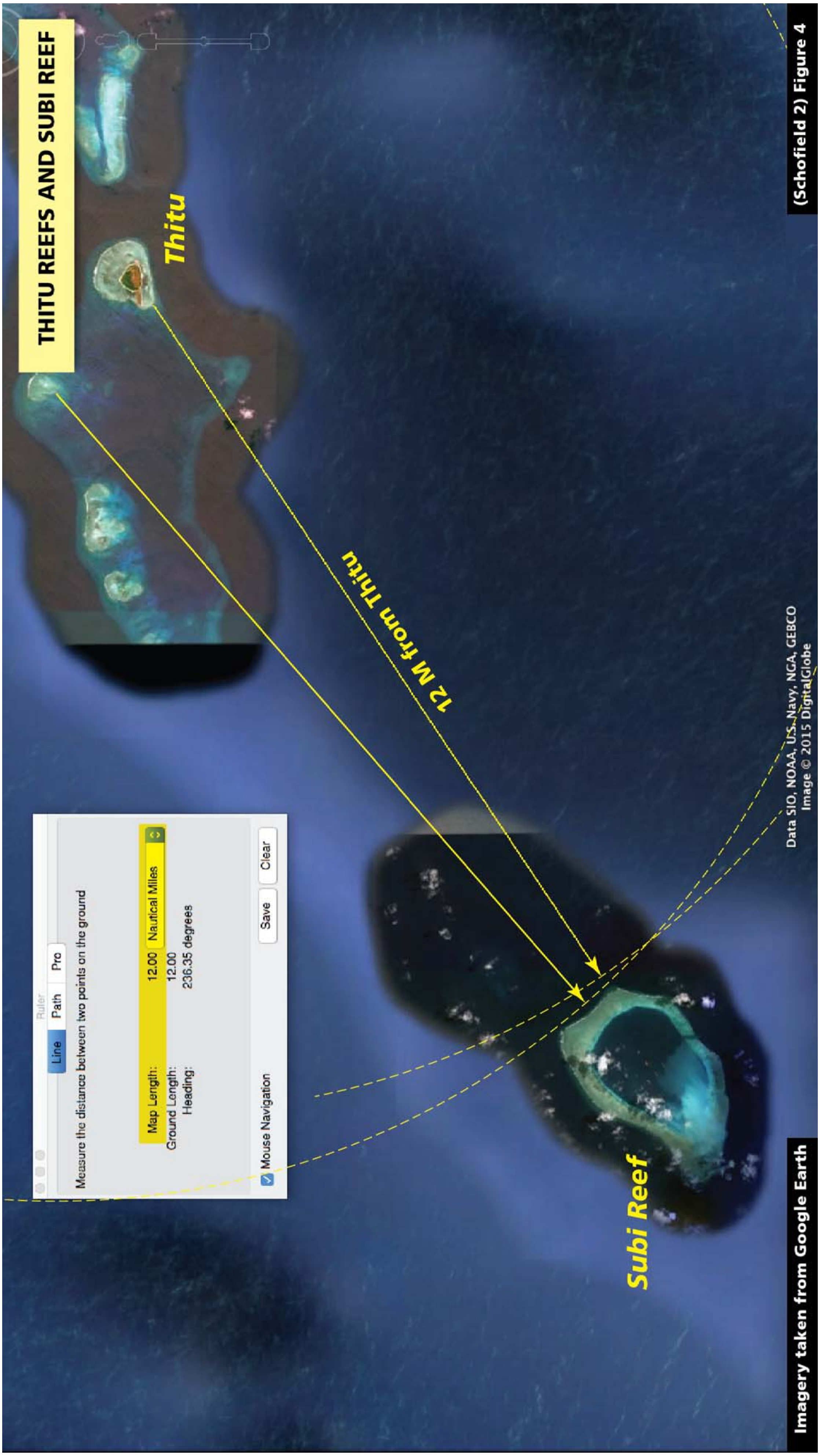
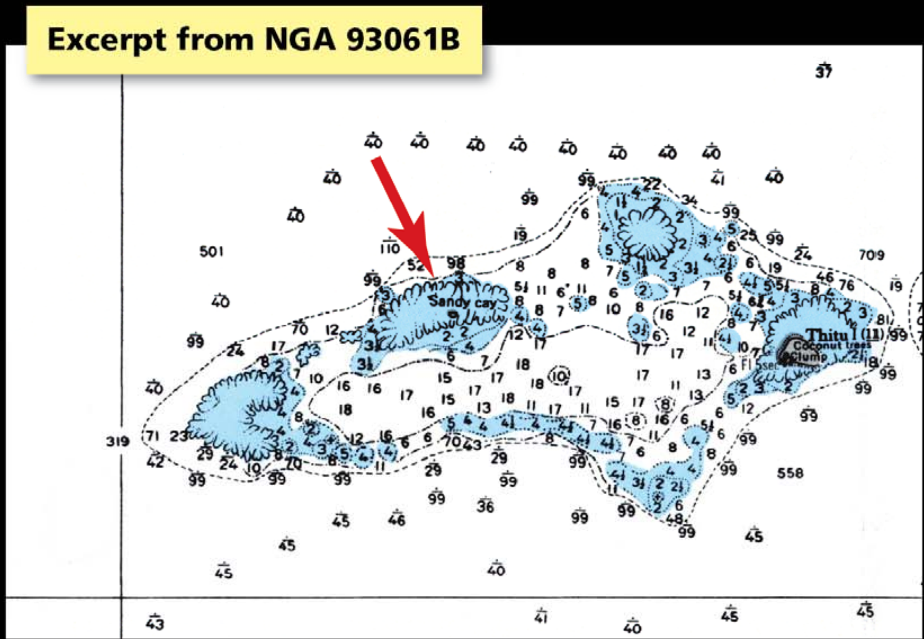
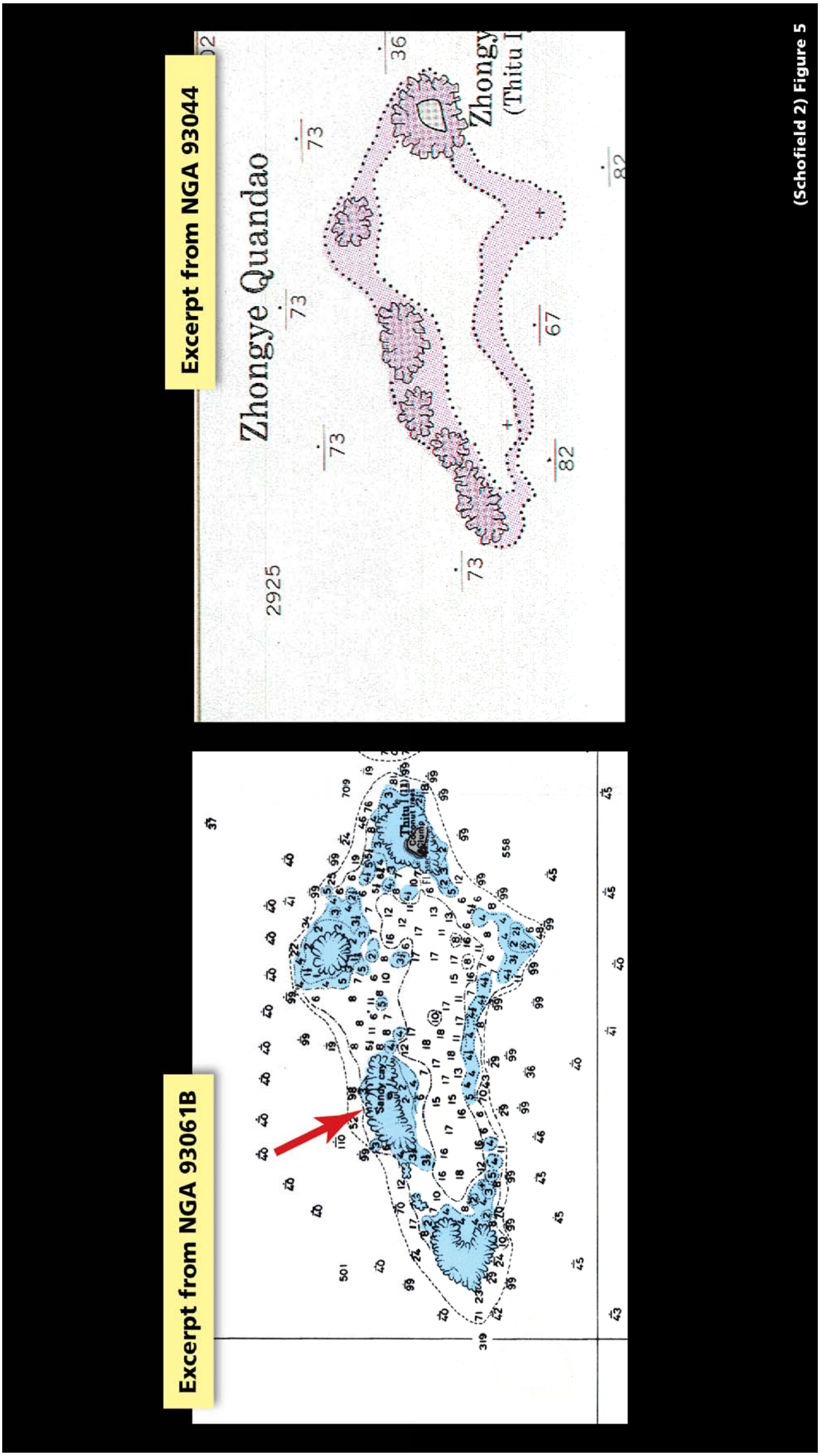
Imagery taken from Google Earth

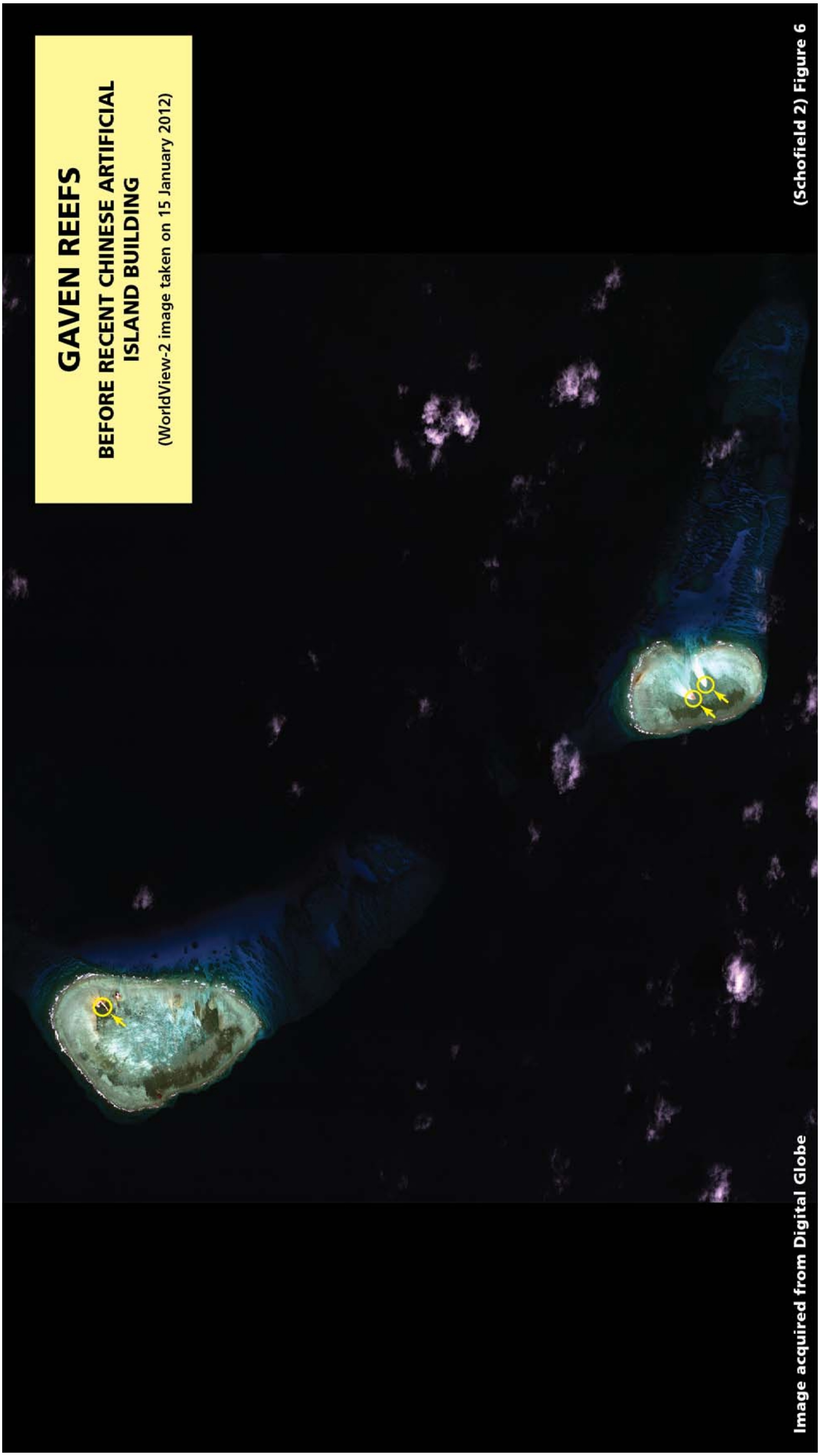

THITU REEFS AND SUBI REEF
Thitu
12 M from Thitu
Subi Reef
Ruler
Line
Path
Pro
Measure the distance between two points on the ground
Map Length: 12.00 Nautical Miles
Ground Length: 12.00
Heading: 236.35 degrees
Mouse Navigation
Save
Clear
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2015 DigitalGlobe
Imagery taken from Google Earth
(Schofield 2) Figure 4



(Schofield 2) Figure 5

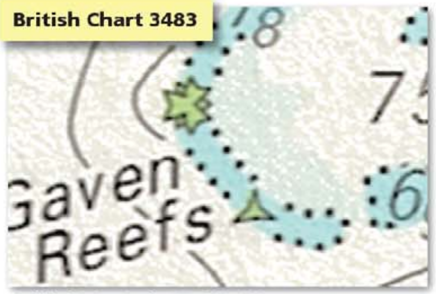


(Schofield 2) Figure 5


GAVEN REEFS
BEFORE RECENT CHINESE ARTIFICIAL ISLAND BUILDING
(WorldView-2 image taken on 15 January 2012)
Image acquired from Digital Globe
(Schofield 2) Figure 6

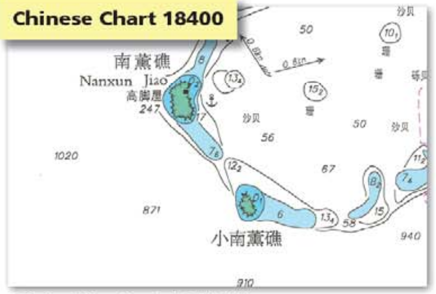
NAUTICAL CHARTING OF GAVEN REEF

British Chart 3483



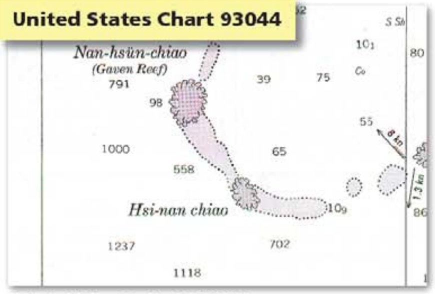
Original Map Scale 1:1,500,000
Complete chart reproduced as Annex NC1

Chinese Chart 18400



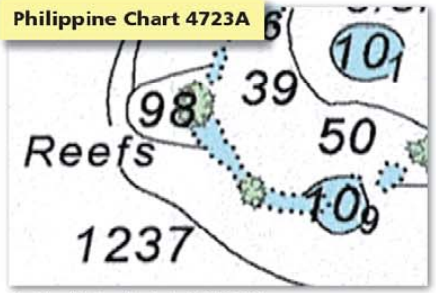
Original Map Scale 1:250,000
Complete chart reproduced as Annex NC17

United States Chart 93044



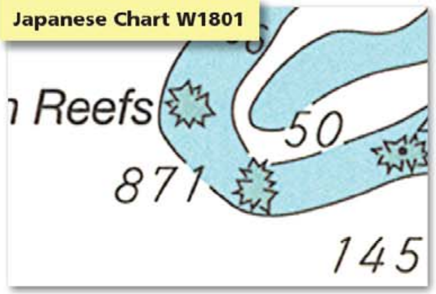
Original Map Scale 1:250,000
Complete chart reproduced as Annex NC6

Philippine Chart 4723A



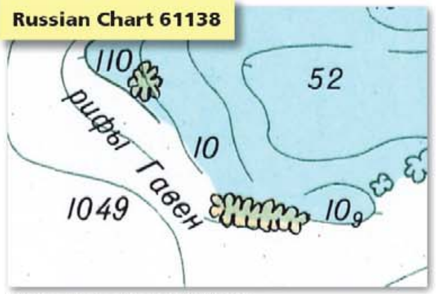
Original Map Scale 1:1,250,000
Complete chart reproduced as Annex NC5

Japanese Chart W1801



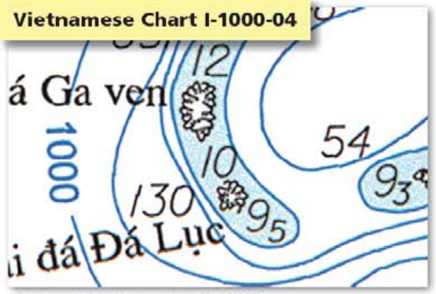
Original Map Scale 1:1,200,000
Complete chart reproduced as Annex NC11

Russian Chart 61138



Original Map Scale 1:500,000
Complete chart reproduced as Annex NC40

Vietnamese Chart I-1000-04



Original Map Scale 1:1,000,000
Complete chart reproduced as Annex NC64

Philippine Supplemental Written Pleading, Volume II, pgs. 57 & 58

(Schofield 2) Figure 7

Excerpt from Question 12, Annex B

Excerpt from Question 12:

“Please also address the implications of the United States National Geospatial-Intelligence Agency, Pub. 161 Saling Directions (Enroute), South China Sea and the Gulf of Thailand . . . insofar as those sources refer to the presence of a white sand dune approximately 2 meters above water at high tide.”

(Schofield 2) Figure 8

Excerpt from Question 12, Annex B

Excerpt from Question 12:

"Please also address the implications of the United States National Geospatial-Intelligence Agency, Pub. 161 Saling Directions (Enroute), South China Sea and the Gulf of Thailand . . . insofar as those sources refer to the presence of a white sand dune approximately 2 meters above water at high tide."

Actual text of the Sailing Direction:

"**Gaven Reefs** (10°12'N., 114°13'E.) is comprised of two reefs which cover at HW and lie 7 miles W and 8.5 miles WNW, respectively, of Namyit Island. They are the SW dangers of Tizard Bank. The N of the two reefs is marked by a white sand dune about 2m high."

(Schofield 2) Figure 8

Excerpt from Question 12, Annex B

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(Schofield 2) **Figure 8**

Annex 856

Geographical Information on Thitu Reefs

THITU REEFS

Also known as:

Chinese: Zhongye Qunjiao (中业群礁)

Philippine: Pagasa Reefs

Coordinate Location: 11°02'56"N - 114°12'05"E

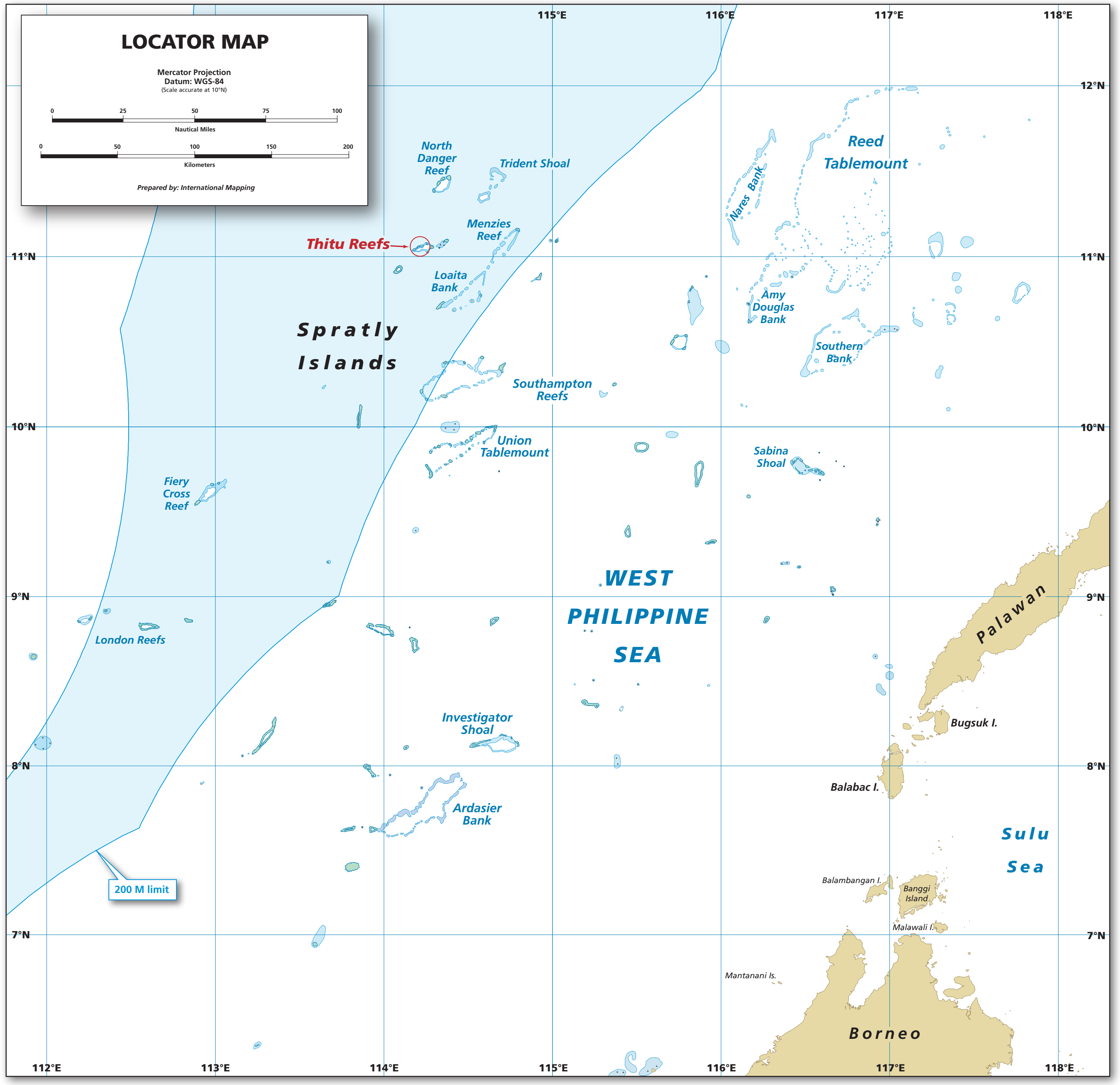
Nearest High Tide Feature: Thitu Island (4.5 M from centroid)

Distance to Palawan: 231.8 M

Distance to Hainan: 499.9 M

Claimed by: China, Philippines, Vietnam

Occupied by: Unoccupied



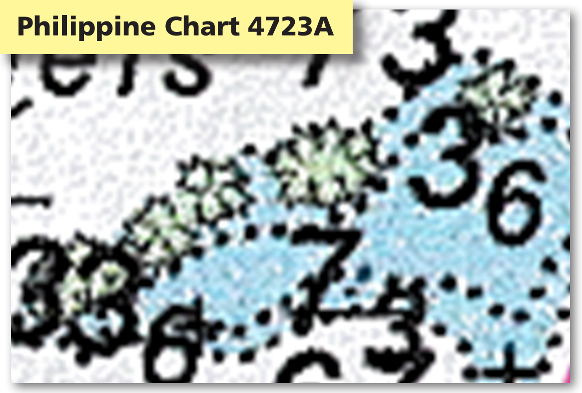
THITU REEFS

Sailing Directions and Charts

1) Philippine National Mapping and Resource Information Agency, *Philippine Coast Pilot* (6th ed., 1995) (MP, Annex 231)

[Pagasa Island] is surrounded by a drying reef which extends up to 0.5 mile from its NE side.

Philippine Chart 4723A

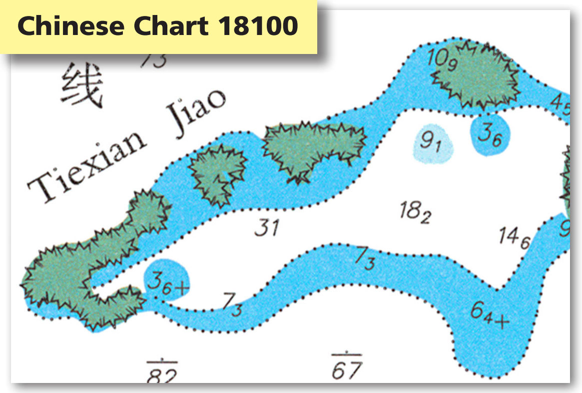


Original Map Scale 1:1,250,000
Complete chart reproduced as Annex NC5

2) Navigation Guarantee Department of the Chinese Navy Headquarters, *China Sailing Directions: South China Sea* (A103) (2011) (SWSP, Annex 232(bis))

Zhongye Reefs - Zhongye Reefs are 18 NM south of Shuangzi Reefs. There are two coral beaches. The beaches are separated by a deep water waterway as wide as 7 chains. Zhongye Island is located at the east end of the western reef and the height is 3.4 meters. Tiezhi Jiao is located at the northeast end of the eastern reef. There are many dangerous reefs on the beaches.

Chinese Chart 18100

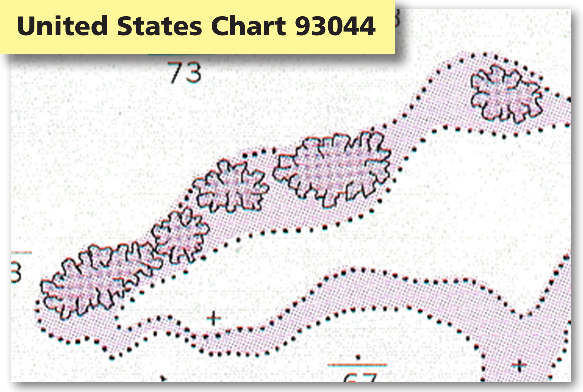


Original Map Scale 1:250,000
Complete chart reproduced as Annex NC25

3) United States National Geospatial-Intelligence Agency, Pub. 161 Sailing Directions (Enroute), *South China Sea and The Gulf of Thailand* (13th ed., 2011) (MP, Annex 233)

The W reefs of Thitu Island are composed of several drying reefs and shoal patches. A sand cay lies on one of these drying reefs about 3.5 miles W of the island. Entrance to the lagoon can be taken through the passage to the E of the sand cay, with a least depth of 9m in the center of the channel. Many of the surrounding reefs are marked by breakers.

United States Chart 93044



Original Map Scale 1:250,000
Complete chart reproduced as Annex NC6

4) United Kingdom Hydrographic Office, *Admiralty Sailing Directions: China Sea Pilot (NP31)*, Vol. 2 (10th ed., 2012) (MP, Annex 235)

The W bank [of Thitu Island] has reefs and irregular depths at its edges, and greater depths within. Features on the W bank, with positions from Thitu Island are:

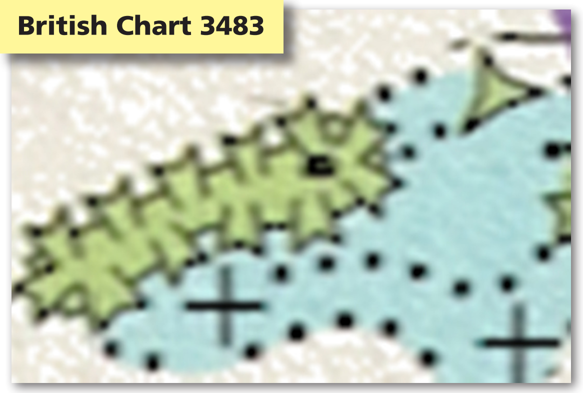
A reef 1 ½ miles NW. Irregular depths exist in the channel between Thitu Island and the reef.

A drying reef with a sand cay near its centre 3 ½ miles WNW. In the middle of the passage, between this reef and the reef 1 ¼ miles ENE, leading into the lagoon, there is a shoal.

A reef forming the W extremity of the W bank 6 miles W. There are detached reefs, always marked by breakers, between this reef and the reef 1 ¼ miles ENE.

A small reef on the S edge of the bank 2 miles SW. The S edge of the bank is not as dangerous as the N edge.

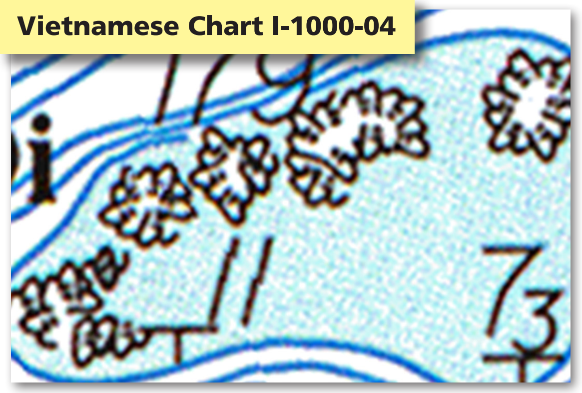
British Chart 3483



Original Map Scale 1:1,500,000
Complete chart reproduced as Annex NC1

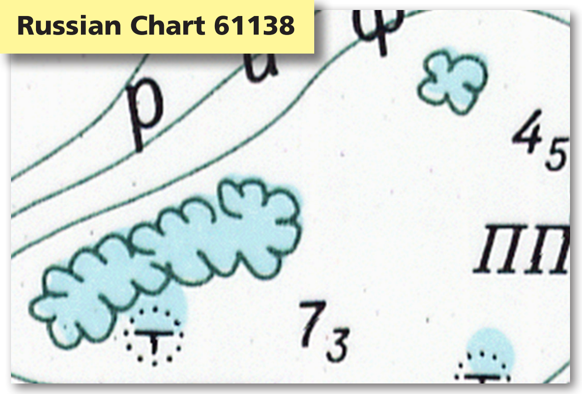
THITU REEFS
Additional Charts

Vietnamese Chart I-1000-04



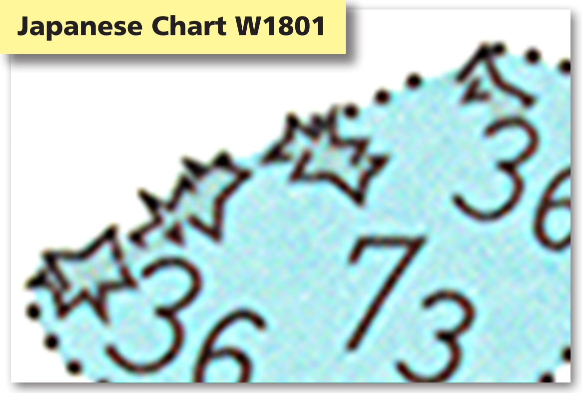
Original Map Scale 1:1,000,000
Complete chart reproduced as Annex NC64

Russian Chart 61138



Original Map Scale 1:500,000
Complete chart reproduced as Annex NC40

Japanese Chart W1801



Original Map Scale 1:1,200,000
Complete chart reproduced as Annex NC11

Malaysian Chart

Malaysian chart coverage stops at 8°50' N

Geographic/Hydrographic Observations by Dr. Robert Smith

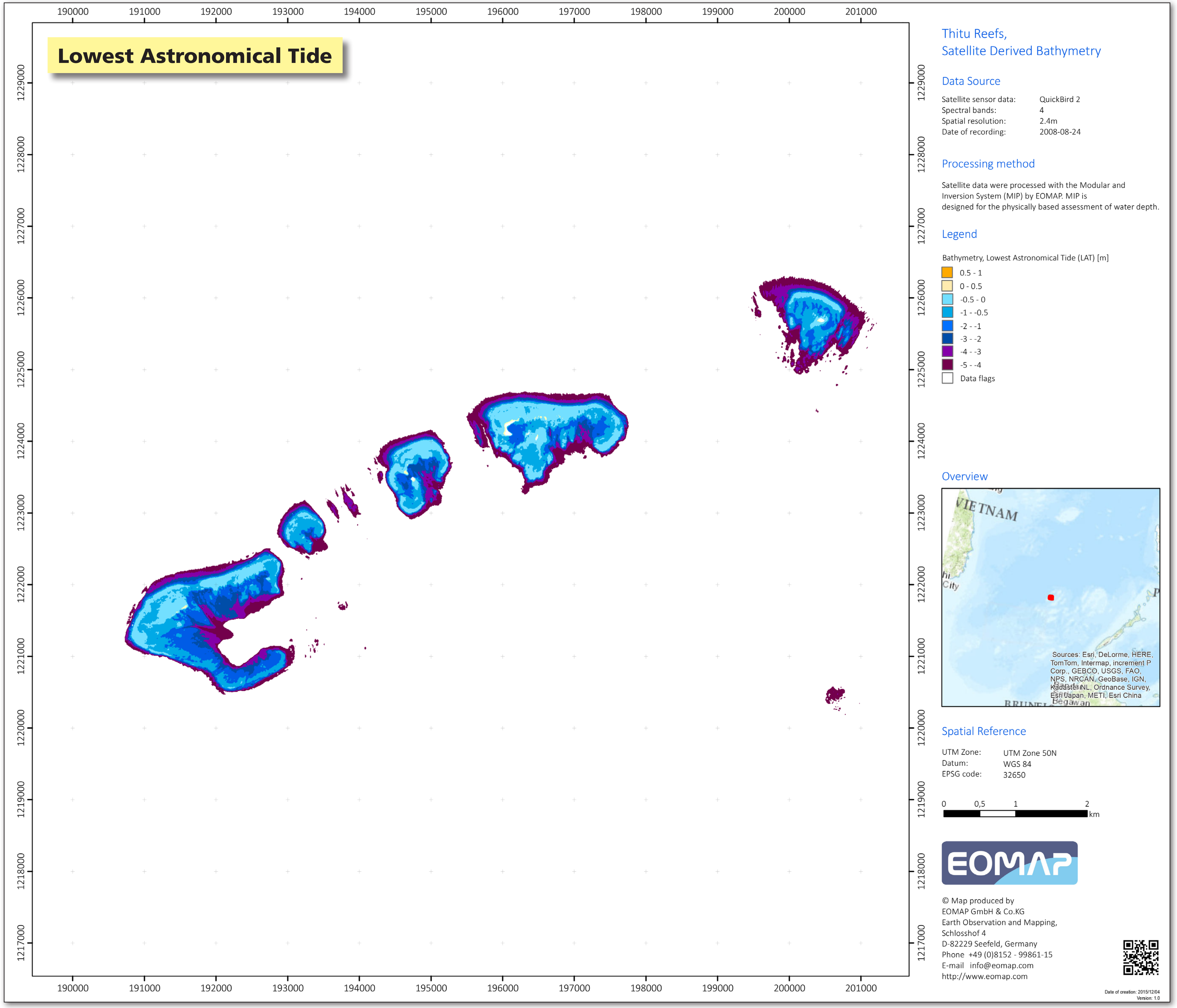
Thitu Reefs are five drying reefs that extend for a distance of slightly more than 5 nautical miles due west of Thitu Island. Both the U.S. and U.K. Sailing Directions indicate that a sand cay lies on one of the reefs approximately 3.5 nautical miles from Thitu. However, U.S. chart NGA 93044 (2nd ed. 5/84) has removed the indication of a cay that had been present on the previous U.S. chart of the area, NGA 93061B (4th ed. revised through 9/70). Currently, only British Chart 3483 shows the presence of a tiny cay on one of these reefs. Charts published by the Philippines, China, Vietnam, Japan and Russia give no indication of any feature above water at high tide among these reefs.

When the satellite imagery used in the EOMap analysis was taken, the tidal level was determined (by EOMap) to be 71 cm *below* Mean High Water. Even at that relatively low tidal level, the two westernmost reefs were completely submerged.

On the three easternmost reefs, there are indications of tiny sand spits that had uncovered at that tidal level. While it is likely that these sandy areas cover fully at tidal levels approaching Mean High Water, the EOMap analysis automatically depicts them as small white spots identified as “data flags,” because the technology employed only reads the relative heights of features that are covered by water at the time of image capture.

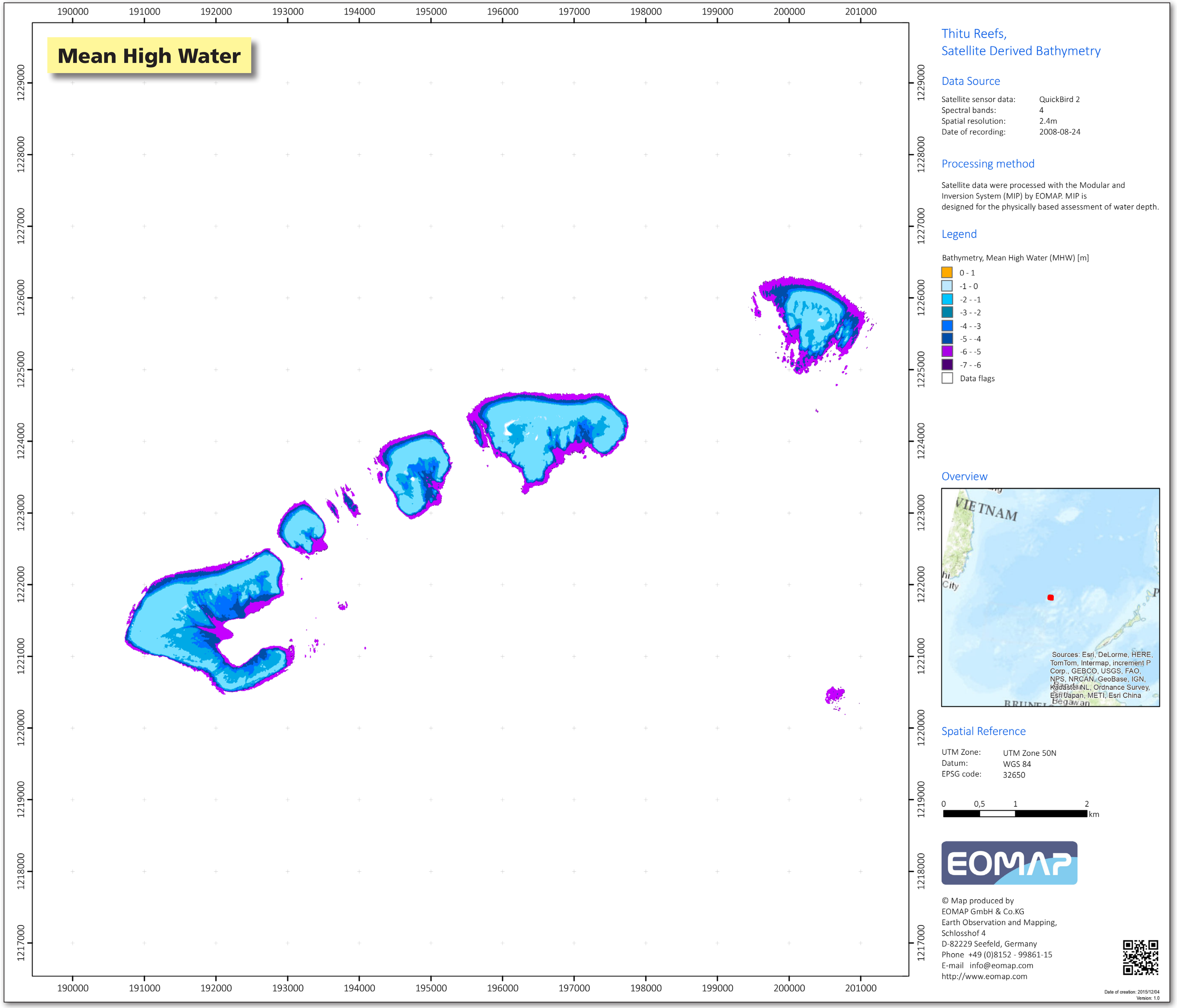
THITU REEFS

EOMap Analysis of Thitu Reefs from High-resolution Imagery



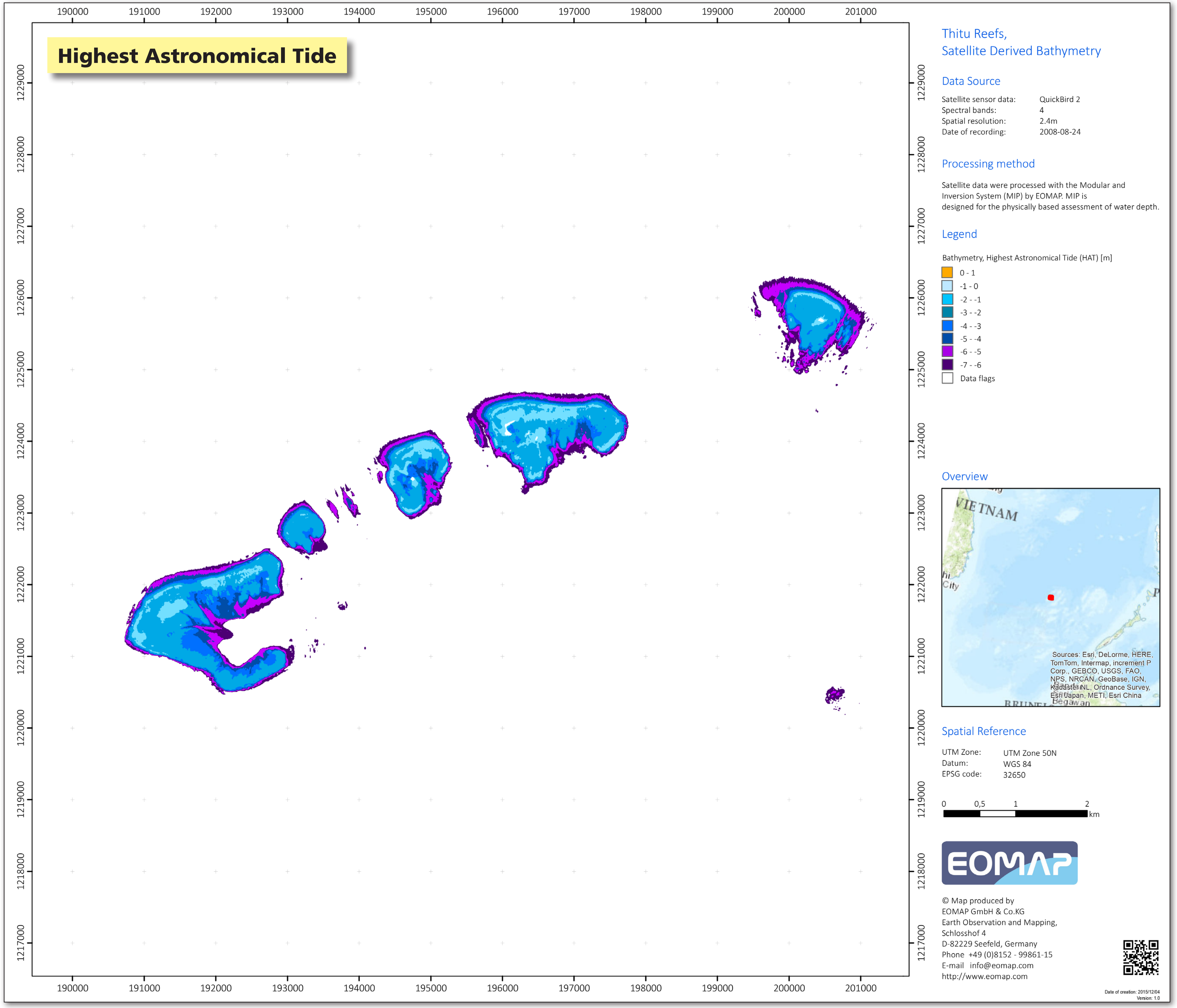
THITU REEFS

EOMap Analysis of Thitu Reefs from High-resolution Imagery



THITU REEFS

EOMap Analysis of Thitu Reefs from High-resolution Imagery



Annex 857

CCCC Tianjin Dredging Co., Ltd. “Tian Jing Hao”, *available at* http://en.tjhdj.com/index.php?mod=product&act=view&cid=46&id=397 (accessed 24 Nov. 2015)

Tian Jing Hao

With a dredging depth of 30m and a production rate of 4500m^3/h, Tian Jing Hao is rated as Asia's first and the world's third most powerful among the self-propelled cutter suction dredgers, and the production capacity is the best in Asian. Equipped with the most advanced automatic control system in the world and Asia's most powerful dredging system, Tian Jing Hao can perform automatic self-monitoring and self dredging. Thanks to its cutter power of 4200KW, Tian Jing Hao can dredge clay, gravel, dense sand, and also rock of 40 MPa. Being able to navigate and load barges in unrestricted areas, Tian Jing Hao is suitable for large-scale dredging projects under various sea conditions. It is also equipped with highly efficient dredge pumps and has a powerful ability of land reclamation, which ranks it the flagship of CCCC and even the dredging industry of China.

Annex 858

"Tian Jing Hao", *Dredgepoint.org*, *available at* https://www.dredgepoint.org/dredging-database/equipment/tian-jing-hao (accessed 24 Nov. 2015)

Tian Jing Hao

Current position

Latitude / Longitude: 22.0815 / 113.838 (click to view on map)
Course: 149°
Speed: 11.8 knts
Last Port: Nansha
Destination: Hainansanya
Updated: *47 weeks* ago

General properties

IMO number: 9549073
MMSI number: 412018470
Callsign: BSSZ
Vessel type: CSD, Self-propelled
Flag: CN
Owner: CCCC Tianjin Dredging Co
Manager: CCCC Tianjin Dredging Co
Built in: 2009
Shipyard: China Merchants Heavy Industrie (Shenzhen) Vo. Ltd

Physical properties

Length (OA): 127.5 m
Length (BP): 103 m
Width: 23 m
Depth: 8.3 m
Draft (loaded): 5.48 m
speed: 12 knts
Cutter power: 4200 kW
Total power: 28500 kW
Delivery diameter: 0.9 m
Dredging depth: 30 m
Suction pipe diameter: 0.9 m
Number of dredging pipes: 1

Page review

Status: Active

Last Updated

1 year 28 weeks ago

About this equipment

Name: 4500M3/H SELF-PROPELLED CUTTER SUCTION DREDGER Client: CCCC Tianjin Dredging Co.LTD. Builder: China Merchants Heavy Industry (Shenzhen) Co.LTD. Class: CCS Basic Designer: VOSTA LMG Germany Function: All-welded steel structure self-propelled cutter suction dredger with two propellers and two rudders. sailing in the international unlimited areas. Suitable for various large scale dredging work with dredging capacity of 4500m3/h. Main Particulars Hull Length over all, incl. cutter ladder and spuds 127.5m Length over deck 103.00m Breadth moulded 23m Design draught 5.48m Depth hull 8.3m Speed at 90% MCR 12 Kn Autonomy Sailing distance 8000miles Autonomy capacity during dredging 20 days Tank capacities Fuel HFO (incl.day-and settling tank) 1465m3 Fuel MDO (incl.day tanks) 212m3 Fresh water 256m3 Ballast 1897m3 Lubrication oil 80m3 Machinery Dredge pump diesel engines: 2x4400kW Main Generator /Propulsion diesel sets: 2x4400kW Auxiliary generator set: 2x880kW Berthing/Emergency generator set: 1x660kW Generators: Main generator sets: 2 x 5300kVA Auxiliary generator: 2x1000kVA Berthing emergency: 2×750KVA Electric motors: E-motor for dredge pump drive: 1×2200KW E-motor for cutter drive: 2×2100KW E-motor for ladder hoisting winch drive: 2×420KW E-motor for side winch drive: 2×550KW E-motor for bow thrusters: 1×440KW Dredging system Ladder Dredging depth: 30m Inclination 58° Cutter head: Power 4000KW Speed 0-32/32-38rpm Cutter gearbox: Speed in 1000rpm - Speed out 32rpm Inboard dredge pump(double wall): 2×3800KW Submerged pump: 2×2200KW Mixture pipe(internal diameter): 900mm Deck cranes: 2×30t Class ABS 1A1 Self-Elavating Drilling Unit CCS CSA Self Self-Elavating Drilling Unit HELDX In the morning of 19th January 2010, the ship delivery ceremony of "Tian Jing Hao"4500m3/h Self-propelled Cutter Suction Dredger held at our ship building and repairing base in Mazhou Island Nanshan Dist., Shenzhen, P.R .C.

Images



Technical files and datasheets

No files available

Position on map

In cooperation with MarineTraffic

demas

Annex 859

"Reclamation", *Oxford Learner's Dictionary*, *available at* http://www.oxfordlearnersdictionaries.com/definition/english/reclamation (accessed 28 Nov. 2015)

reclamation *noun*

BrE /ˌrekləˈmeɪʃn/ ; NAmE /ˌrekləˈmeɪʃn/

[uncountable]

1 the process of turning land that is naturally too wet or too dry into land that is suitable to be built on, farmed, etc.

- *land reclamation*

2 the process of obtaining materials from waste products so that they can be used again

- *There are opportunities for a company that can develop more efficient water reclamation and purification technology.*

3 **reclamation (of something) (from something)** the act of getting something back after it has been lost, taken away, etc.

- *The group urges the reclamation of our democracy from corporate power.*

Check pronunciation: reclamation