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

SUPPLEMENTAL DOCUMENTS OF THE PHILIPPINES

VOLUME III
ANNEXES

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ECOLOGICAL
ECONOMICS

ANALYSIS

Ecological goods and services of coral reef ecosystems

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Abstract

This article identifies ecological goods and services of coral reef ecosystems, with special emphasis on how they are generated. Goods are divided into renewable resources and reef mining. Ecological services are classified into physical structure services, biotic services, biogeochemical services, information services, and social/cultural services. A review of economic valuation studies reveals that only a few of the goods and services of reefs have been captured. We synthesize current understanding of the relationships between ecological services and functional groups of species and biological communities of coral reefs in different regions of the world. The consequences of human impacts on coral reefs are also discussed, including loss of resilience, or buffer capacity. Such loss may impair the capacity for recovery of coral reefs and as a consequence the quality and quantity of their delivery of ecological goods and services. Conserving the capacity of reefs to generate essential services requires that they are managed as components of a larger seascape-landscape of which human activities are seen as integrated parts.

Keywords: Coral reefs; Ecological services; Management; Biodiversity; Resilience; Valuation

1. Introduction

Coral reefs are among the most productive and biologically diverse ecosystems on Earth (e.g. Odum and Odum, 1955; Connell, 1978). They supply vast numbers of people with goods and services such as seafood, recreational possibilities, coastal protection as well as aesthetic and cultural

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PII: S0921-8009(99)00009-9

benefits (e.g. Smith, 1978; Kühlmann, 1988; Spurgeon, 1992; Done et al., 1996; Peterson and Lubchenco, 1997).

Estimates of coral reef cover range from approximately 0.1–0.5% of the ocean floor (Spalding and Grenfell, 1997: 255 000 km^2; Smith, 1978: 617 000 km^2; and Copper, 1994: 1 500 000 km^2). Nevertheless, almost a third of the world's marine fish species are found on coral reefs (McAllister, 1991) and the catch from reef areas constitutes around 10% of the fish consumed by humans (Smith, 1978). More than 100 countries have coastlines with coral reefs. In those countries at least tens of millions of people depend on coral reefs for part of their livelihood or for part of their protein intake (Salvat, 1992). For example, Jennings and Polunin (1996) calculate that 1 km^2 of actively growing reef could support over 300 people if no other protein sources were available.

Unfortunately, many coral reefs are in serious decline (Brown, 1987; Richmond, 1993; Wilkinson, 1993; Bryant et al., 1998). This is particularly true for coral reefs in embayments and near shallow shelves in densely populated areas and for coral reefs affected by deforestation, intensive agriculture, urbanization, and consequent increases of nutrient and sediment loads as well as other kinds of pollution. Other human-associated factors that degrade coral reefs are overharvesting of reef organisms, destructive fishing methods, uncontrolled tourism, new diseases, and possibly global climate change (e.g. Johannes, 1975; Grigg and Dollar, 1990; Wilkinson and Buddemeier, 1994; Roberts, 1995; Peters, 1997).

There are different views on how the degradation and loss of biological diversity affect the functions of coral reef ecosystems and their generation of system services (cf. Done et al., 1996; Paulay, 1997). Moreover, the ecological services of reef ecosystems are generally poorly perceived and the studies dealing specifically with these issues are surprisingly few (McAllister, 1988; de Groot, 1992; Birkeland, 1997a; Costanza et al., 1997).

In this article we describe a diversity of ecological goods and services of coral reef ecosystems, and discuss the value of coral reefs as life-support systems to society. In particular, we focus on how goods and services are generated and sustained by biological communities of coral reefs in different regions of the world. Needless to say, this is not a simple task since reefs come in a great variety of forms, and are considered as one of the most complex systems of all marine ecosystems. The understanding of their dynamic interactions is by no means complete (Hughes et al., 1992; Done et al., 1996).

The consequences of human impacts on coral reefs are also addressed; for example, how loss of resilience, or the buffer capacity that maintains options for recovery and development (Holling, 1973, 1986) may be followed by a shift from coral-dominated to macroalgae-dominated systems (e.g. Done, 1992). Such loss of resilience is affecting the capacity for renewal of coral reefs and thereby the quality and quantity of their delivery of ecological goods and services. Since coral reefs to a large extent are passive receivers of decisions taken elsewhere, their conservation and sustainable use requires a landscape-seascape perspective.

2. Ecological goods and services of coral reefs

The four main types of coral reefs are fringing reefs, barrier reefs, atolls and platform reefs (Table 1). There are many functional differences among these reef types, and they are connected in varying degree to other systems, such as mangrove forests, seagrass beds, and the open ocean (see Fig. 1). Mangroves and seagrass beds interrupt freshwater discharge, are sinks for organic and inorganic materials as well as pollutants, and can generate an environment with clear, nutrient poor water that promotes the growth of coral reefs offshore (e.g. Kühlmann, 1988; Ogden, 1988), but see also Szmant (1997) hypothesising that reefs may have the ability to utilise and benefit from higher nutrient fluxes than the present paradigms imply. Coral reefs in turn serve as physical buffers for oceanic currents and waves, creating, over geologic time, a suitable environment for seagrass beds and mangroves. In addition to these physical interactions there are several biological and biogeochemical interactions between these interconnected ecosystems.

Ogden (1988) called this large biome of the tropical coastal zone the seascape, consisting of a complex mosaic of mangroves, seagrass beds and coral reefs interacting in a dynamic fashion, all influenced by terrestrial as well as open ocean activities (Fig. 1). In the following we have collected information on ecological goods and services of coral reefs (Table 2). In doing so it is important to keep in mind that this life-support to humans is dependent on complex interactions in the seascape as a whole, and also that the supply of these goods and services differs among biogeographic regions, reef types, individual reefs, and even among zones in the individual reefs.

3. Ecological goods

3.1. Renewable resources

Reefs generate a variety of seafood products such as fish, mussels, crustaceans, sea cucumbers and seaweeds (e.g. Craik et al., 1990; Birkeland, 1997a). Reef-related fisheries constitute approximately 9–12% of the world's total fisheries (Smith, 1978) and in some parts of the Indo-Pacific region, the reef fishery constitutes up to 25% of the total fish catch (Cesar, 1996). However, overfishing of coral reefs or reef associated fish populations is a major problem (e.g. Roberts, 1995; Jennings and Polunin, 1996; Jackson, 1997).

The pharmaceutical industry has discovered potentially useful substances with anticancer, AIDS-inhibiting, antimicrobial, antiinflammatory and anticoagulating properties among the seaweeds, sponges, molluscs, corals (e.g. soft-corals (order Alcyonacea) and gorgonians (order Gorgonacea)) and sea anemones of the reefs (e.g. Sorokin, 1993; Carté, 1996; Birkeland, 1997a). It has been claimed that the discovery of prostaglandins in many of the gorgonians in the early 1970s was responsible for the expansion of marine natural products (Carté, 1996).

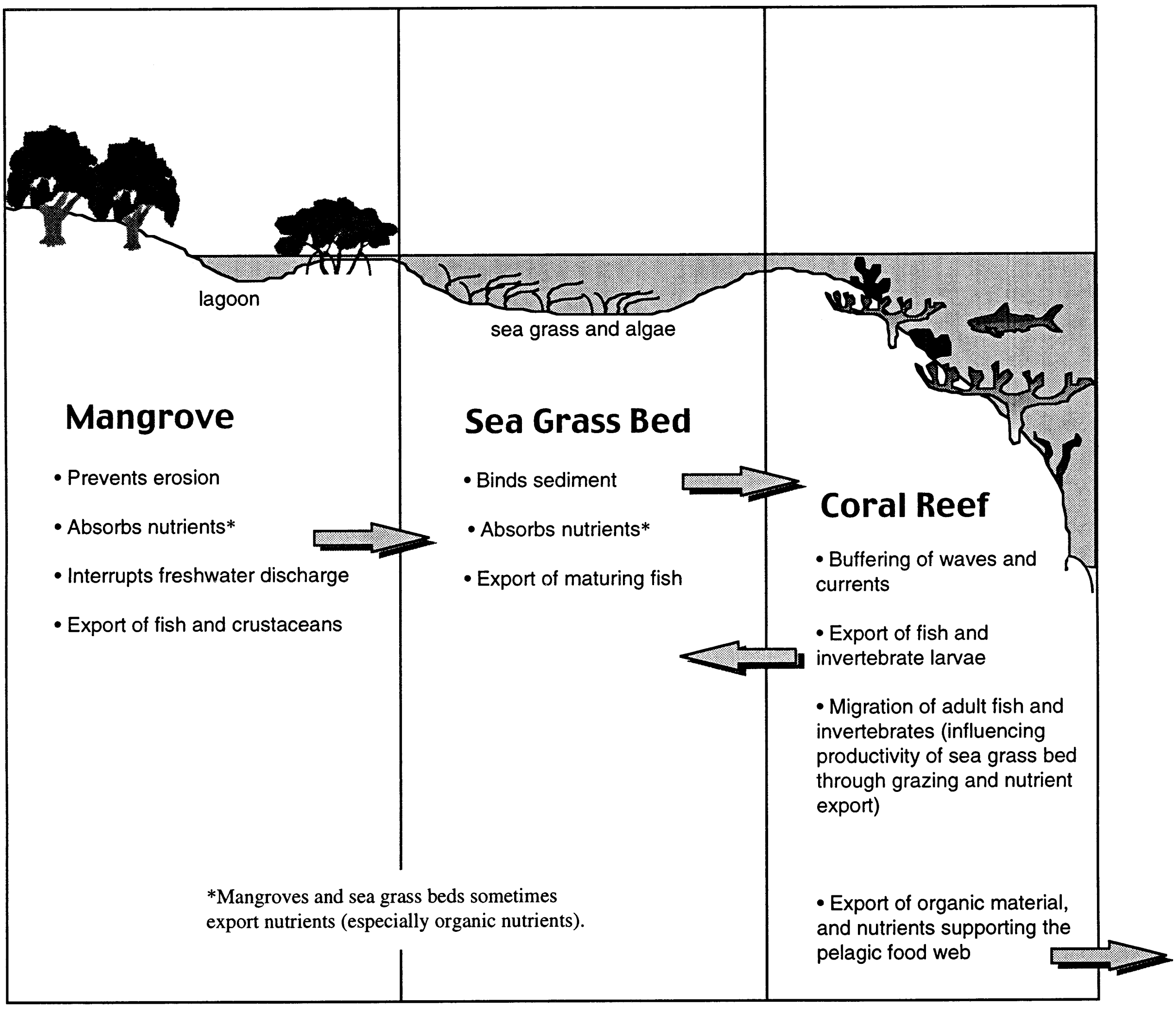
Many species of seaweed are collected from reefs to be used in the production of agar and carrageenan (Birkeland, 1997a) and as manure (Craik et al., 1990), and coral skeletons have proven to be promising in bone graft operations (Spurgeon, 1992).

Mother-of-pearl shells (*Trochus* spp.) and giant clams (*Tridacna* spp.) are collected not only as food but also to sell as jewellery and as souvenirs. In 1978 more than 5000 tons of mother-of-pearl from the gastropod *Trochus niloticus* was collected for the curio trade (Craik et al., 1990). Another example from the ornamental trade is the red coral *(Corallium rubrum)* that was sold for US$ 900 per kg in 1980 (Goh and Chou, 1994). In 1988, almost 1500 tons of corals were imported to the United States for the souvenir market (Wells and Hannah, 1992).

The marine aquarium market in 1985 was a 24–40 million dollar per year industry (Wood, 1985). Unfortunately, live fish collection involves pumping hundreds of tons of toxic cyanide per year into coral communities to stun reef dwelling fishes (Johannes and Riepen, 1995). According to Wells and Hannah (1992) about 250 000 live

Table 1
The four main reef types

Platform reefs	Fringing reefs	Barrier reefs	Atolls
Frequently found in the lagoons created by atolls and barrier reefs	Closely follow shorelines, narrow shallow lagoon	Separated from land by a relatively wide, deep lagoon	Horseshoe shaped or circular reef surrounding a central lagoon (often far from land in the open ocean)
In the Great Barrier Reef lagoon, Belize, Red Sea, Bahamas	Red sea, East Africa, Seychelles and other Indo-Pacific islands, most Caribbean reefs	The Great Barrier Reef in Australia, Belize Barrier Reef, off Mayotte in the Western Indian Ocean	>95% of the atolls are in the Indo-Pacific, others are found outside Belize and in Western Atlantic



Adopted from White (1986) and Ogden (1988).

Fig. 1. Interactions in the tropical seascape, showing the connections between mangroves, sea-grass beds and coral reefs.

corals were imported to the United States in 1991.

The use of the natural resources described above could perhaps be sustainable, but there is a tendency for their overexploitation, especially when world market prices rise (e.g. Cesar, 1996; Birkeland, 1997b). Further, the dynamic complexity of coral reef ecosystems implies that it is extremely difficult to estimate sustainable harvest rates of reef organisms (Sorokin, 1993; Hodgson, 1997).

3.2. *Mining of reefs*

Among the obviously destructive coral reef uses are the exploitation of hard corals for building materials and for the production of lime, mortar and cement (Dulvy et al., 1995). In the Maldives, coral blocks, rubble and sands serve as the main construction materials with approximately 20 000 m^3 corals mined every year (Cesar, 1996). Lime is also used as a pH regulator in agriculture (Cesar 1996), and in some regions coral debris is also

Table 2
Goods and ecological services of coral reef ecosystems identified in this article

Goods		Ecological services					
Renewable resources	Mining of reefs	Physical structure services	Biotic services		Biogeochemical services	Information services	Social and cultural services
			Within ecosystems	Between ecosystems			
Sea food products	Coral blocks, rubble and sand for building	Shoreline protection	Maintenance of habitats	Biological support through 'mobile links'	Nitrogen fixation	Monitoring and pollution record	Support recreation
Raw materials for medicines	Raw materials for production of lime and cement	Build up of land	Maintenance of biodiversity and a genetic library	Export of organic production, and plankton to pelagic food webs	CO_2/Ca budget control	Climate record	Aesthetic values and artistic inspiration
Other raw materials (seeweed and algae for agar, manure, etc.)	Mineral oil and gas	Promoting growth of mangroves and seagrass beds	Regulation of ecosystem processes and functions	–	Waste assimilation	–	Sustaining the livelihood of communities
Curio and jewellery	–	Generation of coral sand	Biological maintenance of resilience		–	–	Support of cultural, religious and spiritual values
Live fish and coral collected for the aquarium trade	–	–	–	–	–	–	–

collected and crushed to be used as fertilizer (Kühlmann, 1988).

Physicochemical processes acting over millions of years convert biomass of reef organisms into mineral oils and gas. These resources are thought to exist in large quantities below living reefs. Ancient reef structures in Siberia, Saudi Arabia, USA and Canada are potentially rich in oil, stored in the porous limestone (Sorokin, 1993; Hodgson, 1997). As a consequence, the petroleum industry is subsidizing more and more research in finding mineral oils (Kühlmann, 1988), and studies of the ecology and geomorphology of modern reefs help to locate oil deposits in ancient reef structures (Sorokin, 1993). Exploitation of these resources conflicts with all the other uses of reefs and can by no means be considered as sustainable (e.g. Hodgson, 1997).

4. Ecological services

4.1. Physical structure services

Without coral reefs protecting the shoreline from currents, waves, and storms there will be loss of land due to erosion. In Indonesia, Cesar (1996) estimated that between US$ 820–1 000 000 per km of coastline was lost due to decreased coastal protection as a consequence of coral destruction (based on 0.2 m $year^{-1}$ of coast erosion, 10% discount rate and a 25-year period). In the Maldives an artificial substitute breakwater (a 1 km pier) cost around US$12 000 000 to construct (Weber, 1993).

Coral reefs build up land. Many tropical, nations in the Indian and Pacific oceans with large human populations are situated on islands built by coral reefs (e.g. Stoddart, 1973).

The capacity of coral reefs to dissipate wave energy creates lagoons and sedimentary environments. Coral reefs thus physically create favourable conditions for the growth of sea-grasses and mangrove ecosystems (Birkeland, 1985; Ogden, 1988).

Coral reefs generate the fine coral sand supplying shores with the white sand characteristic of tropical islands and one of the main attractions in beach tourism (e.g. Richmond, 1993). It is not only generated from physical forces but also by the biota. Bioeroders, such as algae, sponges, polychaetes, crustaceans, sea urchins, and fishes are important in producing the reef sediments (rubble, sand, silt, and clay) (Trudgill, 1983). For sea urchins, erosion rates have been reported to exceed 20 kg $CaCO_3$ m^{-2} $year^{-1}$ in some reefs, whereas the highest figure reported for fishes (parrotfish) is 9 kg $CaCO_3$ m^{-2} $year^{-1}$ (Glynn, 1997).

4.2. Biotic services

These are in essence the services listed by Holmlund and Hammer (this issue) under the subtitle 'fundamental services', and also very similar to what de Groot (1992) named 'regulation functions'. These services are essentially the prerequisites for a functioning ecosystem. Here we also include the biotic services supporting the adjacent systems in the seascape.

4.2.1. Biotic services within the ecosystems

Coral reefs function as important spawning, nursery, breeding and feeding areas for a multitude of organisms. Being one of the most species-rich habitats of the world, coral reefs are important in maintaining a vast biological diversity and genetic library for future generations. The extremely high habitat heterogeneity of reef systems created by the complex three-dimensional structure facilitates niche diversification and thus also possibilities for evolution of new species (Birkeland, 1997a; Paulay, 1997). Up to 60 000 reef living animals and plants have been described to date (Reaka-Kudla, 1994).

Among these species are keystone process species that regulate ecosystem processes and functions, for example through grazing and predation (Hughes, 1994; McClanahan et al., 1994; Done et al., 1996). Others species and groups of species are important in maintaining resilience of coral reef ecosystems (McClanahan et al., in press). In most reefs there are many species within each functional group (cf. Choat and Bellwood, 1991; Roberts, 1995). Many of those species do not appear to perform key functions but may be able to take over such functions (Peterson and

Lubchenco, 1997) if the keystone process species within a functional group is lost (McClanahan et al., in press). This has been seen, for example, in East African reefs where overfishing has resulted in a loss of the dominant fish predator on sea urchin (red-line triggerfish). Its role in controlling grazing has been replaced by species of wrasses and scavengers (McClanahan, unpubl. data). However, these sea urchin predators did not fully substitute the control function of the red-line triggerfish, since they could not suppress the sea urchin population to levels of undisturbed reefs. Although the qualitative function was maintained, resilience may have been impaired.

4.2.2. Biotic services between ecosystems

Some coral reef organisms migrate back and forth between adjacent ecosystems. Examples of such 'mobile links', i.e. species that link one ecosystem to another, are fish that migrate to mangroves and sea-grass beds and use them as nursery grounds (Ogden and Gladfelter, 1983; Ogden, 1988; Parrish, 1989). Herbivorous fishes and sea urchins from the reefs move to sea-grasses for grazing and influence plant community structure there (e.g. Birkeland, 1985), and may serve as a food source for predators in other systems, as well as food for humans (Parrish, 1989; Spurgeon, 1992). The net result of migration is a transfer of energy from the system where feeding or development occurs to the system that shelters the adults (Ogden and Gladfelter, 1983). In addition the pelagic juvenile stages of many reef organisms that drift into these adjacent ecosystems serve as a food source for commercially important fishes, or they may settle and mature until harvested by fishermen (Spurgeon, 1992).

Herbivorous fishes and invertebrates from coral reefs can also indirectly control the productivity of benthic algae and sea-grass assemblages by reducing self-shading, weeding out large algae with low productivity, and enhancement of nutrient exchange with the water (Hatcher, 1983; McRoy, 1983). Moreover, fishes migrating from the coral reef ecosystem may also influence the nutrient cycles of the sea-grass beds and mangroves through their excretion and defecation (Ogden and Gladfelter, 1983). Coral reefs thus not only provide physical protection but also biological support to sea-grass beds, mangroves, and the open ocean. Another biological link is input to the reef of excretory and fecal products from migrating fish. This input of nutrients and organic matter from migrating white grunts, which feed in seagrass beds at night and rest over coral colonies during the day, may enhance the growth of reef corals (Meyer and Schultz, 1985).

Coral reefs appear to support the pelagic food web with export of excess of organic production such as mucus, wax esters, and dissolved organic matter as well as bacterioplankton, phyto- and zooplankton (Hatcher, 1988; Sorokin, 1990). This net flow to surrounding waters enhances the productivity of local planktonic communities and consequently also supports local fisheries (Sorokin, 1990).

4.3. Biogeochemical services

Coral reefs function as nitrogen fixers in nutrient poor environments (Sorokin, 1993). Reefs would probably not have been able to become so productive and diverse without the capacity of microbial and cyanobacterial associations in reef-bottom biotopes, and also cyanobacteria in the water column, to assimilate atmospheric nitrogen. Compared with other marine ecosystems, nitrogen fixation on coral reefs occurs at a considerably high rate. The nitrogen fixing ability is not only of local importance to the reef system itself but also to the productivity of the adjacent pelagic communities due to the release of excess nitrogen fixed in the reefs (D'Elia 1988; D'Elia and Wiebe, 1990; Sorokin, 1990). However, reefs near high islands may receive enough nutrients via run-off or groundwater inputs (D'Elia and Wiebe, 1990). Furthermore, because eutrophication is a major problem in many tropical coastal areas (e.g. Hunter and Evans, 1995; Goreau et al., 1997), the relative importance of nitrogen fixation, with regard to community requirements, may be larger in isolated reefs such as ocean atolls (Sorokin, 1993).

Reefs appear to act as sinks for carbon dioxide over geological time scales, but are net sources of carbon dioxide in time perspectives relevant for humans (Gattuso et al., 1996; Hallock, 1997).

This net source seems to be of minor significance in the current global carbon budget (Gattuso et al., 1996), as it has been estimated that the release of CO_2 to the atmosphere from human activities the last 100 years is larger than release from reefs in 15 000 years (Hallock, 1997). Buddemeier (1996) claims that those reefs which are sinks for carbon dioxide are subject to human impact, and have an increased ratio of organic production to calcification compared with normal reefs.

Biochemical processes on coral reefs play a significant role in the world's calcium balance (e.g. Kühlmann, 1988). Reefs precipitate approximately half of the 1.2×10^{13} mol of calcium delivered to the sea each year (Smith, 1978). In addition to the reef building corals there are also algae and foraminifera on coral reefs that produce $CaCO_3$ (Wiebe, 1988). This ability of reefs to bind calcium and construct massive calcium carbonate frameworks is the basis for reef development and makes reefs unique. It is essentially the prerequisite for the rest of the services.

Coral reefs can transform, detoxify, and sequester wastes released by humans, thus providing a cleansing service. For instance, petroleum products in the marine environment are detoxified by microbes, turning hydrocarbons into carbon dioxide and water (Peterson and Lubchenco, 1997). More persistent pollutants can be immobilised or sequestered. Such waste assimilation services of reefs are described in a Galapagos case study by de Groot (1992), and was estimated as having a value of US$ 58 per ha and year (replacement cost). However, the waste assimilation capacity of reefs seems limited to us. This is particularly true when there are persistent or chronic quality and quantity emissions of waste that reduce the window for recovery after disturbance.

4.4. Information services

Reef organisms are used in monitoring and as pollution records. Skeletons of reef building corals act as long-term chemical recorders of levels of metals in seawater (e.g. Dodge and Gilbert, 1984; Howard and Brown, 1984). Coral reefs are highly sensitive systems and extensively used in monitoring the recent changes in the marine environment and the effects of human disturbances (e.g. Wilkinson, 1993; Eakin et al., 1997).

Reef corals function as climate records. The chemical composition of coral skeletons can been used to reconstruct the sea surface temperature of the tropics and to track variations in salinity (de Villiers et al., 1995; Swart and Dodge, 1997; Gagan et al., 1998). Long-lived, massive corals deposit layers of skeleton which vary in width and density depending on the environmental conditions (season etc.) (e.g. Barnes and Lough, 1996). These bands can be counted like the growth rings of trees and as such give indications of past conditions. Moreover, it is possible to trace the periods of monsoonal floodings in the past by looking at fluorescent bands in nearshore corals (Isdale, 1984; Veron, 1993).

4.5. Social/cultural services

Coral reefs support recreation. The recreational value of reefs, as indicated by income from tourism is enormous (Dixon et al., 1993; Pendleton, 1995; Cesar, 1996). The financial value of tourism in the Great Barrier Reef World Heritage Area (WHA) was estimated by Driml (1994) to be AUS$ 682 000 000 annually. In 1990 Caribbean tourism earned US$ 8 900 000 000 and employed over 350 000 people (Dixon et al., 1993).

Coral reefs hold aesthetic values (cf. de Groot, 1992). Countless films, photos, and paintings with reefs or reef organisms as motifs are produced every year. The monetary value of all books, films and paintings produced using coral reefs as inspiration is undoubtedly huge.

Coral reefs sustain the livelihood of many local communities. For example, it has been estimated that damages to reefs in Philippines caused by overfishing and pollution have led to the loss of at least 100 000 fishermen's jobs (McAllister, 1988).

Another important and often forgotten service of reefs is their support of cultural and spiritual values. For instance religious rituals have developed around reefs in southern Kenya, where traditional management with the primary purpose to appease spirits has also served to regulate fish stocks (McClanahan et al., 1996). Similar systems of traditional management was developed by

Pacific islanders centuries ago to regulate the use of reef resources (Johannes, 1992; Ruddle et al., 1992). Thus, many local communities living in the tropical coastal zone seem to have gone through a process of co-evolution (Gadgil et al., 1993; Norgaard, 1994), where their cultural traditions have developed in synergy with adjacent reefs. Reefs are in this sense important when it comes to stabilizing the social and institutional structures that underlie cooperative fishing activities in more traditional coastal communities (Birkeland, 1997a).

5. Economic valuations of coral reef ecological goods and services

Illuminating economic values of coral reefs, their goods, and their services may contribute to improved management and conservation. Valuation studies of reefs have predominantly focused on the economic values of tourism and fisheries (Hodgson and Dixon, 1988; Dixon et al., 1993; Barton, 1994; Driml, 1994; Cesar, 1996). The focus of the bulk of valuation studies that exist is shown in Table 3 in relation to ecological goods and services. The table reveals that only some of the reefs' goods and services have been captured in valuation studies.

Monetary values of the environment are directly or indirectly derived from consumer preferences, and generally defined in terms of small or marginal changes. Marginal values are context specific, i.e. they belong to a given decision situation of alternative policy options (Barbier et al. 1994). Since they are context specific marginal values cannot easily be transferred to another area, region, or be applied in economic valuation of the same area in the future (Brookshire and Neill, 1992). Therefore, an estimated economic value of an ecological good or service is not an absolute value, but a relative value on the margin founded on people's preferences.

However, people do not always perceive their dependence on critical goods, ecological services, and ecosystem support. And even if they do, they may not value them: preferences are not necessarily linked to biophysical realities. We have argued elsewhere that there are many ecological goods and services that meet the criteria of having economic value (they contribute to well-being and are scarce), but for which humans have not yet developed preferences (Costanza and Folke, 1997). Making decisions based on economic valuations of people's preferences alone may, therefore, lead to devastating results. Decision-making has to incorporate information and understanding of essential ecological life-support conditions for human well-being. Institutions are critical in this context as they provide the framework, the norms, and rules for individuals (e.g. Ostrom, 1990; Hanna et al., 1996). In the following sections we will address the work of coral reefs, including the role that biological diversity plays, in the generation of life-support conditions and ecological goods and services of value to society.

6. Biodiversity, ecosystem function and ecological services

The coral reef ecosystem is open and complex, its structure, function, biodiversity, and resilience prone to influence by human alterations of water quality and biogeochemical and hydrological flows (locally or at distance). The bulk of ecological goods and services of reef ecosystems are dependent on a vast variety of complex and dynamic interactions between networks of species within and between ecosystems. Although biodiversity in coral reefs and its influence on maintenance of ecosystem function is highlighted in the literature, comparatively little is known about the diversity of these systems and how changes in diversity might result in system instability and potential threshold effects (Done et al., 1996).

6.1. The reef building framework

The existence of a reef framework which creates a three-dimensional, complex habitat is the basis for the diversity of fishes and other reef dwelling animals (e.g. Sutton, 1983; Sale, 1991). The structure also breaks waves and generates a diversity of ecological services (e.g. McAllister, 1991; Done et al., 1996). Corals are the main builders of the

Table 3
Articles with economic valuation of ecological goods and/or ecological services of coral reef ecosystems

Authors, year	Goods	Ecological Services				
		Physical structure	Biotic	Biogeochemical	Information	Social/cultural
Andersson and Ngazi, 1995	Fishery, lime prod, construction	–	–	–	–	Tourism
Berg et al., 1998	Fishery, Mining	Coastal protection	–	–	–	Tourism
Cesar, 1996	Fishery, Mining,	Coastal protection	–	–	–	Tourism
de Groot, 1992	Fishery, ornaments, construction	Coastal protection	Biological control, habitat	Waste assimilation	Research/education	Artistic inspiration, Spiritual values
Dixon et al., 1993	–	–	–	–	–	Tourism
Driml, 1994	Fishery	–	–	–	Research	Tourism
Hoagland et al., 1995[a]	Aquarium trade	–	–	–	–	Tourism, recreation
Hodgson and Dixon, 1988	Fishery	–	–	–	–	Tourism
Hundloe, 1990[b]	–	–	–	–	–	Tourism, recreation
Johannes and Riepen, 1995	Live fish	–	–	–	–	–
Mattson and DeFoor, 1985[b]	Live coral	–	–	–	–	Tourism
McAllister, 1988	Fishery	–	–	–	–	Livelihood
McAllister, 1991[c]	–	Coastal protection	–	–	–	–
Pendleton, 1995	–	–	–	–	–	Tourism
van't Hof, 1985	–	–	–	–	–	Tourism
Wood, 1985	Aquarium trade	–	–	–	–	–

[a] In Costanza et al. (1997).
[b] In Spurgeon (1992).
[c] McAllister (1991) also includes a value based on a court settlement for damage to a whole coral reef.

reef framework through the accumulation of limestone (calcification), but a diversity of other organisms, e.g. encrusting coral line algae, foraminifera, molluscs, and echinoderms are also needed in the building of the reef (e.g. Smith, 1983).

The calcifying process of the main reef builders, the hermatypic corals, is heavily dependent on the internal symbiosis with the microalgae zooxanthellae. These unicellular algae living inside the tissue of hermatypic corals not only provide oxygen, sugars, lipids, and amino acids to the coral host, but also facilitate skeletal growth via the 'light-enhanced calcification' which is two to three times as fast as dark calcification (Goreau, 1959; Muscatine, 1990; Muller-Parker and D'Elia, 1997). Without reef building corals, no proper framework would exist (e.g. Davies, 1983), and as a consequence there would be no porous three-dimensional structures that provide habitat for so many other organisms. All the goods and services of the reef are thus directly or indirectly dependent on one group of species: the reef building corals (e.g. Johannes, 1975; Done et al., 1996).

However, the symbiosis between corals and their microalgae is also the reason why reef corals are relatively sensitive to changes in environmental conditions (Kühlmann, 1988; Birkeland, 1997a; Muller-Parker and D'Elia, 1997). The symbiosis requires sufficient light and good water circulation, and exists in a rather narrow range of water temperature and salinity, with low nutrient and sedimentation loads.

6.2. Keystone process species

Reef building corals drive critical processes for ecosystem functioning, physically shaping their own community (Baskin, 1997). In the Caribbean, the sea urchin *Diadema antillarum* has proven to be a keystone species (Paine, 1966) or keystone process species through its role in facilitating coral growth and settlement by grazing down algae (Hay, 1984; Lessios et al., 1984; Carpenter, 1986; Hughes, 1994). In the Indo-West Pacific region, other species are important in structuring the coral communities, including the crown-of-thorns starfish *Acanthaster planci*, the asteroids *Culcita* sp., the gastropod *Drupella* sp. and coral eating parrotfishes (Done et al., 1996; Paulay, 1997).

Without herbivores, the main reef builders, corals and crustose coral line algae would be overgrown and excluded by faster growing erect algae (Carpenter, 1990; Glynn, 1990; McCook, 1996). Herbivores, such as fishes and invertebrates, influence species composition, productivity, nitrogen fixation, succession, and other ecosystem processes (e.g. Hatcher, 1988; Glynn, 1990; Roberts, 1995) and thereby play an important indirect role in generating ecological goods and services. For example the herbivorous territorial damselfishes enhance several reef processes such as primary production (Hixon and Brostoff, 1996), recovery of reef corals (Done et al., 1991) and nitrogen fixation since cyanobacteria are more common within their territories than outside (Hixon and Brostoff, 1996). Damselfishes may also, due to their aggressive territorial behaviour, exclude coral eating animals such as pufferfishes and parrotfishes, and possibly also crown-of-thorns starfishes (Hixon, 1997).

Other important keystone process species are the top predators in reef systems, such as triggerfishes and pufferfishes that regulate the herbivores (including sea urchins) (Hughes, 1994; McClanahan et al., 1994; Roberts, 1995). In Kenyan reefs, the overfishing of top predators resulted in population outbreaks of sea urchins which reduced coral accretion and at times led to a negative calcium carbonate balance (net erosion where the reef slowly disappears: McClanahan and Muthiga, 1988). The increased abundance of such boring sea urchins and their eroding activities not only impairs the reef growth but may also result in a loss of structural complexity, leading to decreased fish production (Jennings and Polunin, 1996) and other ecological services. The loss of fish predators might be partly responsible for the outbreaks of both the crown-of-thorns starfish and the coral eating mollusc *Drupella* (Glynn, 1990; Bell and Elmetri, 1995; Roberts, 1995). Further, predators feeding on corals may be important distributors of zooxanthellae (Parker, 1984; Muller-Parker and D'Elia, 1997), which are critical in the reef construction process as discussed above.

6.3. Biogeographic regions, reef types, and ecological services

There are four major biogeographic regions of the tropical oceans; the Indo-West Pacific (IWP); Eastern Pacific (EP); Western Atlantic (WA); and the Eastern Atlantic (EA) (Fig. 2). These regions display considerable variation in species composition and diversity (e.g. Sebens, 1994; Paulay, 1997), mainly resulting from differences in evolutionary history and oceanographic conditions (Veron, 1993; Birkeland, 1997a). The differences are expressed in, for example, that the IWP and WA have only one hermatypic coral species in common (Veron, 1993). The IWP has far higher diversity than the other regions and also highest endemism. Although the WA has the second highest reef community species diversity of the biogeographic regions, there are approximately ten times more scleractinian coral species (order Scleractinia, which includes almost all of the reef building coral species) in the IWP compared with the WA (Paulay, 1997). Fish diversity is approximately four to six times higher in the IWP than in WA reefs (Thresher, 1991; Lieske and Myers, 1994). In IWP reefs soft corals are often abundant and diverse, whereas Caribbean reefs have more gorgonians and sponges than the other regions (Paulay, 1997). In addition, mutualistic associations, e.g. giant clam zooxanthellae and anemone-anemone fishes, are more diverse in the IWP compared with reefs in the Eastern Pacific and Atlantic oceans (Birkeland, 1997a).

Despite the considerable variation in species diversity, many system parameters such as calcification, community productivity, and reef structure are often rather similar between regions (Kinsey, 1983, but see also Hatcher, 1997). However, reefs with maintained functions in spite of less diversity might have lower resilience, that is, lower capacity to absorb or buffer disturbance (Holling, 1973, 1986; Holling et al., 1995), as will be discussed below.

Hence, coral communities in different biogeographic regions may not be equally important in terms of supply of certain goods and services and sustaining their flow. Coral communities in the Eastern Atlantic that form no real reefs are of course less important providers of most of the services listed here compared with the other regions, e.g. no significant wave barriers, display lower diversity, less interesting for dive-tourism and play a minor relative role in the global calcium balance as well (e.g. Sebens, 1994; Paulay, 1997). This is not to say that these coral communities are of low value. Locally such less developed coral communities may be of great importance, e.g. for local fisheries (McManus, 1988) as fishery yields may be rather high even in low diversity reefs (Menasveta et al., 1986).

Furthermore, among different reef types (Table 1) there are functional differences. For example, as mentioned earlier (Section 4.3), nitrogen fixation appears to be more important in the functioning of isolated reefs than in coastal areas. Moreover, Hatcher (1997) concludes that fringing reefs most likely depart from the 'sweeping gener-

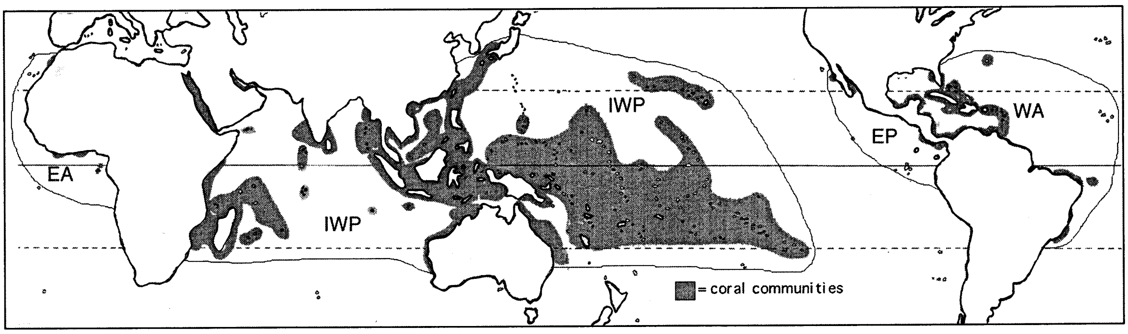


Fig. 2. The distribution of coral reefs in the four tropical biogeographic regions: the Indo-West Pacific (IWP); Eastern Pacific (EP); Western Atlantic (WA); and the Eastern Atlantic (EA).

alisation' that all reef ecosystems exist in crystal-clear nutrient poor waters and display similar metabolic performance. Thus, reefs close to human developments are poorly understood in studies at the system level and seem to have more of their primary production left for sustained reef growth, and export to adjacent ecosystems than was previously believed (e.g. Odum and Odum, 1955). The services listed in Table 2 that are associated with the seascape (mangroves, seagrass beds, coral reefs) are mainly of importance for fringing reefs and to some extent for barrier reefs.

7. Human impacts, loss of resilience and system flips

Many uses of coral reefs are unsustainable, and in this sense many of the assets of reefs are also the cause of their decline (Weber, 1993). On the list of destructive activities are coral mining for lime production, collection of reef organisms for the curio trade, destructive fishing methods like cyanide or dynamite fishing, fishing with small-sized seine nets, uncontrolled tourism activities and oil extraction (e.g. Hawkins and Roberts, 1994; Johannes and Riepen, 1995; Dulvy et al., 1995).

Furthermore, reefs are often affected by decisions taken in their drainage basins. For example, intensified land use and urbanization often increase run-off of pollutants, nutrients and sediment particles and cause major problems in the coral reefs (e.g. Kühlmann, 1988; Grigg and Dollar, 1990). Humans are thereby responsible for much of the change in the nature of disturbances in reef environments. Coral reefs seem to be resilient when facing natural disturbances with a periodicity occurring as pulses (e.g. hurricanes, predator outbreaks) (Connell, 1978; Grigg and Dollar, 1990; Connell, 1997). These disturbances seem to be a part of the dynamic development of coral reefs. However, chronic, persistent human induced disturbance (e.g. nutrient emissions and overfishing) appear to be more damaging to coral reefs (e.g. Richmond, 1993; Hughes, 1994; Connell et al., 1997). As a consequence, reef systems often show poor recovery when affected by natural disturbances if they have already been exposed to persistent human disturbances (Brown, 1997). This is presumably a consequence of loss of resilience (buffer capacity), making the coral reef ecosystem more susceptible to natural disturbance that otherwise could have been absorbed (c.f. Holling, 1973). Loss of resilience may cause unexpected and non-linear cascading effects as well as system 'flips', i.e. when the state of the ecosystem is so altered that it enters a new stability domain—a change that can be essentially irreversible (Holling et al., 1995).

7.1. System flips

Coral reef degradation may lead to invasion by populations of non-reef building organisms such as soft corals or zoanthids, but more often mass coral mortality is followed by an invasion of algae; this changes the community from a high diversity coral-based ecosystem to a macroalgae-dominated system, with diminished genetic, species and functional diversity (Done, 1992). Such 'flips' may be regarded as mere noise over evolutionary time scales, but within human life spans they certainly result in the loss of fish production (Bouchon et al., 1992), and a number of other ecological services (Done, 1992; Jennings and Polunin, 1996).

Although coral reefs are extremely complex dynamic systems with multiple stable states (e.g. Done, 1992; Knowlton, 1992), there seem to be a few main factors that trigger the shift from coral to macroalgae-dominance: (1) reduction or disappearance of grazers (Hughes, 1994); (2) increased nutrient and sediment loads (Rogers, 1990; Goreau et al., 1997); (3) reduced competition from corals by inhibiting their growth (Done, 1992); (4) rapid increase in substratum area available for colonisation by algae that exceeds the grazing ability of resident herbivores (Hatcher, 1984; Done, 1992).

The classic example of an ecosystem flip from coral to macroalgae-dominance is from Caribbean reefs in Jamaica and elsewhere (e.g. Hay, 1984; Lessios et al., 1984; Carpenter, 1990; Hughes, 1994). Overharvesting of fish that predate on sea urchins led to increased abundance of the keystone grazer, the sea urchin *Diadema antillarum*. After being damaged by Hurricane Allen in 1980 the corals did first recover, as the urchins could suppress algal growth which had been stimulated by increased amounts of nutrients from land use change. However, *Diadema* then suffered from a pathogen which caused mass mortality. Coupled with overfishing of herbivorous fishes, the mass mortality removed virtually all the grazers and the flip, or slide, to a community dominated by fleshy, unpalatable algae was a fact. In this stability domain, coral recruitment is inhibited by macro algae growth (Bell and Elmetri, 1995). However, there are other researchers who claim that the role of overfishing and *Diadema* die-off is overestimated (Jackson, 1997) and that eutrophication is a major reason (Goreau et al., 1997).

The sustained algal growth and lack of reef recovery in Jamaica is presumably also due to recruitment areas ('source reefs') having been degraded or lost, causing a lack of supply of larvae of corals, other invertebrates, and fish (Goreau, pers. comm.). In this context it is important to take metapopulations of reef organisms into consideration: that is, to include in management the location of upstream reefs for recruitment to reefs hit by disturbances in order to replenish damaged population on reefs downstream (Harrison and Wallace, 1990; Done, 1994, 1995a,b; Roberts, 1997).

These kinds of system flips, with large changes in ecology and poor recovery after disturbance, are less reported from more species diverse regions although disturbances are as common (Indo-West Pacific) (Eakin, 1993; Paulay, 1997; Connell, 1997). Therefore, it has been postulated that coral reefs in the Caribbean may in general be less resilient since they seem to have fewer species within each functional group compared with reefs in the Indo-West Pacific (McClanahan et al., in press). Such aspects may be of great importance for the provision of ecological goods and services of coral reefs in the long run.

7.2. Bleaching

There are a variety of natural and human induced disturbances affecting the delicate balance between the reef corals and their symbiotic microalgae (zooxanthellae). This often leads to loss of the zooxanthellae (or their pigment), a process called bleaching because corals lose their color (e.g. Brown, 1987; Goreau and Hayes, 1994). During 1997–98, coral bleaching was reported from all the major tropical oceans, implying that this is the most geographically widespread bleaching ever recorded. This mass bleaching is probably caused by elevated water temperatures, linked to one of the strongest El Niños of this century (ISRS, 1998). In addition, there are various other stresses that may lead to bleaching, including decreased salinity as a consequence of enhanced run-off due to clear-cuttings and urbanisation (Moberg et al., 1997), release of toxic substances such as heavy metals (Harland and Brown, 1989), and high UV radiation (Goreau and Hayes, 1994). Hence, impacts of human decisions taken elsewhere (e.g. in forestry or in cities) are impairing functions at the cellular level of reef corals. A disturbed symbiosis will affect coral nutrition, metabolism and the overall calcium balance in the reef system (e.g. Richmond, 1993). This will influence the resilience of the reef community at the ecosystem level and thereby the capacity of the reefs to generate essential ecological goods and services. Another thing that might affect reef calcification is the threat from human-induced increases in CO_2 in the air, resulting in decreased concentrations of carbonate in the water, and as a consequence, reduced growth of reef corals (Brown, 1997; Pennisi, 1997).

8. Concluding remarks

We have emphasized that to secure the capacity of coral reefs to supply humanity with ecological goods and services the resilience of reefs must be conserved. Loss of resilience is caused by unsustainable uses of the reef itself as well as unwise and inefficient fisheries management (Ludwig et al., 1993; Jackson, 1997). It is also caused by impacts on the marine environment from many uncoordinated human activities in the coastal zone and on land. Human impacts on coral reefs can have far reaching consequences on adjacent ecosystems such as mangroves, sea-grass beds and the open ocean, and vice versa. Therefore, coral reefs cannot be managed in isolation. To conserve the resilience of these complex systems we have to adopt an ecosystem approach (Christensen et al., 1996; Hatcher, 1997) that addresses management of coral reefs in the context of the seascape (Ogden, 1988; Done, 1994, 1995b). This approach has to recognise that the seascape in turn is affected by land use decisions in its drainage basin (e.g. Johannes, 1975; Done, 1995b; Birkeland, 1997a; Goreau et al., 1997; Done and Reichelt, 1998; Folke and Falkenmark, 1998).

The situation for coral reefs, in particular fringing reefs, is serious (e.g. Gomez, 1997). Humanity may choose consciously or unconsciously to continue to destroy coral reefs worldwide in the name of development. In our opinion it would be very sad for current and future generations to lose these unique ecosystems. To conserve the capacity of coral reefs to generate ecological goods and services requires innovative national and international policies, incentives, and effective institutional arrangements.

Acknowledgements

Many thanks to Nils Kautsky, Magnus Nyström, and three reviewers for valuable comments on the manuscript. Fredrik Moberg's work is financed through a Ph.D. grant received from Department of Systems Ecology and also supported by a scholarship from The Royal Swedish Academy of Sciences (Hierta-Retzius). Carl Folke's work is partly supported by the Pew Charitable Trusts. The paper is a product under the Resilience Network of the University of Florida, Gainesville, and The Beijer Institute, Stockholm, supported by the John D. and Catherine T. MacArthur Foundation, in the US and the Marcus Wallenberg Foundation for International Cooperation in Science, Sweden.

References

Andersson, J.E.Z., Ngazi, Z., 1995. Marine resource use and the establishment of a marine park: the Mafia island, Tanzania. Ambio 24 (7–8), 475–481.

Barbier, E.B., Burgess, J., Folke, C., 1994. Paradise Lost? The Ecological Economics of Biodiversity. Earthscan, London, p. 267.

Barnes, D.J., Lough, J.M., 1996. Coral skeletons: Storage and recovery of environmental information. Global Change Biol. 2 (6), 569–582.

Barton, D.N., 1994. Economic factors and evaluation of tropical coastal resources. SMR-report 14/94, Universitetet i Bergen, Senter for Miljø-og Resursstudier.

Baskin, Y., 1997. The Work of Nature. How the Diversity of Life Sustains Us. Island Press, Washington, DC, p. 263.

Bell, P.R.F., Elmetri, I., 1995. Ecological indicators of large-scale eutrophication in the Great Barrier Reef Lagoon. Ambio 23 (4), 208–215.

Berg, H., Öhman, M.C., Troëng, S., Lindén, O., 1998. Environmental economics of coral reef destruction in Sri Lanka. Ambio 27 (8), 627–634.

Birkeland, C., 1985. Ecological interactions between tropical coastal ecosystems. UNEP Reg. Seas Rep. Stud. 73, 1–26.

Birkeland, C., 1997a. Life and Death of Coral reefs. Chapman and Hall, New York, p. 536.

Birkeland, C., 1997b. Disposable income in Asia—a new and powerful external pressure against sustainability of coral reef resources on Pacific islands. Reef Encounter 22, 9–13.

Bouchon, C., Bouchon-Navaro, Y., Louis, M., 1992. A first record of a Sargassum outbreak in a Caribbean coral reef ecosystem. In: Goodwin, M.H., Kau, S.M., Waugh, G.T. (Eds.), Proc. 41 Ann. Gulf and Car. Fisheries Inst., St Thomas, U.S.V.I., pp. 171–180.

Brookshire, D.S., Neill, H.R., 1992. Benefit transfers: conceptual and empirical issues. Water Resour. Res. 28, 651–655.

Brown, B.E., 1987. Worldwide death of corals: natural cyclic events or man-made pollution? Mar. Pollut. Bull. 18, 9–13.

Brown, B.E., 1997. Disturbances to reefs in recent times. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 354–378.

Bryant, D., Burke, L., McManus, J.W., Spalding, M., 1998. Reefs at risk. A Map-Based Indicator of Potential Threats to the World's Coral Reefs. Internet website address: http://www.wri.org/wri/indictrs/reefrisk.htm.

Buddemeier, R.W., 1996. Coral reefs and carbon dioxide (technical comment). Science 271, 1298–1299.

Carpenter, R.C., 1986. Partitioning herbivory and its effects on coral reef algal communities. Ecol. Monogr. 56, 345–363.

Carpenter, R.C., 1990. Mass mortality of *Diadema antillarum*. I. Long term effects on sea urchin population-dynamics and coral reef algae communities. Mar. Biol. 104, 67–77.

Carté, B.K., 1996. Biomedical potential of marine natural products. BioScience 46 (4), 271–286.

Cesar, H., 1996. Economic Analysis of Indonesian Coral Reefs. The World Bank.

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Christensen, N.L., et al., 1996. The scientific basis for ecosystem management. Ecol. Appl. 6, 665–691.

Choat, J.H., Bellwood, D.R., 1991. Reef fishes: their history and evolution. In: Sale, P.F. (Ed.), The ecology of fishes on coral reefs. Academic Press, San Diego, pp. 39–66.

Connell, J.H., 1978. Diversity in tropical rain forests and coral reefs. Science 199, 1302–1310.

Connell, J.H., Hughes, T.P., Wallace, C.C., 1997. A 30-year study of coral abundance, recruitment, and disturbance at several scales in space and time. Ecol. Monogr. 67 (4), 461–488.

Connell, J.H., 1997. Disturbance and recovery of coral assemblages. Coral Reefs 16, S101–S113.

Copper, P., 1994. Ancient reef ecosystem expansion and collapse. Coral Reefs 13, 3–11.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260.

Costanza, R., Folke, C., 1997. The structure and function of ecological systems in relation to property-right regimes. In: Hanna, S., Folke, C., Mäler, K.-G. (Eds.), Rights to Nature. Island Press, Washington, DC, pp. 13–34.

Craik, W., Kenchington, R., Kelleher, G., 1990. Coral-Reef Management. In: Dubinsky, Z. (Ed.), Ecosystems of the World 25: Coral Reefs. Elsevier, New York, pp. 453–467.

Davies, P.J., 1983. Reef growth. In: Barnes, D.J. (Ed.), Perspectives on coral reefs. Brian Clouston, A.C.T., Australia, pp. 69–95.

de Groot, R.S., 1992. Functions of Nature: Evaluation of nature in environmental planning, management and decision making. Wolters, Nordhoff BV, Groningen, The Netherlands.

D'Elia, C.F., 1988. Coral reef energetics. In: Pomeroy, L.R., Alberts, J.J. (Eds.), Concepts of Ecosystem Ecology. Springer Verlag, New York, pp. 195–230.

D'Elia, C.F., Wiebe, W.J., 1990. Biochemical nutrient cycles in coral reef ecosystems. In: Dubinsky, Z. (Ed.), Ecosystems of the World 25: Coral Reefs. Elsevier, New York, pp. 49–74.

de Villiers, S., Nelson, B.K., Chivas, A.R., 1995. Biological control on Sr/Ca and δ^{18}O reconstructions of sea surface temperatures. Science 269, 1247–1249.

Dixon, J.A., Scura, L.F., van't Hof, T., 1993. Meeting ecological and economic goals: marine parks in the Caribbean. Ambio 22 (2–3), 117–125.

Dodge, R.E., Gilbert, T.R., 1984. Chronology of lead pollution contained in banded coral skeletons. Mar. Biol. 82, 9–13.

Done, T.J., 1992. Phase shifts in coral reef communities and their ecological significance. Hydrobiologia 247, 121–132.

Done, T.J., 1994. Maintenance of biodiversity of coral reef systems through management for resilience of populations. In: Munro, J.L., Munro, P.E., (Eds.), The Management of Coral Reef Resource Systems. ICLARM Conf. Proc. 44, 64–65.

Done, T.J., 1995a. Ecological criteria for evaluating coral reefs and their implications for managers and researchers. Coral Reefs 14 (4), 183–192.

Done, T.J., 1995b. Remediation of degraded coral reefs: the need for broad focus. Mar. Pollut. Bull. 30 (11), 686–688.

Done, T.J., Dayton, P.K., Dayton, A.E., Steger, R., 1991. Regional and local variability in recovery of shallow coral communities: Moorea, French Polynesia and central Great Barrier Reef. Coral Reefs 9, 183–192.

Done, T.J., Ogden, J.C., Wiebe, W.J., Rosen, B.R., 1996. Biodiversity and ecosystem function of coral reefs. In: Mooney, H.A., Cushman, J.H., Medina, E., Sala, O.E., Schulze, E.-D. (Eds.), Functional Roles of Biodiversity: A Global Perspective. SCOPE 1996, John Wiley and Sons.

Done, T.J., Reichelt, R.E., 1998. Integrated coastal zone and fisheries ecosystem management: generic goals and performance indices. Ecol Appl. 8 (1), 110–118.

Driml, S., 1994. Protection for Profit-Economic and Financial Values of the Great Barrier Reef World Heritage Area and Other Protected Areas. Great Barrier Reef Marine Park Authority. Research Publication No. 35, Townsville, Australia, pp. 83.

Dulvy, N.K., Stanwell-Smith, D., Darwall, W.R.T., Horrill, C.J., 1995. Coral mining at Mafia Island, Tanzania: a management dilemma. Ambio 24 (6), 358–365.

Eakin, C.M., 1993. Post-El Niño Panamanian reefs: less accretion, more erosion and damselfish protection. Proc. 7th Int. Coral Reef Symp. 1, 387–396.

Eakin, C.M., McManus, J.W., Spalding, M.D., Jameson, S.C., 1997. Coral reef status around the world: where are we and where do we go from here? Proc. 8th Int. Coral Reef Symp. 1, 227–282.

Folke, C., Falkenmark, M., 1998. Linking water flows and ecosystem services: a conceptual framework for improved ecosystem management. In: Falkenmark, M.(Ed.), Proc. 7th Stockholm Water Symp. 3rd Int. Conf. Environ. Manag. Enclosed Coastal Seas (EMECS), Stockholm, 10–14 August, 1997.

Gadgil, M., Berkes, F., Folke, C., 1993. Indigenous knowledge for biodiversity conservation. Ambio 22, 151–156.

Gagan, M.K., Ayliffe, L.K., Hopley, D., Cali, J.A., Mortimer, G.E., Chappel, J., McCulloch, M.T., Head, M.J., 1998. Temperature and surface ocean water balance of the mid-Holocene tropical Western Pacific. Science 279, 1014–1018.

Gattuso, J.-P., Frankignoulle, M., Smith, S.V., Ware, J.R., Wollast, R., 1996. Coral reefs and carbon dioxide (technical comment). Science 271, 1298.

Glynn, P.W., 1990. Feeding ecology of selected coral-reef macroconsumers: patterns and effects on coral community structure. In: Dubinsky, Z. (Ed.), Ecosystems of the World 25: Coral Reefs. Elsevier, New York, pp. 365–391.

Glynn, P.W., 1997. Bioerosion and coral-reef growth: a dynamic balance. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 68–94.

Goh, N.K.C., Chou, L.M., 1994. Distribution and biodiversity of Singapore gorgonians (sub-class Octocorallia)—a preliminary survey. Hydrobiologia 285, 101–109.

Gomez, E.D., 1997. Reef management in developing countries: The Philippines as a case study. Proc. 8th Int. Coral Reef Symp. 1, 123–128.

Goreau, T.F., 1959. The physiology of skeleton formation in corals. I. A method for measuring the rate of calcium deposition by corals under different conditions. Biol. Bull. 116, 59–75.

Goreau, T.J., Daley, L., Ciappara, S., Brown, J., Bourke, S., Thacker, K., 1997. Community-based whole-watershed and coastal zone management in Jamaica. Proc. 8th Int. Coral Reef Symp. 2, 2093–2096.

Goreau, T.J., Hayes, R.L., 1994. Coral bleaching and ocean 'hot spots'. Ambio 23 (3), 176–180.

Grigg, R.W., Dollar, S.J., 1990. Natural and anthropogenic disturbance on coral reefs. In: Dubinsky, Z. (Ed.), Ecosystem of the world 25. Elsevier, New York, pp. 439–452.

Hallock, P., 1997. Reefs and reef limestones in Earth history. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 13–42.

Hanna, S.S., Folke, C., Mäler, K.-G., 1996. Rights to Nature: Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment. Island Press, Washington DC, p. 298.

Harland, A.D., Brown, B.E., 1989. Metal tolerance in the scleractinian coral *Porites lutea*. Mar. Pollut. Bull. 20 (7), 353–357.

Harrison, P.L., Wallace, C.C., 1990. Reproduction, dispersal and recruitment of Scleractinian corals. In: Dubinsky, Z. (Ed.), Ecosystems of the World 25: Coral Reefs. Elsevier, New York, pp. 133–196.

Hatcher, B.G., 1983. Grazing in coral reef ecosystems. In: Barnes, D.J. (Ed.), Perspectives on Coral Reefs. Brian Clouston Publishing, A.C.T., Australia, pp. 164–172.

Hatcher, B.G., 1984. A maritime accident provides evidence for alternate stable states in benthic communities on coral reefs. Coral Reefs 4, 199–204.

Hatcher, B.G., 1988. Coral reef primary productivity: a beggar's banquet. Trends Ecol. Evol. 3 (5), 106–111.

Hatcher, B.G., 1997. Organic production and decomposition. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 140–174.

Hawkins, J.P., Roberts, C.M., 1994. The growth of coastal tourism in the Red Sea: present and future effects on coral reefs. Ambio 23 (8), 503–508.

Hay, M.E., 1984. Patterns of fish and urchin grazing on Caribbean coral reefs: are previous results typical? Ecology 65 (2), 446–454.

Hixon, M.A., 1997. Effects of reef fishes on corals and algae. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 230–246.

Hixon, M.A., Brostoff, W.N., 1996. Succession and herbivory: effects of differential fish grazing on Hawaiian coral-reef algae. Ecol. Monogr. 66, 67–90.

Hodgson, G., 1997. Resource use: conflicts and management solutions. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 386–410.

Hodgson, G., Dixon, J.A., 1988. Logging versus fisheries and tourism: economic dimensions. Occasional paper. East-West Center Environment and Policy Institute, Honolulu.

Holling, C.S., 1973. Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4, 1–23.

Holling, C.S., 1986. The resilience of terrestrial ecosystems: local surprise and global change. In: Clark, W.C., Munn, R.E. (Eds.), Sustainable Development of the Biosphere, International Institute for Applied Systems Analysis, (IIASA). Cambridge University Press, Cambridge, UK.

Holling, C.S., Schindler, D.W., Walker, B.W., Roughgarden, J., 1995. Biodiversity in the functioning of ecosystems: an ecological synthesis. In: Perrings, C.A., Mäler, K.-G., Folke, C., Holling, C.S., Jansson, B.-O. (Eds.), Biodiversity Loss. Ecological and Economical Issues. Cambridge University Press, Cambridge, UK.

Howard, L.S., Brown, B.E., 1984. Heavy metals and reef corals. Oceanogr. Mar. Biol. Ann. Rev. 22, 195–210.

Hughes, T.P., 1994. Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef. Science 265, 1547–1551.

Hughes, T.P., Ayer, D., Connell, J.H., 1992. The evolutionary ecology of corals. Trends Ecol. Evol. 7, 292–295.

Hunter, C.L., Evans, C.W., 1995. Coral reefs in Kaneohe bay, Hawaii: two centuries of western influence and two decades of data. Bull. Mar. Sci. 57 (2), 501–515.

Isdale, P., 1984. Fluorescent bands in massive corals record centuries of coastal rainfall. Nature 310, 578–579.

Jackson, J.B.C., 1997. Reefs since Columbus. Coral Reefs 16, S23–S32.

Jennings, S., Polunin, N.V.C., 1996. Impacts of fishing on tropical reef ecosystems. Ambio 25 (1), 44–49.

Johannes, R.E., 1975. Pollution and degradation of coral reef communities. In: Ferguson Wood, E.J., Johannes, R.E. (Eds.), Tropical Marine Pollution. Elsevier, Amsterdam, pp. 13–50.

Johannes, R.E., 1992. Words of the lagoon. University of California Press.

Johannes, R.E., Riepen, M., 1995. Environmental, economic and social implications of the live reef fish trade in Asia and the western Pacific. Report to the Nature Conservancy and the South Pacific Forum Fisheries Agency. pp. 80.

Kinsey, D.W., 1983. Standards of performance in coral reef primary production and carbon turnover. In: Barnes, D.J. (Ed.), Perspectives on Coral Reefs. Brian Clouston, A.C.T., Australia, pp. 209–220.

Knowlton, N., 1992. Thresholds and multiple states in coral reef dynamics. Amer. Zool. 32, 674–682.

Kühlmann, D.H.H., 1988. The sensitivity of coral reefs to environmental pollution. Ambio 17 (1), 13–21.

Lessios, H.A., Robertson, D.R., Cubit, J.D., 1984. Spread of *Diadema* mass mortality through the Caribbean. Science 226, 335–337.

Lieske, E., Myers, R.M., 1994. Collins' Hand Guide to the Coral Reef Fishes of the World. Harper-Collins, London.

Ludwig, D., Hilborn, R., Walters, C., 1993. Uncertainty, resource exploitation, and conservation.: lessons from history. Science 260, 17–36.

McAllister, D.E., 1988. Environmental, economic and social costs of coral reef destruction in the Philippines. Galaxea 7, 161–178.

McAllister, D.E., 1991. What is the status of the world's coral reef fishes? Sea Wind 5, 14–18.

McClanahan, T.R., Done, T.J., Polunin, N.V.C., in press. Resiliency of coral reefs. In: Gunderson, L., Holling, C.S., Jansson, B-O., Folke, C. (Eds.), Resilience and the behaviour of large scale ecosystems, John Wiley and Sons, New York.

McClanahan, T.R., Muthiga, N.A., 1988. Changes in Kenya coral reef community structure and function due to exploitation. Hydrobiologia 166, 269–276.

McClanahan, T.R., Nugues, M., Mwachireya, S., 1994. Fish and sea urchin herbivory and competition in Kenyan coral reef lagoons: the role of reef management. J. Exp. Mar. Biol. Ecol. 184, 237–254.

McClanahan, T.R., Rubens, J., Glaesel, H., Kiambo, R., 1996. The Diani-Kinondo coral reefs, fisheries, and traditional management. Coral Reef Conservation Project Report, The Wildlife Conservation Society, Mombasa, Kenya, pp. 28.

McCook, L., 1996. Effects of herbivores and water quality on the distribution of Sargassum on the central Great Barrier Reef: Cross-shelf transplants. Mar. Ecol. Prog. Ser. 139, 177–192.

McManus, J.W., 1988. Coral Reefs of the ASEAN Region: Status and Management. Ambio 17 (3), 189–193.

McRoy, C.P., 1983. Nutrient cycles in Caribbean seagrass ecosystems. In: Ogden J.C., Gladfelter, E.H. (Eds.), Coral reefs, seagrass beds and mangroves: their interactions in the coastal zones of the Caribbean. UNESCO Rep. Mar. Sci. 23, 133

Menasveta, P., Wongratana, T., Chaitanawisuti, N., Rungsupa, S., 1986. Species composition and standing crop of coral reef fishes in the Sichang Islands, Gulf of Thailand. Galaxea 5, 115–121.

Meyer, J.L., Schultz, E.T., 1985. Migrating haemulid fishes as a source of nutrients and organic matter on coral reefs. Limnol. Oceanogr. 301 (1), 146–156.

Moberg, F., Nyström, M., Tedengren, M., Kautsky, N., Jarayabhand, P., 1997. Effects of reduced salinity on the rates of photosynthesis and respiration in the hermatypic corals *Porites lutea* and *Pocillopora damicornis*. Mar. Ecol. Progr. Ser. 157, 53–59.

Muller-Parker, G., D'Elia, C.F., 1997. Interactions between corals and their symbiotic algae. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 96–112.

Muscatine, L., 1990. The role of symbiotic algae in carbon and energy flux in reef corals. In: Dubinsky, Z. (Ed.), Ecosystems of the world 25: Coral reefs. Elsevier, New York, pp. 75–84.

Norgaard, R.B., 1994. Development betrayed. The end of progress and a coevolutionary revision of the future. Routledge, London, New York.

Odum, H.T., Odum, E.P., 1955. Trophic structure and productivity of a windward coral reef community on Eniwetok Atoll. Ecol. Monogr. 25, 291–320.

Ogden, J.C., 1988. The influence of adjacent systems on the structure and function of coral reefs. Proc. 6th Int. Coral Reef Symp. 1.

Ogden, J.C., 1998. ISRS Statement on Bleaching. Reef Encounter 24, 19–20.

Ogden, J.C., Gladfelter, E.H., 1983. Coral reefs, seagrass beds and mangroves: their interactions in the coastal zones of the Caribbean. UNESCO Rep. Mar. Sci. 23, 133.

Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, New York.

Paine, R.T., 1966. Foodweb complexity and species diversity. Am. Nature 100, 65–75.

Parker, G.M., 1984. Dispersal of zooxanthellae on coral reefs by predators on cnidarians. Biol. Bull. (Woods Hole) 167, 159–167.

Parrish, J.D., 1989. Fish communities of interacting shallow-water habitats in tropical oceanic regions. Mar. Ecol. Progr. Ser. 58, 143–160.

Paulay, G., 1997. Diversity and distribution of reef organisms. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 298–345.

Pendleton, L.H., 1995. Valuing coral reef protection. Ocean Coastal Manag. 26 (2), 119–131.

Pennisi, E., 1997. Brighter prospects for the world's coral reefs? Science 277, 491–493.

Peters, E.C., 1997. Diseases of coral-reef organisms. In: Birkeland, C. (Ed.), Life and Death of Coral Reefs. Chapman and Hall, New York, pp. 114–136.

Peterson, C.H., Lubchenco, J., 1997. On the value of marine ecosystems to society. In: Daily, G.C. (Ed.), Nature's Services. Societal Dependence on Natural Ecosystems. Island Press, New York, pp. 177–194.

Reaka-Kudla, M.L., 1994. Biodiversity of coral reefs. In: Heasley, C. (Ed.), Science and a changing world. AAAS '94, Program and abstracts, p. 22.

Richmond, R.H., 1993. Coral reefs: present problems and future concerns resulting from anthropogenic disturbance. Am. Zool. 33, 524–536.

Roberts, C.M., 1995. Effects of fishing on the ecosystem structure of coral reefs. Conserv. Biol. 9 (5), 988–995.

Roberts, C.M., 1997. Connectivity and management of Caribbean coral reefs. Science 278, 1454–1457.

Rogers, C.S., 1990. Responses of coral reefs and reef organisms to sedimentation. Mar. Ecol. Progr. Ser. 62, 185–202.

Ruddle, K., Hviding, E., Johannes, R.E., 1992. Marine resources management in the context of customary tenure. Mar. Res. Econ. 7, 249–273.

Sale, P.F., 1991. The ecology of fishes on coral reefs. Academic Press, San Diego.

Salvat, B., 1992. Coral reefs—a challenging ecosystem for human societies. Global Environ. Change 2, 12–18.

Sebens, K.P., 1994. Biodiversity of coral reefs: what are we losing and why? Am. Zool. 34, 115–133.

Smith, S.V., 1978. Coral-reef area and the contribution of reefs to processes and resources of the world's oceans. Nature 273, 225–226.
Smith, S.V., 1983. Coral reef calcification. In: Barnes, D.J. (Ed.), Perspectives on Coral Reefs. Brian Clouston, A.C.T., Australia, pp. 240–247.
Sorokin, Yu I., 1990. Aspects of trophic relations, productivity and energy balance in reef ecosystems. In: Dubinsky, Z. (Ed.), Ecosystems of the World 25: Coral Reefs. Elsevier, New York, pp. 401–410.
Sorokin, Yu I., 1993 (Ed.). Coral Reef Ecology. Ecological Studies 102. Springer Verlag, Berlin, pp. 4–28.
Spalding, M.D., Grenfell, A.M., 1997. New estimates of global and regional coral reef areas. Coral Reefs 16, 225–230.
Spurgeon, J.P.G., 1992. The economic valuation of coral reefs. Mar. Pollut. Bull. 4 (11), 529–536.
Stoddart, D.R., 1973. Coral reefs of the Indian Ocean. In: Jones, O.A., Endean, R. (Eds.), Biology and geology of coral reefs, vol. 1. Academic Press, New York, pp. 51–92.
Sutton, M., 1983. Relationship between reef fishes and coral reefs. In: Barnes, D.J. (Ed.), Perspectives on coral reefs. Brian Clouston, A.C.T., Australia, pp. 248–252.
Swart, P.K., Dodge, R.E., 1997. Climate records in coral skeletons. Proc. 8th Int. Coral Reef Symp. 2, 1695–1696.
Szmant, A.M., 1997. Nutrient effects on coral reefs: a hypothesis on the importance of topographic and trophic complexity to reef nutrient dynamics. Proc. 8th Coral Reef Symp. 2, 1527–1532.
Thresher, R.E., 1991. Geographic variability in the ecology of coral reef fishes: evidence, evolution, and possible implications. In: Sale, P.F. (Ed.), The Ecology of Fishes on Coral Reefs. Academic Press, San Diego, pp. 431–436.
Trudgill, S.T., 1983. Measurements of rates of erosion of reefs and reef limestones. In: Barnes, D.J. (Ed.), Perspectives on coral reefs. Brian Clouston, A.C.T., Australia, pp. 256–262.
van't Hof, T.,1985. The economic benifits of marine parks and protected areas in the Caribbean region. Proc. 5th Int. Coral Reef Congress, Tahiti.
Veron, A.T., 1993. Corals of Australia and the Indo-Pacific. University of Hawaii Press edition.
Weber, P., 1993. Reviving the coral reefs. In: Brown, L.R. (Ed.), State of the World. W.W. Norton, New York, pp. 42–60.
Wells, S., Hannah, N., 1992. The Greenpeace book of coral reefs. Sterling, New York, p. 160.
Wiebe, W.J., 1988. Coral reef energetics. In: Pomeroy, L.R., Alberts, J.J. (Eds.), Concepts of Ecosystem Ecology. Springer Verlag, New York, pp. 231–245.
Wilkinson, C.R., 1993. Coral reefs are facing widespread extinctions: can we prevent these through sustainable management practices? Proc. 7th Int. Coral Reef Symp. 1, 11–21.
Wilkinson, C.R., Buddemeier, R.W., 1994. 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, Switzerland, pp. 124.
Wood, E.M., 1985. Exploitation of coral reef fishes for the aquarium fish trade. Marine Conservation Society, Ross-on-Wye, UK.

Annex 710

Intentionally Omitted

Annex 711

Clive Symmons, “When is an ‘Island’ Not an ‘Island’ in International Law? The Riddle of Dinkum Sands in the Case of *US vs. Alaska*”, *IBRU Maritime Briefing*, Vol. 2, No. 6 (1999)

Maritime Briefing

Volume 2 Number 6
ISBN 1-897643-33-0
1999

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When is an 'Island' Not an 'Island' in International Law? The Riddle of Dinkum Sands in the Case of *US v. Alaska*

Clive R. Symmons

1. Introduction

This *Briefing* deals with the problem of defining an 'island' in international law arising from the United States federal/state case of *US v. Alaska* concerning the disputed status of a small formation in the Beaufort Sea known as 'Dinkum Sands'. Issues arose here, under Article 10 of the 1958 Convention on the Territorial Sea, on the meaning of *"above water at high tide"* (where the formation itself goes up and down), the relevant tidal datum, the meaning of the term *"land"*, the possible necessity for locational permanence; and whether there is such a phenomenon in international law as a 'seasonal' or 'occasional' island. Although this was in essence not a case of inter-State litigation, it did directly involve international legal considerations. It is suggested, therefore, that the case has future importance for other insular disputes throughout the world as, to date, such issues concerning the law of the sea have never been judicially determined in any international tribunal.

Under the United States Submerged Lands Act,[1] the constituent States of the Union are entitled to "*the lands beneath navigable waters within the boundaries of the respective States*." Thus in essence any seabed *outside* this definition is owned by the federal government who are consequently entitled to any revenues from exploitation of resources therein. As the Special Master put it in the case which is analysed in this *Briefing – US v. Alaska:*

> *These proceedings concern the rights to lands underlying tidal waters off the Arctic coast of Alaska. Important oil and gas reserves have been discovered nearby [e.g. Prudhoe Bay], and the controversy arose from the desire of both sovereigns [sic] to grant leases for exploration of these offshore areas…In general, the Submerged Lands Act grants to the states lands under tidal waters out to three miles from their coastlines, and the United States [i.e. the federal government] retains the rights over resources of the continental shelf beyond the three-mile limit.*[2]

The vital phrase "*lands beneath navigable waters*" is defined to include:

> *…all lands permanently or periodically covered by tidal waters up to but not above the line of mean high tide and seaward to a line three geographical miles distant from the coast of each state…*

Thus in essence, an individual US state has exclusive rights to revenues from minerals lying in its internal waters or "*within the traditional belt of territorial sea*."[3] In the post-war period much litigation has resulted in the US relating to this provision; and, as the Special Master summed up the matter in the most recent case, *US v. Alaska*:

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1 Chapter 65,67 Statute 29 (1953).

2 No. 84 (Original) Supreme Court of the United States (March 1996) (*Report of the Special Master*, p.3). Hereinafter referred to as "Report, 1996."

3 *Id.*: 3.

> *Under the Submerged Lands Act...Alaska is entitled to a three-mile belt of submerged lands measured from its coastline. Under the Court's interpretation...[of the Act], the term 'coast' is in general to conform to the baseline [under the Territorial Sea Convention ('TSC')1958].*[4]

Importantly, it was determined in the earliest case, *US v California*[5] (referred obliquely to in the above *dictum*), that international law governing the maritime definitions provided "*the best and most workable definitions available*"[6], at least for most delimitation purposes.[7] The international law instrument specifically referred to was the *UN Convention on the Territorial Sea and Contiguous Zon*e (1958) (hereafter referred to as the TSC) to which the US was then a signatory[8] and to the rules of which it (allegedly) "*moved...immediately on signing*."[9] Because of the international legal features evident in past US litigation, such essentially domestic litigation is of general interest to international lawyers and of direct relevance for delimitation disputes elsewhere between independent States.

For instance, if a particular matter of the law of the sea has not been aired in litigation involving a genuine 'State-to-State' situation, any determination of such a matter even in a (federal) domestic US context is of great persuasive value for the same matter when a truly international inter-State dispute arises. As a recent commentator on the case has stated, this latest one, like those federal-state cases previously, offers "*practical interpretations and applications of the baseline-drawing provisions of the law of the sea*", and is an example of how "*municipal courts can give precise content to treaty rules*."[10] This is certainly true on the matter of the international legal definition of islands which has hardly been touched on in past inter-State litigation.[11]

However, in some ways the case of *US v. Alaska* – analysed here in relation to the question of insular definition – has a 'municipalised' aspect to it in terms of creating an international precedent. To take one critical example, it seems to have gone unargued in the case that the usual US tidal datum practice[12] should be other than that of 'mean high tide' – in effect a very liberal criterion in determining insularity; whereas in this writer's opinion, an attempt should have been made to discover (if possible) the appropriate international legal criterion, for which there are several possibilities.[13] Unfortunately the Special Master seems to have uncritically accepted the (essentially domestic precedent) "*mean high tide*" test for the purposes of the case, though he does make occasional reference to the question of "*choice of tidal datum*", so implying other tidal possibilities.[14] As he states:

4 *Id*.: 228.
5 381 US 139 (1965).
6 *Id*.: 164-5.
7 But see *Report*, 1996: 42.
8 The United States signed the TSC on 15 September 1958.
9 *Report*, 1996: 134; but note the Special Master's doubts on this issue (*Id*: 135). Alaska initially contested application of the TSC in the instant case (*Id*.: 228, fn.3).
10 Note by Bederman, 1998: 86 and 87 respectively.
11 See the arbitral decision in the *Franco-British Arbitration on the Western Approaches*, *infra* fn.127.
12 As reflected in the domestic case of *Borax Consolidated v Los Angeles* 296 US 10 (1935).
13 For a discussion on these 'tidal datum' possibilities before any judgment was given in *US v. Alaska*, see Symmons, 1995: 17-24, 27-28.
14 See his *Report*, 1996: esp. p.302, referring to the case of the Eddystone Rocks in the *Franco-British Arbitration* (see fn.11 *supra*).

> *For a feature of fixed elevation, the application of Article 10 [of the TSC] requires only that one select [sic] an appropriate tidal datum to be used as 'high tide' and compare the elevation of the feature with that datum.* [15]

Notwithstanding this, the recent decision of the Special Master (in his *Report* of March 1996[16]) on the status in international law of a natural formation in the Beaufort Sea called 'Dinkum Sands' in *US v. Alaska* – and the confirmation of his findings by the (plenary) Supreme Court in its judgment of 19 June 1997 – is of great interest for the law of the sea. This is because for the first time (as stated above) the definition of an island in international law has been subjected to detailed analysis in a judicial setting.[17]

It was aptly stated in the US pleadings that "*naturally formed*" was probably the only criterion of legal insularity which was "*not at issue in this case*."[18] For example, even though dubious 'islands' have featured in at least one earlier state-federal dispute – *US v. Louisiana* – over the status of certain "*mudlumps*" as 'islands' in the Mississippi Delta[19], the plenary Supreme Court in *US v. Alaska* considered that the Special Master's finding there that Louisiana's *Submerged Lands Act* grant could be measured from "*two mudlumps*" as "*not deciding whether the mudlumps were islands under Article 10(1) or low-tide elevations under Article 11(1) [of the TSC, 1958]*."[20]

From the early 1980s, the present writer prepared a detailed *Report* on this issue of the legal status of 'Dinkum Sands' prior to appearing as an expert witness for the US (federal) side in 1984 when evidentiary hearings were held on the matter[21] in this federal-state context. This was followed by further briefings from both sides in 1985, and final argument (for the first instance proceedings) in 1986.[22] Other matters of international legal interest in this case include the question of drawing of straight baselines off the Alaskan coast[23] and the enclosing, and meaning, of "*bays*"[24]; but these are considered beyond the scope of this *Briefing*. The Special Master finally made his *Report* in March 1996, followed by a (plenary) Supreme Court judgment of 24 February 1997 in response to the "*exceptions*" raised by Alaska to this *Report*.[25]

15 *Report,* 1996: 302.
16 *Id.*
17 See fn.13, *supra*. and my critique there of lack of discussion of the totality this issue in many existing academic writings on islands (*Id*.: 17, fn.128 and 27, fn.190).
18 See US *Post-Trial Memorandum on Issue 5*, 1985: 11.
19 *Report*, 1996: 292.
20 138 L.Ed.231, 256 (see fn.25 below).
21 *Id*.: 11.
22 *Id*.: 227 and 228, fn.2.
23 *Id*.: 19-174.
24 *Id*.: 176-276.
25 Reported in 521 USI and in US Supreme Court Reports, Lawyers Edition, Second Series, Vol.138, p.231 (8 August 1997). Hereafter referred to as '138, L.Ed., 2nd, 231'.

2. Origins of the Dispute over "Dinkum Sands"

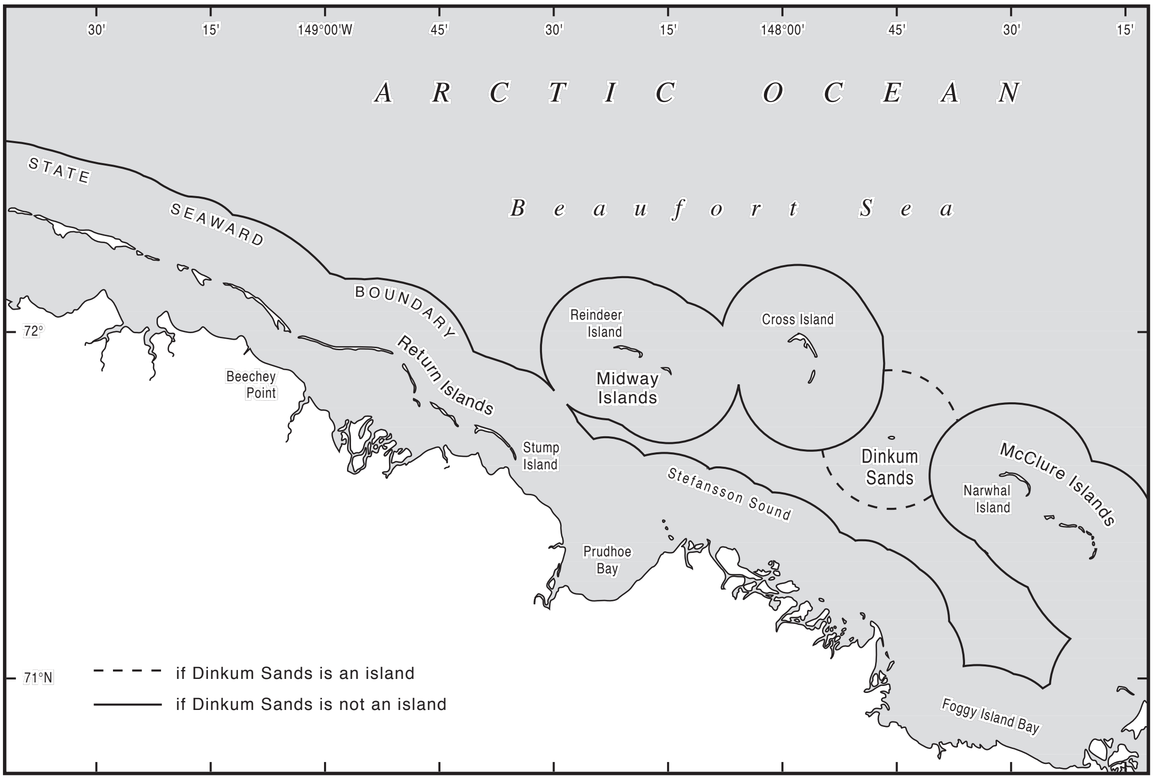
These are well summarised in the Special Master's 1996 *Report*. Geographically speaking, the North Alaskan coastline is fringed by many barrier islands. The 'formation' (to use a neutral term) known as Dinkum Sands lies between the genuinely insular Narwhal and Cross 'barrier' islands (approximately 4-5 nautical miles (nm) from each) and about 8nm from the Alaskan mainland (see Figure 1). In size, the exposed part often amounts to about that of a sleeping bag (see Figure 3). But more generally the formation is completely covered by shallow water (see Figure 4).

2.1 Cartographic Evidence

Voluminous testimony was made in the proceedings as to the alleged existence of Dinkum Sands[26] dating from the early nineteenth century, including in particular cartographic evidence in this century. In 1949 a US Coast and Geodetic Survey encountered a formation described as "*a new gravel bar baring about three feet*."[27] It was given the unlikely name of "*Dinkum Sands*" because a boat named *Fair Dinkum* had previously grounded on it. A survey target was then erected on it. At trial, expert testimony estimated it to be, at that earlier time, three to four feet above sea level and hundreds of yards wide and long;[28] and the resulting "*Smooth Sheet*" stated that the formation bared *"[t]hree feet at mean high water."*

Based on this survey, US maps from the early 1950s showed Dinkum Sands as an island.[29] But in 1955, after an inspection of aids to navigation by the USS *Merrick* it was reported in dramatic and laconic fashion that the survey target was "*not there*." Accordingly, the Coast and Geodetic Survey revised its charts, so that in the second edition thereof (in 1956), Dinkum

Figure 1: The Location of Dinkum Sands



Sands was now shown as a low-tide elevation and was indicated to be a navigational hazard which might not be visible to shipping.[30] However, in 1970, a move was made to change this description back to that of "*island*." A member of the US Baseline Committee, Admiral Nygren (who was later to be an expert witness for Alaska in 1984), seemingly persuaded the Baseline Committee, purely on the basis of his experience in 1949, to approve a depiction of a three-mile belt of territorial sea around Dinkum Sands. Not surprisingly, Alaska seized on this fact with vigour in the recent litigation, if only because this factor acted as a sort of 'estoppel' against the federal government.[31] It was on the basis of this last-mentioned map that federal and Alaskan State officials recommended approval of a leasing map for a joint oil and gas lease sale in the Prudhoe Bay area, assigning "*ownership of the territory around Dinkum Sands to Alaska*."[32] Unfortunately for Alaska, a marine geologist and expert glaciologist (on Arctic ice), Dr Erk Reimnitz (who was also to be a vital witness for the US federal side in the 1984 proceedings), noticed this designation and complained in 1979 to the Bureau of Land Management that he had not seen the formation in question above water in recent years. As a result, the above-mentioned Bureau proposed to cancel the three mile lease extending from the formation.

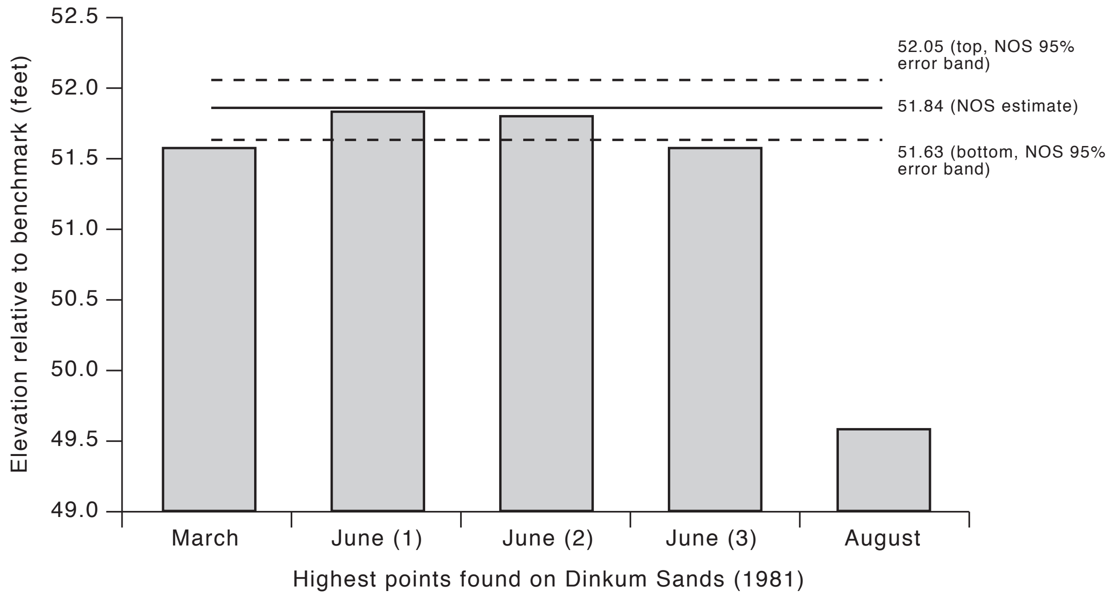
The plenary Supreme Court agreed with the Special Master on this issue, namely that the three cartographic sources, which hinged on recollection of a personal observation as early as 1949, were of no avail to Alaska. As the Supreme Court stated: "*visual observations of Dinkum Sands are not dispositive*" [33]; and Alaska had not explained "*why the [Special] Master should have relied on a single August 1949 measurement of Dinkum Sands in relation to mean high water rather than on the exhaustive survey expressly designed to determine Dinkum Sands' status under Article 10(1) of the Convention*." As will be next discussed, the reference here to the "*exhaustive survey*" is to the jointly commissioned US/Alaskan study in 1981 to calculate mean high water in the feature's vicinity and to determine the feature's elevation in relation to the same.

2.2 Tidal Evidence

In view of the abovementioned turn of events, the two parties agreed in 1981 to commission a jointly-funded study to determine the formation's height "*relative to mean high water*" (the latter being the traditional US charting test).[34] This study involved not only periodic topographical profiles of the feature in 1981 (a benchmark set at Dinkum[35]) but also installation of tidal gauges in the Beaufort Sea to determine tidal measurements in 1980 and 1981 in an attempt to "*determine the level of mean water at Dinkum Sands and to determine the elevation of Dinkum Sands itself*."[36] The basic result of this study – though hotly contested by Alaska – was that on the basis of both tests, Dinkum Sands was "*below mean high water on each of the three occasions when it was surveyed in 1981*"[37] (see Figure 2). In Alaska's view, there should have been "*appropriate corrections*"[38] which would have lowered the mean high

30 *Id*.: 232.
31 See Alaskan *Reply Brief*, 1985: 4, 8, 10, 44, 53, 66-69, 97, 100; and more generally, Symmons, 1995: 11.
32 *Report*, 1996: 233.
33 138, L.Ed., 2nd, 257.
34 *Report*, 1996: 233. See also fn.12, *supra*.
35 *Id*.: 251.
36 *Id*.: 248.
37 *Id*.
38 *Id*.

Figure 2: NOS Estimates of Mean High Water and Error Band Compared to 1981 Measurements of Dinkum Sands



water level, so showing that Dinkum Sands was above mean high water in two of the three 1981 surveys. As well as this, Alaska alleged a lack of precision in the assessment of mean high water. In other words, the contention was that "*the NOS [National Ocean Survey] estimate of mean high water [was] too high and also that the NOS error band [was] too narrow*."[39]

On this matter the Master did admit in his *Report*[40] that *"[a]lthough the datum would ideally have been computed from 19 years of tide readings, no American tide station in the Arctic had such a long series of data."* The federal government recognised this as a "*tidal epoch*",[41] though Alaska was to argue that rising sea level should result in a retrospective correction downwards at Dinkum Sands.[42] Such a 19-year period should ideally take into account such matters as changes in sea level (resulting from global warming) as well as glacial melting and vertical movements of the land;[43] but the Special Master rejected Alaskan complaints on this ground saying that:

> *...in view of the evidence that the trend [in sea level] may vary locally not only in magnitude but in direction, and in view of the lack of evidence of trend specific to Dinkum Sands, I believe that NOS was justified in declining to take sea level trend into effect in making its estimate of mean high water.*[44]

39 *Id.*: 255.
40 *Id.*: 249.
41 *Id.*: 259.
42 *Id.*
43 *Id.*: 258. The global warming phenomenon has already been the subject of academic discussion elsewhere with regard to its potential effect on insular status in international law (see, e.g., Prescott and Bird, 1989: 279 and 287.
44 *Id.*: 262.

This opinion as to the potential effects of global warming effects on the juridical status of islands – and the adoption of a "*here-and-now*" approach to tidal assessment – will be of interest to States throughout the world owning very low-lying formations in the case of any maritime boundary dispute.

In effect, the abovementioned chosen survey body, the NOS, had to check its estimates of mean high water in the region of Dinkum Sands by comparing data from other tide stations – including those in the Canadian Arctic – where longer-term data was available.[45] Such statistical analysis showed that the one year's data was 95% accurate (plus or minus 0.206 of a foot or 2.47 inches). The "*error analysis*" problem, frequently described in the proceedings as the "*error band*", which the NOS had worked out by looking at trends at the nearest American tidal stations which did have "*long data series*",[46] as well as Canadian Arctic stations and those in southern Alaska, was to be (unsuccessfully) attacked by Alaska as being underestimated.[47] In fact Alaska claimed it should be "*enlarged to plus or minus 0.6 foot*."[48] On this the Special Master stated with impeccable common sense;

> *The controlling point is the estimate of mean high water, for whatever the width of the error band, the chance that the estimate of mean high water is too high is matched by an equal chance that it is too low. Although there may be more or less uncertainty about how accurate the estimate would prove to be after 19 years of observation it is the best estimate now available.*[49]

In any event, Alaska had effectively agreed, as had the US federal side, in setting up the joint monitoring project, to consciously give up "*some precision of result for the sake of reasonable time and expense*."[50] This is not, of course, a problem unique to this case; for in the case of many disputes over 'marginal islands' elsewhere in the world it is similarly unlikely that the optimum timescale of tidal monitoring – of, as seen above, 19 years[51] – would be available.

A further adjustment was advocated by Alaska because of weather, the allegation being that during the NOS monitoring project "*abnormal weather caused the water level around Dinkum sands to be exceptionally high*", so that the estimate of mean high water should be reduced by 0.72 of an inch. This was supported by expert testimony on the Alaskan side.[52] However the Special Master found this, in effect, not to be relevant as, even if it were true, the adjustment would still leave the formation below the abovementioned error band level.

By way of contrast, *subsequent* to 1981, a number of further observations of Dinkum Sands were made (in 1982 and 1983) when on "*several occasions*" the formation was found to be above mean high water.[53] These were also to be taken account of by the Special Master.

45 *Id.*: 250.
46 *Id.*: 267.
47 *Id.*
48 *Id.*
49 *Id.*
50 *Id.*: 269, fn.34.
51 See fn.40, *supra* and accompanying text.
52 See *Report*, 1996: 263-4.
53 *Id.*: 276. See *infra* fn.79 and accompanying text.

2.3 Variation in the Elevation of the Formation Itself

Determining the high tide level relative to Dinkum Sands involved in this instance more than simply "*measurement of tidal datum*."[54] For it was evident that the formation itself was apt to go up and down because of "*changes of elevation*"[55] – what might be whimsically described as the "*now-you-see-it-now-you-don't*" phenomenon. As the Supreme Court posed the problem: "*Apart from daily shifts in the tide and seasonal shifts in sea level, the **feature itself changes height***."[56] So this aspect involved further investigation in the case by subcontractor surveyors of the joint monitors mentioned above. These subcontractors measured the height of Dinkum Sands on three occasions under different conditions, in March, June and August 1981 (Figure 2).

On the first occasion (in March) Dinkum was under the ice – in fact, ice covers the feature for some nine months of the year. As a result, holes were drilled through the ice until gravel was reached and that distance measured.[57] There is no doubt that in any ice-bound environment like the Arctic, topographic surveys for gauging insularity are attended by added practical difficulties, most particularly the seasonal overlying pack ice.

The March survey showed the highest point to be some 0.28 feet below mean high water. However the three apparently highest sites were also excavated for examination of the ice and gravel content. The legal significance of this will be discussed later. The second survey in June was done at a time when the pack ice was melting and the highest readings were barely below estimated mean high water[58] (i.e. close to the middle of the 95% estimated error band). This survey may have been made inaccurate as a result of gravel disturbance in the course of carrying out the previous survey, so further downgrading its importance,[59] particularly as the gravel "*was on top of clear ice*."[60] Another problematic aspect of the case was that 'ice rubble pile' could also be easily confused as being a pile of (terrestrial) gravel.[61]

The third survey took place after the melt in "*open-water season*" in mid-August. This produced the most dramatic result that was to flavour important legal aspects of the case; namely that there was an underwater "*slump*" at this time of the season bringing the highest apparent point "*2.90 feet below water*."[62] The US federal side's explanation of this "*decline*"[63] was that it was largely due to "*melting of ice embedded in the formation*." Indeed, one of their expert witnesses, Dr Reimnitz,[64] estimated that on the basis of "*excess ice*" found in the formation – roughly 50% – the summer thaw would penetrate to a depth of one metre. The effect of this phenomenon would be the reduction of the height of Dinkum Sands by 1.6 feet during the summer. Not surprisingly, the Special Master stressed that "*late season data is necessary to an adequate picture of the behaviour of Dinkum Sands over the year*."[65] Anything less would have given a distorted picture and would have led to what may be described as the "*seasonal island*" problem.

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54 *Id*.: 253.
55 *Id*.
56 138, L.Ed. 2nd: 258 (emphasis added).
57 *Report*, 1996: 253.
58 *Id*.: 254.
59 *Id*.: 255.
60 *Id*.: 255, fn.25.
61 *Id*.: 280.
62 *Id*.: 254 and 269. See Figure 4.
63 *Id*.: 269.
64 *Id*.: 270.
65 *Id*.: 280.

On this whole question of the correct elevational height of Dinkum Sands, the Special Master found that even if Alaska's proposed amended adjustments to height were accepted, the elevations found to exist in June (allegedly *above* the critical datum) were "*based on questionable piles of gravel*."[66]

The Alaskan side attempted to bolster its argument, interrelated as it was with rising sea level trends as mentioned above, by contending that barrier islands (which in Alaska's opinion included Dinkum Sands)[67] "*adapt to long-term increases in sea level by gaining in elevation and migrating landward*." This too was rejected by the Special Master, particularly as if it did not occur at Dinkum, adjusting the sea level backwards in time could "*prolong its status fictitiously*."[68]

3. The Gist of the Legal Dispute

3.1 Was Dinkum Sands an "Island" in International Law?

As seen above, a large part of the *US v. Alaska* litigation centred on what might be described as Alaska's "*methodological objections*";[69] but international legal factors also figured prominently in the Dinkum Sands problem. The two parties were agreed that for Dinkum Sands to be part of the Alaskan "*coastline*" for the purposes of the US legislation, it had to be "*an island as defined in Article 10(1)*" of the TSC of 1958,[70] in other words, "*a naturally formed area of land, surrounded by water, which is above water at high tide*." In identification of the issues to be decided by the Special Master of the Supreme Court, a "*Joint Statement of Questions Presented*" was submitted in 1980 which listed as Question 5 the following:[71]

> *Is the formation known as Dinkum Sands an island constituting part of Alaska's coastline for the purposes of delimiting Alaska's offshore submerged lands?*

The basic federal government contention was that Dinkum Sands was nothing more than a low-tide elevation[72] at best, (or even merely part of the seabed[73]), whilst the Alaskan contention was that it was an 'island'. As the Special Master summed up the position:

> *If Dinkum Sands fails to qualify as an island, it may be only a submerged shoal, or it may be a low-tide elevation [under Art.11 of the TSC]*,[74]

in either of which event "*the legal consequences would be the same*", namely,

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66 *Id*.: 257.
67 *Id*.: 263-4.
68 *Id*.: 263.
69 This was the view taken by the Supreme Court on appeal (the filing of "*exceptions*"). See 138, L.Ed., 2nd, 258.
70 *Report*, 1996: 263-4.
71 See Appendix A of the *Report*, 1996.
72 Defined in Article11 of the TSC as a "*naturally-formed area of land which is surrounded by and above water at low tide but submerged at high tide*."
73 See Symmons, 1995: 10. In some disputes the States concerned have agreed to designate low-tide elevations as simply part of the seabed for reasons of convenience. See Burmester, 1982: 333.
74 *Report*, 1996: 229.

> *[b]ecause it lies more than three miles from the nearest point on the coastline [including the nearest islands], status as a low-tide elevation would be insufficient to create Submerged Lands Act rights in Alaska* (see Figure 1).[75]

The Special Master indicated throughout his *Report* that the answer to the Question 5 insular issue lay essentially in the realm of international law; and that the "*significance of the varying measurements of Dinkum Sands depends on interpretation of the standard for an island*" (in international law).[76]

3.2 Particular Problems over Dinkum Sands' Insular Status

3.2.1 Was it "above water at high tide"?

The main[77] problem relating to Dinkum Sands' insular status was whether it was "*above water at high tide*" for the purposes of the TSC in the light of the fact (as seen above) that the formation was likely to have been "*below mean high water continuously*" during the topographic survey mentioned above,[78] but possibly was above this mean level in July 1982 and from May to September 1983.[79] In other words, the above-surface manifestation of this formation did vary from time to time; and added to this uncertainty was the masking effect of the Arctic environment, namely that being covered over by pack ice for some nine months of the year, "*very little*" was known "*about the usual elevation of Dinkum Sands during the winter*."[80] However, despite the latter 'climatic factor' difficulty, the plenary Supreme Court still stated categorically that there was "*no basis*" for concluding that Dinkum Sands "*remains above mean high water during the winter months*."[81]

The Special Master indicated that on this vital question ('above high water') there was "*fundamental disagreement*" between the Parties.[82] Other legal issues also arose, though these might be seen as being only tangentially inter-related with this (and were, in fact, dealt with separately in this writer's *Report*). These other issues included whether the composition of Dinkum Sands was even "*land*" (discussed below in section 6). However, the Special Master took a different view, opining that "*the extent to which Dinkum Sands qualifies as 'land' and the extent to which its characteristics must be permanent*" could "*most readily be treated as questions about aspects of the meaning and application of 'above water at high tide*.'" Though there is undoubtedly some pragmatic value in this synthetic viewpoint, the present writer disagrees with it on the basis of over-simplification of the problem. Nonetheless, the Special Master's methodology on this will be followed in the following discussion.

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75 *Id*.: 230. See also fn.5 where the Special Master describes the fact that the formation was within a 12-mile distance of the nearest baselines "*immaterial*." This is because for the purposes of the Submerged Lands Act, the former territorial sea distance of 3nms is fossilised as a statutory distance.
76 *Id*.: 283.
77 *Id*.: 288, the "*critical*" evaluation.
78 *Id*.: 287.
79 *Id*.: 288.
80 *Id*.
81 138, L.Ed., 2nd: 258.
82 *Report*, 1996: 229.

3.2.2 The Notion of 'Permanence' in the Definition of an Island

Two problems relating to permanence were raised in the case, namely "*vertical*" permanence and "*horizontal*" permanence. Horizontal permanence was seen to apply (in its broadest sense) where a formation frequently changes position relative to above-surface manifestation. The other of the types of definitionally-relevant permanence, so-called vertical permanence, is particularly important. This latter, in the Master's view,[83] had two aspects to it in its "*several overlapping strands*", including (firstly) "*long-term existence*" as "*an identifiable feature*" and, (secondly) "*whether the feature must always be above the tidal datum*." He found the first point – long-term existence – to be satisfied. As he said:

> *Taking the name 'Dinkum Sands' to refer to the entire formation, most of which is always submerged , the US agrees that a permanent feature exists.*[84]

With respect, this is a rather unlegalistic interpretation of the evidence where there is no international dispute as to title as such. From an international legal view, an inquiry as to insular status should be concerned not so much with evidence of the existence of a geographical phenomenon – such as a mere shoal – in a particular locality, as with the continuing existence (in at least a relatively fixed position) of an insular (i.e., *above-water* phenomenon) formation as such. For example, in the Bay of Bengal, practical problems have arisen in the case of some low-lying "*chars*" as to whether after serious monsoon flooding, a new insular feature is in fact the former "*char*" or a completely reformed one.[85] This might have repercussions for ownership of a named phenomenon in appropriate cases, but it seems not to be directly relevant for assessing insular status under the law of the sea.

The Special Master did admit that *"[i]t is certainly possible for a* ***new island*** *to come into existence and be recognised as such under Article 10 [of the TSC]."*[86] There were several examples of such mentioned in the present writer's expert witness *Report* in the case, though, of course, many such formations may be transient and lack long-term existence above high water.[87] In some parts of the world the legal status of such suddenly formed 'islands' – e.g. from volcanic eruption – may cause disputes.[88]

Contrariwise, the Special Master stated that it was "*possible for an existing island to disappear, changing the waters around it from territorial sea to high seas*."[89] The problem of the "*disappearing*", or indeed, "*disappeared*" insular formation, is (again) not geographically uncommon; and may indeed ultimately involve a change of basepoints for maritime

83 *Id*.: 288.
84 *Id*.: 288.
85 See Symmons, 1995: 25-26.
86 *Report*, 1996: 305 (emphasis added).
87 See Symmons, US Exhibit 84A, 1984: 53-60. This 'transience' may relate particularly to 'ice islands'. For example, it was reported in March 1989, that a German Antarctic expedition failed to find two small "*islands*" supposedly discovered by an Australian team in 1961 (the so-called "*Terra Nova Islands*"), thought to be 17 miles off the Antarctic coast (*Daily Telegraph*, 9 March 1989).
88 For example, the Icelandic islet of Surtsey (see *Id*: 58-59; and, Symmons, 1995: 25-26, fn.12). A dramatic example reported in June 1979, happened in the Pacific Tonga island chain between the volcanoes of Kao and Late when the green outline of a (volcanic) mountain peak could be seen from the air just beneath the surface, only to rise dramatically above the surface a few days later as an 'island' some 10 miles in diameter (see *Daily Telegraph*, 27 June 1979).
89 *Report*, 1996: 305.

delimitation purposes,[90] unless, possibly, the interested States have provided by agreement for maintenance of such an unstable basepoint in perpetuity.[91]

The situation of the "*disappearing island*" is in fact a very real one throughout the world: that is to say a (generally) small formation which undoubtedly (even if only marginally) exists today,[92] but which may by dint of erosion or similar forces may disappear for ever tomorrow, is somewhat analogous to one which comes and goes in the same location with great regularity, but where there is no imminent danger of complete future disappearance. In either case – as the writer himself has stated in his expert witness *Report* and elsewhere[93] – there are definitional problems associated with "*permanence*." These difficulties have sometimes led States to employ artificial means to prevent such situations arising, either by effectively rebuilding a formation which is only marginal or disappearing (e.g. on some Pacific reefs[94]) or at least taking preventative measures to prevent erosion around the formation.[95] In the latter case the formation arguably retains its legal insular status. Apart from this, however, in the case of the slowly disappearing 'island' it may be difficult to argue – even on the basis (if it is the case) of its pre-existing longevity – that it retains insular status in perpetuity short of "*fossilised*" status in a treaty.[96]

The Special Master did make some brief reference to this problem when he said (implying that insularity may be lost as well as gained):

> *It **may be that Dinkum Sands did qualify as an island in 1949-50** [see above fn.27]. If so, it has changed its status since then. As noted in section 3(c) another sustained change could conceivably take place in the future.*[97]

The other 'impermanency' situation may be dubbed that of the "*occasional*" (or even "*seasonal*" 'island'. As will be seen,[98] "*relative permanency*" tests again seem important here in assessing legal insularity – i.e. whether the formation appears for sufficiently long periods and regularity above tidal datum.

3.2.3 'Horizontal' Permanence

One of the problems with Dinkum Sands was not only that it tends itself to go up and down, but also (and in conjunction with this), to move about. The US federal side argued that there had been *"dramatic movements of the exposed area of Dinkum Sands"*;[99] and indeed it appears that this 'shoal' area in the Beaufort Sea is constantly changing position, often by hundreds of

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90 See this author's expert witness *Report* in the case (Symmons, 1984 (*supra* fn.87): 54-55).

91 As, e.g., by treaty provision as in the Papua New Guinea-Australia delimitation treaty (ILM, 1979: 291) discussed by Burmester, 1982: 321 and 341. More generally it may happen by estoppel.

92 A good example would be where a few coral boulders have been thrown up on a low-lying reef (i.e., essentially a low-tide elevation) by storm surges, as, e.g., in some areas of the Pacific. See, e.g., Prescott, 1985: 190 who says in respect of such a phenomenon round the edge of Tokelau and Tele ki Tonga reefs that *"[t]hese features are probably impermanent"* – for example, a "*prominent boulder*" shown on Admiralty chart BA985(1979) had *"disappeared by June 1980."*

93 See Symmons, 1995: 25-26.

94 *Id*.: 2.

95 *Id*.: 3.

96 See fn.91, *supra*.

97 *Report*, 1996: 309 (emphasis added).

98 Infra Section 5.

99 *Report*, 1996: 289.

feet (and may even be subject to "*long-term drift*"[100]). Thus this writer argued, as referred to by the Special Master, that this phenomenon, might, (albeit in a subsidiary sense and only if the formation is of a "*fickle nature*" and "*moves in a haphazard or frequent fashion*") disqualify a formation from having insular status in international law.[101] This could be argued on the basis that there is no such thing as an "*ambulatory island*" in international law,[102] at least where the movement is sudden and dramatic.[103]

The "*policy rationale*" that might be put forward for this for this, as repeated by the Special Master,[104] is that "*mariners need to be sure of the position of the territorial sea, which is arguably impossible if mobile islands are taken into account*." Indeed, this navigational factor has found isolated mention by commentators such as Fulton[105] who talks of sandbanks (in the context of a 1882 North Sea Fishery Treaty) which "*may not be permanent, and usually vary in extent, configuration and position with lapse of time and even after a single tempest*" so causing the "*extent of appendant sea*" to "*vary likewise*." And in past US oil and gas leases, this "*ambulatory*" difficulty over baselines generally has been referred to[106] as raising "*extraordinary practical difficulties*" in this context for the lessee.

In the writer's view (as stated in the case), American precedents arguably exist to bolster a locational 'permanency' rule for true islands. In the much-cited *Anna* case involving capture of a ship within three miles of the American "*mudlumps*" in the Mississippi Delta, these formations were described by the captor's counsel as "*temporary deposits of logs and drift*."[107] In more recent times, however, these "*mudlumps*" were described in *US v. Louisiana*[108] as "*islands*" despite their "*highly changeable and perhaps mobile nature*." Although the US federal side argued in the *US v. Alaska* case that "*the appearances of Dinkum Sands*" were "*far more fleeting than those [Mississippi formations]*", the Special Master paid no special heed to this as he found such insular 'behavioural' evidence to be unclear.[109]

In fact on this question of horizontal permanence, the Special Master, seemingly influenced by the fact that "*[m]ore generally, it is clear from the [TSC] that mariners must live with an ambulatory coastline*",[110] decided that the Supreme Court "*has chosen to accept resource*

[100] The phenomenon of 'long-shore drift' was the subject of voluminous evidence from Alaska in the case.

[101] *Report*, 1996: 290.

[102] *Id*.

[103] If a formation's topographical movement is only *gradual* or virtually imperceptible, then the legal situation may be different. See, for instance, the Special Master's statement that: "*[i]t is not, suggested...that this movement [i.e. of neighbouring islands migration landward by about 11 metres a year as a result of 'long-shore drift'] changes the legal status of [those] islands*" (*Report*, 1996: 290-291, fn.46). One of the US expert witnesses, Erk Reimnitz, a glaciologist, stated in testimony that "*a typical island would not move about as erratically as I have observed Dinkum Sands to move*..." (see US *Post-Trial Memorandum*, 1985: 105). The US *Post Trial Memorandum* made the valid point (at p.100) that it was important to distinguish between "*the entire shoal*" and the "*small high points on that shoal*" which were known to "*move erratically*."

[104] *Id*., p.290.

[105] Fulton, 1911: 634-635 (cited by the Special Master in his *Report*, 1996: 290). See, more recently, Prescott (1981: 490), who points out that cays and rocks formed from the Great Barrier Reef off Australia "*by the accumulation of coral debris*" may be only "*temporary features*" and be destroyed by storms or strong waves; so that some features from which territorial waters might be claimed one year may disappear the next year.

[106] See *Report*, 1996: 291, fn.48.

[107] 165 English Reports 809, 811 (cited by the Special Master in his *Report*, 1996: 291).

[108] Case cited in *Report*, 1996: 292.

[109] See *Report* (1996: 292, fn.49), where he affirms that one, at least, of these 'mudlumps' lasted for at least 10 years.

[110] *Id*.: 293, citing two previous US cases (*US v. California* (1965) and *US v. Louisiana* (1969)).

Annex 711

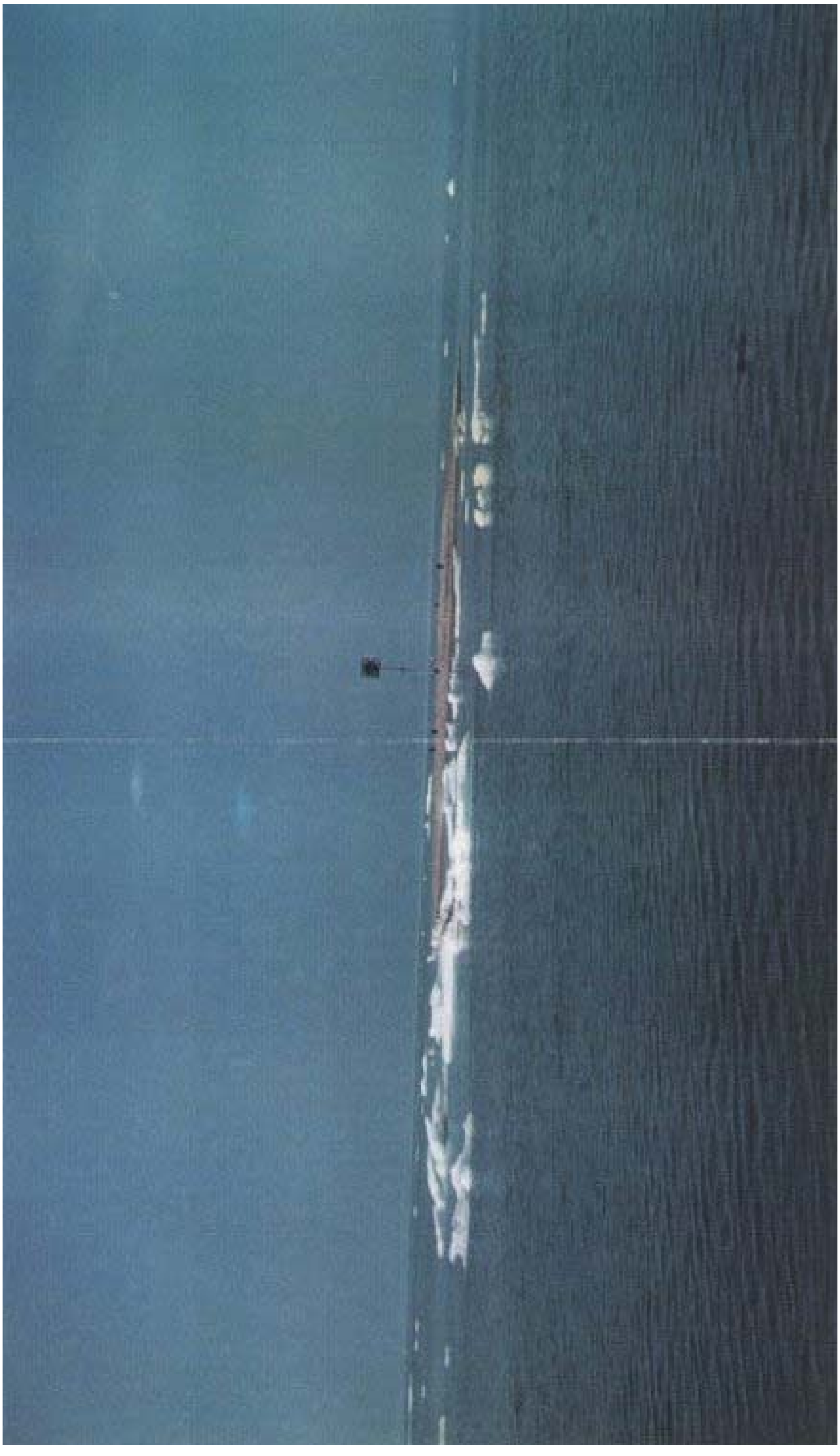

Figure 3: Admiral Nygren's 1949 Photograph of Dinkum Sands

Annex 711

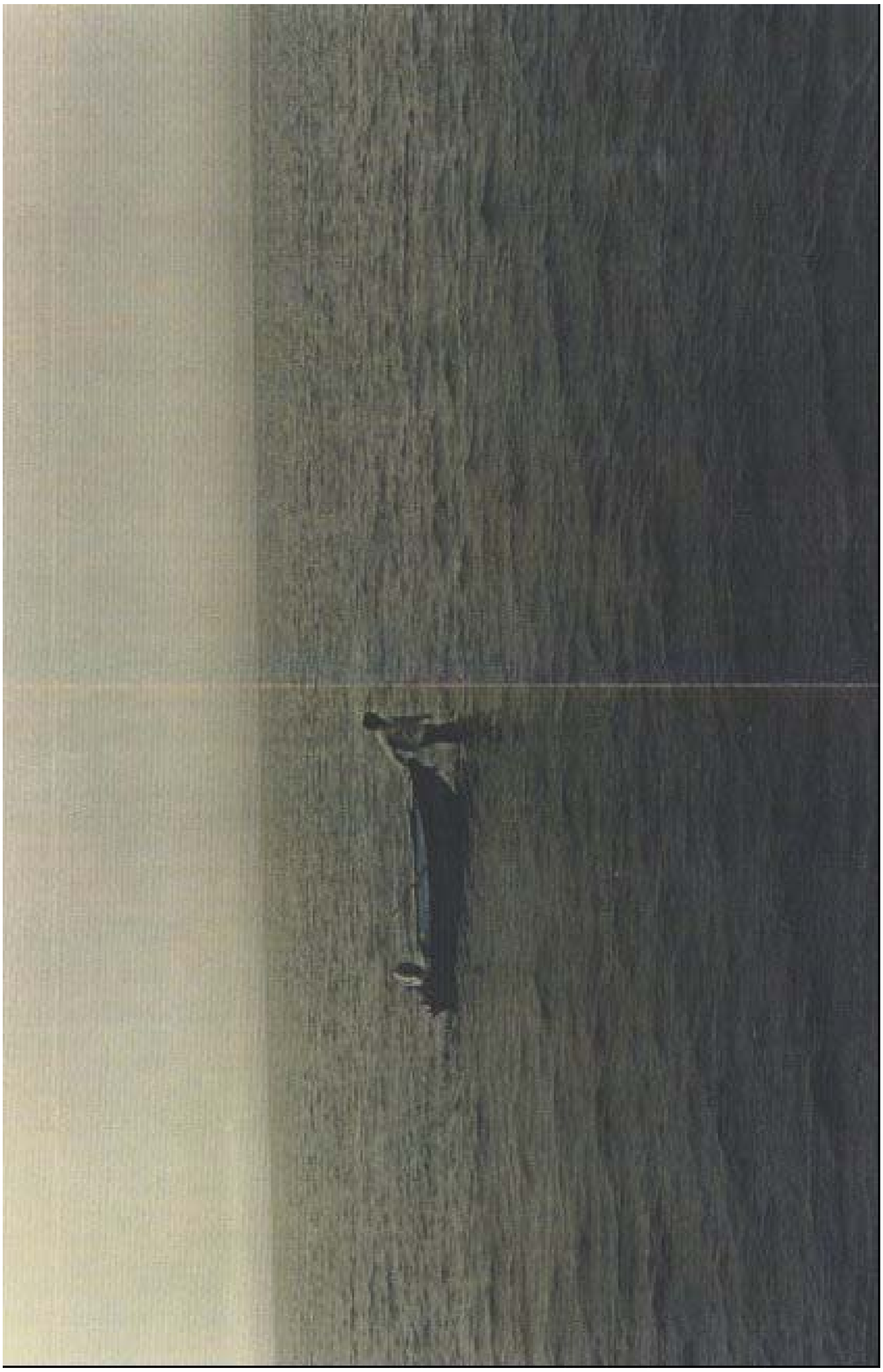

Figure 4: Photograph of Dinkum Sands, 25 July 1979

allocation problems of an ambulatory coastline as an implication of using [the TSC] to interpret the Submerged Lands Act."[111] Accordingly, he opined that "*a requirement of strict locational permanence should not be read into the Convention's definition of an island*."[112]

This seems to the writer to be an unnecessary over-generalisation. For although it is true the topographical 'permanency' aspect of possible insular definition is not spelt out in the Article 10 TSC definition of an "*island*", it may still be added by implication for the practical (charting and navigational) reasons given above. This is despite the fact that in more general terms a territorial sea baseline may be ambulatory in effect in the case of a continental territory (or a permanent island); and indeed, in the case of unstable coastlines or deltas in this context there is some explicit endorsement for such ultimate change of baseline in the LOSC, 1982.[113] At least one geographer has suggested that there may be a legal duty on a coastal State to survey offshore areas liable to rapid change at regular intervals,[114] and so, by implication, its baselines in consequence.

In this writer's view, and as argued by the US federal side, where the *centripetal feature* of the formation itself – rather than just its accompanying baseline – moves around in a dramatic fashion (and often such a transposition will in any event involve some temporary submergence in the process), this is a quite different legal situation from that relating to 'moving baselines' generally. Indeed, as in the instant case, the US federal side did argue that where there were "*intermittent exposure of high points*" (as in Dinkum Sands) in "*different places*", this amounted not to an "*ambulatory coastline*" but to an "***entirely new coastline***";[115] and, additionally, there may be an insular 'identity' problem here; that is, if "*a feature pop[s] up today in one location, disappears, and another feature pops up in another location, we do not have one island...but two*."[116]

In his conclusion, the Special Master seems to have seen some logic at least in the locational 'permanence' argument – but only in the context that "*the horizontal movement of Dinkum Sands* ***cannot be considered in isolation from its vertical movement***."[117] As he had already decided that "*vertical permanence*" sufficed to resolve the status of Dinkum Sands, he found that it was "*unnecessary to consider the effects of vertical and horizontal movement together*."[118] So as a matter of international law this definitional aspect, in effect, seems to

111 *Id*.:293.
112 *Id*.
113 See Article 7(2) thereof which, where a regression of the low-water line occurs, seems to require an eventual re-drawing of such a baseline. Arguably here the word *"coastline"* could include an unstable island or low tide elevation. See, e.g., Prescott, 1987: 288 and 306.
114 See Prescott, *supra* fn.105 at p.493 where he states that this may mean that "*new surveys will have to be conducted at intervals to take account of features which have been freshly created or recently destroyed*." For further discussion on this issue, see the present author's *Report* (*supra* fn.87): 54-65.
115 *Report*, 1996: 293 (emphasis added). See also, e.g., Beazley (1971: 149) who points out that *"[e]ven the low-water line of the mainland is liable to large changes...but in general its effect is unlikely to be so great as with a* ***low-tide elevation which actually ceases to exist***" (emphasis added). It can be argued analogously that this magnitude of change can be applied to an '*island*' in a peripatetic state of transition.
116 *Id*.: 293. Volcanic 'instant islets' off Iceland have caused this problem, most particularly the sudden appearance of Surtsey and similar satellite formations in offshore, some of which soon disappeared. See, e.g., Fredricksson, 1975: 26, 29 and 31.
117 *Id*. (emphasis added).
118 *Id*.: 294. There seems, in fact, to be some inconsistency in the Special Master's later finding a propos the related issues on *vertical* permanence, where he partly supported his finding on *navigational* grounds as such when he referred to *"**reliably visible** basepoints"* (emphasis added) (See fn.167 *infra* and accompanying text). Note also that he decided at the end of his *Report* that his rejection of Alaska's

remain as an open question. In this writer's opinion, though, where these two features of insular 'impermanence' are present *in combination*, as is often the case, this amounts to even more clear-cut evidence of lack of insular status in international law.

It may also be noted that the Special Master rejected Alaskan evidence on a more general matter inter-relating with that of horizontal and vertical permanence.[119] This was to the effect that because Dinkum Sands was allegedly in "*long-term equilibrium*" in the barrier island chain, and, because, in that part of the Beaufort Sea such formations above mean high tide maintained their features, therefore Dinkum Sands must itself be above this mean.[120]

3.2.4 Must the Feature always be above the Tidal Datum?

What tidal datum?

This directly involved interpretation of the meaning of the phrase "*above high tide*" in Article 10 of the TSC (1958) which, as seen, gives no tidal datum.[121] So that theoretically it might be possible for States to choose their own datum amongst the many possibilities,[122] which include at the most extreme end of the spectrum (among astronomy-related datums), the highest astronomical tide[123] or at the less extreme end the 'median high tide' test which, as seen, forms the basis of US domestic practice and which has, as stated above, been uncritically re-applied in US caselaw to international legal definitions.[124] As the Special Master pointed out, in essence this criterion is applicable, *"where the top of the formation is in itself stable and constant"*, as a sort of 'rule of thumb' by dint of a "*simple comparison between two constant numbers*" (viz., the height of the high tide mean and the height of the formation.[125] So that, *prima facie*, (apart, as seen, from surveying practicalities and error-banding disputes) no great legal problem resides here once the type of tidal datum is accepted.

In between the parameters of the two possible tidal test extremes mentioned above lie several intermediate possibilities such as, e.g., the mean high spring tide test which has traditionally been the basis of British and common law practice.[126] Interestingly the Special Master made little reference to this tidal choice aspect of the Article 10 definition, though he did mention one possible international precedent, the case of the *Anglo-French Arbitration on Delimitation of the Continental Shelf* (1977)[127] as an example of "*an arguably relevant international case*

'occasional island' idea (see below) did *not* contravene the authorities he had cited in section I(2), i.e., with regard to "*horizontal*' permanence" (*Id*.: 306).

119 *Id*.: 284.

120 *Id*.: 285 and also 287: "*persistence of Dinkum Sands near mean high water*" does not compel the inference that "*it must be above mean high water for most or all the time*."

121 Nor, by the same token, is any tidal datum given in connection with the definition of low-tide elevations. See Aurrocoechea and Pethick, 1986: 29 and 38 (no definition of the "*lower tidal limit*").

122 See Symmons, 1995: 12-24. As Alaska stated (*Reply Brief*, 1985: 8), there is "*no international agreement regarding the appropriate water level datum*."

123 Alaska argued that "*permanency relating to elevation*", never attained the status of customary international law in terms of sanctioning a "*higher high water mark*" test (See *Reply Brief*, 1985: 26). The word "*is*" in the phrase "***is** above water at high tide*" (emphasis added) in Article 10 of the TSC may be said to imply such a permanency requirement above water in a literal sense. See the US argument in its *Post-Trial Memorandum*, 1985: 17 and 27.

124 See *supra* fn.12 and accompanying text.

125 *Report*, 1996: 302.

126 See Symmons, 1995: 22.

127 18 *Review of International Arbitration Awards* 3, 65-74 (1977). For supporting comment on the French tidal position, see Fusillo, 1978: 51, fn.9.

that supports a rather demanding standard [of tidal level]."[128] In that case – arguably the only truly international case to date where this definitional aspect of an 'island' has been raised – the UK had argued that (in the case of the protrusion of the natural rock of the Eddystone) that although other interpretations of the expression "*high tide*" were possible, "***mean high-water spring*** *tides*" was the only "*precise one*" (emphasis added). On this tidal basis the Eddystone was well above high water – by about two feet. But against this the French side argued that the international rule (coinciding with French practice) was that of the "*highest astronomical tide*", on which basis the Eddystone was, at most, only marginally above high water (by 0.2 feet). In fact the Arbitral tribunal in that case did not have to make a decision as France had already accepted the low-water mark of the Eddystone as a baseline for fishery zone purposes. The Special Master appears to view this case as being, in effect, not just concerned with dispute over choice of tidal datums, but also (and perhaps more importantly) with wider aspects of the 'permanence above water' requirement, when he comments:

> *[t]he question was the choice of tidal datum (as to which the United States uses mean high water), not the treatment of a formation which rises and falls. Nevertheless, the parties did argue the case as if a formation, to be an island, must be almost never below water.*[129]

The plenary Supreme Court appears to have been equally accepting of this 'mean' domestic test for international legal purposes. As it was to say, "*the [TSC] separately categorises features that are below* ***mean high water, but above water at low tide***." [130] In other words, the plenary Supreme Court also makes the automatic assumption that the mean high tide test is the acceptable international rule. Even if there is no commonly accepted international rule, this US test seems particularly inapt; and very few States apart from the USA use this test in their domestic legislation for insular definition.[131] The only rationale the Court states for the acceptability of the US test is that the "*problem of abnormal or seasonal tidal activity*"[132] is fully solved by the United States' practice of construing "*high tide*" to mean "*mean high water*"; so that (supposedly) "*[a]veraging high waters over a 19-year period accounts for periodic variations attributable to astronomic forces; non-periodic, meteorological variations can be assumed to balance out over this length of time.*"[133] This justification seems doubtful, as it seems a far better argument to use a more stringent tidal test with the proviso of "*exceptional circumstances*"[134] to allow for wholly abnormal natural events – such conditions seemingly being the ones the Supreme Court is hinting at. Indeed, the Supreme Court somewhat inconsistently concludes discussion on this point by saying: "*In sum, the Convention's drafting history suggests that, to qualify as an island, a feature must be above high water* ***except in abnormal circumstances***."[135]

As seen above, although the Special Master accepted the US domestic rule of the "*mean*" high tide test, he did seem to indirectly undermine the validity of such a test by pointing out how it might lead to formations still being islands thereunder even when effectively submerged at high tide for continuous periods during certain seasons, and worse still, **sometimes not even**

128 *Report*, 1996: 301.
129 *Id.*: 302.
130 See 138, L.Ed. 2nd: 259 (emphasis added).
131 One of the very few is Kuwait. See Symmons, 1995: 23, fn.23.
132 Which a US amendment to the ILC draft in 1954 addressed.
133 See 138, L.Ed. 2nd: 256.
134 Fn.123 And accompanying text.
135 See 138, L.Ed. 2nd: 256 (emphasis added).

appearing at low tide.[136] It may be commented that this factor in itself shows the absurdity of having too lax a high tidal test for the purposes of gauging insularity in international law. It was partly because of this factor that he formulated what may be dubbed the 'normally-appearing-at-high-tide' rule in the case of formations which themselves go up and down (the 'variable height' problem).[137]

At least in *US v. Alaska*, the parties were agreed on the basic tidal datum test. Where, in an inter-State dispute, they are not, the problem of insular definition is obviously further exacerbated.[138]

3.2.5 How Often may the Formation Fall Below Tidal Datum?

The general rule

In effect this was a central – and perhaps the most critical issue – in the dispute over the legal status of Dinkum Sands, bearing in mind that seasonal changes in the water level and seasonal changes in elevation of the formation both appeared to be "*normal processes at Dinkum Sands*."[139] In other words, as seen above, the evidence was that Dinkum Sands was subject to frequent erosion and seasonal 'collapse', particularly at the end of the open water season. In large part this collapse may have been due to the melting of the *interstitial* ice in the upper formations thereof. Added to this, of course, is that fact that US use of a mean high tide (based on a period of 19 years) in itself is open to criticism in that such a lax test may allow a formation to periodically not show above high water at high tide (or *in extremis*, as seen, not even above low tide). Indeed even the Special Master pointed out the "*seasonal*" implications of such a test:

> *In typical circumstances, a feature of fixed height, if just high enough to qualify as an island under United States practice, can be expected to be above water always except at high tides that are higher than the mean. In an atypical situation like that of the Beaufort Sea, where the seasonal changes in the water level are much greater than the twice-daily changes between high tide and low tide, all the high tides of one season may be higher than any of the high tides of another.* ***Here, too, however, a formation of fixed height that is above mean high water can be expected to remain exposed at high tide for considerable periods of the year***.[140]

In other words, the emphasised part of the above *dictum* indicates that even on the 'median' high tide test, normally a formation constituting a juridical island will have its head above water for a large part (or most) of the year, even if at some seasonal times, it is (by the very nature of this 'mean' test) covered at high tide. Indeed, as this writer emphasised in his *Report*, there is no such phenomenon as a "*seasonal island*" in international law.[141] However (as seen above) the Special Master went on to add further words to the above dictum; namely "*[t]hat this is true* ***despite the fact that, when water levels are at their highest, the feature may not be seen even at low tide***."[142] If indeed this is statistically possible on such a 'mean' test, it

136 *Report*, 1996: 303.
137 See *infra* fn.180 and accompanying text.
138 See Symmons, 1995: 18-19; and (in respect of low-tide elevations) see Beazley, 1994: 6.
139 *Report*, 1996: 300, fn.59.
140 *Id*.: 302-303 (emphasis added).
141 Symmons, 1984: 67 (see fn.87).
142 *Report*, 1996: 303 (emphasis added).

points up the demerits of such a lax test for the purposes of international law; for it may entail that a formation which periodically does not even constitute, at such times, a low tide elevation – the minimalist type of insular-like formation[143] and at most a 'quasi-island' – is still apparently to be considered to be a true island. Indeed at one stage in his *Report* the Special Master even comes close to implying that a feature may (in theory) technically be a "*seasonal island*" only under such a 'mean' test. As he states:

> *Such a feature, constantly above mean high tide, but also constantly submerged at some seasons of the year, already strains the definition of an island. Alaska emphasises that although Dinkum Sands may be invisible in summer, when water levels are high, summer submersion is not inconsistent with it being above mean high water...The United States emphasises that Dinkum Sands is invisible in winter, being entirely covered for nine months of the year by the ice pack…These characteristics in a (hypothetical) feature of fixed height, differing from those of a prototypical island that is almost always exposed, do not invite one to relax the definition further by permitting the feature frequently to slump below mean high water.*[144]

In effect, this appears to be an indirect indictment (even if unintended) on the US mean high tide test which, as seen, the Special Master seems readily to regard as acceptable as an international standard. But if such a test can mean that a feature (effectively) seasonally disappearing can still retain insular status, such a datum seems fatally flawed as an appropriate standard from the start. Furthermore, it seems to the writer that the reference to the coverage of Dinkum by pack ice for most of the year also merits more analysis than a one-line mention here[145] inasmuch as pack ice is in effect frozen sea water; and so might be taken as part and parcel of the 'high-tide' phenomenon. The Special Master seems at times to take in this latter point. For example, as he footnotes: "*[t]he location of Dinkum Sands may be distinguishable in winter by ice rubble*", whereas "*[a]dmitted islands...were described as having gravel extending above the ice even in winter*".[146]

The 'mean high tide' test also ill fits in with the basic criterion of visibility to the mariner,[147] as well as the idea of 'permanence' which has been discussed above. Indeed later in his *Report*[148] the Special Master effectively returns to this point when he refers to "*[a]nother difficulty*", namely that for either an island or a low-tide elevation, their respective territorial seas are measured from the "*low-water line*" under the TSC; so that if a "*feature* '*slumps not only*

143 See Symmons, 1995: 6 and 7. Wemelsfelder (1971: 115 and 122) lists how many regional and local influences there may be on mean tidal level, including wind, barometric pressure, storm surges, tectonic movements, sea-bed slopes etc.

144 See *Report*, 1996: 303.

145 In fact this writer's *Report* was much taken up with this issue (see Symmons, 1984: 67-73). Much argument on this aspect also took place in the written briefs. See, e.g., US *Post-Trial Memorandum* (1985: 12 and 13), indicating that sediment deposited on 'shorefast ice' should not be considered insular, spending 9 months of the year under the "*pack ice*" which is "*a **layer of frozen sea water***" (*Id*.: 104, emphasis added); and its *Reply Memorandum* (1985: 14), that "*ice is to be treated as water*." Alaska tended to avoid arguing the possible legal difference between frozen *fresh* water (e.g., glacial ice) and *salt* water; as e.g., in its *Post Trial Brief* (1985: 45-46). In its *Reply Brief* of 6 May 1985, Alaska did, however, admit (at p.5) that "*taken in their proper context, the authorities strongly suggest that features containing subsurface ice do qualify as land [under the TSC], while surface ice may not*." Pack ice has been legally described elsewhere as being "***generally categorised as sea ice***", and as being formed by the "*freezing of the sea water*" (Bernhardt, 1995: 330, emphasis added).

146 *Report*, 1996: 303, fn.61.

147 Infra fn.165 and accompanying text.

148 *Report*, 1996: 304 (emphasis added).

below the high-water datum but **also below the low-water datum***…there is during the slump no low-water line from which the territorial sea can be measured*."

The plenary Supreme Court[149] made a similar comment to the effect that if a feature slumped below even the low tide datum on occasions, "*the baseline for measuring the surrounding maritime zone would shift and then disappear*." The practical repercussion of a periodically disappearing baseline for maritime delimitation is only too obvious.

The History Behind the "above high tide" Test

The Special Master considered the background to Article 10 of the TSC,[150] pointing out that the drafting history "*goes back at least to the League of Nations Conference for the Codification of International Law*" in 1930.[151] It was at this Conference that the word "*permanently*" is to be found – in *Basis of Discussion No.14:* "*In order that an island may have its own territorial waters, it is necessary that it should be permanently above the level of high tide*." It was also at this Conference that the other type of insular formation was differentiated, namely the low-tide elevation, for which it was "*sufficient for it to be above water at low tide*",[152] it being defined as an "*elevation of the seabed, which is only exposed at low tide*"; this was deemed "*not to be an island*." However, at this early stage in the law of the sea some confusion still reigned over whether the term 'island' could be given to the latter phenomenon, even in US thinking.[153]

When the International Law Commission (ILC) looked into the definition of 'islands' from 1951 onwards, Special Rapporteur François initially proposed a legal definition "*in the same language as the 1930 proposal*,"[154] i.e., "*an area of land surrounded by water, which is permanently above high-water mark*"; the only agreed amendment to which was that of Lauterpacht who had inserted "*in normal circumstances*" before the adverb "*permanently*" so as to allow for "*exceptional circumstances*." This phrase – "*which in normal circumstances is permanently above high-water mark*" – appeared in the final ILC Report of 1956; and the accompanying commentary reiterated that "*except in abnormal circumstances*", an "*island*" should be "*permanently above high-water mark.*"[155]

Then came an ironic twist in 1958 when the United States, no less, tabled two amendments which were to provoke voluminous discussion and argument in the Dinkum Sands litigation; and in historical retrospect, this potentially redounded against its federal-based interest in *US v. Alaska*. For as the US proposal then laconically stated:

> *The requirements in the [ILC's] definition of an island that it should be above the high water mark 'in normal circumstances' and 'permanently' are conflicting, and since there is no established state practice regarding the effect of subnormal or abnormal seasonal tidal action, these terms should be omitted*.[156]

149 138, L.Ed., 2nd, 259 – see further below, Section 5.
150 *Report*, 1996: 294-300.
151 *Id*.: 294.
152 See the present writer's *Report* (Symmons, 1984: 13-15).
153 See US reply (*Report*, 1996: 294, fn.52).
154 *Id*.: 297.
155 See ILC, 1954: 92 (emphasis added).
156 Official Records, 1958: 242.

In fact both these US amendments were accepted by the ILC. US internal memoranda of 1957 indicate[157] clearly to this writer's mind, and as he put in his expert opinion in the case, that the omission of the word "*permanently*" was merely a tidying-up process of drafting; because the addition of the words "*in normal circumstances*" seemed incompatible with the succeeding word "*permanently*" in the definition. Further, as a US Memorandum went on to say:

> *Both terms might well be omitted, since current international law does not purport to solve such minor problems [sic]...as how to treat land which is above sea level at neap high tide but not spring high tide or only at high tides during certain seasons of the year.*[158]

In other words what the US amendment of the time seemed to be additionally suggesting was that as there was no accepted State practice on the requisite tidal datum, some types of tidal criteria might allow for periodic submergence of a formation at high tide. This interpretation is further brought out in this US Memorandum which prophetically makes specific mention of Arctic conditions[159] when it asks:

> *How should elevations in the Arctic regions be treated which appear above sea level at low tide only during the months of the year when the sun appears above the horizon to add to the moon's gravitational pull? The ILC has wisely refused to resolve these questions for which there is little or no legal authority.*

On this important issue – concerned with the TSC's *travaux préparatoires* (i.e., "*preparatory materials*") – the US Government argued strongly in the present case (as had the present writer) that "*permanently*" is still implicit in Article 10 [of the TSC], along with an implicit exception for "*abnormal circumstances*."[160] On this federal-side argument the words of rejection by the Special Master are worthy of full citation:

> *If that is correct, then Dinkum Sands would appear to be disqualified from island status by the August 1981 survey alone. I am not persuaded, however, that the pre-Convention materials lead to such a clear-cut result. Neither do I agree with the United States that the Convention left any previous customary law of islands entirely intact, for the Convention did adopt a distinction between islands and low-tide elevations that had earlier represented only a compromise between inconsistent positions.*

With all respect, this is a rather weak analysis of the background to the amendments; and the reference to pre-existing customary law is dubious as one could say that in 1930 at least (i.e. at the time of the Hague Conference), there was, for example, a clear differentiation already developed (or at least developing) between islands on the one hand and low-tide elevations on the other.[161]

The Special Master did in the end, however, seem to accept in substance the drift of the US federal side argument on the vital point in question, namely the continuing legal importance of some permanent supersurface manifestation. For as he concluded:

157 See *Report* (1996: 298 and 299) where the Special Master tends to follow the present writer's line of argument in his own *Report* (Symmons, 1984).
158 *Memorandum on Islands, Drying Rocks and Drying Shoals*, September 1957.
159 See *Report*, 1996: 299.
160 *Id*.: 300.
161 See the present author's *Report*, (Symmons, 1984: 10-13).

> *The 1958 deletion of 'permanently' must be read together with the deletion of 'in normal circumstances'. The two phrases were viewed as conflicting, but in fact any conflict seems to be limited to the case where abnormal circumstances lead to the temporary inundation of a feature that would otherwise qualify as an island.* ***I do not believe the drafters intended, in eliminating supposedly conflicting standards, to adopt yet another standard less demanding than either of the first two****. That the drafters declined to say an island must be "permanently above water at high tide" or "normally above water at high tide"* ***does not mean that they intended to insert some weaker qualifier such as "sometimes" or "occasionally"****. Even Alaska contends only that Article 10 permits a feature "to slump on occasion" below the tidal datum and still to qualify as an island.*[162]

In coming to this conclusion, the Special Master used several 'make-weight' subsidiary arguments, including the (apparent) laxity of the US-favoured median high tide rule (see below), and the fact that a "*relaxation*" of the above-surface aspect of insular definition would not be "*consistent with the policies of the [TSC] as a whole*."[163] These latter policies included the fact that the TSC recognised "*a separate character for features which are below the high-water datum, namely low-tide elevations*." He concluded on these latter that, in effect, Article 11 (of the TSC) avoids extending the territorial sea in "*close cases*", leaving a larger expanse open to the "*freedom of the seas*."[164] Secondly, he mentioned that *"[n]avigational interests also favor using reliably visible basepoints*"[165] – a point also raised by the writer in his expert witness' *Report,*[166] citing in support of this Article 4(3) of the TSC which stipulates that straight baselines shall not be drawn to and from low-tide elevations "*unless lighthouses or similar installations which are permanently above sea level have been built on them*." Curiously, this latter point does not rest well (as seen above) with his earlier seeming dismissal of the importance of the broader "*navigational*" factor concerning 'horizontal' permanence in insular definition.[167]

The above-cited passage, then, forms the heart of the Special Master's conclusion as to the historical outcome of the international legal rule on so-called 'vertical' permanence in the case of true islands. This is to be welcomed as the first exhaustive judicial analysis of this vital aspect of the definition of an 'island' in the Law of the Sea; and in the end he seems largely to have accepted, albeit by a circuitous route, a species of 'permanency' requirement which is arguably latent in the pre-1958 Convention deliberations.

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162 *Report*, 1996: 301 (emphasis added).

163 *Id*., 1996: 303.

164 *Id*., 1996: 304. See also Symmons, 1995: 6-8.

165 *Id*. Academic opinion seems to support this consideration. See, e.g., Jayawardene, (1990: 71) who notes, "*it was regarded as obvious that [basepoints] should be visible at all states of the tide*."

166 See *supra* fn.87: 59-61; and, e.g., Boggs (1951: 240 and 252): "*the practice believed best adapted to the requirements of the navigator…is to represent as the land area that which always appears as land above high tide",* a particular difficulty being if the basepoints of straight baselines lie in positions where nothing is visible at many states of the tide.

167 See above, fn.118.

The Exception in International Law to Above-High-Tide-Appearance: "exceptional circumstances"

As this writer emphasised in his *Report*,[168] the *travaux preparatoires* of the First Law of the Sea Conference seem, as has been discussed in the previous section, to opt for a basic permanence as to supersurface manifestation of a true island above high tidal datum (albeit no tidal datum is specified). But this was with one (initially expressed) exception; and that was to cater for exceptional natural conditions. It was for this purpose that the phrase "*in normal circumstances*" appeared in the earlier ILC drafts in conjunction with the mention of 'permanent' appearance above high tide (until the US-inspired exclusion of both).[169] The US federal side's argument in the present case was that not only was the idea of permanency "*still*" to be implied in the Article10 (TSC) definition, but so also was the idea of a qualification to this 'permanency' above high water in the case of "*abnormal*" or "*exceptional*" circumstances.[170]

The "*exceptional circumstances*" phrase was specifically added to the original ILC definition at the suggestion of the UK delegate, Lauterpacht, to cater for "*exceptional cases*";[171] and the commentary to the ILC (International Law Commission) Report in 1956 states that this requirement of permanence above high water applies "*except in abnormal circumstances*."[172] Indeed, the Special Master makes brief mention of this pre-conference history.[173] There is no further elaboration in the ILC materials of what such "*exceptional*" or "*abnormal*" circumstances are; but clearly, as this writer stated in his *Report* in the case,[174] the phrase (presupposing it is still a definitional requirement) does not include extremes which are regular or seasonally foreseeable in the way of high tides and weather conditions. For what was envisaged in the *travaux préparatoires* seems to be confined to the category of freakish natural events – such as hurricane surges, or tidal waves following volcanic activity – i.e. an event of 'Krakatoan' proportions.

In *US v. Alaska* the Special Master ruled out any such abnormal conditions as applying in the context of Dinkum Sands (although application of this was argued by Alaska[175]), as he found seasonal changes in both water level and elevation concerning Dinkum Sands to be "*normal processes*."[176] And he specifically found, as already seen above,[177] that when, in the end, both amending phrases were deleted, the drafters did not intend "*yet another standard less demanding than either of the first two*"; and that, more specifically, "*in fact any conflict seems to be limited to the case where* ***abnormal circumstances lead to the temporary inundation of a feature that would otherwise qualify as an island***."[178]

168 See Symmons, 1984: 40-44.
169 See above fn.156 and accompanying text.
170 See *Report*, 1996: 300.
171 See ILC, 1954: 92.
172 See ILC, 1956: 270.
173 *Report*, 1996: 297, esp. fn.56 where he cites examples which the present writer gave in his own *Report*.
174 Symmons, 1984: 41-44.
175 *Report*, 1996: 300, fn.59.
176 *Id*.
177 Supra fn.162 and accompanying text.
178 *Report*, 1996: 301(emphasis added).

4. The Application of the Law to Dinkum Sands

In the relevant section of his *Report*,[179] the Special Master does not initially say what particular single qualifying phrase or adverb he was applying in place of the word "*permanently*."[180] As one reads in his *Report*, he at one stage uses the adverb "*generally*" to qualify "*above high tide*",[181] but finally returns to the 'trilogy' of "*generally, normally or usually*." As he says:

> *..Article 10(1) [of the TSC] requires an island to be "above water at high tide" at least "generally", "normally" or "usually."*[182]

The mention of "*generally*" (or either of the other two epithets for that matter) obviously leaves straws in the wind as it has a built-in ambiguity and subjectivity contained in it. For what statistical frequency of appearance above high tide does it imply? It seems that in its final argument the US federal side did mention some statistical figures, namely above-surface appearance "*seventy-five or eighty percent of the time as a range for argument*."[183] However the Special Master is careful not to endorse any detailed percentage figures on this as he merely refers to some rather vague "*further comparisons*" which might "*help to determine the meaning of the requirement*."[184]

The Special Master does, however, also conversely indicate, albeit in equally broad terms, that if a "*feature **frequently** slumps below the high-water [tidal] datum, it should not be treated as an island*"; or – as both parties agreed – it should be "*almost never below water*."[185] Thus he concludes on the evidence before him that "*Dinkum Sands is **frequently** below mean high water and therefore does not meet the standard for an island*."[186] In the Supreme Court, the Alaskan challenge to the Special Master's finding on this issue was firmly rejected in terms that the Court "*found no error*" in his conclusion.[187]

The Special Master concluded that:

> *The evidence shows that Dinkum Sands is sometimes above mean high water and sometimes below; but not every such change in elevation is automatically to change its status as an island or not. The question remains how the evidence of its varying elevation is to be combined to yield a conclusion.*[188]

In other words, he appeared to accept that any kind of "*snap-shot*" consideration of Dinkum Sands' status problem would not yield the right legal result; and that in effect a longer time-frame of analysis was necessary – a point already discussed above in terms of the "*relative permanence*" problem[189] – despite the fact that Alaska had stressed a selective viewpoint on the evidence and had stated that the few occasions when the disputed formation was above

179 Section 3.2.5.
180 *Report*, 1996: Section 3(b).
181 *Id.*: 302. *"For a feature of varying height like Dinkum Sands, I have just found that the question is whether the feature is **generally** above mean high water"* (emphasis added).
182 *Id.*: 309.
183 *Id.*: 302.
184 *Id.*
185 *Id.*: 304 and 302 respectively (emphasis added).
186 *Id.*: 309.
187 138, L.Ed., 2nd: 258.
188 *Report*, 1996: 307.
189 See above, Section 3.2.2.

mean high water represented "*the true **long-term** status of Dinkum Sands*" and that its "*behaviour in 1981 during the joint monitoring project, was anomalous*."[190]

In choosing his timeframe, the Special Master decided that his recommendation "*should rest primarily on the most recent period, 1981 through 1983*,"[191] during which time, of course, the most extensive surveys in the area had been made. He viewed the 1982 and 1983 measurements to have been just as carefully made as those during the joint project in 1981; and he stated that it was "*important to consider all of the 1982 and 1983 measurements, not just those made early in the season*", so indicating that mere seasonal evidence is not sufficient to give the full picture. In terms of practicalities, this seems a sensible route to take, particularly as future long-term stability appears to lie at the heart of international legal insular definition.[192]

He found the evidence on this not to be "*conflicting*",[193] saying:

> *It simply shows that the formation does not behave exactly the same way every year. This is not surprising, since it is a creature of natural processes*[194] *that are themselves not wholly uniform from year to year.*

In conclusion, then, the Special Master found the "*loss of elevation during the summer*" to be "*part of a regular pattern*",[195] though he admitted that not every change of status below mean high water would automatically "*change its status as an island or not*."[196] But, as seen, his conclusion that Dinkum Sands "*frequently*" slumped below the relevant tidal test meant that he finally found that it did not constitute an "*island*"[197] and accordingly it did not "*constitute part of Alaska's coastline for the purposes of delimiting Alaska's offshore submerged lands*."[198]

5. Is There Such a Thing as an "*Occasional*" or "*Quasi-island*" in International Law?

In their initial pleadings[199] both parties had used the alternative 'fall-back' argument that the Dinkum Sands could in effect be considered to be a 'periodic' island formation. As the US federal side pleadings stated, the formation should at least have "*no effect on the extent of Alaska's submerged lands for such periods as it is submerged at mean high tide*." And Alaska (in turn) argued in the alternative that it was entitled to the resources around the formation "*within a three-mile radius for such periods as the formation is determined to be above the level of mean high water*." In fact this mutual claim was "*not briefed*" (i.e. argued at the hearings), though even the US federal side "*returned to it on final argument as a fall-back*

190 *Report*, 1996: 307-8 (emphasis added).
191 *Id.*: 308.
192 See, e.g., Symmons, 1979: 23 and 24.
193 *Report*, 1996: 308.
194 Such 'building up' processes could include (in Arctic areas) such matters as "*ice push*", transferred sediment washed across fast ice etc. (see Alaskan *Post-Trial Brief*, 1985: 22).
195 *Id.*: 309, fn.66.
196 *Id.*: 307.
197 See fn.186, *supra*, and accompanying text.
198 *Report*, 1996: 310.
199 See *Joint Statement of Questions Presented and Contentions of the Parties*, 1979: 13-14.

position."[200] The Special Master entitled this argument as the "*possibility of divided ownership*." As he said:

> *Both parties have suggested an alternative to looking at whether Dinkum Sands is often enough above mean high water over the long term. This is to read the Convention [i.e. the TSC] as* ***making Dinkum Sands an island during such periods as it is above mean high water and as not an island the rest of the time****...Any revenues from resource exploitation around such a quasi-island would be divided based either on actual continuing measurements of its elevation...or possibly on some formula using past measurements of Dinkum Sands as above or below mean high water.*[201]

The Special Master rejected such a contention, although he accepted the analogy (in the TSC) of a low-tide baseline change (because of shoreline changes) altering in ambulatory fashion such a normal baseline, citing the *Louisiana Boundary Case*.[202] As was stated by the Special Master involved in the previous case of *US v. Louisiana*:[203]

> *…it has been recognised by the Supreme Court and throughout these proceedings that any coastline which might be established at any time is necessarily ambulatory, as due to the natural processes of erosion and avulsion the coastal area of Louisiana is in a constant state of flux.*

However, in the case of *US v. California* the Supreme Court had first adopted the 1958 TSC "*definitions*" because they purportedly served to fulfil "*the requirements of* ***definiteness and stability*** *which should attend any congressional grant of property rights belonging to the United States*."[204] In effect the Special Master in the present case accepted the present writer's contention there that "*there is no such thing as an occasional...island*" in international law.[205] He accepted,[206] as already seen, that it was possible "*for a* ***new*** *island to come into existence*" and likewise for "*an existing island to disappear*." In the latter event he accepted that the waters around such a disappeared 'island' would revert from territorial waters to "*high seas*"[207] and that the "*theory would be that these [changes of status] possibilities have been realised repeatedly at Dinkum Sands*";[208] but he stressed that "*Article 10 [of the TSC] does* ***not*** *demand an interpretation under which islands may* ***frequently come and go,***" partly because of the obvious "*practical problems*" which would attach to such a possibility.[209] As he said:

> *It would invite continued difficult and expensive monitoring, and, as the present dispute demonstrates, possible further litigation over interpretation of the results of that monitoring.*[210]

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200 *Report*, 1996: 305.
201 *Id*.: 304-305 (emphasis added).
202 394 US 11, 32-35 (1969).
203 No. 9 Original (in the Supreme Court of the United States) (1974): 33-34.
204 381 US 139, 167 (1965) (emphasis added).
205 *Report,* 1996: 305.
206 *Id*. (emphasis added).
207 See (for further discussion) Symmons, 1995: 2-3, 25-26 and 1979: 23.
208 *Report*, 1996: 305.
209 *Id*. (emphasis added). See the US federal side's *Brief in Opposition to the Exceptions of the State of Alaska* (1996: 5): "*Treatment of Dinkum Sands as a temporary island, which would result in unpredictable extensions and contractions of the territorial sea on a weekly or monthly basis, would pose numerous practical problems*."
210 *Id*.

Thus the Special Master concluded that *"there appears to be no authority under the Convention for treating a formation as frequently changing between island and non-island status."*[211] He did, however, proceed to suggest in a footnote to his *Report*[212] that dividing the ownership of Dinkum Sands would not necessarily be "*undesirable*" as the result of a negotiated settlement between the two parties, but that it was not the Special Master's function, as an *ad hoc* judge, to "*recommend a compromise solution*" that was "*independent of legal principles*."

The plenary Supreme Court in turn agreed with the Special Master's decision here on what it called a "*compromise resolution*", agreeing with the impracticability of it,[213] as well as the *legal* objections to such a position. As it said:

> *What Alaska seeks here…is not an entitlement to submerged lands seaward of a gradually accreting or eroding shore. Rather, Alaska's ownership of submerged lands around Dinkum Sands would appear and disappear periodically, depending on whether the feature was above or below mean high water. Not only does Article 10(1) of the Convention not support such a reading, but Alaska's position makes a sensible application of other provisions of the Convention impossible. The Convention separately categorises features that are below mean high water but above water at low tide. See Article11. In addition, under Articles 10(2) and 3, an island's belt of territorial sea is measured from the line of low water. As Dinkum Sands elevation slumps toward the mean high-water datum, below the mean high-water datum and possibly below the low-water datum, the* ***baseline for measuring the surrounding maritime zone would shift and then disappear****.*

6. The Meaning of *"Land"* in Article 10(1) of the TSC

Article 10(1) of the TSC – and Article 121 of the LOSC – require an island to be a "*naturally-formed area of* ***land***" (emphasis added). Just what the meaning of "*land*" is in this context has never been subject to much legal examination, except in connection of its qualifying phrase of having to be "*naturally-formed*";[214] and in most disputes over islands, the seeming requirement that a formation is of a truly terrestrial character (as the word *"land"* seems to require) is probably not a critical factor. However in exceptional cases it may cause problems insofar as this matter can inter-relate with the type of basic problem in the case of Dinkum Sands; that is, whether the relevantly terrestrial parts of the formation are above the tidal datum; for example, where vegetative matter growing on an 'island' (the lone 'palm tree' problem!) is the sole part of an insular formation which is always above high water level.

This problem did, however, arise in *US v. Alaska* and was subject to an analysis in the present writer's *Report* in the case[215] as well as to much argument in the pleadings and oral hearings. It arose in this way. The pre-trial geological reports on the composition of Dinkum Sands indicated that the higher part of the formation at least was composed of alternating layers of frozen sea ice and sand or gravel, so that tests showed that melted core samples from the

211 *Id*.: 306.
212 *Id*.: 307, fn 65.
213 138, L.Ed, 2nd: 258-259 (emphasis added).
214 See Symmons, 1995: 3-4.
215 Symmons, 1984**:** 73 *et seq*.

formation were composed of 50% or more free water (perhaps in its "*cap*" as much as 80% in total).[216] This so-called "*excess ice*" was of a salt-water origin compared with fresh water onshore. This was in contrast to the so-called true 'barrier islands' in the vicinity where such "*free water*" was absent; and a marine geologist testified at the trial that he would have excluded such ice from the term "*mineral*", because, for example, ice is temperature sensitive and ephemeral.[217] Thus one might argue that the term "*land*" in Article 10 of the TSC should "*partake of terra firma and have an equal degree of permanence*", neither of which qualities does frozen sea-ice (as opposed possibly to glacial ice) possess.[218] As the US federal side argument put it:

> *The [TSC's] requirement that an island be composed of land prevents such results [of impermanence]. Unlike Dinkum Sands,* ***a true island does not lose its elevation through temperature rises*** *and maritime zones do not come and go with changes in the season.*[219]

To the contrary, Alaska argued in the present case that "*under current international law, the composition of a naturally-formed feature is irrelevant to its status as an island*"[220] and that the only legally-relevant consideration was whether such "*land*" was "*naturally-formed*";[221] and that in particular "*sub-surface ice*" did qualify as "*land*" for insular definition.[222] To opposite effect, the US federal side argued that ice in this context was to be "*treated as water*";[223] and furthermore (as seen above[224]), as Dinkum Sands spent nine months of the year not only surrounded by, but also submerged under, frozen sea-ice (in comparison with other barrier islands), this was a further consideration militating against its insularity.

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216 See *Report*, 1996: 270.

217 The geologist, Erk Reimnitz, mentioned above. See his deposition, US Exhibit 84A, 1984: 1,016, 1,017. Also see the evidence of another expert witness at the trial, Dr Lewellen, who testified that the salinity of "*excess ice*" can vary considerably and it is difficult to tell whether it is "*annual or permanent*" (Alaska's *Post-Trial Brief*, 1985: 51).

218 Symmons, 1979: 21.

219 US *Post-Trial Memorandum*, 1985: 91.

220 *Reply Brief*, May 6 1985: 5.

221 *Id*.: 18.

222 *Id*. See also Alaska's argument in *Reply Brief*, 1985: 16 (the "*icy matrix*" of Arctic islands has enough structural strength to resist thermal forces etc; and its *Post Trial Brief* (1985: 10 and 14), arguing that so-called "*excess ice*" is to be considered a terrestrial material, like that in the coastal plain itself. Alaska's argument here is very dubious. Compare for example, the analogous, but broader, problem relating to the use of sea-ice as baselines, where the present law of the sea is notoriously unsettled, but where suggestions include the iceline in summer, or even disregard of the ice entirely and use only from the position of the bedrock (Green, 1996: 345). See also Boyd (1984: 100, 105 and 119) who points out that "*sea ice usually has been assimilated to sea water for the purposes of international law*" (especially "*pack ice*" and the "*sometimes solid yet transitory character of sea ice*"; and Molde (1982: 164): *"[t]he Geneva conventions [of 1958] do not mention the question of ice formations*" nor does the new LOSC contain any "*particular regulations*" for same; also Prescott (1984: 93), where he states that (arguably) the Antarctic baseline should be from the point of known solid land, whether the rocks are visible or covered by thick layers of ice; but that this would be "*unrealistic*". Similar problems relate to the requirement of being "*surrounded by water*." Green (1996: 349) suggests that where an island is "*embedded in an ice shelf*", it is not necessarily "*surrounded by water*"; whereas if it is only surrounded by sea ice during the *winter*, it is a true 'island'. See on this the US argument in US v Alaska (*Reply Memorandum*, 1985: 13-14): *"[Alaska] has now specifically taken the view that ice is water for the purpose of one criterion of definition of an island (surrounded by water) but is land for another "naturally formed area of land*" and c.f. Alaska's *Post-Trial Brief,* 1985: 54 on this).

223 US *Reply Brief,* 1985: 14.

224 US *Post-Trial Memorandum*, 1985: 104. See fn.145 *supra*.

Quite apart from the broad notion that coverage for a lengthy period by frozen sea-ice is equivalent to the formation being below water at high tide,[225] the legal importance of the ice-influenced compositional aspect is that if one notionally subtracts (as 'non-land') the known layers of frozen sea-ice (as opposed to sand/gravel layers) which seemingly make up Dinkum Sands' elevation, then the formation clearly never qualifies in having the requisite above high water character in any event. It was untypical compared with other features in the Beaufort Sea in that even in the 'open water' season, it arguably only stood above high water because of the introduction of seasonal ice.[226] As the US federal side argued: the "*proper test was to measure [Dinkum Sands'] elevation after* ***discounting any height which is attributable to the existence [in it] of excess ice***." [227] To contrary effect Alaska argued against such a discounting of the sea ice content, partly on the basis of impracticability.[228]

In his *Report*, the Special Master in effect accepted the Alaskan argument on the general question, first of all not ruling out "*ice*" as being dissimilar to "*land*". As he stated, but somewhat tentatively:

> *The distinction between surface ice and subsurface ice is perhaps not wholly clear-cut. A borderline case was presented by the small piles of gravel that were found in the June 1981 survey...Nevertheless I do not believe that treatment of surface ice features like icebergs or ice shelves should control the analysis of Dinkum Sands, which has been shown to have its origins in the same processes that formed the admitted barrier islands.*[229]

The Special Master, having made this finding on the relevant status of Dinkum Sands' ice component, then went on to stress the practical problems which would be involved in making such any 'ice deduction' assessment of the formation's elevation:[230]

> *To discount the elevation of Dinkum Sands for ice that melts seasonally would raise practical difficulties. In particular, one would need a reasonably accurate prediction of how far the surface would subside in the summer. Dr Reimnitz [expert Arctic geologist witness for the federal side] did not claim much precision for his estimate of 50 centimetres, either in general, or as a prediction specific to the summer of 1981...In addition, there was evidence that the nature and amount of submerged ice can vary widely across a formation...The witnesses agreed that for an accurate survey of the ice content it would be desirable to have a complete cross-section, as by digging a trench along the feature...But trenching might destroy the feature by changing its balance with the environment...Furthermore, knowing the amount of ice present falls short of knowing how much of it will melt during the summer.*[231]

In other words, quite apart from the difficulty of assessing the extent of ice in an off-shore Arctic formation, the Special Master seems to have viewed a discounting of frozen sea water at most only if it was in fact temporary and subject to (assessable) summer melt-down. And so he concluded with what, to this writer, is an over-sweeping conclusion to avoid the "*difficulties*"

225 See fn.145, *supra*.
226 US *Post-Trial Memorandum*, 1985: 97.
227 *Id*.: 92 (emphasis added).
228 *Reply Brief, 1985*: 23-24.
229 *Report*, 1996: 274.
230 Though he did mention that at least one measurement of elevation in the winter months was attempted in March, 1981 (*Report*, 1996: 286).
231 *Id*.: 275.

that would be caused by trying to discount for temporary subsurface ice; namely be recommended "*that **Article 10 [of the TSC] be read to assimilate all submerged ice to land**.*"[232] However, having taken with one hand here, he effectively gave back with the other by stating the obvious common-sense factor that seasonal melt of the top layers of Dinkum Sands could not be totally ignored as it inter-related with the "*varying height*" problem in assessing a formation's height above high tidal datum, as discussed above.[233] As he continued:

> *At the same time, where seasonal ice may make the difference as to whether a feature **reaches a critical elevation, it must be recognised that the pre-thaw measurement cannot be representative of the whole year**. Thus although I would not discount the elevations measured in March and June 1981 [i.e. the 'early season' joint surveys] on account of temporary ice, I view the survey of August 1981 [i.e. the late season joint survey] as an essential step in obtaining a fair picture of the height of Dinkum Sands. Similarly for 1982 and 1983,...end-of-summer observations are as important as those from early in the season.*[234]

In fact, as seen above,[235] the Special Master found that late summer measurements probably indicated a drop due to "*ice collapse*"[236] in the 'open water' season.

7. Conclusion

As stated earlier[237] in this *Briefing*, important aspects of the definition of an island in international law bound up in the innocent phrase "*above water at high tide*" (Article 10 of the TSC; Article 121(1) LOSC, 1982[238]) have never in the past been subjected to adequate academic analysis;[239] and least of all to judicial scrutiny before an international tribunal. Even in the *Anglo-French Western Approaches* Case, the question, though raised, was not determined.[240] Now for the first time the important analysis of this question in *US v. Alaska* – albeit in a federal maritime delimitation context – has cast some light on this vital aspect of insular definition. However, the optimal high-tide datum requirement for an 'island' in international law remains unsettled after the Dinkum Sands case. As this writer has suggested elsewhere, some *intermediate* type of tidal datum – such as mean high-water spring tide – *should* be adopted in international law to avoid a diversity of criteria.[241]

Although it is true that some aspects of the determination of status in the case of Dinkum Sands may be of more limited value for other situations – because, for example, of the

232 *Id*. (emphasis added).
233 See above Section 3.2.5.
234 *Report* (1996: 275 and esp. 280): *"late-season data is necessary to an adequate picture of the behaviour of Dinkum Sands over the year*."
235 *Supra*, Section 2.3.
236 *Report*, 1996: 282.
237 See fn.77 and accompanying text.
238 See also Symmons, 1995.
239 Most of the existing academic works on islands tend to skate over such definitional problems. See Symmons (1995: 27, fn.190) and the same author's review of the latest book on the topic, Jayewardene (1990) in *International and Comparative Law Quarterly*, 40 (1991): 740, 741 (who states that an island should be an "*elevation above the surface of the sea*"!).
240 See fn.127, *supra* and accompanying text.
241 See Symmons, 1995: 17-24 and 28.

peculiarities of an ice-bound environment[242] or the idiosyncratic and lax nature of the domestically-orientated US tidal datum test[243] – there is no doubt that this precedent will be of importance for many other delimitation disputes across the world where ownership of small and dubious insular formations are alleged by one of the contending States to have a vital influence on the direction of a maritime boundary. Low-lying formations exist in rivers[244] and seas across the globe[245] and it is surely only a matter of time before this question of insular definition arises again in a legal setting, particularly with the gradual advent of 'global warming' and consequential rising sea levels. This apart, though, the actual methodology used in the Dinkum Sands saga to determine the appropriate tidal datum in the area – including a so-called "*error band*" – and the topographical efforts of the disputing Parties to determine the feature's height – may be of practical value to other States in disputes in different oceans.

242 See e.g., Section 6 above.
243 See Symmons, 1995.
244 See, e.g., Erasmus and Hannum, 1987-88: 49, 52-53 and 55; and in respect of the application of Article 10 of the TSC to low-lying river formations dealt with in a British-Portuguese Accord of 1938 relating to a Tanzanian-Mozambique frontier river, see Dipla, 1985: 589, 616.
245 See e.g., the problems of identifying true 'islands' in the low-lying Spratlys in the East China Sea (Gardner, 1994: 61 and 67).

Annex 712

D. Souter & O. Linden, “The health and future of coral reef systems”, *Ocean & Coastal Management* Vol. 43 (2000)

ELSEVIER

Ocean & Coastal Management 43 (2000) 657–688

Ocean & Coastal Management

www.elsevier.com/locate/ocecoaman

The health and future of coral reef systems

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Abstract

Coral reefs are among the most productive and diverse ecosystems on earth and provide a multitude of valuable ecosystem services. Moreover, the resources derived from coral reefs are essential to the food security of millions of people living within tropical coastal communities. Unfortunately, burgeoning human populations in coastal regions are placing an unsustainable burden on these resources such that degradation of coral reefs is common. In addition, during 1998, El Niño driven increases in sea temperature caused a mass bleaching event that further degraded many of the world's coral reefs. This article provides a brief review of the status of the world's coral reefs and highlights their value to society. Also, the anthropogenic and natural disturbances that threaten the future of coral reefs are discussed and finally, this article offers some potential remedies that promote sustainable use of coral reef resources thus ensuring their future survival.

1. Introduction

Coral reefs are the most diverse of all marine ecosystems and support a myriad of fish and invertebrate species [1]. The fundamental unit of these ecosystems is the scleractinian (hard or reef-building) coral itself. Most corals are colonial organisms consisting of thousands of individual polyps. In order to survive, corals, like all organisms, have a specific set of physiological and environmental requirements. Corals flourish only in clear, shallow, warm water that ranges between 18 and 30°C [2]. Subsequently, coral reefs are limited to the tropics with most major reef systems occurring between the Tropic of Cancer and the Tropic of Capricorn. Light is also essential for the survival of reef-building corals and, as a consequence, their distribution is limited to depths shallower than 100 m [3]. Corals also are fairly intolerant to fluctuations in salinity generally preferring salinities that range between 32 and 40‰ [3].

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0964-5691/00/$ - see front matter
PII: S0964-5691(00)00053-3

Modern coral reefs have been present in the world's oceans in, more or less, their current form since the Mesozoic era some 250 million yr ago [4]. Coral reefs are unique among marine ecosystems because they flourish in waters that are virtually devoid of nutrients [3,5]. Their high productivity has prompted The World Conservation Strategy (IUCN/UNEP/WWF) to recognise coral reefs as one of the essential global life support systems necessary for food production, health and other aspects of human survival and sustainable development [6].

Bleaching and subsequent mortality of corals as a result of increased sea temperatures is a relatively recent phenomenon that has resulted in a dramatic decline in the number of healthy reefs around the world [4,7]. However, long before climate change became a major problem for coral reefs, burgeoning human populations, especially in coastal areas, and increasing prevalence of non-sustainable, exploitive activities have been degrading coral reefs throughout the world [1,7–13]. Indeed, as early as the 1930s Gardiner [14] expressed concern regarding the apparent decline in species numbers on reefs he studied close to population centres in the Indian Ocean. Recently, Jameson et al. [9] reported that reefs in 93 countries had been damaged or destroyed and Wilkinson [8] stated that 10% of the world's reefs had already disappeared and it is predicted that within the next two decades an additional 20% might collapse [9]. Reefs in the Indian Ocean have already suffered heavier damage, IUCN/UNEP [15] estimating that already 20% have been lost or severely damaged. Malakoff [16] estimated that within the last few hundred year nearly 1200 extinctions had been recorded, most of which, he thought, were little known species inhabiting coral reefs. Reaka-Kudla [16] thought that this worrying trend of species extinction would only increase and predicted that within the next 40 yr 1.2 million species that depend on coral reefs would be extinct. If neglect of ecosystems such as coral reefs, and the life-support services they provide continues unabated then it "could ultimately compromise the sustainability of humans in the biosphere" [17, p. 253].

2. Value of coral reefs

The value of the biosphere (collective term encompassing all regions of the globe that support life) and the services it provides has been recently estimated at between \$16 trillion and \$54 trillion (10^{12}) USD annually [17] which is between 1 and 3 times the gross national product (GNP) of the entire globe. Marine ecosystems alone contributed 63% of this value and coral reefs, in particular, contributed 1.8% (\$375 billion USD) [17]. As coral reefs constitute only 0.2% of the world's marine ecosystems [18] these figures demonstrate that the contribution of coral reefs to the welfare of the globe and the people living on it is disproportionately large. However, it should be noted that some activities conducted on coral reefs such as coral mining are destructive and, despite reaping short-term economic gains, have long-term costs associated with them.

2.1. Food resources

Coral reefs provide a diverse array of items such as fish, molluscs (clams, scallops, octopi, oysters), crustaceans (crabs, lobsters, shrimps), turtles (adults and eggs) and algae that are consumed by humans [6]. Coral reefs provide between 10 and 12% of the harvest of finned fish from tropical countries and up to 25% in developing nations [8,19]. These estimates should be considered as the lower end of the scale as many fish are caught by subsistence fisherman and are never recorded officially. In addition, 9 million metric tons of shellfish and molluscs are harvested from coral reefs annually [9]. Because many of the world's coral reefs bound the coastlines of developing countries they are essential for the survival of the people who reside within the coastal zones of these nations [1,7,12]. Indeed, the fish catches from shallow coastal waters (Fig. 1) dominated by coral reefs in Asia alone are estimated to support 1 billion people [9,20] and destruction of these reefs would undoubtedly lead to substantial reduction of the supply of animal protein in the diets of the populations of the coastal countries.

2.2. Tourism

Much of the economic value of coral reefs stems from their intrinsic beauty that attracts millions of tourists annually to gaze upon their magnificence. Indeed, in many parts of the world, especially in small island nations such as Maldives, Mauritius, Solomon's, Fiji, and those in the Caribbean, tourism is vital to their economies. In Seychelles tourism is the single largest foreign exchange earner [6] and in Florida nearby coral reefs contribute an estimated $1.6 billion USD to the local economy each year [21]. Tourism contributes 45% of the GNP of Maldives [7,22] and up to 50% of the GNP of some Caribbean countries. In 1990 tourism in the Caribbean generated $8.9 billion USD and employed 350 000 people [9].

Fig. 1. The vast majority of the human population of coastal communities in tropical developing nations are dependent on shallow water fisheries for the provision of animal protein. Many of the fish are dependent on coral reefs for part, or the whole, of their life cycle.

2.3. Coastal protection

Many of the world's coral reefs are situated along continental margins and surround small islands. As such, they perform an important role in protecting the shoreline from erosion by oceanic swells and tropical storms [1,3,7,9,23,24]. The protection offered by coral reefs permits productive mangrove and wetland habitats to flourish in sheltered areas and provide essential nursery areas for juvenile fish, many of which inhabit coral reefs as adults [1,3,9,24]. In addition, accretion of white, coral sand along coastlines protected by coral reefs is a significant attractant to thousands of tourists annually.

2.4. Biodiversity

Coral reefs are second only to tropical rainforests as the most diverse ecosystem in the world (Fig. 2a and b). Only one of the 33 phyla that exist on this planet does not occur on coral reefs and 15 occur nowhere else [25]. Recently, Reaka-Kudla [16] estimated that coral reefs support between 1 and 9 million species. Of these, only approximately 4000 species of fish and 800 species of coral have been described [16,26].

2.5. Medicines

The inhabitants of coral reefs are coming under increasing scrutiny from pharmaceutical companies in search of potential new drugs. The chronic overuse of traditional antibiotics such as penicillin has resulted in many bacteria, that were once killed by these drugs, becoming resistant. Subsequently, new sources of drugs to fight disease are being sought [18]. Because many inhabitants of coral reefs produce bioactive substances for their own defence against predators and competitors [27–32] and the environment [33] they are prime targets for this type of research. Indeed, half of all cancer research is concentrating on active compounds derived from marine organisms [34,35] and the calcium carbonate skeletons of corals are already being used for human bone grafts [21].

2.6. Biotechnology (alternative to medicines)

The field of marine biotechnology is an area which provides many exciting scientific and economic opportunities. Coral reef organisms are a reservoir for biomedically important substances, biodegraders, antifouling and anticorrosion substances, biosensors, biocatalysts, biopolymers and many other potentially important compounds and products [36]. Substances or naturally occurring metabolites of reef sponges, sea whips, and corals have been found to have antiviral, antifungal, antibacterial and anti-inflammatory properties [37–41]. In addition, reef organisms contain numerous compounds useful for a variety of other commercial applications, such as amino acids, vitamins, lipids, waxes, polysaccharides and pigments [42].

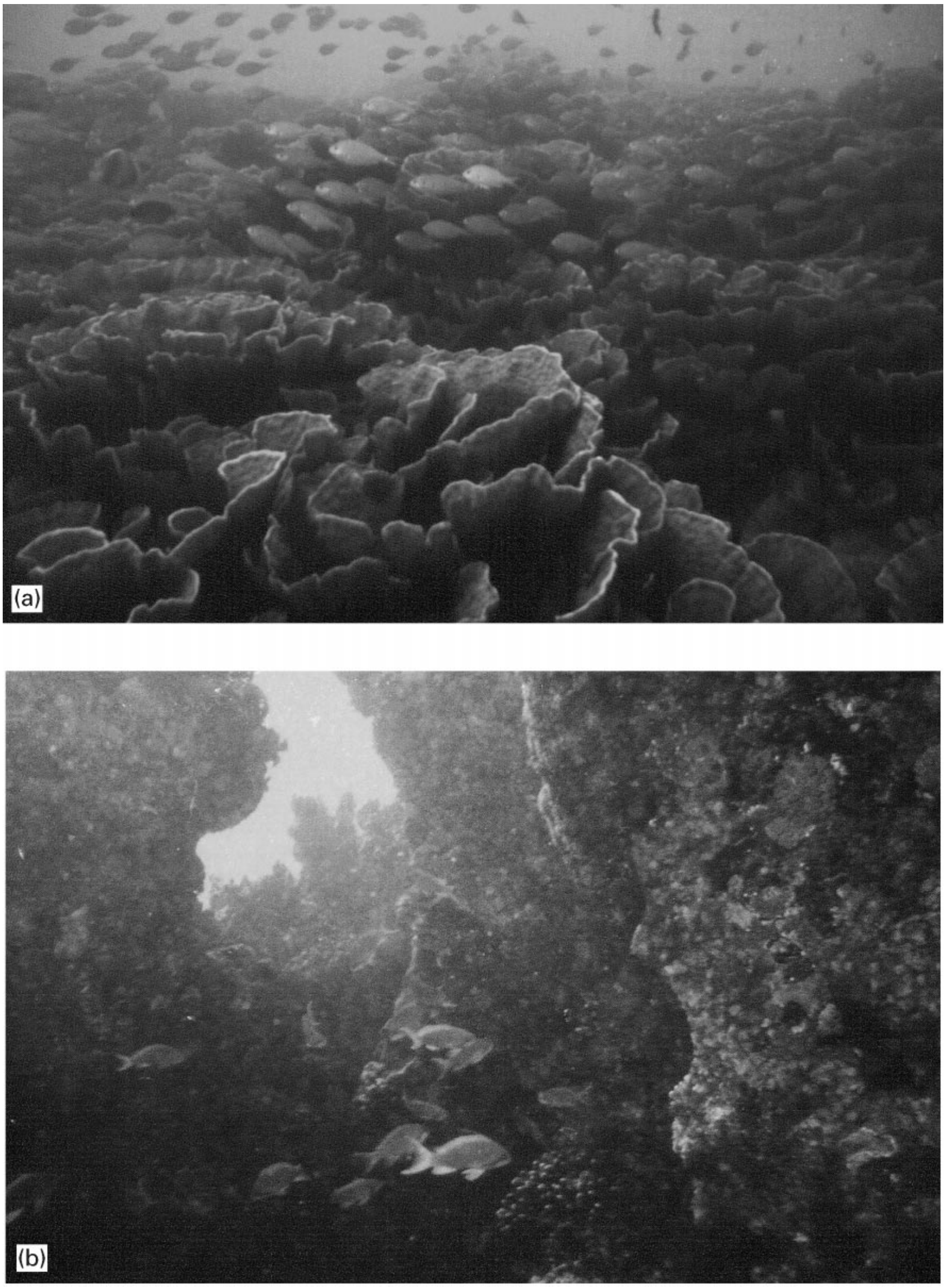

Fig. 2. (a) and (b) Coral reefs are the most diverse marine ecosystems. A single reef in the Indian Ocean might support up to 400 species of fish and more than 100 species of hard coral.

3. Major threats to coral reefs

Generally, the major threats to coral reefs can be divided into two broad categories, those of anthropogenic origin and those that can be considered natural.

However, sometimes the distinction between the two is ambiguous. For example, some threats that are considered natural, such as coral bleaching caused by increased sea temperatures, are intimately linked to increasing global temperatures brought about by man's activities and therefore have an anthropogenic component [3,19].

3.1. *Threats of anthropogenic origin*

The major anthropogenic threats to coral reefs are intimately linked to high human population densities in coastal areas [6]. Recently, Bryant et al. [18] developed a risk index based on the effect of the greatest threats to the health of coral reef systems namely, coastal development, overexploitation, inland and marine pollution and erosion. This analysis determined that 58% of the world's coral reefs are at medium-to high-level risk of degradation from these anthropogenic disturbances and that greater than two-thirds of those reefs that lie outside the Pacific Ocean are threatened.

3.2. *Coastal development*

According to Bryant et al. [18], 30% of the world's reefs are at risk from coastal development. The limited space in coastal areas means that development often occurs at the expense of coastal habitats, namely coral reefs. The construction of airports, especially in some small island nations, often occurs directly on coral reef habitats causing direct and irreparable damage to the reef. The use of land fill to provide sites for housing, industry, recreational facilities and other public works threatens reefs through increased turbidity and sedimentation resulting from soil being washed from development sites and onto nearby reefs, particularly during severe rain storms [43,44]. Once the sediment reaches the reef it blocks the sunlight required by the symbiotic zooxanthellae that reside within the tissues of the coral for photosynthesis subsequently affecting the growth of the coral. In severe cases, sedimentation can kill corals outright by smothering them [43]. Often, the dredging of harbours and channels results in similar outcomes. Furthermore, construction within coastal zones often causes an increase in beach erosion as a result of altered water circulation patterns [45].

The construction of hotels and accommodation facilities along the foreshore adjacent to coral reefs increases the number of people living in these areas and subsequently the amount of waste (Fig. 3). Often waste produced by these developments is discharged directly into inshore lagoons without any treatment. As a consequence, reefs situated close to these tourist developments often suffer from eutrophication that promotes increased growth of algae and exclusion of corals [9]. In addition, uncontrolled construction on the foreshore, the construction of up-stream dams and mining of sand in river beds, stops the natural deposition of sand that has accumulated in the dunes onto the beach which inevitably leads to increased beach erosion [46]. In the worst cases entire resorts have simply fallen into the sea.

Coastal development, especially in small island nations where terrestrial resources are scarce, has promoted the practise of coral mining [23,47,48]. The removal of coral for the purposes of cement manufacture destroys the reef and therefore the barrier that protects coastal zones from oceanic waves and storms [9,23]. Removing large quantities of coral also changes the topography of the reef flat and, as a result, alters the patterns of water flow resulting in increased beach erosion [45]. Furthermore, to produce lime ($Ca(OH_2)$) from coral ($CaCO_3$) the skeletons must be burnt (Fig. 4) which indirectly promotes the cutting of mangroves and forest timber for firewood. The estimated cost of such logging is approximately $7000 USD/km^2 of reef flat that is mined [45].

Fig. 3. A consequence of unplanned urban expansion in coastal zones is the accumulation of waste. Often it is mangrove communities adjacent to population centres, such as this one in Mombasa, Kenya, that bear the brunt of such human ignorance.

Fig. 4. Coral skeletons mined from nearshore reefs are burnt in kilns such as this one in Sri Lanka to produce lime for cement and building materials.

3.3. Overexploitation and use of destructive fishing techniques

Bryant et al. [18] estimated that 36% of the world's reefs were at risk from overexploitation. Fishing is the most widespread activity undertaken by humans that exploits coral reefs [11]. Overfishing using destructive methods such as dynamite, cyanide, muro-ami and kayakas techniques is usually a result of increasing human populations, poverty and declining fish stocks [12] and contributes significantly to the degradation of the world's coral reefs [9,11,13,20,49].

Blast fishing uses explosive charges dropped into the water to concuss and kill fish that are then simply picked up by fishers. This form of fishing is widespread, especially in south-east Asia [45,49,50] and along the east coast of Africa [6,13]. Fishers that use this destructive method usually live in urban areas and lack traditional ties to the areas where they use the explosives or they are desperate to meet immediate requirements for food or income [11]. This method of fishing is highly destructive. A blast at close range shatters the skeletons of all corals destroying the complex substrate that attracts many of the fish in the first place [11,12,45] and at increasing distances from the blast all fish and invertebrates are killed irrespective of whether they are desirable. Intensive blast fishing on any reef can rapidly reduce a once flourishing ecosystem to a pile of rubble [11]. Recovery from this form of destruction would take many years. Subsequently, because the abundance of fish on reef communities is determined by such factors as the complexity of the habitat, coral cover and reef size [51–53], blast fishing can cause a considerable reduction in the fisheries productivity of reefs [11].

Cyanide fishing began in the 1960s in the Philippines as a result of the increasing market for aquarium fish (Fig. 5). Sodium cyanide is used to stun fish so they can be captured easily and exported live to European and North American markets [18]. Since then, 1 million kg of sodium cyanide have been squirted or dumped onto the reefs of the Philippines alone [18]. Unfortunately, this practise has spread both geographically and in the range of species targeted. Cyanide fishing, despite being illegal, is prevalent throughout the southeast Asian region and, in addition to aquarium fish, now targets larger predatory fish such as groupers (Serranidae) and famed Napoleon Wrasse (*Chelinus undulatus*) for the live fish restaurant trade [18,45]. Indonesia is currently the largest exporter of live fish supplying approximately 50% of the world market which is worth approximately $200 million USD per year [45]. Species such as *C. undulatus*, when exported alive to restaurants in Hong Kong and other Asian cities that support sizeable Chinese populations, can fetch prices between $60 and $180 USD per kg [45]. Cyanide fishing, despite being more selective than other destructive fishing techniques, is unsustainable. Cesar et al. [45] predicts that if fish continue to be caught at the current rate the live fish restaurant trade will collapse within 4 yr and the economic loss will approach $46 million USD.

Cyanide fishing is more insidious than other fishing techniques because the more remote reefs that generally escape land-based threats such as pollution, sedimentation and coastal development are the reefs that are prime targets for this method of fishing [18]. Cyanide fishing also damages the corals themselves. At high

Fig. 5. The global trade in coral reef organisms poses a threat to sustainability of reef resources. The capture of fish such as this juvenile *Pomacanthus semicirculatus* for the aquarium trade often means that reefs become denuded of particular species which, in turn, may upset the balance of the ecosystem.

concentrations cyanide kills corals outright [54] and at lower concentrations it impedes the photosynthetic function of the symbiotic zooxanthellae and causes bleaching in corals [55] which, in turn, slows the growth of the coral and renders it more vulnerable to other disturbances [7].

Muro-ami and kayakas drive netting techniques may involve as many as 300 people each using either a weighted scare line or a thrashing palm frond to scare fish into a pre-set bag net. The manner in which the scare lines, each weighted with a stone or length of chain of between 3 and 6 kg, are picked up and dropped onto the reef substrate causes considerable damage to the corals [11,12]. Further, the great number of people involved in these forms of fishing increases the likelihood of physical damage being done to the coral substrate. Finally, when the nets are retrieved they are often fouled on colonies of coral, especially branching Acroporids, which invariably leads to breakage of these branches and further damage to these colonies [11] (Fig. 6). These forms of fishing are non-selective and result in considerable by-catch of undesirable species.

Overfishing causes a change in the size distribution of fish populations, decreases in abundance and shifts in species composition [10], genetic structure and life-history characteristics of some target species [11]. Furthermore, overfishing can lead to the removal of keystone predators which may cause shifts in the community dynamic of a reef [11–13,19]. For example, on Kenyan reefs overfishing of triggerfish (Balistidae) resulted in a dramatic increase in the numbers of the boring sea urchin *Echinometra matthei* which, in turn, lead to increased rates of reef erosion [56]. Also, on some

Fig. 6. Seine nets dragged across the reef flat by fishers break coral colonies and, as a consequence, can cause significant damage to reefs.

reefs of the Caribbean overfishing of herbivorous fish species reduced competition for algae for the sea urchin *Diadema antillarum* that resulted in a dramatic increase in their abundance. However, afterwards the sea urchins succumbed to a disease that effectively reduced their population size and removed all predator control of algal populations on these reefs. Without continual cropping by herbivores, the algae then began to outcompete the corals by smothering adult colonies and preventing settlement of new recruits. The subsequent reduction in coral cover and structural integrity of the reef reduced the capacity of the reef to withstand physical perturbations. The occurrence of Hurricane Allen then destroyed many of these reefs leaving nothing but piles of coral rubble from which many have never recovered [57,58].

Fish species are not the only examples of overexploitation. Many mollusc species, especially of the genus *Tridacna* (giant clams), have been fished to extinction in some parts of the Philippines. Sea urchins (Echinoidea) and sea cucumbers (Holothuroidea) have apparently vanished from certain reefs in the Galapagos [18].

3.4. Land-based pollution

Coral reefs have flourished in waters with extremely low nutrient levels through efficiently recycling nutrients within the system [3,5]. The addition of nutrients as untreated effluents from coastal population centres has caused dramatic changes on some reefs within these areas [13,47,50]. The addition of nutrients promotes the growth of algal competitors which may smother the corals and inhibit the settlement of new recruits. Increased nutrient loads also cause algal blooms (Fig. 7) that increase the turbidity of the water and block the sunlight necessary for the coral's

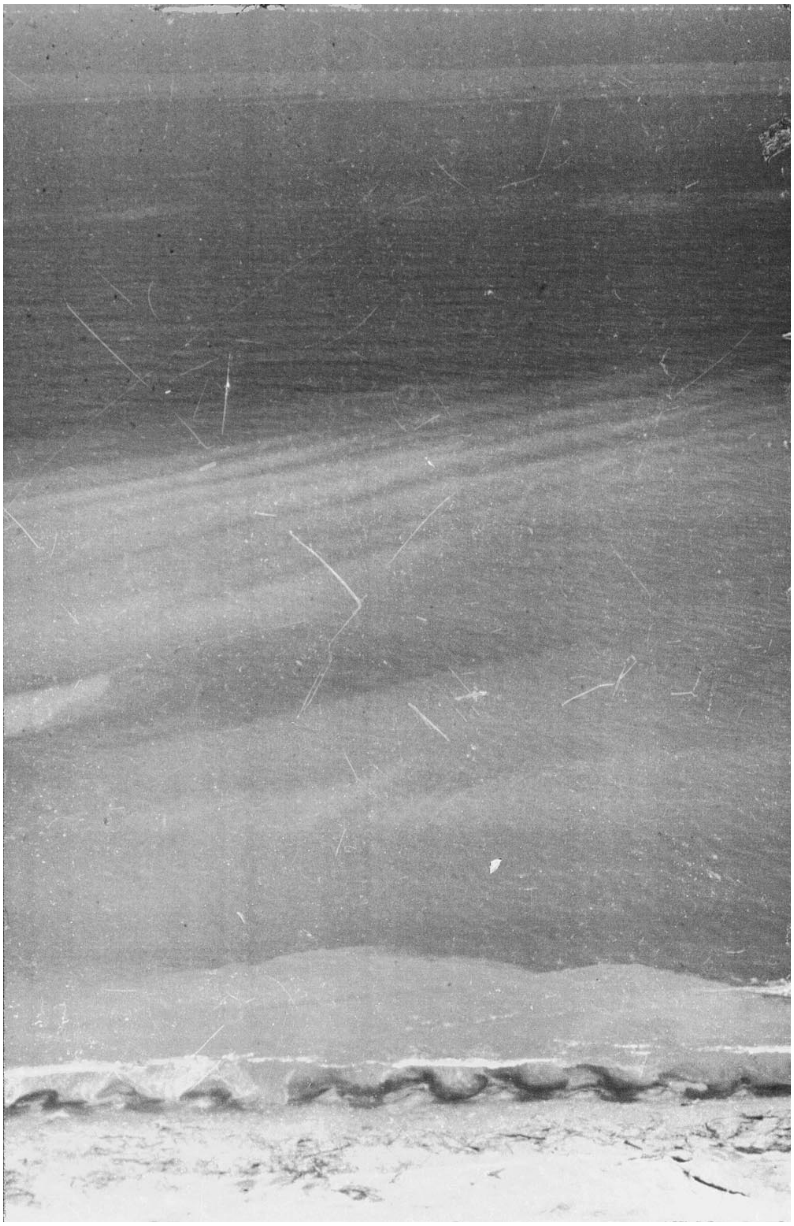

Fig. 7. Influx of nutrients into coastal waters promotes the proliferation of algal blooms and other micro-organisms. These so-called *Red Tides*, such as this one seen on the Atlantic coast of Mexico, can produce toxic substances harmful to organisms residing in these shallow coastal waters.

zooxanthellae to photosynthesise. This reduces coral growth and in severe cases can cause death.

Poor agricultural practices and deforestation have also led to decrease in the extent of coral reefs, especially near river mouths [18,19,46]. Deforestation increases the vulnerability of a watershed to erosion and flooding. Subsequently, rainfall washes soil, pesticides and fertilisers from arable land into rivers which are then transported to coastal waters and dumped on nearby coral reefs (Fig. 8). The sediments smother the corals impeding coral growth and in severe cases killing the coral [43]. Destruction of mangrove habitats at the mouths of these rivers may

Fig. 8. Erosion of land though deforestation and poor agricultural practices increases the input of sediment into coastal waters thus smothering corals and blocking the sunlight needed for the zooxanthellae to photosynthesize. Only a few sediment-tolerant species can survive in this environment and as a consequence the distribution of corals near river mouths is decreasing.

exacerbate the problem as they act as filters removing excess sediment and nutrients from the water [9]. If they have been removed to create space for aquaculture, coastal development or simply to supply firewood (Fig. 9) then the sediment and nutrients are not retained and are washed directly onto the reefs.

3.5. Threats of natural origin

3.5.1. Bleaching of coral and the significance of increases in global sea temperature

In order to understand the phenomenon of bleaching, something of the relationship between the coral and its symbiotic dinoflagellate zooxanthellae must be known. The existence of corals and coral reefs is dependent on a mutualistic symbiotic relationship between the individual coral polyp and a photosynthetic dinoflagellate known as zooxanthellae. Until recently, zooxanthellae were thought to belong to a single pandemic species, *Symbiodinium microadriaticum*. However, it is now known that zooxanthellae are in fact a very diverse group comprising many species [59–61]. The zooxanthellae are intracellular residents of the tissues of the coral [59] and provide the coral with energy (sugars and amino acids) produced by its photosynthetic activities [59,62–64]. In return, the coral effectively fertilises the zooxanthellae providing nutrients in the form of ammonia and phosphates which are waste products of the coral's metabolism [59]. Symbioses between a primary producer and a consumer such as this are paramount to the survival of coral reefs because they ensure that nutrients are recycled within coral reef systems and are not lost to the surrounding oligotrophic waters [3,5].

Bleaching of hard corals and several other benthic invertebrates that possess zooxanthellae, such as soft corals (Alcyonaria), anemones (Actiniaria) sponges

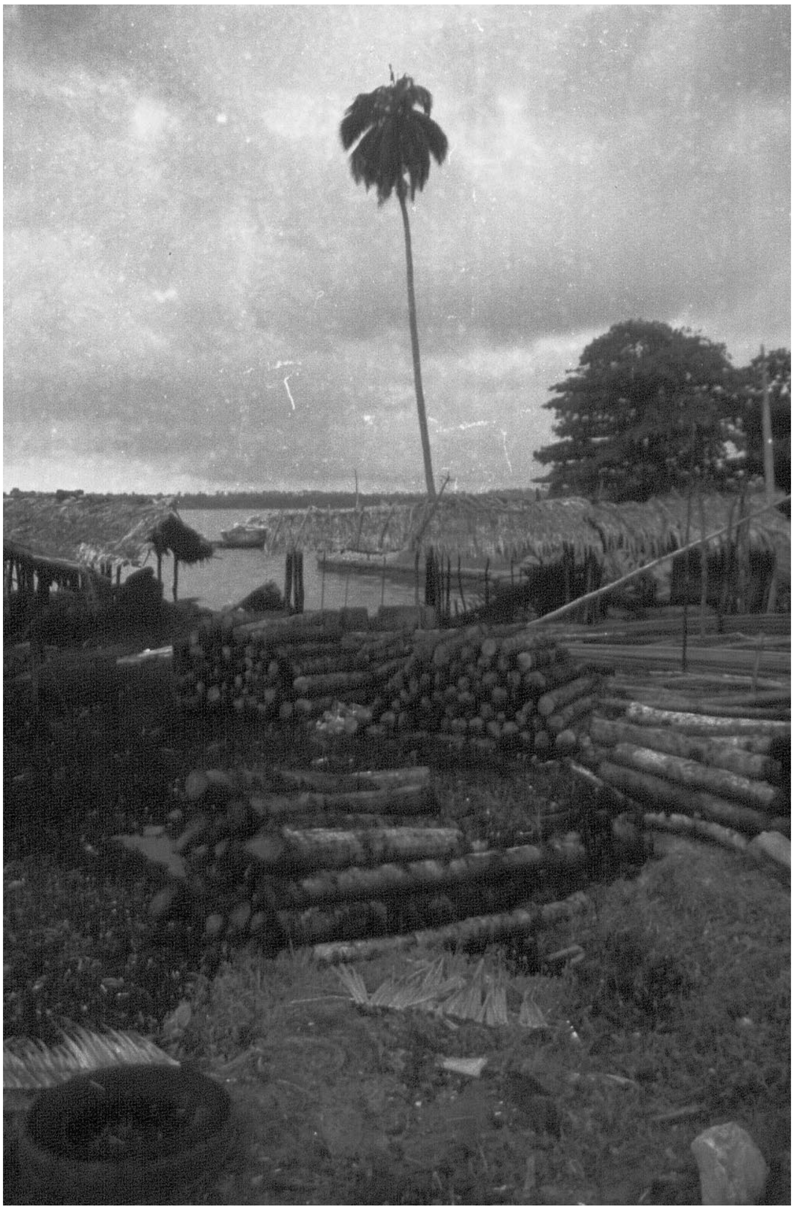

Fig. 9. Mangrove ecosystems formed in the coastal waters protected by coral reefs are an important refuge and nursery for juvenile fish, many of which migrate to coral reefs as adults. Unfortunately, mangroves are an easily accessible source of firewood and the clearing of these ecosystems poses a serious threat to coastal communities.

(Porifera) and clams (Tridacnidae) is a sign of stress [7,65,66] and can result either from the loss of zooxanthellae [67,68] or from loss of zooxanthellar pigment [69] or both [66,70,71]. A variety of adverse environmental conditions, such as reduced salinity [67,72,73], fluctuations in light intensity [67,68,74–76], increases in sea temperature [3,7,65,67,75,77–80], bacterial infection [81] and contamination from chemicals such as cyanide introduced during cyanide fishing [54,55] and pesticides [3], have all been implicated in causing bleaching in reef-building corals. However, increased sea temperature is undoubtedly the primary cause of mass bleaching of coral. Several authors have reported that elevated sea temperatures reduces the photosynthetic rate of the zooxanthellae [67,82–85]. Initially, this was thought to be caused by a malfunction of the light photosynthetic reactions. Recently, however, Jones et al. [76] have demonstrated that it is in fact the dark photosynthetic reactions that are affected by increased sea temperatures and also that increased light intensity plays a significant secondary role. Under normal circumstances the rate of photosynthesis of the zooxanthellae increases with increasing amounts of light until the threshold or saturation point at which photosynthesis can no longer utilize the available light energy [3]. When the amount of available light surpasses this threshold the excess energy is dissipated through non-photochemical pathways. However, when corals and their zooxanthellae are exposed to increased sea temperatures Jones et al. [76] reported that a malfunction of the dark photosynthetic reactions occurs preventing the zooxanthellae from dissipating excess photosynthetic energy. As a consequence, over-reduction of light reactions occurs producing toxic singlet oxygen, super oxide and oxygen-free radicals that cause damage to membranes and proteins. Subsequently, during periods of high sea temperature and high light intensity, such as those seen in the Indian Ocean during 1998, the production of such toxins creates a potentially lethal environment for the zooxanthellae and their host. Thus, in order to prevent intoxication the zooxanthellae are expelled. Once the zooxanthellae are lost from the tissues of the coral, the tissues become transparent revealing the coral's calcium carbonate skeleton giving the coral a white "bleached" appearance (Fig. 10). Although a coral that is bleached retains its own tissues and may survive in this condition for weeks even months, the sugars and amino acids produced by the zooxanthellae are essential for its survival. Therefore, if the conditions that caused the bleaching do not abate allowing the coral to recruit new zooxanthellae it will die [7,66].

Fig. 10. Bleached corals from St. Pierre, the Fahquar Group, Seychelles. Note that the under side of the colony retains some pigment demonstrating the role of light intensity in causing bleaching. Photo: A. Maslennikov.

Fig. 11. During 1998 vast expanses of coral suffered bleaching as a result of El Niño driven increases in sea temperature. Photo: A. Maslennikov.

During 1998 coral reefs of the world suffered a bleaching event that many regard as the most severe ever witnessed [3,7] (Fig. 11). Reports of coral bleaching that lasted for several weeks or months were obtained from all tropical regions of the globe [4]. The subsequent mortality of corals was extensive. The Indian Ocean, in particular, was seriously affected with morality frequently exceeding 75% and sometimes approaching 90% [7,86]. Further, almost half of all corals on several reefs in the East, Central and West Pacific, and the Caribbean were killed [4].

Similar to previous mass bleaching events, bleaching was most pronounced in shallow water (< 15 m) and was most severe on rapidly growing species such as *Acropora, Montipora* and *Echinopora*. Most alarming however, was that unlike past bleaching events in which massive corals such as *Porites* survived, the mass bleaching of 1998 affected virtually all species of coral and was recorded at unprecedented depths (down to 42 and 50 m in Sri Lanka and Maldives, respectively) [4,87]. The severity of the 1998 bleaching event was further exemplified by the death of corals that had survived for the past 700 yr or more [3,7,88].

Prior to 1979 bleaching of coral was known only as a local phenomenon. Since then six mass bleaching events have occurred, each coinciding with a period of El Niño [3]. What then has caused the increase in number of mass bleaching events and what is the significance of El Niño? The last two decades has been the warmest period ever recorded during which 1998 was the hottest single year [7]. Subsequently, the temperature of the sea is rising at rates greater than ever recorded. In the last 100 yr the mean global sea temperature has increased by 1°C and the latest predictions suggest it will rise by approximately 2°C within the next 50 yr [89]. This has brought sea temperatures close to the upper thermal limit of many corals and their zooxanthellae. As a consequence, any thermal anomaly that causes abnormal rises in the sea temperature is sufficient to cause bleaching.

If increases in sea temperature are the cause of mass bleaching events, why then do they coincide with periods of El Niño? Periods of El Niño are the trigger that cause mass bleaching events and the El Niño of 1997–1998 was the most extreme ever recorded [7]. El Niño is a climatic state during which low air pressure systems in the tropical Pacific Ocean migrate from their usual location over the Australian/Indonesian region to the central tropical Pacific (Tahiti). As a consequence, the normal easterly trade winds become weaker producing relatively calm weather conditions near the equator. Subsequently, solar radiation that would otherwise be dissipated by surface winds, currents and mixing of oceanic waters is absorbed causing the sea temperature to rise. If these conditions prevail, then the sea temperature will increase to such an extent that it exceeds that which can be tolerated by the corals and their zooxanthellae, leading inevitably to bleaching. Once bleached, the likelihood that a coral will die is proportional to the length of time for which the thermal limit of the coral is exceeded [3,75].

In late 1997, and continuing through much of 1998, surface sea-water temperatures rose progressively throughout the world. Over much of the tropical oceans where corals are found, sea-surface temperatures increased 2–3°C and in large areas as much as 4–6°C. Direct measurements by divers and the use of sensors showed that the temperatures in places such as Sri Lanka were clearly elevated down to 40–50 m [4]. The bleaching of coral resulting from these temperature increases was the worst ever witnessed [3,7].

At present, mass bleaching of corals only occurs if a period of El Niño of sufficient strength prevails for long enough to cause significant increases in sea temperature. However, if global sea temperatures continue to rise as is predicted, becoming closer to the thermal tolerance limit of corals, El Niños of smaller magnitude will be sufficient to cause bleaching. Moreover, the closer the mean sea temperature is to the thermal limit of corals the longer will be the period for which the tolerances of corals will be exceeded during any El Niño, thus increasing the likelihood of coral mortality. Eventually, the mean sea temperature will reach a level where normal seasonal increases in temperature during summer will be sufficient to cause mass bleaching of corals [3,7]. Unless changes to current predictions of rising sea temperatures occur, Hoegh-Guldberg [3] forecasts that annual bleaching of corals will begin in southeast Asia and the Caribbean around the year 2020 (Fig. 12a), in the northern GBR approximately 2040 and in about 2070 on the southern GBR (Fig. 12b).

3.5.2. The consequences of mass bleaching

Reduced reproductive capacity and recruitment. Increased frequency and intensity of bleaching will obviously lead to greater mortality in mature colonies of coral. In colonies that survive, bleaching is likely to inhibit reproduction through the reduction in fecundity and reproductive output thus limiting the chances of successful fertilisation and settlement [3,7]. However, if some corals do manage to settle, several years are required before they become reproductively mature. If the

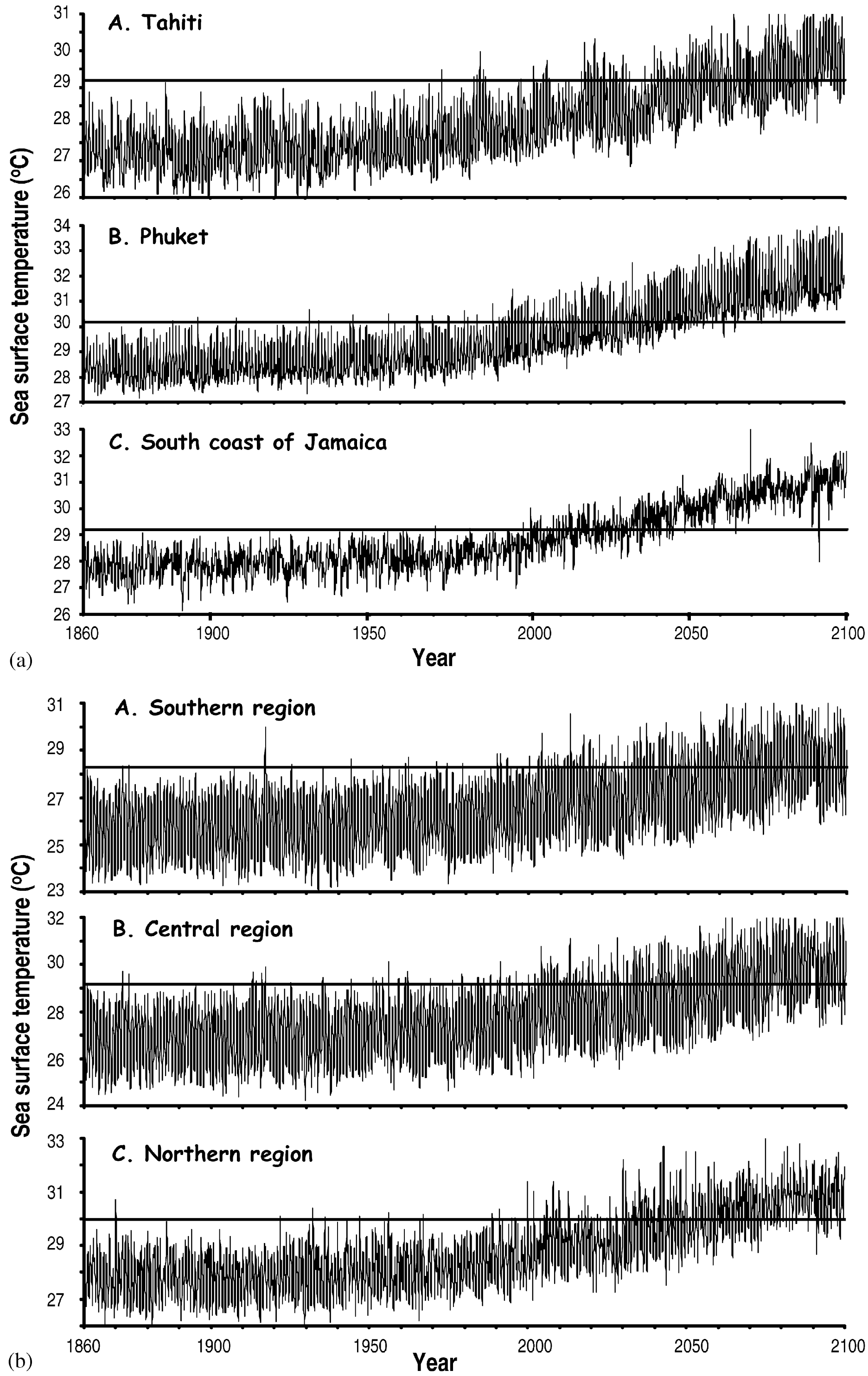

Fig. 12. The predicted increases in sea temperature over the next century at three sites in the northern hemisphere (a) and along the extent of Australia's Great Barrier Reef (b) derived from the ECHAM4/OPYC3 IS2a climate model. The solid horizontal line represents the known thermal tolerance limits of corals at each particular site. If sea temperatures continue to rise as is predicted by this climate model then bleaching of corals will very soon become a annual phenomenon. If the subsequent mortality of corals as a result of this annual bleaching is comparable to that recorded during the 1998 event then the continued existence of corals and the health of the world's coral reefs could be seriously jeopardized. Source: Hoegh-Guldberg (1999).

frequency of mass coral bleaching and mortality exceeds that which is required for the attainment of reproductive age then perpetuation of the species will be hindered.

Reduced rate of calcification and growth. The products of photosynthesis by zooxanthellae are the primary source of energy used by corals for calcification and skeletal growth [63]. Therefore, the loss of zooxanthellae because of bleaching reduces the amount of energy available for accretion of calcium carbonate and subsequently growth. For the corals themselves, reduced growth rates might translate into reduced competitive capacity and loss of space to algal competitors, ability to recover from disturbance [3,7], susceptibility to disease and attack from bio-eroding organisms and an inability to remove sediment [7]. For the entire reef, on the other hand, reduced rates of calcification and growth of corals might significantly compromise the structural integrity of the reef.

Exacerbating the effects of bleaching on the rate of calcification are increasing levels of carbon-dioxide (CO_2) in the atmosphere. As the concentration of atmospheric CO_2 increases, so too will the acidity of the sea water which will cause a concomitant decrease in the available carbonate [1,3]. At the present rates of CO_2 increase Hoegh-Guldberg [3] predicts that the rate of calcification of corals will decrease by between 14 and 30% by the year 2050 and a net loss of calcium from the system through physical- and bio-erosion will further weaken the framework of the reef. Once the structural integrity of the reefs are compromised the reef itself can be rapidly eroded resulting in the destruction of coastlines, loss of housing, tourism and coastal ecosystems such as mangroves and sea grass beds upon which many commercially important species rely for reproduction and nursery areas [1].

A mechanism for change in community composition. Some species of corals are more tolerant to fluctuations in temperature than others. For example, during previous bleaching events it was the Acroporid corals, especially the branching and tabulate forms that were most susceptible. Large massive forms such as *Porites* spp. seemed less affected and when some colonies did lose their zooxanthellae they were among the first to recover. This differential ability of corals to cope with temperature change could lead to changes in community composition toward more heat-tolerant species. Goreau and Hayes [80] suggested that coral species present on reefs at higher latitudes might be replaced by more temperature tolerant species from lower latitudes. This may occur in the short-term but if sea temperatures continue to rise then the thermal tolerances of all corals will be exceeded and they will be replaced by more heat-tolerant species. Obviously, the consequences of shifts away from coral communities will have an effect on associated fauna and flora. The most important of these to human populations will be the decline in fish stocks upon which many millions of people depend.

3.5.3. Tropical storms, volcanic and tectonic activity

Coral reefs are also subjected sporadically to tropical storms, encroaching lava flows or upheaval of land associated with volcanic or tectonic activity [19,90]. While these unpredictable forces of Nature can cause massive damage to reefs, the damage tends to be localised, seriously affecting only a few reefs within a small area. The real threat is when these natural perturbations affect reefs that are already disturbed by human influences. In such cases recovery of the reef ecosystem may be severely retarded or might not happen at all [58].

3.5.4. *Outbreaks of Crown-of-thorns starfish*

Population outbreaks of the Crown-of-thorns-starfish *Acanthaster planci* have been recorded throughout the world since the early 1960s (see reviews by Endean [91], Potts [92], Moran [93] and Birkeland and Lucas [94]). The damage done to reefs by feeding aggregations of this corallivorous starfish is devastating and reports of up to 90% of the live hard coral cover of reefs being consumed are common [95–98]. The question as to what causes population outbreaks of *A. planci* on some reefs is one of the most asked in modern marine science. Despite the plethora of hypotheses attempting to explain this phenomenon (see review by Moran [93]), to date, a satisfactory answer has not been forthcoming. Regardless of the cause(s), outbreaks of this starfish appear to be occurring more often and in some areas pose a serious threat to continued health of coral reefs.

4. Socio-economic impacts of coral reef degradation

The socio-economic consequences of the bleaching event are obvious but difficult to quantify. Only speculative estimates are available and have been provided by several authors. Cesar et al. [45] estimated that the cost resulting from destructive fishing methods on Indonesian reefs resided somewhere between \$137 000 USD and \$1.2 million USD/km^2 of reef over a 25-yr period. Wilkinson et al. [7] and Cesar [22] estimate that the economic cost of the 1998 mass bleaching event might range anywhere from \$700 million USD to in excess of \$8 billion USD over the next 20 yr. The bulk of these losses are a result of decline in fisheries (between \$260 million USD and \$1.3 billion USD), tourism (between \$332 million USD and \$3.4 billion USD) and coastal protection (up to \$2.1 billion USD depending on the extent of reef framework collapse). However, these authors acknowledge that the effect on human populations will extend far beyond the scope of economics. The loss of livelihoods and food security for the millions of people that depend on coral reefs is impossible to value. At present, Coral Reef Degradation in the Indian Ocean (CORDIO), a multi-disciplinary research programme involving scientists from 12 countries, is being implemented to determine the biological and socio-economic effects of the 1998 mass bleaching event on the entire Indian Ocean region (see Box 1 for details). Preliminary results from initial investigations indicate that economic losses from tourism and fisheries will be significant [99].

Box 1

Assessment of the damage — the CORDIO programme

CORDIO was started in January 1999. The programme has as its goal to provide information on the extent and speed of coral degradation in the Indian Ocean. At present the programme supports about 25 targeted studies and monitoring projects in 12 countries. Ecological as well as socio-economic effects are studied. Investigations also focus on the natural recovery processes on different reefs, and methods of mitigation of damage and artificial recovery of reefs. In addition, the programme intends to support alternative livelihoods among local human populations affected by the coral mortality. During its first year the programme received about US$ 1 million from the World Bank (through the Dutch Trust Fund), Sida (Swedish International Development Cooperation Agency), the Swedish Council for Planning and Coordination of Research, the Foundation for Strategic Environmental Research and WWF-Sweden.

Projects to study the status of the reefs, including the signs of recovery or continued deterioration are carried out in Kenya, Tanzania and Mozambique, as well as throughout the Seychelles and Maldives archipelagos, Mauritius, Reunion, Comores, Sri Lanka and the Indian reefs in Bay of Bengal (Andaman and Nicobar) and in Gulf of Mannar and the western Indian Ocean (Lakshadweep). These studies have not provided enough compiled data yet and it is too early to report any results. However, it is obvious that there is a significant recovery in some reefs in East Africa, while in isolated reefs in Maldives, Seychelles and Sri Lanka, no signs of recovery were seen about 1 yr after the peek of the bleaching. Some reefs in East Africa and in Sri Lanka have been transformed into algal-covered reefs. It is difficult to believe that some of these reefs will be able to recover in foreseeable future.

Projects to study the secondary effects on the fish communities and other reef organisms are carried out in a few projects in East Africa, South Asia and the Indian Ocean Islands. A preliminary account of these results show that the fish communities associated with the coral reefs were affected, and algal feeding fish tended to increase in numbers while coral feeding species decreased. In some areas the entire reef fish communities (abundance and diversity) decreased to less than 25% of their former levels. Some studies reported drastic reductions in butterfly fish numbers. Monitoring of the potentially toxic, epiphytic dinoflagellates has shown drastically increased concentrations in areas with dead corals.

Studies to investigate the socio-economic impacts of the bleaching in coastal communities in affected areas have only just started, and therefore it is too early to report any results. Also studies to look into the effects on tourism, particularly the dive tourism, has also only just started.

The implementation of the projects under the CORDIO programme is coordinated from three centres in the Indian Ocean Region. The actual project, including field sampling and compilation of results, is carried out by about 10 country teams.

5. Recovery of coral reefs from disturbance

5.1. Natural recovery

Coral reefs are fairly resilient ecosystems [4]. Nevertheless, with man's activities becoming more extensive and more exploitive this inherent resilience is being threatened. How a coral reef will recover from a disturbance and the length of time required is difficult to predict. Obviously, how quickly a reef will recover will depend on the nature and magnitude of the perturbation and also the community structure and composition of the reef. However, several factors can be identified as important for the natural recovery of a reef:

- *Cessation or alleviation of the perturbation causing the degradation* — Obviously, if the disturbance causing the degradation of a reef is still active then there is little chance of recovery.
- *The presence of other disturbances (e.g. pollution, sedimentation, removal of keystone species)* — If coral reefs are suffering under the influence of anthropogenic disturbances then their recovery will be hindered. For example, an influx of nutrients in the form of untreated sewage might cause an algal bloom that stops light from reaching the coral. Without light the growth of the coral is retarded which, in turn, compromises the ability of the coral to overcome disturbance and compete with other benthic organisms. If the nutrient influx persists, then the growth of benthic macro-algae might increase allowing them to overgrow and smother the coral leading to a change in community composition.
- *The influx of coral larvae from other reefs* — The recovery and regeneration of disturbed areas of reef is dependent on the influx of coral larvae that settle and grow. The number of larvae a disturbed reef will receive will depend on its juxtaposition with other undisturbed reefs. If, for example, the reef is an isolated reef, then larval input might be limited which, in turn, will cause slow rates of larval settlement and longer periods of recovery [7]. On the other hand, if the reef is part of a group of reefs, such as one situated within the Great Barrier Reef, then recovery is not likely to be limited by recruitment but will be determined by other factors such as the magnitude and extent of the disturbance.
- *The extent of the disturbance* — If the disturbance is only local then there is a greater likelihood of larval input from surrounding reefs and also untouched portions of the damaged reef [7] and, as a consequence, relatively rapid recovery. If, on the other hand, the damage is regional then other factors such as larval dispersal, the length of time larvae remain competent to settle and patterns of local extinction become important determinants of how long before a reef recovers to its pre-disturbed state.
- *The timing of the disturbance* — Most corals reproduce sexually only once per year when the temperature of the water is near its maximum. Therefore, an influx of larvae into the system also occurs only once per year. If the disturbance occurs soon after this reproductive period then it will be almost 1 yr before potential new recruits have an opportunity to settle. This might allow other benthic species that

reproduce more continuously to settle and occupy the substrate thus limiting future settlement of corals. Furthermore, a disturbance during this reproductive period might cause the failure of any corals to settle that year further impeding recovery.

- *The species composition of the community* — Provided the condition of the substrate permits, fast-growing corals will rapidly expand into space created by a disturbance. Therefore, a community with a greater percentage of fast-growing corals might be expected to recover from disturbance quicker than one dominated by slow-growing, persistent species.
- *Local extinction of particular coral species* — In such an event the re-establishment of the extinct species on a disturbed reef will dependent entirely on influx of larvae from extraneous sources. If this does not occur there will be a change in community structure and recovery might proceed to an alternative stable state.
- *Survivals of some polyps on the colony* — When corals bleach, often only polyps on the upper surfaces of the colony expel their zooxanthellae. This is a consequence of the significant role played by high light intensities in contributing to bleaching (see above) and the differences in the amount of light absorbed by polyps on the upper and lower surfaces of the colony. If polyps situated on the shaded, underside of the colony survive they can regenerate and grow over the damaged portion of the colony and assist recovery.
- *Survival of adult corals in deeper water* — Colonies of coral in deeper water are often not exposed to the increased temperatures and high light intensities necessary to cause bleaching. The survival of these colonies can assist recovery by contributing larvae for settlement and regeneration of damaged areas of reef.

5.2. Assisted recovery

During the past decade artificial rehabilitation of degraded reefs has received considerable attention [48,100,101]. Unfortunately, artificial rehabilitation of coral reefs is a very expensive exercise [48] and Lindahl [101] points out that the expense involved is beyond the financial capacity of many countries in which coral reefs occur. However, if artificial rehabilitation is contemplated several factors must be taken into account. First, is the perturbation that caused the degradation still active? Obviously, if it is then rehabilitation will be a fruitless exercise. Second, it is imperative to determine the likelihood that a reef will recover by itself. If it is, then the reef is probably best left to its own regenerative devices. Conversely, if the reef is unlikely to recover without intervention then definite goals should be outlined before rehabilitation commences. For instance, do you want to stabilise the substrate to allow corals to settle naturally? Do you want to rapidly increase the cover of coral? Do you want to develop a community similar in structure and species composition to an undisturbed community? The goals you define before you start will determine the methods you adopt and the expense incurred. Ultimately, however, if artificial rehabilitation of degraded reefs is going to be a viable option in tropical developing countries a cost-effective method must be devised that can be implemented using a minimum of specialised equipment [101]. See further discussion of this issue in the article by Yap herein.

6. Recommendations and future perspectives

6.1. Implementation of integrated coastal zone management

With the exception of direct overexploitation of reef resources, most anthropogenic threats to the future health of coral reefs originate on land. Subsequently, if sustainable use of reef resources is to be achieved management strategies must also incorporate land-based activities so that potential threats such as sedimentation resulting from deforestation, coastal development and poor agricultural practices are recognised and dealt with appropriately. During the last decade the concept of integrated coastal zone management (ICZM) has come to prominence [102] offering a muli-faceted approach to management of both marine and terrestrial resources. A comprehensive ICZM plan should consider the wishes of all user groups, such as local people, local and federal governments, commercial organisations, non-governmental organisations, conservation lobby groups and scientists, and promote open dialogue between them. The introduction of ICZM into tropical developing nations provides a mechanism by which anthropogenic disturbances to coral reefs can be mitigated and resources used sustainably [7,12].

6.2. Development of alternative livelihoods

Traditionally, many coastal communities in tropical developing countries have been reliant on coral reefs for food and economic well being through the conduct of artisinal fishing. However, burgeoning coastal populations is increasing the pressure on coral reefs to continue to supply a rich bounty. Faced with ever diminishing resources, the prospect of economic failure and the lack of any alternative source of income, fishers are increasingly turning to destructive fishing practices to maintain catch sizes and profitability. The alleviation of this sole dependence on coral reef resources is the key to achieving sustainable resource use in these regions. Moffat et al. [103] suggests the only way to accomplish this is through community development.

The introduction of alternative livelihoods to people traditionally dependent on coral reefs serves to reduce exploitation of coral reefs in a number of ways. McManus [12] demonstrates that providing an alternative source of income to fishers reduces the fishing pressure on the reef by making fishing less profitable. This is because in order to go fishing the fisher forgoes whatever income they would have gained from their alternative source hence increasing the amount of fish needed to be caught before a profit is returned. Subsequently, when offered a choice some fishers will stop fishing in favour of the alternative livelihood thus alleviating some of the pressure on coral reef resources. Furthermore, once families develop the financial capacity to purchase food and other goods they are no longer dependent on the reef as their sole source of food.

One of the obvious alternative sources of income in coastal areas supporting coral reefs is tourism. Coral reefs are one of the biggest draw cards for tourism and the introduction of tourism to coastal communities provides a mechanism for economic growth and community development. In addition, because tourists are attracted to the natural beauty of coral reefs, the economic gains generated by tourism will provide incentives to preserve the natural features of the reef rather than exploit them. It should be noted, however, that, despite the benefits of tourism, its introduction into coastal areas often brings undesirable factors such as unplanned coastal development which leads to erosion of beaches and eutrophication of coastal waters. The introduction of tourism to coastal communities of developing nations should therefore be planned and closely managed by all interested parties.

Another example of an alternative livelihood is aquaculture exemplified by the sea weed farming undertaken on Zanzibar, Tanzania. The cultivation of sea weed (*Eucheuma spinosum*) was introduced in the late 1980s to traditional fishing villages situated inshore of the fringing reef on the east coast of Zanzibar [104]. Sea weed, grown in the sheltered lagoon behind this fringing reef, is now one of the largest export earners of Zanzibar. This industry provides an alternative to fishing and an additional source of income for families residing in these coastal communities. Furthermore, because sea weed farming is conducted by the women of the villages, they derive this financial benefit independent of the men which has given them a degree of independence and has also brought greater financial security to individual families within these communities.

6.3. Capacity development

One of the keys to ensuring the sustainable use of resources is having the ability to gather appropriate information to make the correct management decisions and then having the capacity to implement those decisions. Unfortunately, many of the nations that are charged with ensuring the future health of the world's coral reefs do not possess sufficient capacity in either of these sectors. Subsequently, increasing the capacity of scientists and managers to gather pertinent information describing the status of coral reef resources should be one of the primary objectives of any national programme. The international community can assist with training courses and exchange programmes between developed and developing nations. Several organisations such as the Global Coral Reef Monitoring Network (GCRMN) and CORDIO are, at present, conducting such courses ensuring that the nations that possess coral reefs have the capacity to monitor their reefs and identify future trends in their health. In addition, assistance should be given to scientific development, especially in tropical developing nations. Scientists in these regions should have the capacity to recognise and prevent problems arising in their own countries and they should have significant input on management decisions.

The second facet of capacity development is concerned with implementing and enforcing management decisions. Often nations in which coral reefs occur have neither the human nor financial resources to do so. The low salaries of managers and poor job security of government officials make these people vulnerable to bribery and political intimidation which further exacerbates the problem [19]. Obviously, financial donations can be made by the international community but this is often only an immediate solution. A long-term solution is to promote a system of self-regulation in which local user groups monitor and manage activities conducted on reefs. To achieve this form of management it must be demonstrated to local user groups why there is a need for management and what the consequences of unregulated exploitation are. For this to succeed it is imperative that local user groups are involved from the outset in the development and implementation of management strategies. The development of such self-regulatory processes negates the need for otherwise expensive government enforcement and circumvents problems associated with corruption.

6.4. Appropriately managed marine protected areas (MPAs)

The Fourth World Congress on National Parks and Protected Areas called for a minimum of 10% of each of the world's biomes to be incorporated into protected areas. The current number of protected areas in marine environments is well below this recommendation [105]. Jameson et al. [9] suggested the current number of marine protected areas and their dispersed nature are inadequate to preserve the biodiversity and fisheries stocks on coral reefs in any part of the world except in Australia's Great Barrier Reef Marine Park. These authors recommended that a worldwide system of marine protected areas that includes widely dispersed small reserves and several strategically located large reserves encompassing 20% of the world's coral reefs should be set up.

While there is increasing evidence that marine parks contribute to the diversity of adjacent areas through the export of larvae and emigration of adults and protection of spawning stock [19,106,107], institutionalising marine parks must be done in the appropriate places for the appropriate reasons and in the appropriate manner. Kelleher et al. [105], following the guidelines set out by Kelleher and Kenchington [108], provide a comprehensive account of "where" and "why" marine parks should be set up but in developing nations it is often the "how" that is the most difficult to accomplish successfully. Marine parks in these regions often fail because there is lack of public support and willingness of users to follow rules, poor enforcement either through lack of commitment or lack of financial and technical resources, or through failure to address impacts that originate outside the bounds of the marine park [105,109]. Further, in these countries traditional marine parks that conserve resources through strict regulation of access cannot work because of the dependence of these communities on these resources for their economic and physical well being. You cannot ask users to make sacrifices for conservation without providing suitable and viable alternatives. Therefore, biodiversity must be conserved through sustainable use of resources and effective management and the only way to achieve this is to focus on the local people most affected by the implementation of the marine park. To ensure the success of marine parks in these regions user groups must be incorporated into every stage of the park's development. If a feeling of ownership of the park is instilled in the people of the community that depend on the park then they will feel like they have an obligation to see that it is successfully managed. Furthermore, McClanahan [109] warns that a MPA has greater chance of success if it is profitable. Indeed, if local communities can see how the setting up of a marine park can benefit them financially through tourism and continued availability of resources they will be more receptive giving the marine park a greater likelihood of success.

6.5. *Increase monitoring of coral reefs*

The great majority of the world's reefs occur in remote locations and, as a consequence, their condition is unknown [18]. Obviously, without appropriate data describing their condition and trends in their health-making decisions regarding the sustainable use of their resources is difficult. Therefore, increased monitoring of reefs is clearly needed. Wilkinson [4] demonstrates that two products are yielded from regular monitoring of the state of coral reefs. First, the data that describes the status of coral reefs of the world and the establishment of trends in their health and second, the public awareness that is generated by the collection of those data. At present, there are several organisations (GCRMN, Reef Check, Aquanaut, Coral Reef Alliance) conducting monitoring of coral reefs. However, it has only been in the last few years that these organisations have begun to monitor reefs and as yet many reefs remain unsurveyed.

6.6. *Tighter controls on fishing practices especially those employing destructive techniques*

Broad-scale testing for cyanide residues in exported and imported fish should be implemented. For example, a recent alliance has been formed between the government of the Philippines and the International Marinelife Alliance that has set up a network of laboratories around the Philippines to test exported fish for levels of cyanide in their tissues [18]. Reef Check [88] called for similar testing of imported fish in target cities for the live fish trade such as Hong Kong and suggested that offending exporters and importers should be punished with sentences that would dissuade the use of poisons for capturing live fish. In addition, the sale of fish captured using blast fishing techniques should be prohibited. To facilitate such legislation fisheries managers and fish market agents should be taught to recognise fish captured using blast fishing techniques and should report fisherman engaging in these destructive activities.

6.7. Change the focus of existing fisheries management

Many of the current fisheries management techniques have been developed on temperate single species fisheries where the trophic network is simple and predictions regarding the effect of harvesting on the ecosystem and sustainability of the fishery easier to make. However, in tropical, coral reef ecosystems the trophic network is highly complex involving a great many interdependencies between species, many of which are unknown. As a result application of single-species fisheries management models to coral reef systems is not necessarily wise [110]. In fact, exploitation of a single-species or single ecological group (e.g. herbivorous fish) can lead to dramatic shifts in the community dynamic [56,58]. Therefore, the need for alternative management strategies in coral reef fisheries is urgent. Jennings and Polunin [11] and Russ and Alcala [110] have proposed a method that makes use of the trophic complexity of coral reefs and the moderating effect that it brings. They recommend that harvesting of coral reefs should be done in a multi-species way so that species from each trophic group are taken thus, maintaining the diversity both within and between trophic groups which prevents unwanted shifts in the community dynamic. In addition, the fishery as a whole is less reliant on the success of one particular species and, as a result, is less vulnerable to natural fluctuations in population size. Of course, harvesting species from all trophic groups requires that there be a market for representatives from each group. At present, this method of fisheries management is not being promoted. Current fisheries development programmes persist with targeting a few select species.

7. Conclusions

The majority of the world's coral reefs are situated in the national waters of developing nations. The widespread poverty and overpopulation of the coastal zones of these nations places an unsustainable burden on their reefs such that their future could be seriously jeopardised. Only through the systematic implementation of integrated coastal zone management that involves all user groups and managers alike and focuses on poverty alleviation through community and capacity development and issues of public awareness will sustainable use and conservation of coral reef resources be achieved. Without such action the future health of both human and coral reef populations could be compromised.

Furthermore, the spectre of global warming and rising sea temperatures determines that reef management and conservation is no longer the sole responsibility of countries fortunate enough to have coral reefs. Ensuring the sustainability of the world's environment is now the responsibility of all nations including the industrialised, first-world nations of Europe and North America. The United Nations Environmental Programme (UNEP) uses an African proverb that states "we have not inherited the earth from our parents but rather we have borrowed it from our children". If anthropogenic stresses on coral reefs are not reduced in the near future we seriously risk defaulting on that loan and becoming environmentally bankrupt.

Acknowledgements

The authors would like to thank Dr. Gunnar Kullenberg for inviting them to write this contribution to *Oceans and Coasts at the Opening of the New Millennium*. Also, thanks are due to Dr. Ove Hoegh-Guldberg and Dr. Ann Grant, editor of *Marine and Freshwater Research*, for allowing us to reproduce Figs. 12a and b.

References

[1] Wilkinson CR, Buddemeier RW. 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, Switzerland, 1994. 124pp.
[2] Veron JEN. Corals of Australia and Indo-Pacific. London: Angus and Robertson, 1986, 644pp.
[3] Hoegh-Guldberg O. Climate change, coral bleaching and the future of the world's coral reefs. Marine Fresh. Research 1999;50:839–66.
[4] Wilkinson CR, editor. Status of coral reefs of the world: 1998. Australian Institute of Marine Science, and Global Coral Reef Monitoring Network, Townsville, Australia, 1998.
[5] Hatcher BG. Coral reef primary productivity: a beggar's banquet. Trends in Ecology and Evolution 1988;3:106–11.
[6] UNEP/IUCN. Coral reefs of the world. vol. 2: Indian Ocean, Red Sea and Gulf. UNEP Regional Seas Directories and Bibliographies. IUCN, Gland, Switzerland and Cambridge, UK. UNEP, Nairobi, Kenya. 1988. 389pp.
[7] Wilkinson CR, Linden O, Cesar HSJ, Hodgson G, Rubens J, Strong AE. Ecological and socio-economic impacts of the 1998 coral mortality in the Indian Ocean: an Enso impact and a warning of future change?. Ambio 1999;28:188–96.
[8] Wilkinson CR. Coral reefs of the world are facing widespread devastation: can we prevent this through sustainable management practices? Proceedings of 7th International Coral Reef Symposium, vol. 1, 1993. p. 11–21.
[9] Jameson SC, McManus JW, Spalding MD. State of the reefs: regional and global perspectives. Washington, DC: U.S. Department of State, 1995. 26 pp.
[10] Roberts CM. Effects of fishing on ecosystem structure of coral reefs. Conservation Biology 1995;9:988–95.
[11] Jennings S, Polunin NVC. Impacts of fishing on tropical reef ecosystems. Ambio 1996;25:44–9.
[12] McManus JW. Tropical marine fisheries and the future of coral reefs: a brief overview with emphasis on South-east Asia. Proceedings of 8th International Coral Reef Symposium, vol. 1, 1997. p. 129–34.
[13] Johnstone RW, Muhando CA, Francis J. The status of the coral reefs of Zanzibar: one example of a regional predicament. Ambio 1998;27:700–7.
[14] Gardiner JS. The reefs of the western Indian Ocean. 1. Chagos Archipelago. 2. The Mascarene region. Transactions of Linnean Society of London 1936;19:393–436.
[15] IUCN/UNEP. Management and conservation of renewable marine resources in the Indian Ocean region: overview. UNEP Regional Seas Reports and Studies, 60. 1985. 74 pp.
[16] Malakoff D. Extinction on the high seas. Science 1997;277:487–8.
[17] Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neil RV, Paruelo J, Raskin RG, Sutton R, van den Belt M. The value of the world's ecosystem services and natural capital. Nature 1997;387:253–60.

[18] Bryant D, Burke L, McManus J, Spalding M. Reefs at risk: a map-based indicator of threats to the world's coral reefs. Washington, DC: World Resources Institute, 1998. 56 pp.
[19] Gomez ED. Reef management in developing countries: the Philippines as a case study. Proceedings of 8th International Coral Reef Symposium, vol. 1, 1997. p. 123–8.
[20] Linden O. Human impact on tropical coastal zones. Nature and Resources 1990;26:3–11.
[21] Birkeland C, editor. Life and death of coral reefs. New York: Chapman & Hall, 1997. 536 pp.
[22] Cesar HSJ. Socio-economic aspects of the 1998 coral bleaching event in the Indian Ocean. In: Linden O, Sporong N, editors. Coral reef degradation in the Indian Ocean: status report and project presentations 1999. CORDIO, SAREC Marine Science Programme, 1999. p. 82–5.
[23] Berg H, Öhman MC, Troëng S, Linden O. Environmental economics of coral reef destruction in Sri Lanka. Ambio 1998;27:627–34.
[24] Hinrichsen D. Coastal waters of the world: trends, threats and strategies. Washington DC: Island Press, 1998. 275 pp.
[25] Norse E, editor. Global marine biological diversity: a strategy for building conservation into decision making. Washington, DC: Island Press, 1993.
[26] Paulay G. Diversity and distribution of coral reef organisms. In: Birkeland C, editor. Life and death of coral reefs. New York: Chapman & Hall, 1997. p. 298–345.
[27] Bakus GJ. Chemical defense mechanisms on the Great Barrier Reef. Science 1981;211:497–9.
[28] Coll JC, Sammarco PW. Terpenoid toxins of soft corals (Cnidaria: Octocorallia): their nature, toxicity and ecological significance. Toxicon 1983;3(Suppl.):69–72.
[29] Gunthorpe L, Cameron AM. Widespread but variable toxicity in scleractinian corals. Toxicon 1991;28:1199–219.
[30] Gunthorpe L, Cameron AM. Toxic exudate from the hard coral *Goniopora tenuidens*. Toxicon 1991;28:1347–50.
[31] Fearon RJ, Cameron AM. Larvotoxic extracts of the hard coral *Goniopora tenuidens*: allelochemicals that limit settlement of potential competitors?. Toxicon 1996;34:361–7.
[32] Fearon RJ, Cameron AM. Preliminary evidence supporting the ability of hermatypic corals to affect adversely the larvae and early settlement stages of hard coral competitors. Journal of Chemical Ecology 1998;23:1769–80.
[33] Shick JM, Lesser MP, Jokiel PL. Ultraviolet radiation and coral stress. Global Change Biology 1996;2:527–45.
[34] Fenical W. Marine biodiversity and the medicine cabinet: the status of new drugs from marine organisms. Oceanography 1996;9:23–4.
[35] Maragos JE, Crosby MP, McManus JW. Coral reefs and biodiversity: a critical and threatened relationship. Oceanography 1996;9:83–99.
[36] Zilinskas RA, Lundin CG, Marine biotechnology and developing countries. World Bank Discussion Paper # 210, World Bank, Washington, DC, 1993.
[37] de Silva ED, Scheuer PJ. Manoalide, an antibiotic sesterterpenoid from the marine sponge Luffariella variabilis (Polejaeff). Tetrahedron Letters 1980;21:1611–4.
[38] Jacobs RS, Culver P, Langdon R, O'Brian T, White S. Some pharmacological observations on marine natural products. Tetrahedron 1985;41:981–4.
[39] Faulkner DJ. Marine natural products. Natural Product Reproduction 1986;3:1–33.
[40] Look SA, Fenical W, Jacobs RS, Clardy J. The pseudopterosins: a new class of antiinflammatory and analgesic natural products from the sea whip *Pseudopterogorgia elisabethae*. Proceedings of the National Academy of Sciences 1986;78:2825–9.
[41] Rinehart Jr. KL, Shaw PD, Shield LS, Gloer JB, Harbour GC, Kker MES, Samain D, Schwartz RE, Tymiak AA, Weller DL, Carter GT, Monro MHG, Huges Jr. RG, Reins HE, Swynenberg JH, Stringfellow DA, Vavra JJ, Coats JH, Zurenko GE, Kuentzel SL, Li LH, Bakus GJ, Brusca RC, Craft LL, Young DN, Connor JL. Marine natural products as sources of antiviral, antimicrobial, and antineoplastic agents. Pure and Applied Chemistry 1981;53:795–817.
[42] Powers DA. New frontiers in marine biotechnology: opportunities for the 21st century. In: Lundin CG, Zilinskas RA, editors. Marine biotechnology in the Asian pacific region: Sida-SAREC Marine Science Program & World Bank Environment Department, 1995.

[43] Nowlis JS, Roberts CM, Smith AH, Siirila E. Human-enhanced impacts of a tropical storm on nearshore coral reefs. Ambio 1997;26:515–21.
[44] Shah NJ, Linden O, Lundin CG, Johnstone RW. Coastal management in Eastern Africa: status and future. Ambio 1997;26:227–34.
[45] Cesar HSJ, Lundin CG, Bettencourt S, Dixon J. Indonesian coral reefs: an economic analysis of a precious but threatened resource. Ambio 1997;26:345–50.
[46] Coughanowr CA, Ngoile M, Linden O. Coastal zone management in eastern Africa including island states: a review of initiatives. Ambio 1995;24:448–57.
[47] Öhman M, Rajasuriya A, Linden O. Human disturbance on coral reefs in Sri Lanka: a case study. Ambio 1993;22:474–80.
[48] Clark S, Edwards AJ. Coral transplantation as an aid to reef rehabilitation. Coral Reefs 1995;14:201–13.
[49] Gomez ED, Deocadiz E, Hungspreugs M, Jothy AA, Kuan Kwee Jee, Soegiarti A, Wu RSS. The state of the marine environment in the east Asian seas region. UNEP Regional Seas Reports and Studies No. 126. UNEP, 1990.
[50] Lundin CG, Linden O. Coastal ecosystems: attempts to manage a threatened resource. Ambio 1993;22:468–73.
[51] Luckhurst BE, Luckhurst K. Analysis of the influence of substrate variables on coral reef fish communities. Marine Biology 1978;49:317–23.
[52] McClanahan TR. Kenyan coral reef lagoon fish: effects of fishing, substrate complexity and urchins. Coral Reefs 1994;13:231–41.
[53] McCormick MI. Comparison of field methods for measuring surface topography and their association with a tropical reef fish community. Marine Ecology Progress Series 1994;112:87–96.
[54] Jones RJ, Steven AL. Effects of cyanide on corals in relation to cyanide fishing on reefs. Marine Fresh. Research 1997;48:517–22.
[55] Jones RJ, Hoegh-Guldberg O. The effect of cyanide on the photosynthesis of zooxanthellae in reef-building corals. Marine Ecology Progress Series 1999;177:83–91.
[56] McClanahan TR, Muthiga NA. Changes in Kenyan coral reef community structure due to exploitation. Hydrobiologia 1988;166:269–76.
[57] Done TJ. Phase shifts in coral reef communities and their ecological significance. Hydrobiologia 1990;247:121–32.
[58] Hughes TP. Catastrophes, phase shifts and large-scale degradation of a Caribbean coral reef. Science 1994;265:1547–51.
[59] Trench RK. The cell biology of plant–animal symbiosis. Annual Review of Plant Physiology 1979;30:485–531.
[60] Rowan R, Powers DA. Molecular genetic identification of symbiotic dinoflagellates (zooxanthellae). Marine Ecology Progress Series 1991;71:65–73.
[61] Rowan R, Powers DA. Ribosomal RNA sequences and the diversity of symbiotic dinoflagellates (zooxanthellae). Proceedings of the National Academy of Sciences 1992;89:3639–43.
[62] Muscatine L. Nutrition of corals. In: Jones OA, Endean R, editors. Biology and geology of coral reefs, vol. 2. New York: Academic Press, 1973. p. 77–115.
[63] Muscatine L. The role of symbiotic algae in carbon and energy flux in reef corals. In: Dubinsky Z, editor. Ecosystems of the world, 25, Coral reefs. Amsterdam: Elsevier, 1990. p. 75–87.
[64] Swanson R, Hoegh-Guldberg O. The assimilation of ammonium by the symbiotic sea anemone *Aiptasia pulchella*. Marine Biology 1998;131:83–93.
[65] Glynn PW. El Niño-Southern Oscillation 1982–1983: nearshore population, community, and ecosystem responses. Annual Review of Ecological Systems 1988;19:309–45.
[66] Glynn PW. Coral bleaching in the 1980's and possible connections with global warming. Trends in Ecology and Evolution 1991;6:175–9.
[67] Hoegh-Guldberg O, Smith GJ. The effect of sudden changes in temperature, irradiance and salinity on the population density and export of zooxanthellae from the reef corals *Stylophora pistillata* (Esper, 1797) and *Seriatopora hystrix* (Dana, 1846). Journal of Experiments in Marine Biology and Ecology 1989;129:279–303.

[68] Gleason DF, Wellington GM. Ultraviolet radiation and coral bleaching. Nature 1993;365: 836–8.
[69] Muller-Parker G, D'Elia CF. Interactions between corals and their symbiotic algae. In: Birkeland C, editor. Life and death of coral reefs. New York: Chapman & Hall, 1997. p. 96–113.
[70] Glynn PW. Coral reef bleaching ecological perspectives. Coral Reefs 1993;12:1–17.
[71] Fagoonee IHB, Wilson MP, Hassell, Turner JR. The dynamics of zooxanthellae populations: a long-term study in the field. Science 1999;283:843–5.
[72] Goreau TF. Mass expulsion of zooxanthellae from Jamaican reef communities after hurricane Flora. Science 1964;145:383–6.
[73] Egana AC, DiSalvo LH. Mass expulsion of zooxanthellae by Easter Island corals. Pacific Science 1982;36:61–3.
[74] Lesser MP, Stochaj WR, Tapley DW, Shick JM. Bleaching in coral reef anthozoans: effects of irradiance, ultraviolet radiation, and temperature on the activities of protective enzymes against active oxygen. Coral Reefs 1990;8:225–32.
[75] Brown BE. Coral bleaching: causes and consequences. Proceedings of 8th International Coral Reef Symposium, vol. 1, 1997. p. 65–74.
[76] Jones RJ, Hoegh-Guldberg O, Larkum AWL, Schreiber U. Temperature induced bleaching of corals begins with impairment of dark metabolism in zooxanthellae. Plant Cell and Environment 1998;21:1219–30.
[77] Jokiel PL, Coles SL. Effects of temperature on the mortality and growth of Hawaiian reef corals. Marine Biology 1977;43:201–8.
[78] Coles SL, Jokiel PL. Synergistic effects of temperature, salinity and light on the hermatypic coral *Montipora verrucosa*. Marine Biology 1978;49:187–95.
[79] Glynn PW, D'Croz L. Experimental evidence for high temperature stress as the cause of El Niño coincident coral mortality. Coral Reefs 1991;8:181–91.
[80] Goreau TJ, Hayes RM. Coral bleaching and ocean "Hot spots". Ambio 1994;23:176–80.
[81] Kushmaro A, Loya Y, Fine M, Rosenberg E. Bacterial infection and coral bleaching. Nature 1996;380:396.
[82] Iglesias-Prieto R, Matta WA, Robins WA, Trench RK. Photosynthetic response to elevated temperature in the symbiotic dinoflagellate *Symbiodinium microadriaticum* in culture. Proceedings of the National Academy of Sciences 1992;89:10302–5.
[83] Fitt WK, Warner ME. Bleaching patterns of four species of Caribbean reef corals. Biological Bulletin (Woods Hole) 1995;187:298–307.
[84] Iglesias-Prieto R. The effects of elevated temperature on the photosynthetic responses of symbiotic dinoflagellates. In: Mathis P, editor. Light to biosphere, vol. 4. Netherlands: Kluwer Academic Publishers, 1995. p. 793–6.
[85] Warner ME, Fitt WK, Schmidt GW. The effects of elevated temperature on the photosynthetic efficiency of zooxanthellae in hospite from four different species of reef coral: a novel approach. Plant, Cell and Environment 1996;19:291–9.
[86] Linden O, Sporong N, editors. Coral reef degradation in the Indian Ocean: status report and project presentations 1999. CORDIO, SAREC Marine Science Programme. 1999. 108pp.
[87] Rajasuriya A, Maniku MH, Subramanian BR, Rubens J. Coral reef ecosystems in South Asia. In: Linden O, Sporong N, editors. Coral reef degradation in the Indian Ocean: status report and project presentations 1999: CORDIO, SAREC Marine Science Programme, 1999. p. 11–24.
[88] Reef Check. http://www.ust.hk/~webrc/ReefCheck/press.html, 1998.
[89] Hadlee Centre. Climate change and its impacts: some highlights from the ongoing UK research programme: a first look at results from the Hadlee Centre's new climate model. November 1998. The Meteorological Office, UK, 1998.
[90] Grigg RW, Maragos JE. Recolonization of hermatypic corals on submerged lava flows in Hawaii. Ecology 1974;55:387–95.
[91] Endean R. Population explosions of *Acanthaster planci* and associated destruction of hermatypic corals in the Indo-west Pacific region. In: Endean R, Jones OA, editors. Biology and geology of coral reefs, vol 2: Biology 1. New York: Academic Press, 1973. p. 389–438.

[92] Potts DC. Crown-of-thorns starfish — man-induced pest of natural phenomenon?. In: Kitching RL, Jones RE, editors. The ecology of pests. Melbourne: CSIRO, 1981. p. 55–86.

[93] Moran PJ. The *Acanthaster* phenomenon. Oceanogr. Marine Biology Annual Review 1986;24:379–480.

[94] Birkeland C, Lucas JS. *Acanthaster planci*: major management problem of coral reefs. Boca Raton: CRC Press, 1990. 257 pp.

[95] Chesher R. Destruction on Pacific corals by the sea star *Acanthaster planci*. Science 1969;165:280–3.

[96] Pearson R, Endean R. A preliminary study of the coral predator *Acanthaster planci* (L.) (Asteroidea) on the Great Barrier Reef. Queensland Fisheries Notes (Department of Harbours and Manne) 1969;3:22–55.

[97] Endean R, Stablum W. A study of some aspects of the crown-of-thorns starfish (*Acanthaster planci*) infestations of reefs of Australia's Great Barrier Reef. Atoll Research Bulletin 1973;167:1–20.

[98] Nishihira M, Yamazato K. Human interferance with the coral reef community and *Acanthaster* infestation of Okinawa. Proceedings of 2nd International Coral Reef Symposium, vol. 1. 1974. p. 577–90.

[99] Westmacott S, Cesar HSJ, Pet-Soede L. Socio-economic assessment of the impacts of the 1998 coral bleaching in the Indian Ocean. Report to CORDIO. CORDIO, SAREC Marine Science Programme. 2000. 16 pp.

[100] Yap HT, Alino PM, Gomez ED. Trends in growth and mortality of three coral species (Anthozoa: Scleractinia), including effects of transplantation. Marine Ecology Progress Series 1992;83:91–101.

[101] Lindahl U. Low-tech rehabilitation of coral reefs through transplantation of staghorn corals. Ambio 1998;27:645–50.

[102] Linden O, Lundin CG, editors. The journey from Arusha to Seychelles: success and failures of integrated coastal zone management in eastern Africa and island states. The World Bank, Sida/SAREC Marine Science Programme. 1997. 298 pp.

[103] Moffat D, Ngoile MN, Linden O, Francis J. The reality of the stomach: coastal management at the local level in eastern Africa. Ambio 1998;27:590–8.

[104] Johnstone RW, Olafsson E. Some environmental aspects of open water lagal cultivation: Zanzibar. Tanzania. Ambio 1995;24:465–9.

[105] Kelleher G, Bleakley C, Wells SM. A global representative system of marine protected areas. Central Indian Ocean, Arabian Seas, East Africa and East Asian Seas. vol. III. Washington DC: The World Bank, 1995. 147 pp.

[106] Polunin NVC, Roberts CM. Greater biomass and value of target coral reef fishes in two small Caribbean marine reserves. Marine Ecology Progress Series 1993;100:167–76.

[107] Wantiez L, Thollot P, Kullucki M. Effects of marine reserves on coral reef fish communities from five islands in New Caledonia. Coral Reefs 1997;16:215–24.

[108] Kelleher G, Kenchingoton R. Guidelines for establishing marine protected areas. A marine conservation and development report. Gland, Switzerland. IUCN, 1992.

[109] McClanahan TR. Is there a future for coral reef marine parks in poor tropical countries? Coral Reefs 1999;18:321–5.

[110] Russ GR, Alcala AC. Natural fishing experiments in marine reserves 1983 – 1993: community and trophic responses. Coral Reefs 1998;17:383–97.

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M. Spalding et al., *World Atlas of Coral Reefs* (2001)

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World Atlas of Coral Reefs

Mark D. Spalding, Corinna Ravilious, and Edmund P. Green

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY LOS ANGELES LONDON

World Atlas of Coral Reefs

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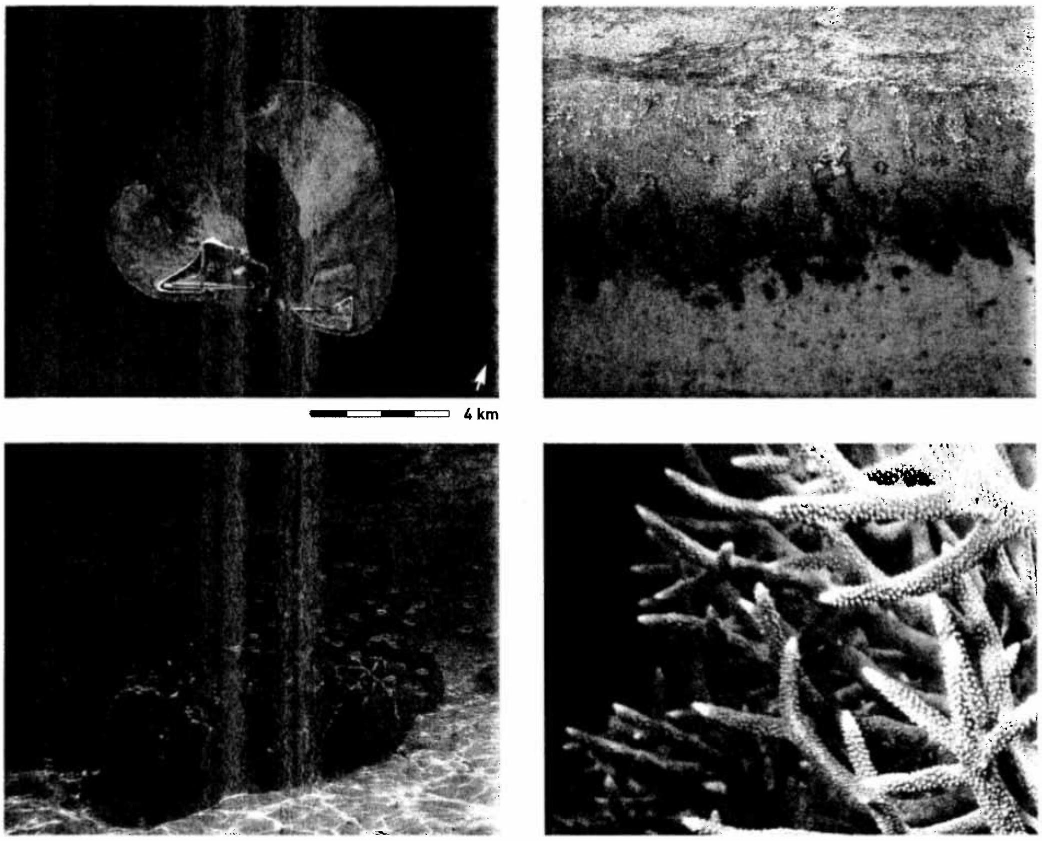
UNEP WCMC

The UNEP World Conservation Monitoring Centre provides objective, scientifically rigorous products and services that include ecosystem assessments, support for implementation of environmental agreements, regional and global biodiversity information, research on threats and impacts, and development of future scenarios for the living world.

The Centre became the biodiversity information and assessment arm of the United Nations Environment Programme in June 2000. It was founded in 1979 by IUCN and in 1988 was transformed into a joint activity of IUCN, WWF and UNEP. The financial support and guidance of these organizations in the Centre's formative years is gratefully acknowledged.

CHAPTER 1
The World of Coral Reefs



Coral reefs are among the most diverse and complex of all ecosystems; they are among the most heavily utilized and economically valuable to humankind; and they are also among the most beautiful and fascinating. In order to understand what lies behind such accolades it is important to appreciate exactly what coral reefs are, how they are formed and where they are found. Building on such a foundation it is also valuable to develop a basic understanding of some of the organisms that make up the complexity of life on coral reefs, and what role they play in maintaining these ecosystems. Such knowledge provides the basis for a wider understanding of the interactions of humans and reefs. It is also critical for understanding the changes that are now occurring on coral reefs, and for responding to such changes.

This chapter offers a simple definition and description of coral reefs. It goes on to provide an overview of their distribution, and of the organisms that make them up. It considers the elements determining these distribution patterns, from factors of geological history to present day limiting processes and the very important role of ocean currents. The chapter also looks briefly into some of the patterns of biodiversity which are observed at finer resolutions, patterns which are observed between neighboring reefs, and zonation patterns across individual reefs. Finally, the chapter provides an overview of the main organisms which make up the patterns of life on coral reefs.

Above, left: Midway Islands (STS055-82-63, 1993). Above, right: The edge of the reef, with spur and groove formations, Great Barrier Reef. Below, left: Shallow waters of an atoll lagoon. Below, right: The intricate branches of an Acropora *coral.*

Defining coral reefs

For all those who have seen one, a coral reef is relatively simple to describe. From land or from the air, reefs are usually clearly visible, marked by a complex patterning of bright colors. These arrays of blues, turquoises and greens delimit a diverse and complex physical structure coming close to the ocean surface. The shallowest points are frequently shown by the brilliant white of breaking surf, and may even briefly become dry land during the lowest tides. From underwater the complexity is still more clearly shown – reefs are typified by the presence of large stony corals growing in profusion and by an often bewildering array of species growing or moving among them. Moving across a reef, patterns or zones become apparent, each dominated by different organisms, depending on factors such as depth, shelter and water movements.

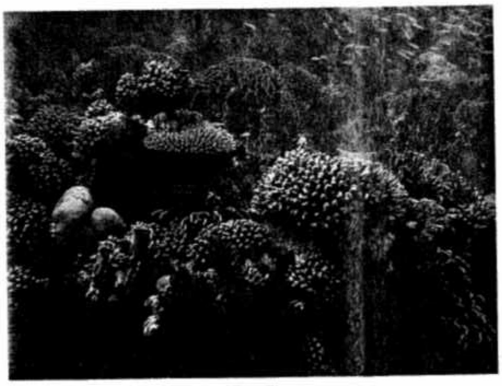
Although simplistic, such descriptions incorporate the key elements of a more thorough scientific definition of a coral reef. Coral reefs are shallow marine habitats, defined both by a physical structure and by the organisms found on them.

Corals themselves are very simple organisms. They are found in all the world's oceans, at all depths. Although described in more detail later in this chapter, typically they have a very small cylindrical body, topped with a ring of tentacles which are used to capture food from the surrounding waters. A large number of corals have developed the ability to live in colonies and to build up a communal skeleton. Among these are many species which lay down a stony skeleton of calcium carbonate. These corals are known as hermatypic or reef-building corals. They are almost entirely confined to areas of warm, shallow water, and it is their skeletons, essentially built of limestone, which are critical to the formation of coral reefs.

Even in ideal conditions, these hermatypic corals are slow growing. Some massive corals, which typically grow as large dome-shaped structures, may build up a skeleton at rates of just a few millimeters per year. The faster growing tips of branching corals may extend at rates of 150 millimeters per year or more.

Over centuries or millennia the active growth of these corals (alongside other organisms such as coralline algae, which also lay down calcium carbonate skeletons) leads to the building up of vast carbonate structures. The process is not simple, and numerous additional factors come into play. Storms frequent many areas of tropical coastlines and the waves they produce can, quite literally, pound a reef to rubble in a few hours. Over longer time scales, corals are eroded by countless organisms. Some fish bite large chunks out of them, digesting the coral tissues and algae on their surface. Unseen but equally important is a great diversity of bio-eroding organisms that burrow into or chemically dissolve the coral rock, weakening and destroying its structure. Sand and rubble from these apparently destructive activities often fill the interstices of the reef, while certain algae and other corals may then bind or overgrow such loose materials, cementing them together with more calcium carbonate to form a yet more solid structure.

In this way a coral reef is built. Only a tiny fraction of the growth of individual corals is converted into upwards development of a reef structure, and so their formation takes place over geological time scales. The most rapid periods of reef "growth" have shown upwards accumulation of reef structures reaching 9-15 meters in 1 000 years in some areas, but much lower figures are probably



Above: Individual polyps of the great star coral Montastrea cavernosa, *clearly showing the cylindrical body, with a ring of tentacles. Below: The growth of numerous corals builds up the massive physical structure of an Indian Ocean reef.*

more normal. In fact the majority of reef structures that exist today are not the result of continuous growth, but of pulses of growth interspersed with quiescent periods, or even periods of erosion, when the reefs might be defined as fossil or non-living reefs. Sea levels in the oceans have varied dramatically, particularly during the recent ice ages, and many reefs have intermittently become dry land, or have been flooded by waters too deep to allow corals to grow. Between these extremes, however, some of these fossil structures become recolonized by corals and reef development recommences.

Over shorter time scales, the division between an actively growing coral reef and a fossil reef is, in many areas, unclear. No reef is in a constant state of growth. During major tropical storm events, all reefs undergo losses in coral cover and often considerable erosion of their physical structure. Over years or decades, the extent of actively growing coral cover also varies considerably. Recently observed events, including coral disease, coral bleaching, outbreaks of the coral-feeding crown-of-thorns starfish, or the die-off of important grazers such as the long-spined sea urchin (see page 61), have all produced considerable losses of live coral cover to some reefs. Recovery from such events points to a natural resilience, but also shows that any understanding of a "reef" measured from only one particular moment in time will be limited.

Taking such points into consideration, a coral reef can thus be more rigorously defined as a physical structure which has been built up, and continues to grow over decadal time scales, as a result of the accumulation of calcium carbonate laid down by hermatypic corals and other organisms. The manner in which such structures develop has led to the recognition of a number of types of reef, while there are also many other communities which, while not as obviously covered by these definitions, are clearly related and equally important.

Types of reef

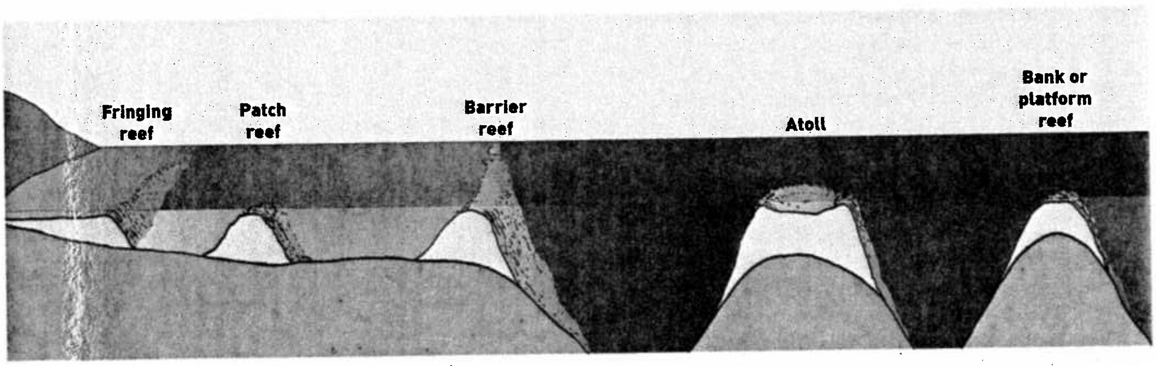
Corals can only grow in warm, well lit waters and require a solid surface on which to settle. These factors restrict the initial appearance of hermatypic corals to shallow rocky substrates in the tropics. As corals proliferate, their skeletons provide a solid substrate for the appearance and settlement of more corals and other organisms. The upward growth of a physical reef structure can also allow corals to continue to grow in shallow well lit waters, even if the basement on which they are growing subsides or sea levels rise.

Fringing reefs are perhaps the simplest structures to understand. These develop from the simple upward growth of a calcium carbonate platform from a shelving coastline. Because growth is most rapid and prolific in shallow water the corals quickly grow to the surface and produce a shallow platform which is usually around the level of the lowest tides. Further offshore growth is slower, but the typical structure of a mature fringing reef includes a shallow platform out to a sharply defined edge, the reef crest, beyond which there is a steeply shelving reef front dropping down to the sea floor.

Barrier reefs are usually older structures rising up from a deeper base at some distance from the shore, with a lagoon separating them from the coast. Some have their origins as fringing reefs on shelving coastlines, but develop when the coastline on which they are growing subsides or is flooded by rising sea levels. Under these conditions the fringing reef continues to grow upwards, but deeper waters fill in a lagoon between this structure and the coastline. In other cases barrier reefs may have simply developed in offshore locations, but still remain separated from the coast by a lagoon.

Atolls are unique reef formations, broadly circular, and enclosing a wide lagoon. They are typically found in oceanic locations, away from the continental shelf.

Figure 1.1: The main types of coral reef structure



Darwin was the first to correctly understand their origin. They initially form as fringing reefs around isolated, usually volcanic, islands. Such islands then subside, but the reefs continue to grow, first forming a barrier around the sinking island, but then, as the island disappears beneath the surface, forming a single ring of coral. The depths of coral limestone which may accrue on these structures are considerable – drilling in the Marshall Islands has revealed reef deposits up to 1.4 kilometers in depth, dating back over 50 million years.

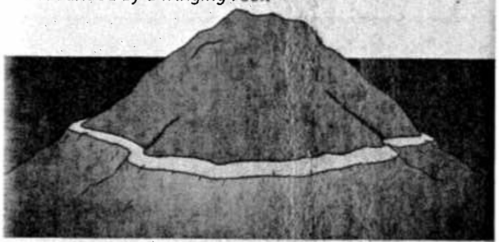
Bank or platform reefs are simple physical structures with a variety of origins. They are essentially reefs with no obvious link to a coastline, but without the clear structure of a barrier reef or atoll. In some cases they may have similar origins to either of the latter, but do not hold back or encircle a lagoon, in other cases they may have simply grown up over natural rises in the coastal shelf. Larger or slightly submerged reef structures of this type are also sometimes referred to as shoals.

Other types of reef and coral communities

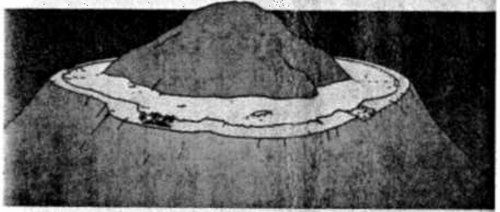
These reef types can be clearly illustrated (Figure 1.1). However, the reality often reveals many other structures which do not conform quite so easily to strict definitions. Near-atolls are described in a few areas where there is a tiny remnant of the original high island in the center of an atoll ring. There are also a considerable number of atoll-like platform reefs which may not have the true geological origin of an atoll (around a subsiding volcanic island), but where the surface structure is almost exactly that of an atoll. There are also a number of structures which lie offshore in the location of a true barrier reef, but which may not quite conform to the definition or geological origin of a barrier reef. Bank barriers are commonly described in parts of the Caribbean where small banks lie at some distance offshore and sometimes do not rise all

Figure 1.2: The development of an atoll, based on Darwin's original theory

A volcanic island is colonized by corals and becomes surrounded by a fringing reef.



The island itself subsides, the corals continue to grow and a barrier reef is formed.



The island is lost, but coral maintains upward growth and a ring-shaped atoll is formed.

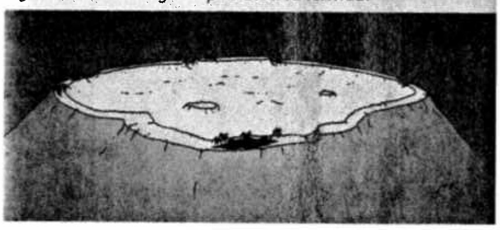


Table 1.1: Estimates of global reef area calculated from the reef maps

Region	Area (km²)	% of world total
Atlantic and Caribbean	21 600	7.6
Caribbean	20 000	7.0
Atlantic	1 600	0.6
Indo-Pacific	261 200	91.9
Red Sea and Gulf of Aden	17 400	6.1
Arabian Gulf and Arabian Sea	4 200	1.5
Indian Ocean	32 000	11.3
Southeast Asia	91 700	32.3
Pacific	115 900	40.8
Eastern Pacific	1 600	0.6
Total	**284 300**	

Figures are rounded to the nearest 100 square kilometers, and percentage figures to one decimal place. National level statistics are provided in the regional accounts later in this book. In order to avoid the problems associated with using maps prepared at multiple scales, such calculations are made by first simplifying the global coverage down to a 1 kilometer grid, each grid cell being simply marked as reef or non-reef. Reef area is then calculated as the total of 1 square kilometer cells with reef. Although this method exaggerates the total area from that actually shown on the maps, this can be justified on the grounds that the maps only show reef flat to reef crest areas, while the true reefs extend beyond these areas (see also Chapter 3).

the way to the sea surface. The long offshore reef tracts of Florida, Cuba and elsewhere rival many true barrier reefs in length, but are frequently not regarded as true barrier reefs because they are only separated from the mainland by a very shallow lagoon, or because they are not located on the edge of the continental shelf. Small physical structures, often lying within the wider formation of a barrier or atoll lagoon, are often referred to as patch reefs.

Perhaps more importantly, there are significant areas around the world where there are coral communities which perform the same ecological function as coral reefs, but lack a clear physical structure. These include recent formations where there may be a thin veneer of live coral, or they may be physical reefs, but not yet mature or clearly visible. For clarity such structures are frequently referred to as coral communities, submerged reefs, or sub-surface reefs.

Global distribution

Charles Darwin was probably the first person to prepare a global map of coral reefs. His and other efforts are described in Chapter 3. Coral reefs are restricted to a broad swathe, roughly confined to the tropics, and circling most of the globe (Map 1.1). Within this range they are far from evenly distributed, with large areas confined to remote island regions and offshore areas far from major land masses. Further investigation shows that coral reefs are largely absent from the Central Atlantic and the shores of West Africa, they are highly restricted along the western (Pacific) shores of the Americas, and are also restricted along the coastline of South Asia from Pakistan to Bangladesh.

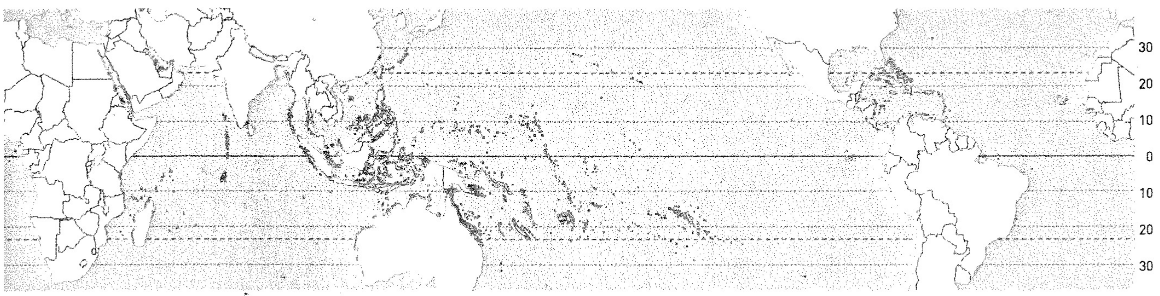
Using the maps shown in this publication it is possible to estimate the total area of coral reefs in the world. Although there are clear limitations to such estimates, these figures are clearly valuable for getting an overall perspective on the area of coral reefs in the world, and in allowing for regional comparisons. There are an estimated 284 300 square kilometers of coral reefs worldwide[1]. This figure represents only 0.089 percent of the world's oceans and less than 1.2 percent of the world's continental shelf area. Thus, at the global scale, coral reefs are a rare habitat. Further analysis clearly shows that the great majority of coral reefs are found in the region known as the Indo-Pacific, which stretches from the Red Sea to the Central Pacific. Less than 8 percent of the world's reefs are found in the Caribbean and Atlantic.

Zooming in to these maps, new patterns emerge at finer resolutions. Reefs are often limited in their development in the nearshore waters of large continental land masses, although barrier structures are widespread in such places. They are poorly developed close to large river mouths. In contrast, they are particularly well developed around islands and along the coastlines of drier continental areas.

In order to understand these patterns of reef distribution it is necessary to look at the organisms which make up the coral reef ecosystem. The factors impinging on their evolution, dispersion, and survival are the same factors which have created the patterns in coral reef distribution that we see today.

1. The reef area figures used throughout this work are based on a new calculation, and replace the early estimate provided by Spalding and Grenfell (1997) of 255 000 square kilometers. It is likely, as mapping work continues, that such figures will continue to be refined and improved. This may lead to further upwards adjustment of the global total, although in some areas there is also likely to be some reduction of figures as maps are improved. Thus it seems unlikely that a "final" figure would exceed 300 000 square kilometers.

Map 1.1: The coral reefs of the world



Distribution of scleractinian corals

Patterns of diversity

Observations of life on coral reefs reveal a number of striking patterns in the distribution of species. At the global level, few species are ubiquitous. Some may be widespread across one or even two ocean basins, but many others are restricted to certain oceans or particular seas.

As a larger picture is built up through looking at many species, certain patterns emerge. Some regions are highly distinctive with large numbers of endemic species, found nowhere else. The total diversity of species is also uneven, with centers of particularly high diversity, and with clear gradients in diversity mirroring environmental gradients.

When looking at finer resolutions, new patterns emerge. Certain species appear to predominate in near continental reefs, while others are found on oceanic reefs. Closer still, and the position on the continental shelf, or that relative to the prevailing wind or currents, appears to hold sway in determining the species composition. At the scale of tens or hundreds of meters, patterns of zonation are observed across individual reefs, with species adapted to different depths, exposure, water circulation and so on.

Finally, at the scale of individual points or quadrats, the pattern of which species are found where seems to disappear in a random noise. Even here, however, the factors driving the settlement and survival of individuals may be far from chaotic, but driven by highly complex interactions, both in the immediate sense and over the life history of the individual.

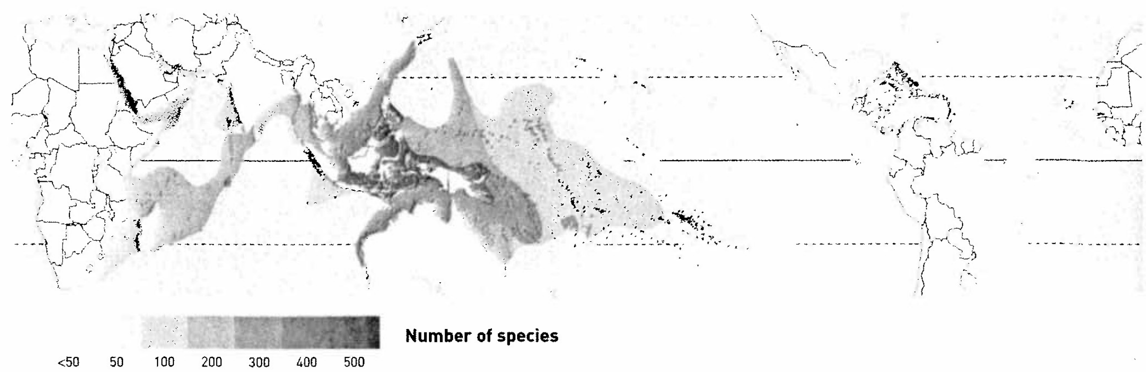
Patterns at the global scale

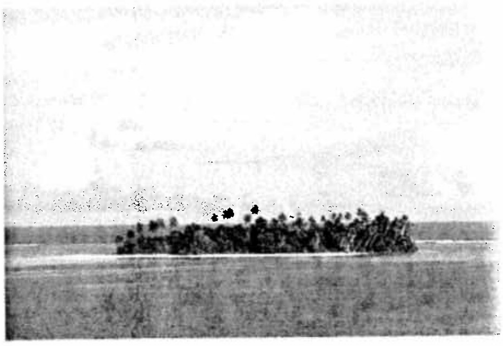
Corals are clearly the most important organisms when it comes to understanding the factors that drive the distribution of coral reefs. The majority of reef-building corals fall within the group known as Scleractinia. They have been the subject of continuing studies by biologists and taxonomists for many years, and a considerable amount is now known about their distribution and about the factors which influence it. Some 794 species of scleractinian coral are considered to be reef builders, and Map 1.2 shows a plot of their distribution, highlighting the patterns of varying diversity. A number of points can be observed:

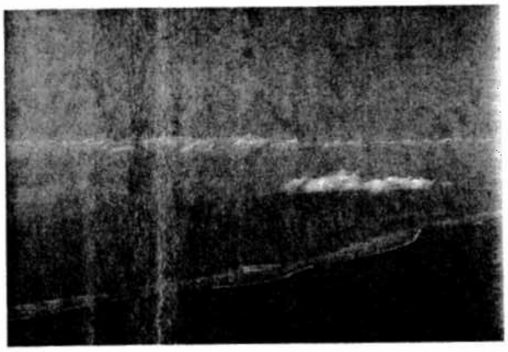
- Corals, like the reefs they build, are restricted to a narrow band of low latitudes, with diversity diminishing fairly rapidly along latitudinal clines.
- There are two distinctive regions of coral distribution, one centered around the Wider Caribbean (the Atlantic), the other reaching from East Africa and the Red Sea to the Central Pacific (the Indo-Pacific).
- Diversity is far lower in the Atlantic than in the Indo-Pacific.
- Coral diversity is at its highest around insular Southeast Asia.
- Coral diversity and reef development are very restricted along the western shores of the Americas and West Africa.

Although only relating to corals, these patterns are reflected in most other groups found in tropical coastal

Map 1.2: Patterns of diversity in reef-building scleractinian corals







waters, as shown by the statistics in Table 1.2. These and other patterns are derived from a complex interaction of historical and contemporary factors. For some groups, the parallel with coral diversity patterns may reflect direct ecological associations between them. However, for a number of others, it may be the same external factors which have actually driven the change. A number of these factors are briefly laid out below.

The influence of temperature

To a large extent, both scleractinian corals and the reefs they build are restricted to a latitudinal band between 30°N and 30°S. This general observation is entirely related to the decreasing temperatures which generally follow increasing latitude. Most reef corals cannot survive in temperatures much below 16-18°C for even a few weeks. In conditions of extreme cold, corals can die within a matter of hours or days, while under slightly less extreme conditions, their growth rates are reduced. There is some evidence that overgrowth by algae rather than the direct influence of cold water may restrict coral development in some high latitude areas.

High temperatures are also inimical to coral growth. Extreme high temperatures drive the phenomenon known as "coral bleaching", during which the corals expel their symbiotic algae (see Chapter 2). Aside from human-induced climate change, it has been suggested that occasional high temperatures associated with El Niño events may be at least a partial explanation for the highly limited reef development which is observed, for example, along the western shores of the Americas.

The role of currents

While temperature influences can be broadly equated with latitude, ocean currents can disrupt these simple patterns. In a few areas of the world, major warm currents flow all year round from the tropics into higher latitudes. These have allowed the development of reefs quite beyond their normal limits. Notable are the Leeuwin Current in Western Australia; the East Australian Current; the Kuroshio Current in Japan; and the Gulf Stream warming the isolated oceanic reefs of Bermuda. In a similar way, cold waters prevent reef growth. Cold water upwellings along the coastlines of northeastern Somalia and southern Arabia are perhaps the clearest example, while the extremely limited development of reefs and coral communities along the western coastlines of the Americas and West Africa may also be influenced by cold water upwellings.

Another role of currents is in the transport of larvae to areas of reef. The establishment of corals in new areas is dependent on the transport of coral larvae in ocean

Left, above: A small coral cay on the reef flat of an atoll, Salomon Atoll, Chagos Archipelago. Left, below: The Beqa Barrier Reef in Fiji. Right: Fringing reefs, near Suva, Fiji.

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Table 1.2: Regional patterns of species diversity in coral reefs and related ecosystems: the clear pattern of maximum diversity in the Indo-Pacific region is shown in all species groups

Taxonomic group	Indo-West Pacific	Eastern Pacific	Western Atlantic	Eastern Atlantic
Scleractinian corals[1]	719	34	62	
Alcyonarian corals	690+	0	6	
Sponges (genera)	244		117	
Gastropods:				
Cypraeidae	178	24	6	9
Conus	316	30	57	22
Bivalves	2 000	564	378	427
Crustaceans:				
Stomatopods	249	50	77	30
Caridean shrimps	91	28	41*	
Echinoderms	1 200	208	148	
Fish	4 000	650	1 400	450
Butterflyfish and angelfish[2]	175	8	15	7
Seagrasses[3]	34	7	9	2
Mangroves[4]	59	13	11	7

* All Atlantic

Source: Paulay (1997) except:
1. Veron (2000).
2. Allen et al (1999).
3. WCMC database - figures include species with warm temperate distributions.
4. Spalding et al (1997).

currents. Unfavorable currents may prevent the colonization of areas by new species, notably in the remote reef regions of Brazil and the Eastern Pacific. The mechanisms, and the importance of this transport, are further considered on page 23.

Changing patterns over geological time scales

Separate faunas – Atlantic and Indo-Pacific. Many of the global patterns in reef and coral development can be explained by looking at the tectonic and climatic history of reefs. Scleractinian corals evolved during the Triassic (205-250 million years ago) and quickly developed a circum-global distribution, only restricted by areas of suitably shallow substrate. As the continents broke up and shifted, the global connection of tropical oceans became more restricted. With the closure of the Tethys Sea, the waters of the Indian Ocean and Western Pacific were separated from those of the Atlantic and far Eastern Pacific, and the coral reef communities in each began to develop distinctive characteristics.

Low diversity in the Atlantic. The closure of the isthmus of Panama divided the "western" fauna into two. This entire region was then subjected to massive extinctions during the Pliocene/Pleistocene glaciations, removing many of the species which were once commonly found on all coral reefs. The Atlantic corals now share only seven genera with the Indo-Pacific. Even as environmental conditions improved, continued eustatic disruption may have prevented subsequent re-expansion and diversification of the coral reef fauna, and there has been little time since the end of these glaciations for any further species radiation. The result today is clearly shown in the far lower species diversity in the Atlantic reefs. For scleractinian corals the Atlantic only holds about one tenth the number of species as the Indo-Pacific, while similar patterns hold for almost all other species groups, with between one third and one tenth of the diversity on Atlantic reefs as compared to Indo-Pacific reefs.

High diversity in the Indo-Pacific. The same period of extinctions was not so extreme in the "eastern fauna", the area now known as the Indo-Pacific. Right across the region there are large areas of shallow coastal shelf spanning considerable latitudinal ranges. Over these areas there were more locations or refuges offering opportunities for survival of species during periods of environmental adversity. Species diversity remains high across much of this region, although there is a clearer decline in diversity moving east across the Central Pacific.

The Southeast Asian center of diversity. Quite apart from the generally high diversity recorded across the Indo-Pacific, there is an area of outstanding diversity centered on a triangle encompassing the Philippines and central and

eastern Indonesia. Species numbers here outstrip any region of the world, and species counts from individual bays or islands typically outstrip total species counts from the entire Caribbean. Some of this great diversity may in fact be linked to the same period of glaciations which caused destruction elsewhere. This region is believed to have maintained somewhat benign conditions during this time, allowing the survival of many species. Additionally, during certain periods, species may only have survived in relict populations restricted to small refugia. Their isolation, exacerbated by changing sea levels, may have allowed the independent evolution of populations and the formation of new species. These would have repopulated the wider region as conditions ameliorated. Further species may have accumulated here from outside the region, driven by patterns of ocean currents flowing westwards from the islands of the Pacific Ocean.

A number of other historical and contemporary factors are responsible for driving regional patterns in biodiversity, notably the low diversity observed in the Eastern Pacific, Brazilian and West African faunas, and the sustained high diversity in the Red Sea and low diversity in the Arabian Gulf. These are considered more fully in the regional chapters.

Patterns at finer scales

Moving in to study reef distribution at finer resolutions, the discontinuous nature of coral reefs within countries or along particular coastlines is highly apparent. Corals, and the reefs they form, are highly sensitive to factors such as salinity, sediments and nutrients. Where conditions are inappropriate they do not occur. More importantly in recent times, where conditions change, the corals, and the reefs themselves, may die.

Sediments and sedimentation

The initial growth of a coral is dependent on a larval animal finding the right substrate on which to settle. Corals cannot grow on fine muds or shifting sediments, and such sediments are a common feature along many of the world's coastlines. Where corals cannot settle and grow, reefs do not form. This is at least part of the explanation for the absence of reefs close to large river mouths and along other stretches of sediment-laden coastlines. Another influence of sediments is that of turbidity – in areas with large amounts of suspended sediments in the water column, the loss of light further reduces or prevents coral growth.

Once established, corals can cope with limited amounts of sediments settling upon them from the waters above, actively removing sediments which smother their tissues and block out the light. Similarly, once a reef is formed it is often able to maintain a presence in areas of otherwise shifting sediments. The reef structure lifts itself above the sediments, and provides the hard substrate on which new corals can grow. Reefs can also reduce the influence of currents and waves which, in some areas, are responsible for resuspending sediments that might otherwise smother corals.

Where conditions of sediments and turbidity change considerably this can lead to the rapid demise of corals and the death of reefs. There is an energetic cost to a coral in removing sediments which settle upon it, while the loss of light associated with increasing turbidity greatly reduces a coral's chances of survival.

Salinity

Corals are wholly marine organisms, unable to grow in freshwater. It is sometimes quite hard to distinguish the effects of freshwater from the influence of the sediments, typically also carried by streams and rivers. However, the absence of corals from wide areas associated with major rivers is at least in part related to the low salinities in these areas.

Nutrients

The considerable biomass and wealth of diversity observed on coral reefs around the world has led to a common misconception among non-specialists that reefs may be dependent on considerable inputs of nutrients. In fact reefs are highly efficient at nutrient recycling, and are widespread in some of the most nutrient-poor parts of the oceans. Where nutrient levels are higher, often close to coastlines or areas of upwelling, reefs still survive, but in very high nutrient situations other opportunistic species

Damselfish and butterflyfish around a blue coral Heliopora coerulea.

Annex 713

Movements between reefs

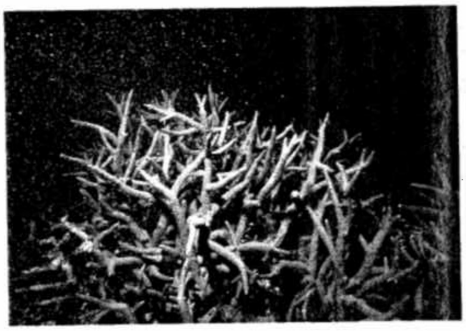
One critical issue when it comes to understanding the establishment of patterns in species distribution is the movement of individuals between localities. Reefs in general are ecological islands, typically surrounded by non-reef areas and often separated from one another by tens or hundreds of kilometers. Many reef organisms are sessile, and do not move at all. Even for the most mobile groups, movements of adult animals between reefs would be so hazardous as to be almost impossible, and such journeys are rarely undertaken. From the largest to the smallest, almost all coral reef species have a larval life history which survives for some time in the plankton. It is these tiny animals which move, or are swept, from place to place within a reef, and from reef to reef.

Typically, corals and other reef species produce vast numbers of eggs – many coral reef fish produce between 10 000 and a million eggs. These may be fertilized internally or in the waters above the reef. Either way, larvae are formed and enter the plankton where they may remain for weeks or even months – larval survival in the plankton has been recorded to over 120 days in some reef fish.

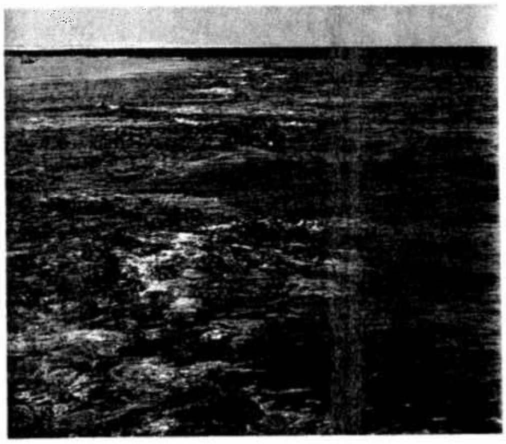
Whilst in the plankton, eggs and larvae may be carried distances ranging from meters to hundreds of kilometers. Many larvae have quite considerable swimming ability, but sea surface currents, more than any other factor, determine the long-distance transport of most organisms. Studies on reef fish distribution have shown that the species with the shortest larval phases tend to be geographically restricted while those with long larval phases are often geographically widespread. The great majority do not survive, or may be carried to areas where they are unable to settle, but it is this same movement which allows genetic flow between widely separated reefs. It also enables the establishment of new species and new reef communities in areas where they may not currently occur, or the recovery of populations which have been lost for any reason. A number of reef communities surviving at the edge of their natural ranges, such as those on the latitudinal limits of reef development in Western Australia, or those periodically impacted by extreme El Niño conditions in the Eastern Pacific, may be entirely dependent on larval recruitment from other, distant, reefs. This also has important implications for management, particularly for the recovery of reefs that are destroyed by pollution or blast fishing, or when overfishing removes all adult fish from an area.

There is still a great deal that remains unknown about this critical dispersive phase of reef organisms. The mass spawning event of reef corals on the Great Barrier Reef was first discovered only in the early 1980s – here it was observed that the great majority of corals released their eggs and sperm during a few nights associated with a particular full moon. Such synchronous spawning events flood the nearby waters, reducing the ability of predators to consume all the eggs and larvae and so increasing the chances of individual survival. Such mass spawning events are being discovered in other areas too, and in other groups. Certain reef fish, such as the larger groupers, have been observed to travel many kilometers to congregate at spawning grounds.

At the same time as these mass spawning events are being discovered, recent genetic studies have shown that patterns of connections between reefs are not a simple reflection of surface currents, but may also reflect other factors, both contemporary and historic. Some work suggests that species may not always travel vast distances or be as "interconnected" as previously thought. Certain "species" are now being broken down into geographically distinct sibling species groups which are sufficiently different from one another in genetic terms to suggest that there may be no gene flow between them, and that they may at the present time be ecologically isolated.



An Acropora *coral releasing clouds of egg and sperm bundles, Western Australia (photo: Bette Willis).*



may out-compete them. These typically include algae and sponges which may compete for space and light and overgrow corals. It can also include algae living within the plankton which can literally block out the light and increase the turbidity to levels which the corals cannot survive.

Patterns across the reef

Where conditions allow, coral reefs form and continue to thrive, marking out a colorful barrier along many coastlines and far out across the Pacific and Indian Oceans. As individual coral reefs are examined more closely, new and distinctive patterns emerge, formed by the species which make up the reef community.

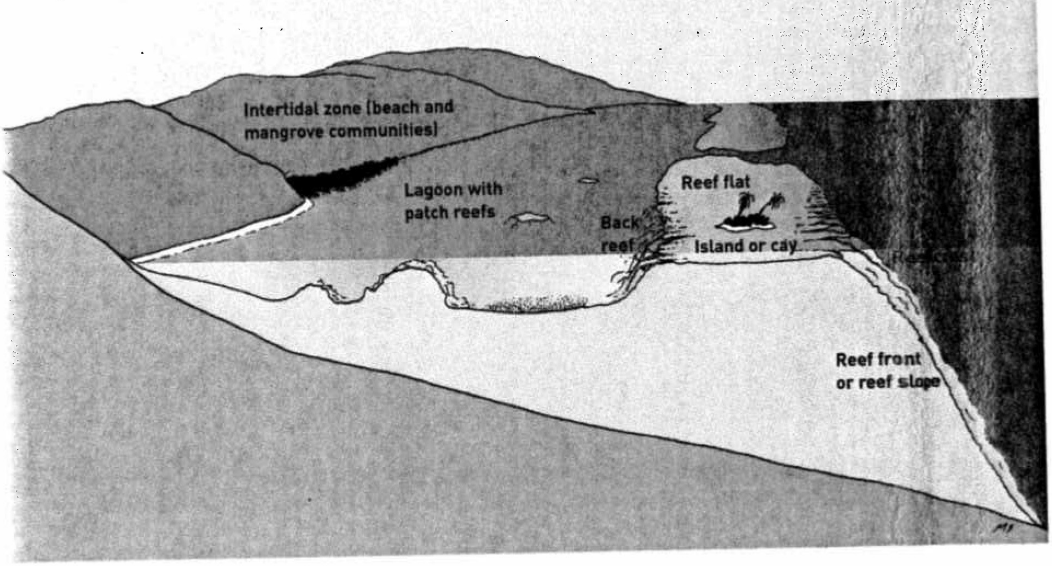
Moving across a reef from the beach to the open sea, environmental conditions vary considerably. Close to the shore there may be freshwater runoff, loose sediments of sand or mud, and regular exposure to the air and sunlight with the shifting tides. Further out conditions are shallow and bright, but there may be little circulation of the water. At the outer edge of the shallow reef, the waters change dramatically. Waves may break on the reef top. Lower down, the light diminishes rapidly with depth. Light and depth, tides, water circulation, wave action, sediments, nutrients, temperature variation and salinity all have a part to play in determining which species are found where on a reef, and clear zones have been recognized. A number of these are illustrated in Figure 1.3.

Beach and intertidal communities

Although considered beautiful by millions of tourists, beaches and other intertidal areas are among the harshest communities for many species. Daily exposure to drying air and hot bright sunshine is inimical to most marine species, while regular or occasional soaking by saltwater is equally difficult for most terrestrial species. Beaches themselves are places of constantly shifting sediments, offering no solid substrate on which to establish, and only tiny interstices between the sediment particles for refuge. The coastline is also the point at which terrestrial inputs are at their most concentrated, with runoff, pollutants and sediments greatly influencing life in some areas. Life on sandy beaches is not abundant. There are many microscopic life forms within the sand, and a range of species, notably crabs, patrol the shores for food. In rocky areas a greater diversity of life occurs, notably molluscs, algae and bryozoans, and a complex pattern of communities may be found associated with tide pools and their position relative to the tidal range. Mangroves are a group of highly adapted plants which thrive in intertidal waters. Although frequently associated with reefs they are somewhat restricted in where they can grow, and only build extensive communities in areas where there are fine silts and muds, particularly where there is some freshwater input.

Above: Mangroves are important intertidal communities in many reef areas. Center: The reef crest, the shallowest part of the reef, northern Red Sea. Below: Coral diversity is highest on the reef slope, typically reaching a peak below the areas of highest exposure to waves, but still in shallow areas where loss of light is not a limiting factor.

Figure 1.3: Basic patterns of reef zonation on a barrier reef



Lagoons

On barrier reefs the shoreline drops relatively rapidly towards depths of a few meters, sometimes a few tens of meters, before rising again to the shallow waters of the main reef structure. This area of deeper water is known as the lagoon. It is paralleled by a similar area at the center of most atolls. Although true fringing reefs do not have such deep water, in fact the division between fringing reefs and barrier reefs is sometimes hazy, and there may be shallow lagoons even on fringing reefs. Conditions in lagoons vary considerably. In some cases the lagoon is enclosed, and the flow of water is restricted by the high rim of the atoll, or by the shallow waters of the barrier reef. The degree of enclosure greatly influences conditions within the lagoon. Relatively shallow, enclosed lagoons may be areas of considerable temperature extremes as the waters cool at night or become rapidly heated during the day. They may also be areas where nutrients and sediments build up. At the same time, the bright, calm waters of the lagoon can provide ideal conditions for many species.

Seagrass communities are a common feature of many reef lagoons, but bare sandy sediments are perhaps even more widespread. Corals also thrive in many lagoon areas. In a few cases they are widespread across the lagoon floor, but more commonly they build up large structures, often known as bommies or patch reefs, which may be a few meters to many tens of meters across. Active coral growth can lead to the development of even more complex structures, such as the faros of the Maldives which have a circular structure very similar to a tiny atoll, but growing within the lagoon of a true atoll.

Back reef

At their seaward edge, most lagoons rise up quite sharply towards the shallow waters of the reef flat (see below). If there is good water circulation in the lagoon itself this area can be ideal for coral growth, with bright conditions, undisturbed by wave action. This area is known as the back reef, and may consist of a simple slope with a surface cover of corals, or may be an area of intricate gardens of coral rising and falling, interspersed with sandy patches.

Reef flat

In a mature reef, the active, upward growth of corals and coralline algae is eventually inhibited by the water surface. Upward growth can no longer occur, although there may be some consolidation and infilling of the reef rock. Outward growth of the reef into deeper water continues, and gradually a wide shallow platform is produced, the reef flat. In fringing reefs the reef flat extends outwards directly from the shore, but atolls and barrier reefs are also topped with reef flats. Small sandy islands or cays may form on the reef flat from the accumulation of sand and coral rubble during storms. Typically, reef flats range between a few tens of centimeters and 1 or 2 meters in depth, but they may reach many hundreds of meters wide. Physical conditions in the reef flat are quite harsh. Water temperature may fluctuate considerably through a 24 hour period, and some parts may be exposed to the air at low tides. Water circulation is also quite limited, and oxygen levels are often rapidly depleted.

The base of this zone is usually coral rock, but it is often covered by a mix of sand and rubble patches, over which there may be algae or seagrass. Corals continue to grow in deeper depressions, and small coral communities develop in larger areas of deep water (such areas are sometimes known as moats). A considerable number of small invertebrates live permanently on the reef flat. Large numbers of organisms feed on the reef flat at high tide, while foraging birds visit during the lowest tides.

Reef crest

The edge of the reef flat facing the ocean is an area of high energy, with almost constant wave action, and occasional exposure to the air. There is a rapid and constant circulation of the water, and water temperatures are generally more constant than those of the reef flat. Conditions for coral growth are not ideal, but a few species, dominated by branching forms, have adapted to them. On some reefs coralline algae are even better adapted and may predominate. Their combined growth builds up to make this the shallowest zone of the reef, often drying out at low tides. In more exposed reefs deep surge channels may be gouged into this reef crest and serve to dissipate the wave energy.

Reef front or reef slope

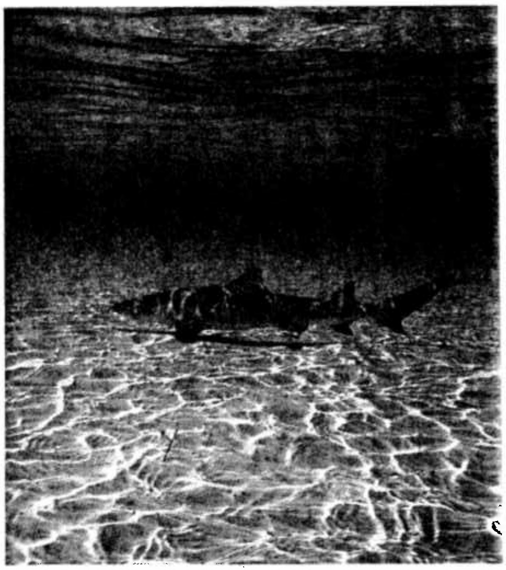
Beyond the reef crest is the zone with the greatest diversity and abundance of life. Typically this reef front or reef slope falls quite steeply towards the seabed. In this zone conditions change quite rapidly with depth and exposure. The shallowest waters, particularly on exposed reefs, may still be subject to considerable wave action and the growth of corals may be restricted. In such places branching corals predominate, and in the most exposed areas their growth forms are typically low and compact. Wave action often leads to the development of deep channels and high ridges known as spur and groove formations.

Below the influence of wave action diversity is unparalleled. Reefs are rarely dominated by single species, and both the corals and most other species groups form highly complex mixed communities. As depths increase, light is rapidly filtered out by the overlying water. Certain species can only grow in bright waters, and so are limited to depths of only 10 or 20 meters. A smaller number of species have adapted to darker conditions and may begin to dominate. The depth limits to coral growth are variable, as the water clarity determines the degree of light penetration. Reefs on more turbid continental margins typically have no active coral growth below about 50 meters and active reef accumulation may stop at 20 meters or less. In the clear waters of oceanic atolls extensive coral growth has been observed as deep as 100 meters, although this is probably unusual.

There is clearly enormous variation across the world of coral reefs, but these broad zones are widespread. Even among the less developed reefs, the natural propensity towards these patterns of zonation is often visible.

It is also important to remember that most of the reefs visible today are in fact ancient structures and much of their present-day shape has been developed over millennia, under quite varied conditions. In some cases there are vestigial structures marking former sea levels. Terraces are often observed on reef slopes, indicating patterns of growth towards an earlier low sea level, while entire submerged reefs may show many of the structures described above, but with reef flats and lagoons now at considerable depths below the present sea surface. Similarly, raised reefs are quite common, with atolls or platform reefs raised up to form modern islands, and the subsequent development of fringing reefs around their margins.

Patterns of diversity on a coral reef are the subject of a great range of influences, from the patterns produced by history, including the massive perturbations of recent ice ages to the present day patterns of temperature, sediments and nutrients. On particular reefs new patterns emerge, the result of a great complexity of local influences, including light, exposure and water circulation. The final section of this chapter examines some of the great wealth of diversity which makes up life on the reef. It provides an overview of all of the major groups which are so critical, not only to the development and functioning of the reef, but also to the great value of coral reefs as a natural resource for humanity.



A juvenile lemon shark Negaprion brevirostris *crosses a Caribbean lagoon at high tide. Lagoon areas are often dominated by wide expanses of bare sand.*

Quantifying diversity

Coral reef diversity is directly comparable to that of the most diverse terrestrial habitats, the lowland tropical rainforests. At levels of higher taxa (the more generalized "groups" of species), reefs greatly outstrip these other mega-diversity ecosystems. Densities of species per unit-area are also staggering. Species are often regarded as the building blocks of biodiversity, and, although reefs occupy only a small area of the planet, there are probably more species per unit-area of coral reefs than in any other ecosystem. There are an estimated 4 000 coral reef fish species worldwide, almost a quarter of all marine fish species. Nearly 1 500 fish species have been recorded at the Great Barrier Reef in Australia, and up to 200 species have been recorded from single samples on individual dives.

Fish represent the dominant vertebrates on coral reefs, perhaps comparable with the birds of a rainforest, but their numbers pale into insignificance when compared with total species composition of reefs. A 5 square meter reef microcosm sampled in the Caribbean yielded 534 species from 27 phyla, with a further 30 percent of species not fully identified. One sample of "boring cryptofauna" (animals which burrow holes and live within the coral rock) from a single dead coral colony yielded 8 265 individuals from some 220 species. We are only just beginning to comprehend the scale and depth of this diversity. Further parallels with tropical rainforests and other high diversity ecosystems abound.

With this wealth of species a great diversity of interactions has evolved between species. No organism lives in isolation, but on reefs the ecological processes which so often drive evolution have pushed the coexistence of species to extremes. Through pressures such as predation and competition, many species have become highly specialized to live in tight niches, with highly specific diets, cryptic habits, or highly evolved defense mechanisms. Others have become masters of stealth and capture or camouflage and escape. Co-evolution has also led to complex two-way interactions between species, including mutualistic partnerships where both organisms benefit. The relationship between corals and their algal partners is perhaps the most important example of such a partnership, having led to the proliferation and success of the reef-building corals.

Like forests, coral reefs also show a considerable structural diversity. Across the reef zones described above, but particularly in the areas of most active coral growth, a coral reef represents a highly complex three dimensional

A dense school of blue-lined snapper Lutjanus kasmira, *Seychelles.*

environment. Wave action creates deep grooves in the shallow reef front, while the corals themselves, with their complexity of forms, create a highly convoluted surface. Even the limestone at the base of the living reef surface is a complex mass of holes formed by the older patterns of coral growth, together with processes of erosion. This not only provides a large area for the settlement of other reef organisms, but also a complex background for the drama of life on the reef, providing passages and holes at all scales for the movement of animals, and for their concealment, shelter, ambush and escape.

One final comparison with rainforests is that the diversity of life in both ecosystems remains remarkably poorly known. It has been estimated that less than 10 percent of the organisms found on reefs have been described by scientists. But not all experts agree on species identification and definition and there is no central record, even of the species which have been described. It is thus impossible, at present, to estimate accurately the total numbers of species occurring on coral reefs. Using a number of broad assumptions, one recent attempt has suggested that there may be some 93 000 described coral reef species. The global total, including the vast number of undescribed species, could thus be closer to 1 million. Others have estimated that there may be over 3 million reef species. Perhaps the greatest problem hindering a more detailed assessment of coral reef biodiversity is the lack of basic taxonomic research and inventory, combined with the lack of sufficiently qualified taxonomists to undertake the work. Defining and describing species is a complex task, and detailed observation and description of external morphological characteristics of animals and plants have traditionally been key tools. A number of recent studies, however, have suggested that many of these morphologically similar "species" may in fact be species complexes, groups of sibling species, each highly distinct in genetic terms. If such examples prove to be commonplace, the final analysis of species diversity may lead to massive increases in the total species numbers.

Left: Expansive beds of branching Acropora *with damselfish above, at the Great Barrier Reef. Right: A barrel sponge, encrusting red algae and corals in the Philippines.*

Organisms of the coral reef

In order to better understand the ecology of the coral reef environment it is important to have an overview of the main species groups which occur there. This final section of the present chapter provides a background to some of the main groups of organisms on coral reefs, focussing on the larger or more conspicuous life forms. A number of major groups are taken in turn, each being briefly described, with their role in the reef ecosystem receiving particular attention. Although the major headings refer to broad taxonomic groupings (such as phyla), a strict taxonomic hierarchy has not been followed. Particular groups have rather been selected based on their importance in the reef environment. For more detailed taxonomic information readers are referred to the sources at the end of this chapter.

Algae and higher plants

As with other ecosystems, sunlight provides the primary energy source for life on the coral reef, and photosynthetic organisms capture this light and convert it to the organic molecules which are the building blocks of life. Higher plants (the more complex life forms, which dominate on land) have an insignificant role to play in most reefs. In contrast, algae are present throughout the reef and are critical, not only as the basis of the complex trophic pathways, but also as a structural component in the building of the reefs themselves. Despite this, algae are not highly conspicuous on the reef, either when compared to terrestrial ecosystems, or even to the marine ecosystems of temperate waters. Four main groups of algae are recognized.

Blue-green algae (Cyanophyta or cyanobacteria)

These are the simplest forms, being prokaryotic (with a simple cell structure and lacking a central nucleus) and related to bacteria. They can be unicellular or filamentous (with cells arranged in long chains) and are widespread throughout the reef, although their role and importance remain little known.

Red algae (Rhodophyta)

These include a great variety of forms and species, ranging from unicellular to filamentous to complex forms. A number of species secrete calcareous skeletons and are referred to as coralline algae. The encrusting coralline algae, such as *Porolithon*, are among the most important plants on the reef, playing a critical role in binding

A shallow scene with branching Acropora *corals and various damselfish, Seychelles.*

sediments, particularly in the shallowest waters. In some places, including many reefs in the western Indo-Pacific, these are the dominant benthic organisms in the shallower parts of coral reefs and may play a more important role in reef building than the corals themselves.

Brown algae (Phyaeophyta)

These are more familiar in temperate rocky shore areas, where they often form the major plant communities. There are no unicellular species and many form quite complex "plants". Although not dominant on reefs, a number of species are widespread, including *Lobophora*, *Padina*, and *Sargassum* in the Indo-Pacific and *Dictyota* in the Caribbean.

Green algae (Chlorophyta)

This is a large and diverse group, including unicellular and complex forms. As with the red algae, some produce secondary calcification. Among these, *Halimeda* is widespread and the calcified remains of its disc-shaped segments are often a major component of reef sand. *Caulerpa* is another common genus in both Caribbean and Indo-Pacific reefs, forming complex and intricate plant structures. There are some 75 species, the majority of which are found in coral reef areas.

In addition to these main groups, there are several other algal groups, such as the diatoms (Bacillariophyta) which, although not important components of the benthos, form a dominant part of the marine phytoplankton. Another group, the dinoflagellates (Dinophyceae) are sometimes considered alongside the algae, but here are considered separately, below.

Higher plants

Two groups of higher plant are often discussed in association with coral reefs, although in reality they form distinctive habitat types which may, or may not, be found in close proximity to reefs. In contrast to coral reefs, the habitats associated with these species have low species diversity.

Seagrasses

Seagrasses are actually a polyphyletic group of marine angiosperms (flowering plants) which are broadly distributed from the tropics to the Arctic, although there is a peak in their diversity in the tropics. All species belong to the monocotyledon families Potomogetonaceae and Hydrocharitaceae. Only one genus, *Thalassodendron*, is able to grow on rocky substrates and is found in very close association with corals, although many species are frequently associated with the soft sediments of reef flat and lagoon areas.

Mangroves

Mangroves are a similarly varied group, and are typically defined as trees or shrubs which normally grow in, or adjacent to, the intertidal zone and which have developed special adaptations in order to survive in this environment. Interpretations of this definition vary, and hence there is no fully agreed list of what does and does not constitute a mangrove. The association between mangroves and coral reefs is somewhat opportunistic: although they are sometimes observed growing on coral rock, mangroves usually require soft sediments and sheltered environments. In many areas the calm waters behind fringing and barrier reef systems provide such areas. The ability of mangrove communities to bind silts and muds may reduce levels of siltation in offshore areas and enable reefs to flourish. There is also a considerable movement of fish species between the two habitats, but again this would appear to be opportunistic rather than essential. Globally the distribution of mangroves and reefs is quite distinct. While both are largely restricted to the tropics and near-tropics (with the exception of mangroves in southern Australia and New Zealand), mangroves flourish in many

Left: Encrusting red algae can be a major structural component of the reef crest. Right: Seagrasses are a common component of deeper reef flat and lagoon areas.

areas where reefs are absent, notably the coasts of West Africa and the Bay of Bengal. Unlike reefs, they are absent over most of the Central and Western Pacific and are very sparsely distributed in the arid regions of the northern Red Sea and the Arabian Gulf, and on many oceanic atolls.

Dinoflagellates (Dinoflagellata)

This is a common group of microscopic organisms generally found in the plankton. Most are heterotrophic, but a few photosynthesize. They are characterized by the possession of two flagella, and are sometimes considered to be algae (Dinophyceae), but more commonly grouped with the Protozoa. The dinoflagellates are particularly important in the coral reef ecosystem, as it is this group which contains the zooxanthellae.

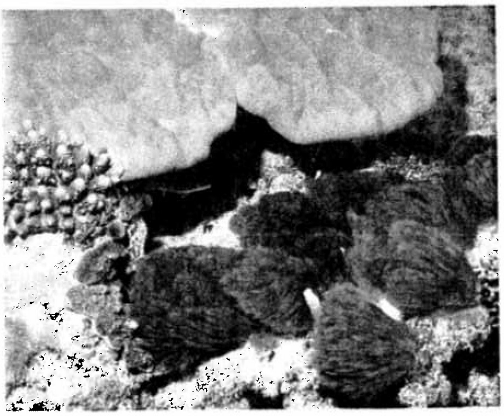
Zooxanthellae are capable of living freely in the plankton, although they are regularly associated with a broad range of coral reef organisms, living as endosymbionts within the tissues of these organisms. As photosynthetic organisms, they are able to supply a considerable amount of the nutrition required by their hosts, but also benefit both from the waste products of their hosts and from the shelter provided by their tissues. The vast majority of reef-building corals are dependent on these organisms. It was long considered that the zooxanthellae inhabiting corals were from only one or two species, but this view is now strongly challenged and the full diversity of this group is in need of further investigation.

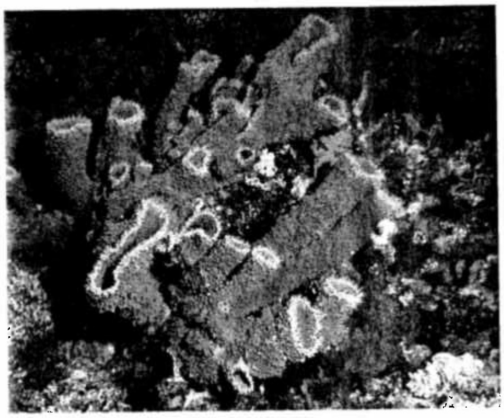
Another important dinoflagellate, at least from a human perspective, is *Gambierdiscus toxicus*, which grows on benthic algae and dead coral rock. This species produces a toxin known as ciguatera which is not broken down by the organisms which unwittingly ingest it. This toxin can build up through the food chain reaching concentrations, in some larger predatory fish, that are highly toxic to humans who eat them. Outbreaks of ciguatera have, in some cases, been linked to extensive coral reef disturbance, the dead and bare surfaces perhaps providing a greater surface area for this species to inhabit.

Sponges

Sponges are among the most primitive multicellular organisms (with ancestral-like organisms detected from pre-Cambrian deposits some 650-700 million years old), and yet they have a high diversity and are widespread across the globe. Although they do not form true bodies with differentiated organs, most sponges grow into well structured forms, with a network of internal canals through which sea water is passed, aided by the movement of flagella and microvillae. Water is drawn into the sponge through specialized cells, and wastewater is then flushed through exhalent pores, which are usually clearly marked on the surface of the sponge. The majority of sponges are filter feeders and are able to process considerable volumes of water every day, filtering out nutrients. Other sponges, including many which live in the nutrient-poor waters of the reef, rely on associations with blue-green algae (cyanobacteria) or zooxanthellae and are effectively autotrophic. A number of sponges are capable of chemically dissolving (etching) into corals in a process which is a major part of bioerosion on coral reefs. Sponges have a great variety of physical structures, and indeed many show considerable plasticity in their growth forms. Within their cellular matrix, certain specialized cells lay down skeletal tissues. Skeletons are formed from numerous smaller elements called spicules made from silica or calcite, while in others they are formed from spicules or longer fibres made from collagen. With these strengthening skeletons sponges produce large structures, which may be encrusting, lattice-, ball-, vase-, or barrel-shaped, or longer rope-like or branching forms.

Unlike many other groups it would appear that the





Left: Bright clumps of the green alga Chlorodesmis. *Right: A conspicuous tubular grey sponge, Indonesia.*

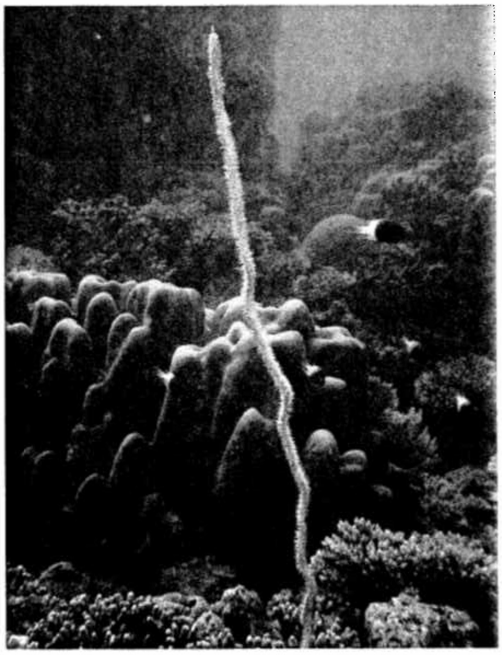
sponge faunas of the Caribbean are at least equal to those of the Indo-Pacific in terms of diversity (per unit-area), while sponge biomass is considerably greater on many Caribbean reefs. One further difference is that Caribbean sponges are more strongly heterotrophic, which could reflect the higher amounts of nutrients available on these reefs. In the Indo-Pacific autotrophic sponges are rather more common.

Despite having high diversity, much of which remains undescribed, sponges are often not highly visible or dominant in the reef benthos. In the tropical island regions of Oceania some 1 000 species have currently been described. For many countries the known species may number no more than 30-40. However, an estimated 500 species have been recorded at Chuuk Atoll (Federated States of Micronesia, in the Pacific) alone. Alongside this genetic diversity, many sponges produce complex chemical compounds, often as a form of defense against predators. The investigation of these chemicals for pharmaceutical products is proving increasingly interesting.

Cnidarians

This is a large group of relatively simple organisms. They are characterized by a basic body structure, with two primary cell layers, an epidermis and an endodermis, separated in most species by a simple, supportive, jelly-like matrix, the mesoglea. A rudimentary nervous system has developed in this group, with a nerve net but no centralized nervous system. Carnivory is common, although some species have developed close associations with endosymbiont algae (see above). One feature of this group is possession of specially adapted cells known as cnidocytes, which incorporate a highly complex capsule or "nematocyst" which, when triggered, is inverted to release a long, whip-like thread with a barbed or pointed tip and often releasing highly potent toxins. These may be used to capture prey or for defense. There are two basic body forms: the medusa is disc shaped, solitary and pelagic, while the polyp is typically sessile, and consists of an upright body with a fringe of tentacles encircling a single opening which acts as both mouth and anus. Colonial living has arisen in a number of members of this group. There are four classes.

The Hydrozoa are a fairly mixed group, and include some complex colonial planktonic members such as the Portuguese man-o'-war *Physalia* spp. There are also a number of sessile groups which are common on reefs worldwide, including colonial hydroids, but also a number of species which lay down a calcareous skeleton. These include the members of the orders Milleporina and Stylasterina. The former are the fire corals, *Millepora* spp. which are widespread in all coral areas and can form an important part of the substrate on the reef crest and reef slope. Growth forms are typically branching or encrusting. The stylasterinids are also known as lace corals and typically form fairly small and fragile branching colonies in darker areas and overhangs. In both milleporids and stylasterinids there is some specialization of polyps, with numbers of specialized stinging polyps surrounding a single feeding polyp.



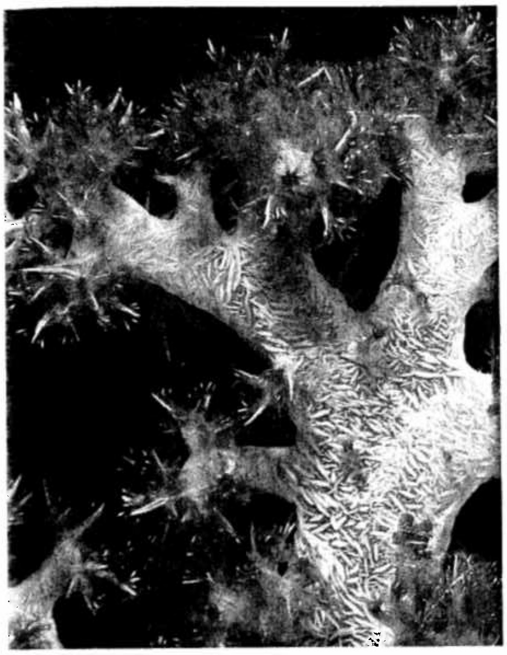
The Scyphozoa, or jellyfish, is a large group, though not dominant on reefs. One genus, the upside-down jellyfish *Cassiopea* is often found resting in reef flat areas. Like many corals these have algal endosymbionts living within their body tissues. Another class, the Cubozoa, are like the jellyfish, but with a clearly four-sided body wall and tentacles concentrated at the corners. Also known as box jellyfish or sea wasps, these include some highly toxic species, including the box jellyfish *Chironex fleckeri* in the waters off Australia and the sea wasp *Carybdea alata* from Caribbean waters.

The most important class on the coral reefs of the world is the anthozoans, and these are considered separately below.

Anthozoans

These are a very large group of cnidarians which lack any medusoid form and have polyps with a central gastrovascular cavity divided into partitions by septae. They are divided into two main groups, the Octocorallia (or Alcyonaria) which have eight tentacles and body partitions and are all colonial, and the Zoantharia (or

A sea whip Junceella. *Unlike stony corals, sea whips have flexible skeletons made predominantly of protein.*



Hexacorallia) which have six tentacles and body partitions, or multiples thereof.

Octocorals are predominantly a tropical group of photic (sunlit) waters, although some species are found in cooler and deeper waters. Many of the reef species contain symbiotic zooxanthellae within their tissues. Perhaps the best known are the gorgonians (Gorgonacea), which are widespread on coral reefs globally. These include the sea whips and sea fans that are often dominant in deeper parts of reefs. Their colonies are strengthened by a central scleroprotein skeleton. Another spectacular group on coral reefs are the soft corals (Alcyonacea), which are common on many Indo-Pacific reefs, but less significant in the Caribbean. These do not have a clear skeletal structure, and body structure is maintained through hydrostatic pressure. Most species secrete spicules of calcium carbonate. Well known and widespread genera include the high, branching colonies of *Dendronephthya* and the spreading, lobed or branching forms of *Lobophyton*, *Sarcophyton* and *Sinularia*.

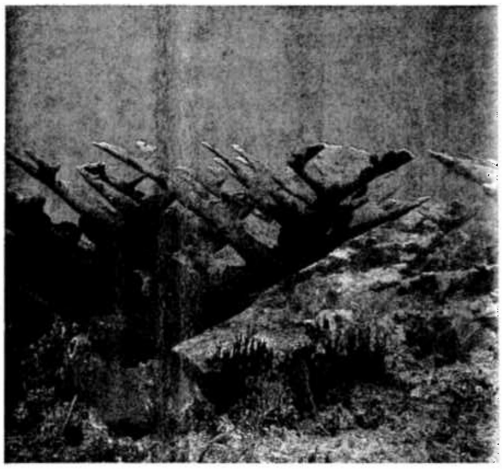
A number of smaller groups are also regularly found on coral reefs. The organ-pipe corals (Stolonifera) lay down parallel calcareous tubes connected with cross-plates to form massive hemispherical domes, and have a distinctive red skeleton. The blue corals (Helioporacea) are a true contributor to reef development, laying down strong calcareous skeletons, and forming large branching colonies in shallow areas. Both of these latter groups are restricted to the Indo-Pacific. Two other groups, the telestaceans (Telestacea) and sea pens (Pennatulacea), are more widespread but not of major importance on most reefs.

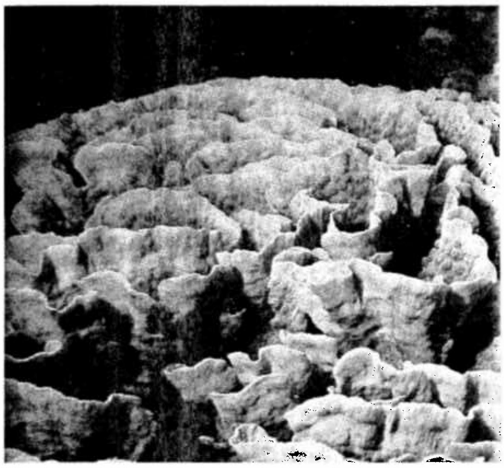
Zoantharians are a diverse group of solitary and colonial species. Many live in close association with symbiotic zooxanthellae. The most important of the zoantharians are the Scleractinia, which include the majority of reef-building corals and are treated separately below. The remainder of this group can best be described at the level of the orders within the group.

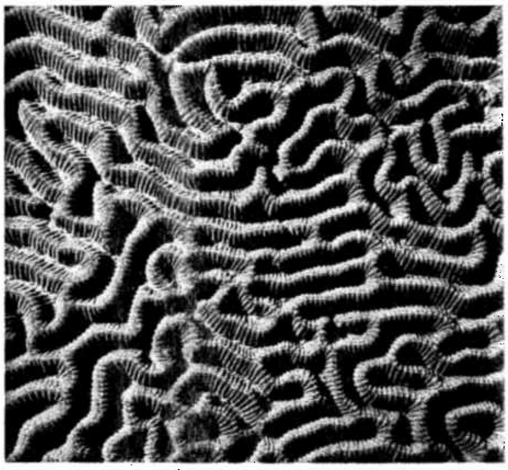
The Actinaria are the familiar sea anemones, which are simple non-colonial zoantharians, some of which can reach considerable sizes. Although primarily carnivores a number of reef species have developed a dependence on symbiotic zooxanthellae, while many have also developed tight symbiotic relationships with anemonefish (Pomacentridae). The Actinaria are a diverse group, with over 1 000 species worldwide, although they are not especially diverse on coral reefs.

Three other smaller orders are also commonly found on reefs, but remain poorly known. The Ceriantharia or tube anemones are another non-colonial group of about 50 species worldwide, which construct a tube buried into soft substrates. The Coralliomorpharia are the disc or coral anemones, with an internal body morphology quite similar to that of corals. The Zoanthidea are a fairly important group within the tropics, and may be abundant in shallow areas such as reef flats and shallow lagoon floors. They are solitary or colonial anemone-like actinarians, which do not secrete a skeleton, but often

Left: The highly colorful soft corals of the genus Dendronephthya *are common in the Indo-Pacific. Right: The central "mouth" of a giant sea anemone* Heteractis.







incorporate sediments into their mesoglea for support or protection.

The Antipatharia are commonly known as the black corals. They are all colonial, and secrete a horny proteinaceous skeleton. Although well known and economically important, they are not a major component of most reef communities and are not common in depths of less than 20 meters, with the majority of species being found below 100 meters.

Scleractinia

The Scleractinia, or stony corals, are a very large order within the zoantharians, all of which secrete a calcium carbonate skeleton. Although widespread throughout the world they reach their greatest extent and abundance in shallow tropical waters where the majority of species are colonial and lay down large skeletal structures, the basic building blocks of reefs. Some 794 species of hermatypic Scleractinia have now been described and the great center of scleractinian diversity lies in insular Southeast Asia, the center of the Indo-Pacific region.

The Scleractinia have an ancient lineage, and leave a good fossil record which can be traced back to at least the mid-Triassic over 200 million years ago. There is no clear evidence that they evolved from a single ancestor, however, and many of the features of this group may in fact have arisen independently.

The skeleton of the individual coral polyp is called a corallite, with a base-plate from which a number of divisions known as septa rise up, radiating in towards the center. The outer edge of the polyp is often defined by a wall forming a tube-like structure enclosing the septae. New polyps are formed in colonial species by budding from existing polyps, or by growth upwards from the connecting tissues between existing polyps. Gradually new skeletal material is laid down over existing material. The skeletal structure of individual polyps forms the basis for species identification, and in many cases full identification can only be completed with dried skeletal material.

The larger structures built by colonies can become highly complex, with massive corals producing domes or towers, encrusting corals, and a vast range of branching (ramose), columnar, foliacious (sheet or leaf-like) and tabular (plate-like) structures. Many ecological studies utilize this coral morphology as a means of describing a reef. The dominance of different growth forms is often indicative of environmental conditions such as wave exposure and varies across the reef profile. It also provides a partial measure of structural complexity. While morphology can appear highly distinctive, it can also be highly varied within a species, influenced by these same external environmental parameters, and hence it is often of limited value in species identification.

Above: The elkhorn coral Acropora palmata, *once a dominant coral on many Caribbean reefs, has been decimated by disease in most areas. Center: The laminar or foliaceous coral* Echinopora lamellosa. *Below: The complex surface of a brain coral* Platygyra.

Most species are involved in a tight symbiosis with zooxanthellae and derive the majority of their nutrients from these algae. They are all equipped with tentacles and capable of feeding independently to some degree, typically on plankton or minute organic particles. However, the dependence on their algal partners is considerable, and many species can be considered virtually autotrophic.

Aside from asexual reproduction during colony growth, corals undergo sexual reproduction. Some species are hermaphroditic, while others have separate sexes. The majority of species release eggs and sperm during a spawning event – such events can be tightly harmonized within and between species leading to spectacular mass spawning events. In a few species the fertilized egg is kept within the polyp and free-swimming larvae or planulae are released some days or weeks later. Both eggs and planulae spend some days or weeks living in the plankton prior to settling and this is critical to the genetic flow between reefs and the establishment of corals in new areas.

Scleractinian corals are one of the few groups on reefs which have been sufficiently well studied to provide a global picture of their distribution and abundance (see Map 1.2).

Worm-like groups

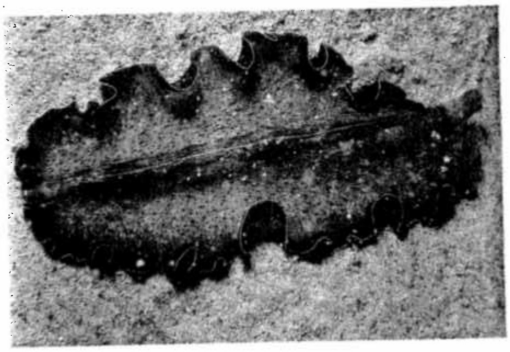
There are several large, unrelated groups in the animal kingdom which have soft, elongated bodies and a general worm-like appearance. Many of these, while inconspicuous, are important residents of the reef.

Bristle worms (Polychaeta)

These are segmented worms with a pair of paddle-like legs on each segment. The head bears a number of sensory organs, which may be highly adapted in different species. They include almost every feeding habit: carnivores, herbivores, omnivores, detritus feeders and filter feeders. Many burrow inside coral or rock, chemically dissolving or physically grinding their way in and then remaining to filter feed or to gather and digest sheets of mucus secreted by the coral. Perhaps the most familiar are the sabellid worms, sessile burrowing forms that extend a feathery net of tentacles to filter the passing water. Such conspicuous species are just the tip of the iceberg, however, and in one study over 1 400 individual polychaete worms representing 103 species were extracted from a single 4.7 kilo lump of branching coral.

Ribbon worms (Nemertea)

These are typically highly elongated and flattened worms, free-living carnivores often feeding on polychaetes. They have very soft bodies, and some produce complex protective chemicals to deter predators.



Peanut worms (Sipuncula)

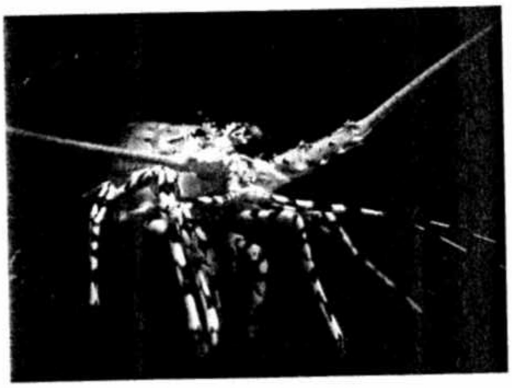
This is a group of unsegmented worms which typically burrow into sand or bore into rocks and corals and are detrital or algal feeders.

Flatworms (Platyhelminthes)

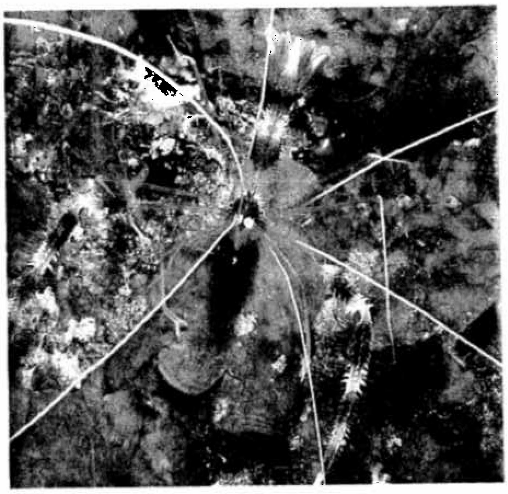
The phylum Platyhelminthes is a large group of small, elongated animals with highly flattened bodies. Many species are parasitic, however there is one highly active carnivorous group, the polyclad flatworms (Polycladida) which are relatively widespread on reefs. Their bodies are covered in cilia and some are capable of swimming. A number of coral reef species are highly colorful and can be confused with nudibranchs (see Molluscs, page 37). Few detailed inventories have been produced and identification to species is usually very difficult.

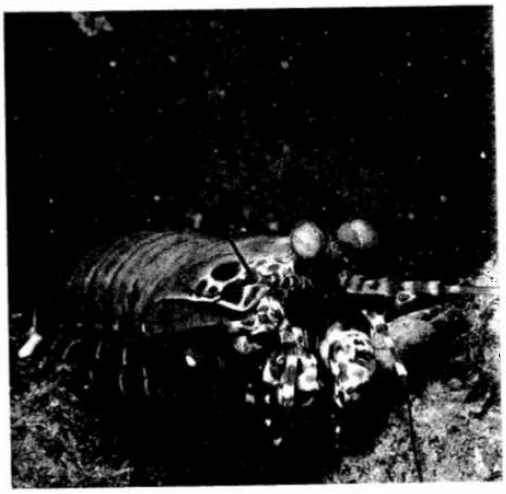
Crustaceans

The Crustacea, one of the largest groups of organisms on the reefs, are not the most conspicuous. They are defined by having two pairs of antennae, and typically have a chitinous exoskeleton and jointed biramous limbs. Beyond this definition, the group includes a vast array of species with highly different body forms. The class



Above: A flatworm on a reef in Pulau Redang, Malaysia. Below: The spiny lobsters Panulirus *spp. are of considerable commercial importance on reefs around the world.*





Maxillopoda contains the abundant copepods which are usually very small, and includes many planktonic species which are found in the coral reef environment. It also includes the barnacles which are commonly observed on reefs and intertidal areas. The class Ostracoda is another highly diverse group, often showing a bivalved appearance. These again are very small, mostly filter feeders or detritivores. The most important and widely recognized group on coral reefs is the class Malacostraca, and in particular, within this, the Decapoda and the Stomatopoda.

Decapoda

These are the shrimps, lobsters and crabs, with some 10 000 species worldwide, including numerous species found on the reef. A brief list of the major groups is provided below.

Penaeidea – these are the commercially important prawns, often associated with inshore lagoon and mangrove areas, but not well represented on the reef.

Stenopodidea (boxing or coral shrimps) – a small but well known group usually found in pairs and living in "cleaning stations" where they regularly remove parasites from fish or other crustaceans. They have a highly enlarged third pair of thoracic legs, with pincers on the tips.

Caridea – a large group of shrimps with a number of sub-groups:

Palaemonidae – on reefs, the palaemonid shrimps are well represented by commensal species which live in facultative or obligate partnerships with corals, anemones, molluscs and echinoderms. The genus *Periclimenes* is particularly widespread. Many species have striking colors which they are capable of adapting to suit their hosts.

Alpheidae (snapping shrimps) – also known as pistol shrimps, these are perhaps the commonest crustacean family on reefs. They are able to make a cracking sound with their pincers and are largely responsible for the almost constant background snapping noises heard on many reefs. Most are detrital feeders. Some of the best known snapping shrimps are those which share their burrows with certain species of goby; the former maintain a burrow in which they both live, while the latter provide warning when predators approach.

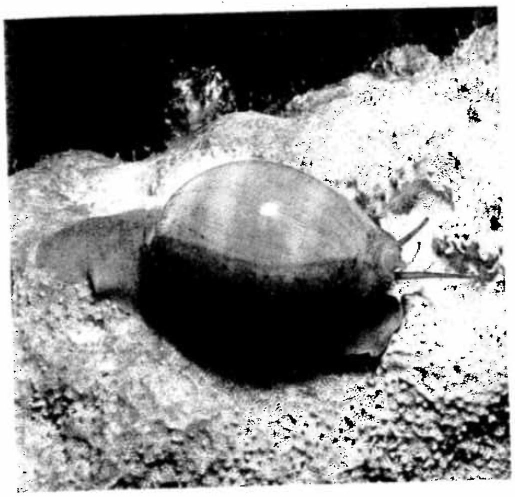
Other caridean shrimps are the hump-backed or cleaner shrimps (Hippolytidae) which include more colorful commensal and cleaner species, and the harlequin shrimps (Gnathophyllidae), also very colorful, which include some species that prey on starfish such as crown-of-thorns.

Palinura (spiny lobsters) – although not a diverse group this includes the familiar crayfish, which are a large, colorful and commercially important group of species found on reefs around the world. The group also includes the less commonly observed slipper lobsters.

Anomura (hermit crabs, squat lobsters and porcelain crabs) – the hermit crabs are widespread on reefs and nearby intertidal areas. They are well known for their habit of utilizing discarded mollusc shells as a form of protection. They have an extended and soft abdomen which fits well into the coiled whorls of these shells, and they regularly exchange shells as they grow. Most are scavengers or detrital feeders. Porcelain crabs are less diverse and less obvious on the reef, but are often found living in association with anemones. They resemble true crabs, but only have three pairs of walking legs, and have elongated antennae.

Brachyura (true crabs) – one of the most diverse crustacean groups on coral reefs, with more than 2 000 species described from the tropical and sub-tropical waters of the Indo-Pacific. The true crabs are recognizable by their strong and usually broad thoracic carapace and their greatly reduced abdomen which remains tucked up

Left: A banded coral shrimp Stenopus hispidus. *These play an important role as "cleaners" on the reef. Right: The peacock mantis shrimp* Odontodactylus scyllarus, *a powerful predator in the Indo-Pacific.*



on the underside of their thorax. All have four pairs of walking legs and often a well developed pair of pincers.

Stomatopoda

Also known as mantis shrimps, these are an ancient group which are thought to have diverged among the Crustacea around 400 million years ago. Over 400 species have been described, the majority of which are to be found in shallow tropical seas. All are active predators, with highly developed visual acuity and a specially adapted second pair of thoracic legs. In one major group, the smashing mantis shrimps (Gonodactylidae), these legs are strengthened into club-like appendages, while in the other group, the spearing mantis shrimps (Lysiosquillidae), they are adapted into barbed spears. Both groups are able to unfold these appendages at remarkable speeds to hit their prey. Smashing mantis shrimps are capable of breaking open the shells of molluscs and crabs, while spearing mantis shrimps are able to impale softer bodied shrimps and fishes.

Molluscs

Molluscs are another highly diverse group found on the reefs, with one estimate of more than 10 000 described species from coral reefs. Members of this phylum all have a body which can be broadly divided into a head, a central visceral mass and a strong muscular foot. Most also have a mantle which to varying degrees folds around the body. A rasping tongue, or radula, is common and most species secrete a calcareous shell. Four groups predominate, and all are present on reefs.

Chitons (Polyplacophora)

These are regarded as the most ancient of the molluscs, recognizable by their low, oval shape dominated by the presence of eight transverse and overlapping shell plates. They are grazers, and are most commonly found in shallow and intertidal areas.

Snails (Gastropoda)

The largest and most diverse group, the Gastropoda usually have a single coiled shell. The simplest forms (Archaeogastropoda) include the limpets, abalones, trochus, turbans and nerites, all of which are algal grazers. Another major group is the Mesogastropoda, which encompasses many reef species, including the cowries, periwinkles and conches. Many are algal grazers, although some have developed specialized diets – the helmet shells, tritons and tun shells feed on echinoderms. The Neogastropoda are a more advanced group. Many have an elongated siphonal canal and highly developed proboscis which can be used for capturing prey. In this way, the murex shells are capable of boring through the shells of other molluscs and injecting them with venom, while the cone shells have developed a highly specialized radula tooth attached to a poison sac. They are able to fire this, rather like a harpoon, and rapidly kill even highly mobile prey such as fish.

Opisthobranch gastropods are another well known sub-group, with some shelled forms such as the bubble shells, but also a large number of shell-less forms including the algal-grazing sea hares and the highly diverse and colorful nudibranchs. The latter are all carnivorous and many have relatively specialized diets. Some are able to maintain nematocysts from their prey and use them in defense, while others utilize the toxic chemicals their prey have developed, again for their own protection.

Bivalves (Bivalvia)

These are a large group of bilaterally symmetrical molluscs with a shell completely split into two matching halves and

Left: A cowrie Cypraea, *clearly showing its muscular foot and the thin mantle of tissue partly covering its shell. Right: A nudibranch* Nembrotha cristata *amidst tunicates and coral.*

joined with a hinge ligament. Many reef species are found to burrow into soft substrates, or become incorporated into the reef matrix as coral or calcareous algae grow around them. The majority of bivalves are filter feeders. Groups include oysters, thorny oysters, scallops, mussels and the giant clams. This latter group (family Tridacnidae) is restricted to the Indo-Pacific and all species live in a close association with zooxanthellae. The giant clam *Tridacna gigas* can reach over 1.3 meters in length and weigh over 300 kilos.

Cephalopods (Cephalopoda)

These are the most highly modified molluscs in which the head, and the eyes in particular, are highly developed, while the foot has been modified into a number of tentacles or arms. One major group, the Nautiloidea or nautili, is largely restricted to deep water and not found on reefs. The other group (Coleoidea) includes the cuttlefish, squids and octopuses. All are active predators, with horny "beaks" developed around their mouth and specialized suction cups on their arms or tentacles for holding prey and other objects. All have chromatophores in their skin and are capable of extremely rapid color changes which they utilize for camouflage, but also as a form of communication between individuals.

Most cuttlefish maintain a significant calcareous "shell" which is internalized, while some squid also contain vestigial traces of a chitinous shell. Both of these groups are highly active free-swimming predators, but neither are numerous or diverse in reef environments. Octopuses are more widespread, although many remain hidden during the day.

Bryozoans

Individual bryozoans are tiny animals with a highly characteristic feeding device known as a lophophore, a ring of ciliated tentacles to capture and direct food into a central mouth. Most lay down a horny or calcareous skeleton, and are capable of withdrawing into this, and sometimes closing it with a hard operculum. They are sessile and colonial. Individual "zooids" in a colony may show particular specializations. Many are encrusting, but a number of species form erect plate or plant-like structures and are known as lace corals. Bryozoans, although inconspicuous, are numerous on all reefs around the world, and are often among the first organisms to colonize newly exposed surfaces. They can play an important role in cementing fragments and consolidating the reef structure.

Echinoderms

The echinoderms are a diverse and highly conspicuous phylum. They are divided into five groups, which appear highly differentiated, but have a few traits in common. Unlike most organisms, which can be divided symmetrically into two halves or are simply radial (corals and some worm-like groups), the echinoderms exhibit penta-radial symmetry – their bodies radiate into five symmetrical parts. All echinoderms also lay down a calcareous skeleton. Extending from their body surface they have small tube feet which are important in respiration and in most groups also serve a role in locomotion.

Left: A scallop Pedum spondyloideum *– this species does not bore into the coral, but the coral has grown up around it.*
Right: A cuttlefish Sepia *sp. hovers over a solitary mushroom coral* Fungia.

Feather stars (Crinoidea)

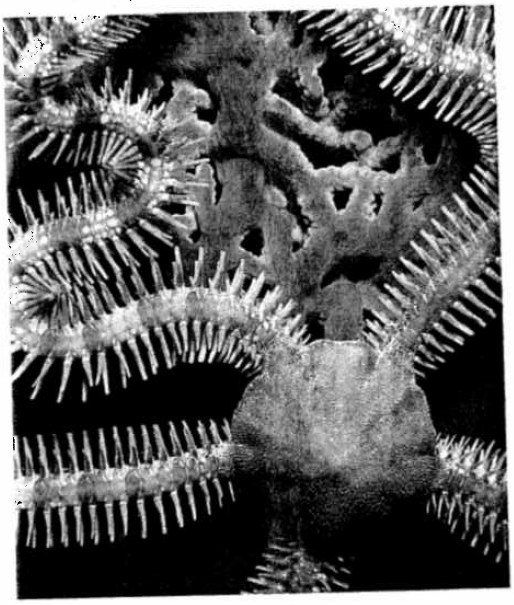
These have a very simple, small body or calyx from which five arms radiate. These branch almost immediately and hence most feather stars appear to have numerous arms. Each is equipped with many short pinnules and the arms are used to sweep the water for plankton. Below the calyx are numbers of short, dextrous cirri which are used for locomotion and to grip the substrate. Most feather stars are nocturnal.

Starfish (Asteroidea)

The starfish, or sea stars, are a well known group. Most have five arms, and in many cases the body organs are housed, or extend into, these arms. They have a mouth on their underside and anus facing upwards. Many species are capable of extruding their stomachs through this opening in order to facilitate digestion. They move using the large numbers of tube feet on their underside. Starfish include detritus feeders, omnivores and predators. One of the better known is the crown-of-thorns starfish *Acanthaster planci*, a large and unusual looking starfish with a large central body, numerous legs and a covering of sharp spines. It is a regular predator of scleractinian corals (see page 60).

Brittle stars (Ophiuroidea)

These are somewhat similar to starfish in general body plan. They have a distinct central disc containing the body organs, with a ventral mouth, but they have a very simple digestive system and no anus. Most have only five arms, which are slender, highly mobile and typically covered in spines. They use these arms, rather than their simple tube feet, for locomotion. Most are detritus feeders, grazing the substrate beneath them. Others utilize their arms, sometimes with a mucous web, to sweep the water and capture prey, while some are more active predators. The basket stars are a sub-group with highly branched arms used to filter the water at night.



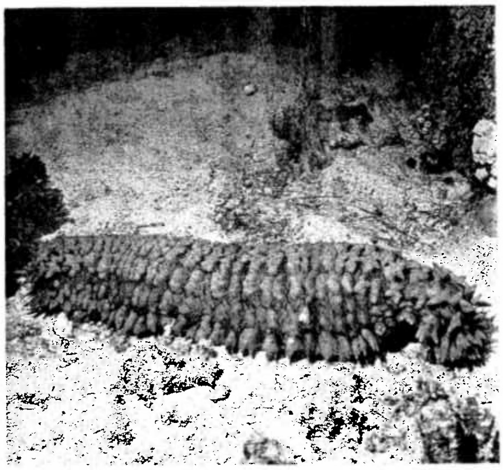
Urchins (Echinoidea)

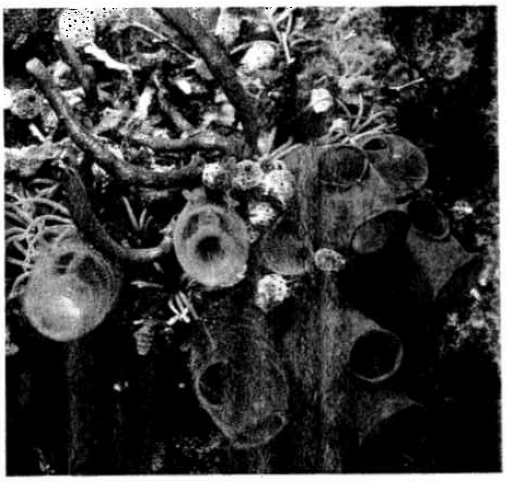
Sea urchins are a highly distinctive group. They have no arms, and the small plates of the skeleton have fused to form a "test" which acts like a shell to protect the internal organs, but is in turn covered by a thin layer of living tissue. The body is typically further protected by a large number of spines. All urchins are grazers or detrital feeders, and have a powerful set of scraping jaws on their underside. Among the most familiar species on the reef are the long-spined species of the family Diadematidae, bearing highly elongated (typically 20 centimeters long) dark spines. These perform a critical function as grazers in many reef ecosystems and their loss on some Caribbean reefs has been linked to rapid declines in coral cover as algal growth predominates (see page 61). A number of urchins have developed secondary bilateral symmetry and have adapted to a burrowing lifestyle. These include the heart urchins and the highly flattened sand dollars.

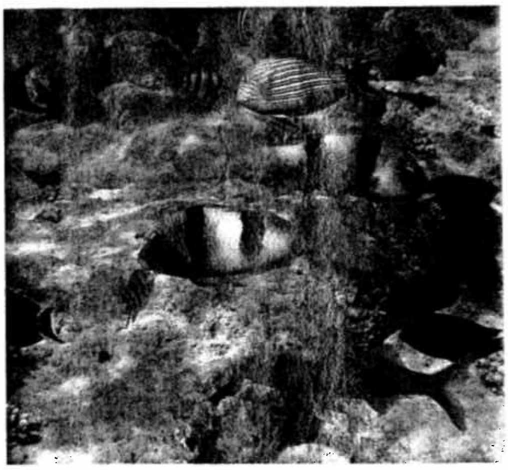
Sea cucumbers (Holothurians)

These are elongated, sometimes even worm-like, creatures in which the calcareous skeleton is highly reduced to a mass

Left: A group of colorful feather stars on a reef in the Philippines. Right: The central disc and highly mobile arms of a brittle star in the Caribbean.







of tiny spicules in the body wall. They have a mouth at one end which is typically ringed by tentacles, while the anus lies at the other end. Tube feet are concentrated along the bottom of the body and used in locomotion in some groups. Some are detrital feeders, and many of the more conspicuous forms on reefs feed by ingesting sand and digesting the microfauna it contains. Others, mainly burrowing species, have long and highly branched tentacles which they use to collect plankton. As a form of defense, many sea cucumbers eject a number of sticky tubules from their anus when threatened. If these do not sufficiently deter their predators they may also eviscerate, expelling most of their internal organs through their anus. These are highly edible and the predator may feed on these while the animal escapes and begins to regenerate its internal organs.

Tunicates

This group includes a number of planktonic salps, but most important on the reefs are the ascideans or sea squirts. These are sessile animals and typically have a tube-like structure with a large opening, the inhalent siphon into which water is drawn, passing through narrow pores or gill slits before being exhaled through a slightly smaller exhalent siphon. Food is captured from this water onto mucus. This group is well represented and quite diverse on most reefs. Some are solitary, although even these are often found in aggregations, while others are colonial and the individual zooids may be more difficult to distinguish. Quite a number of species on the reef have developed a tight association with blue-green algal symbionts.

Fishes

Fish are one of the most conspicuous elements of reef life, being diverse, highly active, and often among the most colorful elements of reef communities. Over 4 000 species of fish inhabit coral reefs, representing over 25 percent of all marine fish species. Although not restricted to reef environments, quite a number of groups are distinctively associated with the reefs and a number of these are briefly described below.

Groupers (Serranidae)

A large group of highly active carnivorous fishes, typically with large mouths and more than one row of teeth. One highly distinctive sub-group are the anthiases, small and colorful zooplankton feeders often forming dense schools over coral heads. Most of the remainder are large stocky fishes which may be active or ambush-based predators, mostly feeding on fishes and crustaceans. The giant grouper *Epinephelus lanceolatus* is the largest true reef fish, recorded to over 270 centimeters long and more than 400 kilos in weight.

Above: A pineapple sea cucumber or prickly redfish Thelenota ananas. *Center: A small group of ascideans or sea squirts* Rhopalaea. *Below: Goatfish (Mullidae) and surgeonfish (Acanthuridae) in the Central Indian Ocean.*

Snappers (Lutjanidae)

This is a family of about 100 medium to large, elongate fishes, all of which are predatory. The majority feed on fishes, with some crustaceans and other invertebrates, while a small number feed on plankton. They are popular food fish in many countries. The majority are found on reefs, although a few commercially important species are found in depths between 100 and 500 meters.

A related family, the fusiliers (Caesionidae) are restricted to the Indo-Pacific. Most of the 20 species are also reef-associated, however they roam more widely, often in large schools, feeding on zooplankton during the day.

Grunts and sweetlips (Haemulidae)

In many ways these are very similar to the snappers, being elongate, but heavy bodied. They are generally nocturnal feeders and largely feed on invertebrates, with some plankton feeders. They are called grunts because of a common habit of grinding their pharyngeal teeth which, amplified by their gas-filled swim bladder, produces a grunting sound. The term sweetlips comes from the highly thickened lips of the Indo-Pacific genus *Plectorhinchus*.

Butterflyfish (Chaetodontidae)

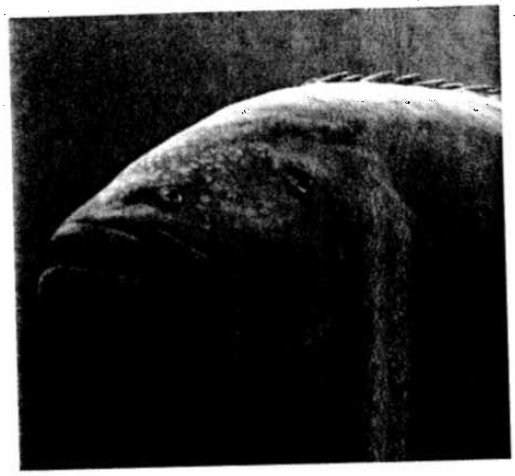
Among the best known of the reef fishes, these are small disc-shaped fish, highly colorful with distinctive, almost flag-like patterns. Most of the 121 recorded species are reef-associated, and only eight are recorded outside the tropics. They have small mouths, and many pick at the substrate, feeding on a mixed diet of invertebrates and algae. Some are more specialist and feed largely or exclusively on live coral polyps, while a few feed on plankton.

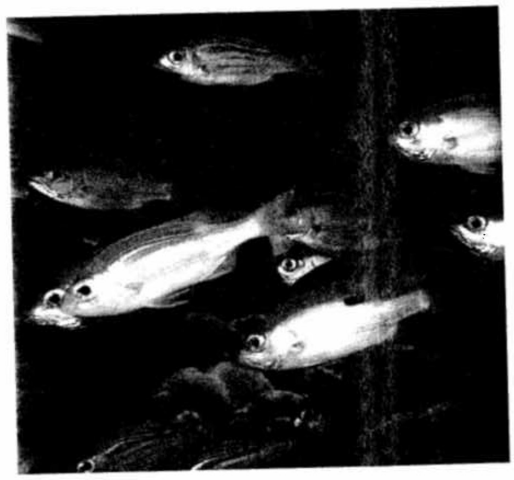
Angelfish (Pomacanthidae)

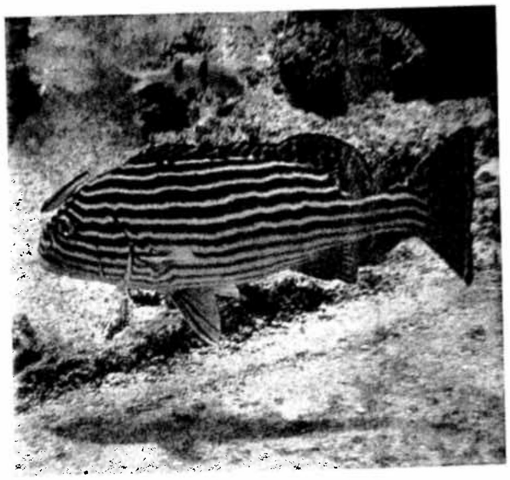
Closely related to the butterflyfish, these also have relatively flattened bodies, though more rectangular in profile. Again this is a highly reef-associated family, with the vast majority of the 83 known species restricted to shallow tropical seas. Most are also highly colorful, but certain smaller species are relatively cryptic. Some species feed on detritus and algae, others specialize on sponges, and a few feed on plankton.

Damselfish (Pomacentridae)

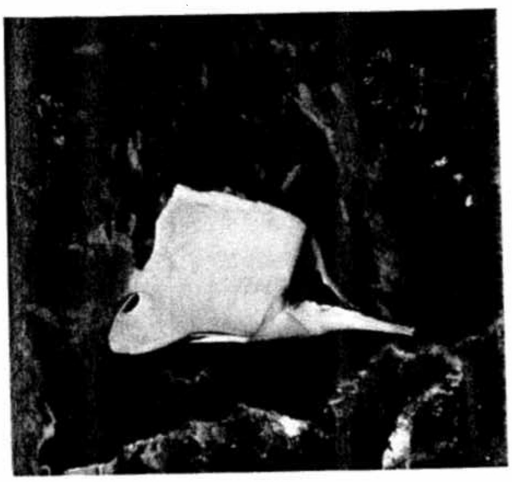
These are an abundant and diverse group found on the coral reefs of the world, with over 320 species. All are small, and often highly colorful. Many are schooling species, and feed on plankton. Some are grazers and a number are known as farmer fish as they actively guard a patch of algal turf from other grazers. The anemonefish live in a close symbiotic association with large sea anemones.

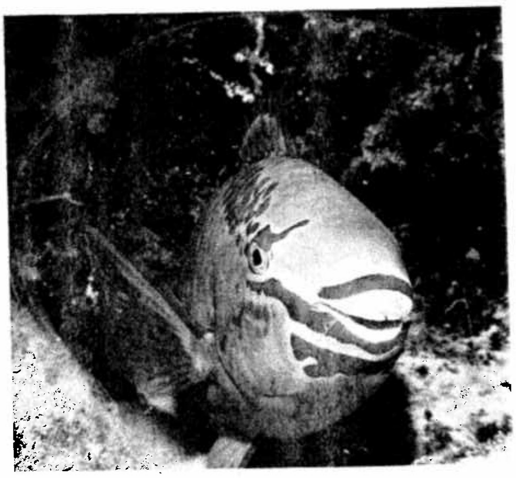






Above: A giant grouper Epinephelus lanceolatus, *the largest true reef fish. Center: A school of snapper* Lutjanus ehrenbergii *and* Gnathodentex aurolineatus. *Below: Oriental sweetlips* Plectorhinchus orientalis, *with a small cleaner wrasse* Labroides dimidiatus.





Wrasses (Labridae)

It is difficult to generalize about this group, which is not only one of the largest groups, but also the most diverse in terms of appearance and lifestyle. All wrasses are carnivorous, but their diet varies considerably. The humphead or Napoleon wrasse *Cheilinus undulatus* is the largest member of the family. Reaching 229 centimeters and over 190 kilos, it feeds primarily on molluscs and crustaceans. Many of the smaller members of the group feed quite generally on benthic invertebrates including some large and quite diverse genera such as *Thalassoma* and *Halichoeres*. A number of species feed on zooplankton, including the genera *Cirrhilabrus* and *Paracheilinus*. In the Indo-Pacific the cleaner wrasses *Labroides* spp. feed on diseased or damaged tissues or external parasites of other fishes – they establish cleaner stations and solicit the attention of other fish, or may be approached by particular fish requiring their services. This role is of considerable importance, and many would-be predators allow these wrasses to perform this service and even to enter the mouth and gill areas without attempting to eat them.

Parrotfish (Scaridae)

Closely related to the wrasses, parrotfish are morphologically all relatively similar: elongate robust fishes, with a powerful beak formed from the fusion of their teeth. The majority are extremely colorful, although these color patterns are also observed to change dramatically over the course of the fish's lifetime. They are a predominantly herbivorous group, and feed by scraping or excavating the rock surface, often ingesting significant amounts of rock with the benthic algae they eat. A few of the larger species also feed in part on live coral. The largest, the bumphead parrotfish *Bolbometopon muricatum*, reach 120 centimeters, and have been estimated to remove between 2.5 and 5 tons of reef rock per year, converting it to sand and thus acting as a major erosive force on some reefs.

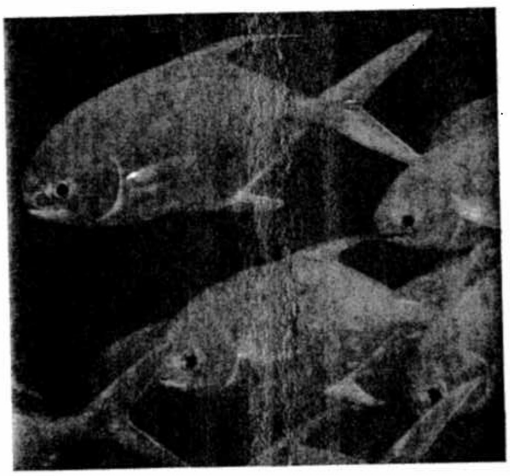
Surgeonfish (Acanthuridae)

This group is named for the sharp spines carried towards the base of the tail and used in defense. They are another highly reef-associated group, with relatively compressed, oval-shaped bodies. Of the 72 species described only six are recorded in the Atlantic. The majority of surgeonfish are algal grazers, but a number, including the unicornfish *Naso* spp., feed on plankton.

In addition to these large and conspicuous groups there are very many others. Some, such as the highly diverse blennies and gobies, and also the moray eels, soldierfish, cardinalfish and scorpionfish, include many reef-associated species, but may be less conspicuous on the reefs. Others are regular visitors, including the sharks

Above: A long-nosed butterflyfish Forcipiger flavissimus, *its fine mouth parts enabling it to forage for invertebrate food in the fine structure of the reef. Center: The Indian dascyllus* Dascyllus carneus, *a small damsel which gains shelter amidst branching corals. Below: A queen parrotfish* Scarus vetula *resting at night in a mucus bubble. Note the powerful "beak".*

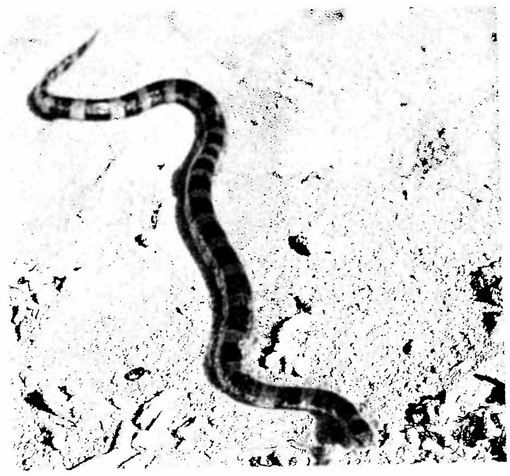
and rays, jacks or trevallies, and barracuda. Reef fish play a vitally important role in the wider functioning of the reef ecosystem, as has been borne out by the observed impacts of overfishing in many areas (see Chapter 2). They are also among the best studied of all species found on reefs, and many are widely regarded as indicators in the study of wider patterns of biodiversity on reefs.



Reptiles

The overall diversity of reptiles in the oceans is very low. Most modern reptiles have kidneys which are unable to tolerate high salinities, so the two main groups which are found on or near reefs are the ancient group of marine turtles and the modern group of sea snakes. There are seven species of marine turtle, all of which are found in tropical and sub-tropical waters. None are strictly reef species, but several regularly make use of reefs as a source of food, notably hawksbill and loggerhead turtles, which feed on invertebrates. Green turtles feed on marine plants and algae and are often seen feeding in seagrass areas near reefs. All marine turtles regularly nest on tropical coastlines, often close to reefs.

There are some 55 species of sea snake belonging to the family Elapidae, only found in the Indo-Pacific. The largest group (sub-family Hydrophiinae) are the most highly adapted, many never leave the water and all give birth to live young. Another group, the sea kraits (Laticaudinae) still leave the water to lay their eggs. All are highly adapted to their aquatic environment, with flattened tails to aid swimming, and considerable breath-holding capabilities. Most eat fish, and have developed highly toxic venom to ensure that their prey die quickly before they have time to swim off.

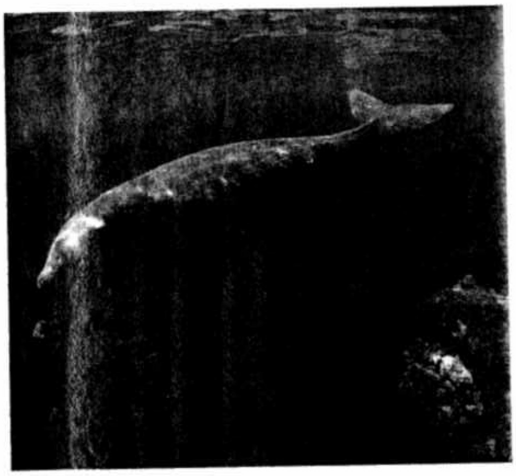


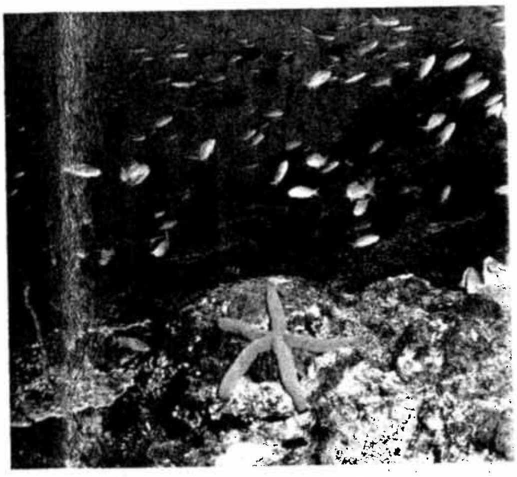
Seabirds

Although not exhibiting spectacular diversity, a number of seabirds are found regularly in coral reef environments. These include predominantly pelagic seabirds which nest on tropical oceanic islands, notably boobies (Sulidae), tropicbirds (Phaethontidae), terns and noddies (Sternidae), frigatebirds (Fregatidae) and shearwaters (Procellariidae). These often breed in spectacular numbers on small coral islands, especially where there is little human disturbance, and no predation from introduced species such as rats. Although they primarily feed on offshore pelagic species they may take some nearshore species.

Smaller numbers of waders and other seabirds are also found on or near reefs. These include sandpipers, oystercatchers, turnstones and plovers. Egrets and herons are also widespread, often feeding across the reef flat at low tide. Pelicans are quite common on reefs in the Caribbean region, and in a few places flamingos have

Above: A school of jacks, the silver pompano Trachinotus blochii. *Center: A banded sea snake* Laticauda *coming ashore to a small coral cay. Below: Hawksbill turtle* Eretmochelys imbricata *on a Caribbean reef.*





been recorded on coral reefs. Birds of prey, including ospreys and sea eagles, are likewise occasional visitors to the reef.

Marine mammals

With the exception of humans, mammals are not widespread on coral reefs. One important group, the sirenians, is often found in close proximity to reefs. These animals, the manatees of the Caribbean and the dugongs of the Indo-Pacific, are large herbivores that feed in seagrass areas, rarely venturing over the reefs themselves.

Another group is seals and sea lions (pinnipeds). Historically, monk seals were distributed in the Caribbean and Hawai'i (with a third Mediterranean species). The Caribbean monk seal is now extinct, and the Hawaiian monk seal is still declining despite extensive measures for its protection. Two other species, the Galapagos fur seal and the Galapagos sea lion, are found in the Galapagos, where there are coral communities but no true reefs.

Perhaps the best known and most diverse group is that of the whales and dolphins (cetaceans). A number of species are found in tropical waters and may be observed near reefs. Dolphins in particular regularly shelter in bays and lagoons near reefs, and occasionally feed on reef organisms. Humpback whales return annually to breed in tropical waters, and have a number of regular breeding grounds close to coral reefs, including locations in Hawai'i, the Great Barrier Reef and the Caribbean. Despite these associations, cetaceans are typically only visitors to coral reefs, and rarely dependent on them.

The human presence

Life on the coral reef is complex and diverse. Our understanding of the diversity of life, of the complexity of interactions, and of the structures and patterns that occur on coral reefs around the world is still extremely limited. Humans have lived in very close proximity to reefs for millennia, and in many areas can certainly be considered to be a part of these ecosystems. At the same time, however, changes almost entirely related to human activities are being imposed on coral reefs around the world. In many areas structures are being degraded, diversity is diminishing, and the complex interactions of the reef are being reduced and undermined. These issues, together with the efforts which are being made to redress them, are considered in the next chapter.

Above: A grey heron stalking prey on the reef flat. Center: A dugong Dugong dugon *swims along the edge of a coral reef. The lines on its back are probably scars from boat propellers* (photo: Doug Perrine/Seapics.com). *Below: A healthy reef off Nusa Penida, Indonesia.*

Selected bibliography

Allen GR, Steene R (1999). *Indo-Pacific Coral Reef Field Guide.* Tropical Reef Research, Singapore.

Allen GR, Steene RC, Allen M (1999). *A Guide to Angelfishes and Butterflyfishes.* Odyssey Publishing/Tropical Reef Research, Singapore.

Benzie JAH (1999). Genetic structure of coral reef organisms: ghosts of dispersal past. *Amer Zool* 39: 131-145.

Birkeland C (ed) (1997). *Life and Death of Coral Reefs.* Chapman and Hall, New York, USA.

Connell JH (1978). Diversity in tropical rain forests and coral reefs. *Science* 199: 1302-1310.

Crossland CJ (1988). Latitudinal comparisons of coral reef structure and function. *Proc 6th Int Coral Reef Symp* 1: 221-226.

Done TJ, Ogden JC, Wiebe WJ, Rosen BR (1996). Biodiversity and ecosystem function of coral reefs. In: Mooney HA, Cushman JH, Medina E, Sala OE, Schulze E-D (eds). *Functional Roles of Biodiversity: A Global Perspective.* John Wiley and Sons Ltd, Chichester, UK.

Hubbell SP (1997). A unified theory of biogeography and relative species abundance and its application to tropical rain forests and coral reefs. *Coral Reefs* 16 (Supplement): S9-S21.

Huston MA (1985). Patterns of species diversity on coral reefs. *Ann Rev Ecol Syst* 16: 149-177.

Huston MA (1994). *Biological Diversity: The Coexistence of Species on Changing Landscapes.* Cambridge University Press, Cambridge, UK.

Jackson JBC (1991). Adaption and diversity of reef corals. *BioScience* 41(7): 475-482.

Knowlton N, Jackson JBC (1994). New taxonomy and niche partitioning on coral reefs: jack of all trades or master of some? *Trends in Ecology and Evolution* 9(1): 7-9.

Lieske E, Myers R (1994). *Collins Pocket Guide: Coral Reef Fishes: Indo-Pacific and Caribbean.* Harper Collins Publishers, London, UK.

McAllister DE, Schueler FW, Roberts CM, Hawkins JP (1994). Mapping and GIS analysis of the global distribution of coral reef fishes on an equal area grid. In: Miller RI (ed). *Mapping the Diversity of Nature.* Chapman and Hall, London, UK.

Mather P, Bennett I (eds) (1993). *A Coral Reef Handbook: A Guide to the Geology, Flora and Fauna of the Great Barrier Reef,* 3rd edn. Surrey Beatty and Sons Pty Ltd, Chipping Norton, NSW, Australia.

Ogden JC (1997). Ecosystem interactions in the tropical coastal seascape. In: Birkeland C (ed). *Life and Death of Coral Reefs.* Chapman and Hall, New York, USA.

Ormond RFG, Roberts CM (1997). The biodiversity of coral reef fishes. In: Ormond RFG, Gage JD, Angel MV (eds). *Marine Biodiversity Patterns and Processes.* Cambridge University Press, Cambridge, UK.

Paulay G (1997). Diversity and distribution of reef organisms. In: Birkeland C (ed). *Life and Death of Coral Reefs.* Chapman and Hall, New York, USA.

Polunin NVC, Roberts CM (eds) (1996). *Reef Fisheries.* Chapman and Hall, London, UK.

Pyle RL (1996). Exploring deep coral reefs: how much biodiversity are we missing? *Global Biodiversity* 6: 3-7.

Reaka-Kudla ML (1997). The global biodiversity of coral reefs: a comparison with rain forests. In: Reaka-Kudla ML, Wilson DE, Wilson EO (eds). *Biodiversity II: Understanding and Protecting our Biological Resources.* Joseph Henry Press, Washington DC, USA.

Roberts CM (1997). Connectivity and management of Caribbean coral reefs. *Science* 278: 1454-1457.

Roberts CM, Ormond RFG (1987). Habitat complexity and coral reef fish diversity and abundance on Red Sea fringing reefs. *Mar Ecol Prog Ser* 41: 1-8.

Sale PF (ed) (1991). *The Ecology of Fishes on Coral Reefs.* Academic Press, San Diego, USA.

Spalding MD, Blasco F, Field CD (1997). *World Mangrove Atlas.* The International Society for Mangrove Ecosystems, Okinawa, Japan.

Spalding MD, Grenfell AM (1997). New estimates of global and regional coral reef areas. *Coral Reefs* 16: 225-230.

Veron JEN (1995). *Corals in Space and Time: The Biogeography and Evolution of the Scleractinia.* UNSW Press, Sydney, Australia.

Veron JEN (2000). *Corals of the World.* 3 vols. Australian Institute of Marine Science, Townsville, Australia.

Annex 714

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?", *Ocean Development and International Law*, Vol. 32, No. 2 (1994)

Ocean Development & International Law, 32:169–190, 2001

0090-8320/01 $12.00 + .00

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?

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A number of small islands (the Paracel Islands, Pratas Island, the Spratly Islands, and Scarborough Reef) may have a considerable influence on the extent of maritime zones in the South China Sea. The maritime zones of these islands can limit the extent of the high seas and the Area in the South China Sea and the extent of the maritime zones of the mainland coasts. To assess the impact of the islands, it is necessary to establish whether they can generate the full suite of maritime zones. Under international law, some islands do not have an entitlement to an exclusive economic zone and continental shelf. Where islands can generate these maritime zones, a second issue arises, namely, how to delimit these zones with those of the mainland coasts bordering the South China Sea.

Keywords islands, rocks, reefs, low-tide elevations, continental shelf, exclusive economic zone, baselines, delimitation

Introduction

A considerable part of the South China Sea is not located within 200 nautical miles of the mainland coasts.[1] However, most of the area beyond 200 nautical miles from the mainland coasts is within 200 nautical miles from various small islands scattered throughout the South China Sea. These islands are the Paracel Islands, Pratas Island, Spratly Islands, and Scarborough Reef.[2] If all these small islands had an entitlement to an exclusive economic zone (EEZ) and continental shelf, there would appear to be no area beyond national jurisdiction in the South China Sea.[3] However, it has been argued that some or all of these islands are likely to fall under the definition of Article 121(3) of the

Received 21 August 2000; accepted 11 November 2000.

The author would like to thank N. S. Marques Antunes, D. Ong and the participants of the Conference on Human and Regional Security around the South China Sea (Oslo, Norway, June 2–4, 2000) organized by the Centre for Development and the Environment, University of Oslo, for their comments on earlier versions of this article. An earlier version of the article was presented at this conference.

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Figure 1.

LOS Convention, which provides that "[r]ocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf."[4]

Even if it were to be established that all or some of these islands do not fall within the ambit of Article 121(3) of the LOS Convention and are entitled to an EEZ and continental shelf, the actual extent of these zones can only be established after a delimitation with the same zones of the mainland coasts surrounding the South China Sea. It has been suggested that in such a delimitation the islands should receive limited weight.

For instance, Claggett has argued that "[t]here seems no doubt that a court, applying existing principles and precedents, would limit the entitlement of each Spratly and Paracel high-tide elevation to, at most, a 12-[nautical-] mile belt of territorial sea."[5]

This article will focus on these two law of the sea issues and will not address the sovereignty disputes over the islands,[6] although any final delimitation of maritime zones of the South China Sea would require that the sovereignty disputes be addressed. The interest of the coastal states of the South China Sea in the island groups is explained in large part by their (potential) maritime zones having a considerable resource potential.[7] This makes an assessment of the extent of the maritime zones of the islands in the South China Sea an essential element in evaluating any proposal for resolving the sovereignty disputes.[8] Solutions for joint management or dividing the South China Sea that one or more states perceive as giving too little or too much weight to the islands may be difficult to accept. A clearer perception of what are the likely outcomes if the law of the sea is applied to establish the extent of the maritime zones of the islands involved may help in reaching a mutually acceptable solution. For instance, if all of the islands clearly fall under the definition of Article 121(3) of the LOS Convention, states might be persuaded to give up claims for maritime zones of the islands beyond a 12 nautical mile territorial sea.

The first part of this article discusses the general geographic setting of the South China Sea. This is followed by a discussion of the provisions of the LOS Convention on the limits of maritime zones and their delimitation between neighboring states. Next, the entitlement of the various islands groups to maritime zones will be assessed. A key element in this respect will be to establish the impact of Article 121(3) of the LOS Convention. After establishing the maritime zones which can in principle be generated by the islands involved, the question of their delimitation with the maritime zones of the mainland coasts will be addressed. The major findings will be restated in a concluding paragraph.

The General Geographic Setting

The South China Sea is surrounded six coastal states (or seven, if Taiwan is considered as being separate from the People's Republic of China [hereinafter China]): Brunei Darussalam, China, Indonesia, Malaysia, Philippines, and Vietnam. As was noted above, if the islands that are the subject of this analysis are excluded in establishing the extent of the EEZ, there remains a considerable area of high seas in the central part of the South China Sea.[9] It seems likely that at least part of this area might be claimed as part of the legal continental shelf of the mainland coasts under Article 76 of the LOS Convention.[10]

If all the islands under consideration in the present analysis were to generate an EEZ, it would appear that no areas of high seas or Area would be left in the South China Sea. Moreover, the EEZs of the islands would, to a considerable extent, overlap with the EEZ of the mainland coasts surrounding the South China Sea. An EEZ of Pratas Island, which is under the sovereignty of China/Taiwan, would overlap with the EEZ of the Philippines. The EEZ of the Paracel Islands, which are in dispute between China/Taiwan and Vietnam, would overlap with the EEZ of the Chinese island of Hainan and the Vietnamese mainland coast. Scarborough Reef, which is claimed by China and the Philippines, is situated well within the EEZ of the Philippines. An EEZ for the entire Spratly Islands group would overlap with the EEZ of all the coastal states bordering the South China Sea except for that of China/Taiwan.[11] The fact that all of the coastal states of the South China Sea, except Indonesia, claim one or more of the Spratly Islands makes this the most complex dispute in terms of territorial sovereignty and claims to maritime zones.

The Relevant Provisions of the LOS Convention

The LOS Convention provides the legal framework for establishing the extent of maritime zones in the South China Sea. The convention, which entered into force on 16 November 1994, has been ratified by all of the coastal states of the South China Sea except for Taiwan.[12] The convention does not allow any reservations and exceptions unless expressly permitted by an article of the convention.[13] This implies that the provisions of the convention concerning the entitlement to and delimitation of maritime zones are applicable unabridged between the coastal states of the South China Sea.[14]

Disputes over Territory and Historic Title

The LOS Convention is not intended to address disputes over sovereignty. However, sovereignty disputes can have an impact on the application of the convention's substantial or procedural rules to specific cases. In the case of the South China Sea this concerns, apart from the major uncertainty about the maritime zones of the coastal states, the procedure for making a submission to the Commission on the Limits on the Continental Shelf (CLCS) under Article 76 of the convention[15] and the applicability of the compulsory dispute settlement mechanisms of Part XV of the convention. Under Article 298 of Part XV of the convention, states may declare that they do not accept third party settlement for disputes concerning the interpretation or application of the articles concerning the delimitation of the territorial sea, the EEZ, or the continental shelf or those involving historic bays or historic title. However, such disputes can be submitted to conciliation if one party so wishes, except for those disputes involving the concurrent consideration of any unsettled dispute concerning sovereignty or other rights over territory. None of the coastal states of the China Sea has made a declaration under Article 298. In any case, disputes concurrently involving a dispute concerning sovereignty or other rights over territory appear to be excluded from the reach of the compulsory dispute settlement provisions of the convention.

One basis for China's claim to the waters of the South China Sea is historic title.[16] The LOS Convention does not define the legal regime of historic title or historic waters, although it recognizes these regimes in Articles 10(6), 15, and 46(b).[17] This implies that the regime for such waters is to be determined in accordance with customary international law. In the *Libya/Tunisia Continental Shelf Case*,[18] the International Court of Justice (ICJ) noted that general international law "does not provide for a *single* 'régime' for 'historic waters' or 'historic bays,' but only for a particular régime for each of the concrete, recognized cases of 'historic waters' or 'historic bays.'"[19] The court further noted that this regime is based on acquisition and occupation, which is distinct from the regime of the continental shelf, which is based on rights existing *ipso facto* and *ab initio*.[20] Furthermore, historic title requires the general acquiescence or recognition by other states.[21]

Baselines

The LOS Convention confirms the basic premise of the law of the sea that "[i]t is the land which confers upon the coastal State a right to the waters off its coasts."[22] In order to be able to make any claim to maritime zones a state has to have a coastline. The normal baseline from which the breadth of all maritime zones is measured is the low-water line along the coast.[23] It can be both the low-water line along a mainland coast or an island coast.

The LOS Convention defines an island as "a naturally formed area of land, surrounded by water, which is above water at high tide."[24] Low-tide elevations, which the convention defines as "a naturally formed area of land which is surrounded by and above water at low tide but submerged at high tide," only may be used as a baseline if they are wholly or partly within 12 nautical miles from the mainland or an island.[25] For an island on an atoll or having fringing reefs, the baseline is the seaward low-water line on the reef.[26]

The provisions of the LOS Convention on baselines clearly indicate that elevations of the seabed that are always submerged do not have any role to play in establishing the extent of maritime zones. The construction of artificial islands, installations, or structures over such elevations does nothing to change their status. The convention explicitly provides that artificial islands, installations, and structures do not possess the status of islands, do not have a territorial sea of their own, and do not affect the delimitation of the territorial sea, the EEZ, or the continental shelf.[27]

Article 121(3)

Article 121(3) of the LOS Convention poses an important restriction on the capacity of islands to have an EEZ and continental shelf. In view of the characteristics of the islands in the South China Sea, any assessment of their impact on the extent of maritime zones has to take into consideration Article 121(3).

It is generally acknowledged that Article 121(3) raises a number of complicated interpretative questions, making it difficult to establish to which islands it is actually applicable.[28] The present analysis does not purport to provide a final answer on rocks and islands. Further elaboration of Article 121(3) is possible through state practice or judicial decisions.[29] However, in order to reach a preliminary conclusion concerning the applicability of Article 121(3) to the islands in the South China Sea, it is necessary to seek to narrow the uncertainties surrounding its interpretation.

Two elements can be distinguished from a reading of Article 121(3). One is the size of the island and the other its capacity to sustain human habitation or economic life of its own. The relevance of size is indicated both by the wording of Article 121(3) and its drafting history.[30] Writings on Article 121(3) also indicate the relevance of this criterion. However, a review of the literature indicates that there is no agreement on what the size criterion should be for an island or a rock. A number of authors suggest that a rock is to measure significantly less than the larger islands under consideration in the present analysis.[31] This is illustrated by the reference to Rockall, which measures only 624 m^2, as an example of a typical rock.[32] Other authors consider that features similar in size to the major Spratly or Paracel Islands fall under the definition of rocks.[33] In any case, size in itself is not decisive. An island of certain size may be a rock, but may still be able to maintain human habitation or economic life of its own, thus escaping the scope of application of Article 121(3) of the LOS Convention.

The term "sustain human habitation or economic life of their own" also has given rise to different interpretations. The drafting history of Article 121(3) offers little help. Writers have discussed these terms in considerable detail. One difference of opinion is whether the word "or" has to be interpreted as being conjunctive[34] or disjunctive.[35] An interpretation in accordance with the ordinary meaning of this term[36] would suggest that the latter interpretation is correct. As far as the question of what constitutes "human habitation or economic life of their own" is concerned, at one end of the spectrum of opinions it is suggested that "economic life" can consist of the presence of a lighthouse or other navigational aids.[37] Whether such presence would really constitute "economic life" can be questioned, as it would seem to render Article 121(3) virtually meaningless. Another approach would be to define "economic life" in terms of an island or its resources significantly contributing to an activity that is economically viable.

The most far-reaching requirement that has been suggested for rocks to be able to have an EEZ and continental shelf is whether they can support a stable community of organized groups of human beings.[38] To justify such a standard it is submitted that the object and purpose of Article 121(3) of the LOS Convention is to prevent small islands, which do not have a population dependent on ocean resources, from infringing on the extent of the Area.[39] However, protecting the community interest in the Area certainly was not the only, and probably not the major, consideration resulting in the adoption of Article 121(3).[40] In any case, there are no indications that there was a consensus at either the Third United Nations Conference on the Law of the Sea or in subsequent practice that "human habitation" has to be interpreted in these broad terms. A less stringent criterion that has been suggested is that the presence of one person on an island may provide an indication that the island can support human habitation.[41] A close reading of Article 121(3) suggests that what is required is the capacity to sustain human habitation and not that a rock is actually inhabited.[42]

State practice, including that of parties to the LOS Convention, suggests a restrictive interpretation of Article 121(3).[43] In general, states take into account islands in establishing the outer limits of the EEZ or continental shelf.[44] An exceptional example of legislation that qualifies the extent of the EEZ or continental shelf is a Mexican Federal Act which provides that islands have a continental shelf and EEZ, but rocks which cannot sustain human habitation or economic life of their own do not.[45] A map of the Mexican EEZ published by the Mexican Foreign Ministry in June 1976 reportedly took into account all islands, except for the Alijos.[46] The United Kingdom decided to roll back its fishery zone limit off Rockall at the time of its accession to the LOS Convention in 1997.[47] It was indicated that "Rockall is not a valid base point for such limits under Article 121(3)" of the convention.[48]

The above discussion indicates that only islands of a very small size qualify as a rock under Article 121(3) of the LOS Convention. Furthermore, some islands that may qualify as such a rock because of their size may still be able to sustain human habitation or economic life of their own. The available arguments indicate that the threshold that has to be met in this respect is rather low and almost certainly is lower than the most far-reaching requirement, a stable community. In any case, the requirements of human habitation and economic life do not have to be met at the same time. This indicates that even if the former criterion is only met by the presence of a stable community, economic life of a rock without a stable community would result in it having an EEZ and continental shelf.

The Outer Limits of Maritime Zones

The LOS Convention lays down the maximum extent of the territorial sea, the EEZ, and the continental shelf. The territorial sea can extend to 12 nautical miles from the baselines determined in accordance with the Convention and the EEZ to 200 nautical miles from these baselines.[49] The continental shelf can either extend to 200 nautical miles from these baselines or to the outer edge of the continental margin.[50] Article 76 of the LOS Convention establishes the criteria to determine the outer limit of the continental shelf where it extends beyond 200 nautical miles. Article 76 provides two rules for establishing the outer limit line and two restraint lines, beyond which the continental shelf cannot extend in any case. Due to the dimensions of the South China Sea, these restraint lines probably are of limited significance.[51] The maximum extent of the continental shelf is either a line defined by fixed points not more than 60 nautical miles from the foot of the continental slope, or fixed points at each of which the sedimentary thickness is at least 1% of the shortest distance from such point to the foot of the continental slope.[52]

In order to establish the outer limit of its continental shelf beyond 200 nautical miles from the baselines, a coastal state has to comply with the procedure of Article 76 of the LOS Convention. An important aspect of this procedure is the submission of information to the CLCS.[53] The Rules of Procedure of the Commission have important implications for submissions involving a dispute on the delimitation of the continental shelf between opposite or adjacent states or in other cases of unresolved land or maritime disputes. Such submissions are to be considered in accordance with Annex I of the Rules of Procedure.[54] Annex I precludes, inter alia, that a submission made by any of the states concerned in such a dispute are to be examined and qualified by the CLCS, expect with prior consent given by all states that are parties to such a dispute.[55] A land or maritime dispute may, for example, concern the sovereignty over islands, the existence of a historic title, or the location of a maritime boundary.[56] The provisions of the LOS Convention do not preclude two states from agreeing on the delimitation of their continental shelf beyond 200 nautical miles if there is a dispute with other states excluding a submission to the CLCS.[57]

Under the LOS Convention, both the EEZ and the continental shelf give a state sovereign rights over the natural resources of the seabed and its subsoil.[58] This parallelism between these regimes raises the question of what happens if the continental shelf beyond 200 nautical miles of one state overlaps with the EEZ of another state or if a state argues for different boundaries for both zones within 200 nautical miles.[59] This is a complex question to which no conclusive answer is readily available. The case law, and some state practice, suggest that a different delimitation line is possible for the EEZ and the continental shelf.[60] One implication of such a situation is that one state would exercise jurisdiction over the water-column of the area concerned, and the other state over the seabed and its subsoil.[61]

Delimitation of Maritime Zones between Neighboring States

A first requirement for effecting a delimitation between two coasts is that there be an overlap of relevant maritime zones. Any maritime zone that does not overlap with the same maritime zone of another state belongs to the coastal state.

The delimitation of the territorial sea, EEZ, and continental shelf is addressed in Articles 15, 74, and 83 of the LOS Convention. Article 15 is not of direct relevance for the present analysis because there only exist areas of overlapping territorial sea between the islands involved and not between the islands and the mainland coasts. However, the existence of the territorial sea has one important implication for the delimitation of the EEZ and the continental shelf. In no case can the EEZ or continental shelf encroach upon the territorial sea.[62] All islands that meet the requirements of Article 121(1) of the

LOS Convention are entitled to a 12 nautical mile territorial sea. The outer limit of this territorial sea has to be established, taking into account the provisions on baselines of the LOS Convention set out above.

Articles 74(1) and 83(1) of the LOS Convention do not indicate what substantive rules of delimitation law have to be applied to delimit the EEZ and continental shelf. They only note that delimitation has to be effected on the basis of international law in order to achieve an equitable solution. The ICJ and arbitral tribunals have had the opportunity to address the meaning of these provisions on a number of occasions. This case law indicates that a court or tribunal applying these provisions will decide a case taking into account the same principles and rules of delimitation as exist under customary international law.[63] Customary law has been mostly developed through the case law.

As maritime delimitation law mostly consists of broad principles, it does not make it possible to predict with certainty the outcome of a specific case. Thus, it is only possible to indicate an area within which the boundary is likely to be located, instead of the actual boundary.[64]

An important distinction that has arisen in the case law is between delimitations involving opposite coasts and those involving adjacent coasts.[65] In the case of opposite coasts, the ICJ has consistently held that the starting point for effecting a delimitation should be the establishment of an equidistance line.[66] The practical implications of an initial choice of a provisional equidistance line or some other provisional starting line should not be overestimated. Maritime delimitation law, as applied by the judiciary, allows a wide margin of appreciation in shifting a provisional median line. This makes it altogether likely that different provisional lines may result in the same boundary.[67]

The next step is to assess whether there are any circumstances requiring a shift of this provisional equidistance line. The circumstances that have been taken into account are mainly of a geographical nature. Examples in this respect are the general geographical context, the distance between the relevant coasts, and the existence of a disparity in the lengths of the relevant coasts.[68]

For the delimitations involving the islands in the South China Sea, the latter of these circumstances seems to be by far the most important relevant circumstance. The case law has used the existence of a disparity in coastal lengths in two distinct ways. Because of their different implications these distinctions have to be carefully distinguished. A disparity in coastal lengths was used in the *Gulf of Maine Case*,[69] *Libya/Malta Continental Shelf Case*,[70] and *Jan Mayen Case*[71] to shift a provisional equidistance line to arrive at a boundary. In these cases, the ICJ only made an assessment of the difference in length of the relevant coasts and did not consider the ratio of maritime spaces of each party to assure that this latter ratio was similar to that of the relevant coasts. The reasons for rejecting this consideration were put eloquently by the ICJ in the *Libya-Malta Continental Shelf Case*:

> [T]o use the ratio of coastal lengths as of itself determinative of the seaward reach and area of continental shelf proper to each Party, is to go far beyond the use of proportionality as a test of equity, and as a corrective of the unjustifiable difference of treatment resulting from some method of drawing the boundary line. If such a use of proportionality were right, it is difficult indeed to see what room would be left for any other consideration [. . .]. Its weakness as a basis of argument, however, is that the use of proportionality as a method in its own right is wanting of support in the practice of States,

> in the public expression of their views at (in particular) the Third United Nations Conference on the Law of the Sea, or in the jurisprudence. [72]

The actual methods to establish the amount of shift in each of these cases differed, depending on the particular circumstances of each case.[73]

The disparity of coastal lengths has also been used to establish whether there is a reasonable proportion between the relevant coasts of the parties and the maritime spaces accorded to each of them once a boundary has been selected.[74] The ICJ and arbitral tribunals have applied this test differently in cases where the boundary was arrived at by shifting a provisional equidistance line as opposed to cases where a boundary was arrived at by a different method. In the latter case, specific calculations were made; in the former case this has only been done in the recent *Eritrea/Yemen Arbitration*.[75] As a matter of fact, in the *Gulf of Maine Case*[76] and the *Jan Mayen Case* the ICJ did not address this issue. In the *Libya-Malta Continental Shelf Case*, the court noted that in applying the proportionality test it was not required to endeavor to achieve a predetermined ratio between the relevant coasts and the respective continental shelf areas. The Court limited itself to noting that there was no evident disproportion and, as a result, the proportionality test as an aspect of equity was satisfied.[77]

Entitlement to Maritime Zones in the South China Sea

As far as entitlement to maritime zones in the South China Sea[78] is concerned, the principal question is which islands are entitled to the full suite of maritime zones. For the mainland coasts this is not an issue, although there can be some doubt over the validity of certain baselines that are used by some of the coastal states.[79]

The LOS Convention makes a distinction between three types of seabed elevations: islands, low-tide elevations, and elevations that are never above the level of the sea. In the case of islands, a further distinction is made between rocks in the sense of Article 121(3) of the Convention, which are not entitled to an EEZ and continental shelf, and all other islands that are entitled to such zones.

In the South China Sea a number of elevations that are never above the level of the sea have been mentioned in connection with the claims to territory and maritime zones. One such feature is Macclesfield Bank. A number of similar banks are located to the southwest of Spratly Island: Alexandra Bank, Grainger Bank, Prince Consort Bank, Prince of Wales Bank, Rifleman Bank, and Vanguard Bank. Other submerged banks are nearer to islands in the Spratly Islands or the Paracel Islands, implying that their absence of entitlement to maritime zones is less consequential than for the earlier mentioned features. These latter banks include, inter alia, Owen Shoal and Reed Bank in the Spratly Islands and Bremen Bank in the Paracel Islands. It has been reported that some of these banks have been occupied.[80] The construction of structures over these banks would not change their status (e.g., they are part of the coastal state's maritime zone in which they are located) and such structures themselves are not entitled to any maritime zones except for a safety zone around them.[81]

Although no sovereignty can be claimed over these banks and they are not entitled to maritime zones, they may form part of the historic waters of a state or a state may have historic rights over such areas. However, reviewing the available information in the light of the applicable rules of international law does not indicate that any such claims can be upheld.[82]

There are numerous low-tide elevations in the Spratly and Paracel Islands, including

Bombay Reef, North Reef, and Passu Keah in the Paracel Islands; and Alison Reef, Ardasier Reef, Bombay Shoal, Cornwallis South Reef, Hardy Reef, Hughes Reef, Ladd Reef, and Subi Reef in the Spratly Islands. These low-tide elevations are only to be part of the baseline for measuring the outer limit of the territorial sea if they are within 12 nautical miles of an island.[83] This implies that, for instance, North Reef in the Paracel Islands, which lies beyond this distance from the Amphitrite Group and the Crescent Group, does not have any influence on the extent of maritime zones. If a low-tide elevation is located in the territorial sea of a state, in principle it is only that state which can use this low-tide elevation for establishing the extent of its maritime zones. A claim of another state to such a low-tide elevation is, in principle, impermissible.

The provisions on low-tide elevations and reefs in the LOS Convention have considerable impact on the extent of the territorial sea of a number of insular features in the Paracel and Spratly Islands. Many low-tide elevations are situated wholly or partly within 12 nautical miles of islands and can be used as part of the baseline for measuring the territorial sea.[84] There are a number of atolls in the Spratly and Paracel Islands, raising the question of whether Article 6 of the LOS Convention can be applied. One difficulty is that in most cases there are no fringing reefs on a large part of the perimeter of the atoll.[85] Closing lines may be used across openings in fringing reefs to establish the limit between internal waters and the territorial sea.[86] It has been suggested that if a fringing reef is found only along one side of an island, it would probably be reasonable to use the shortest possible line to close the internal waters.[87] This solution might be applied to some of the features in the Spratly and Paracel Islands.

Even if Article 6 of the LOS Convention is not applicable to these features, in most cases the fringing reefs in the Spratly and Paracel Islands are close enough to an island to be used as the baseline for the territorial sea and other maritime zones. In this case the waters within these features are part of the territorial sea and do not, as is the case under Article 6, form part of the internal waters.

A large number of features in the Paracel and Spratly Islands, Pratas Island, and Scarborough Reef are permanently above water, making them islands in the sense of Article 121(1) of the LOS Convention. However, Article 121(3) directs that certain islands are not entitled to an EEZ or continental shelf. A subdivision of islands into three categories can be made. Some islands seem to fall squarely within the definition of rocks, due to their very limited size. Apart from certain features in the Paracel and Spratly Islands, this would seem to be the case for Scarborough Reef.[88] On the other hand, Pratas Island and the largest islands in the Paracel and Spratly Islands, due to their size and other characteristics, do not appear to fall within Article 121(3).[89] These include, but are not necessarily limited to, Itu Abu, Spratly Island, and Thi Tu in the Spratly Islands and Lincoln Island and Woody Island in the Paracel Islands. Finally, there are a number of islands in the Paracel and Spratly Islands which might or might not fall under Article 121(3) of the Convention.[90] A detailed discussion of each of these islands is beyond the scope of this article and in any case is not required to indicate in broad terms what delimitations might be effected between the Paracel and Spratly Islands and the mainland coasts surrounding the South China Sea.

Delimitation of Overlapping Maritime Zones in the South China Sea

The starting point of any delimitation of maritime zones is to establish the extent to which these zones overlap. In the South China Sea, there are considerable areas within

200 nautical miles from the islands discussed here which do not overlap with the EEZ of the mainland coasts. Such areas form part of the EEZ of the islands.

In the analysis of the delimitation of maritime zones between islands and mainland coasts in the South China Sea, four separate areas have to be distinguished: between Pratas Island and the Philippines; between Scarborough Reef and the Philippines; between the Paracel Islands and the coasts of Vietnam or China; and between the Spratly Islands and the surrounding mainland coasts.[91]

The coastal relationship and distance between the islands in the South China Sea and the mainland coasts indicate that the delimitation of overlapping EEZs is between opposite coasts. This suggests that the starting point of a delimitation should be a provisional equidistance line between the relevant coasts. One difference between the situations in which the case law applied equidistance as a provisional line and the delimitation involving the islands in the South China Sea is that in the latter case the coastal length (and size) of the islands is very limited. Some pronouncements of the ICJ and arbitral tribunals might be taken to suggest that such small islands should not be given any weight, either in the drawing of a provisional equidistance line or in the establishing of the boundary.[92]

However, the situation in the South China Sea differs fundamentally from the circumstances in which the case law considered it acceptable to ignore minor insular features. In the instances in which the case law indicated that small features could be disregarded, the features were only a minor element in an overall delimitation involving longer coasts.[93] In the South China Sea, the islands are one of the principal elements in the delimitation and not an incidental feature in a larger geographical setting. This is especially the case in those areas in which there are no overlapping zones between the mainland coasts and, consequently, there is a need to delimit the overlap of maritime zones between the islands and one of the mainland coasts.[94]

This difference can be illustrated by looking at the effect of giving no weight to an island in establishing an equidistance line in these two instances. Giving no weight to a small island that is relatively close to a larger island or a mainland coast only has a limited effect on the location of the equidistance line. For instance, in the *Libya-Malta Continental Shelf Case*, the ICJ gave no weight to the Maltese islet of Filfla in establishing a provisional equidistance line.[95] However, this provisional equidistance line was still at a very large distance from Filfla.[96] Discounting the islands in the South China Sea in establishing a provisional equidistance line using only the mainland coasts would place such a line very near or even beyond the islands involved.[97]

Another argument that has been advanced to justify giving no weight to the islands in the South China Sea in establishing maritime boundaries is the large disproportion between their relevant coasts and the relevant mainland coasts.[98] The way in which this circumstance has been applied in cases involving opposite coasts indicates that this argument is not convincing. The case law has argued strongly that there is no place for a comparison between the ratios of coastal lengths and maritime spaces of each of the parties in applying this relevant circumstance. Such a comparison has been made to establish whether the boundary arrived at is equitable in cases involving adjacent coasts. However, in decisions involving opposite coasts this has not been done except in one recent case.[99]

Finally, giving no weight to the islands in the South China Sea in a delimitation, i.e., by letting the EEZ boundary coincide with the 200 nautical mile limit of the opposite mainland coast, would seem to run counter to one of the premises of the law applicable to the delimitation of maritime boundaries. In the *Jan Mayen Case* the ICJ observed:

> Nor do the circumstances require the Court to uphold the claim of Denmark that the boundary line should be drawn 200 miles from the baselines on the coast of eastern Greenland, i.e., a delimitation giving Denmark maximum extension of its claim to continental shelf and fishery zone. The result of such a delimitation would be to leave Norway merely the residual part [. . .] of the "area relevant to the delimitation dispute" as defined by Denmark. The delimitation according to the 200-mile line calculated from the coasts of eastern Greenland may from a mathematical perspective seem more equitable than that effected on the basis of the median line, regard being had to the disparity in coastal lengths; but this does not mean that the result is equitable in itself, which is the objective of every maritime delimitation based on law. The coast of Jan Mayen, no less than that of eastern Greenland, generates potential title to maritime areas recognized by international law, i.e., in principle up to a limit of 200 miles from its baselines. To attribute Norway merely the residual area left after giving full effect to the eastern coast of Greenland would run wholly counter to the rights of Jan Mayen and also to the demands of equity.[100]

The underlying assumption is that delimitation is concerned with establishing how an area of overlapping claims has to be divided, taking, in principle, as a starting point its equal division.[101] This equal division may be adjusted in the light of the relevant circumstances of the case.[102] Attributing all of the area of overlap to one of the states involved would run counter to this basic tenet of delimitation law.[103]

The conclusion that follows from this review of the law applicable to the delimitation of the EEZ is that giving no weight to the islands entitled to an EEZ in a delimitation between mainland coasts has to be rejected. What weight should be accorded to each of the island groups depends on the relevant circumstances of each individual case.

A delimitation between Pratas Island and the Philippines has to start with the establishment of a provisional equidistance line. The major factor for shifting such a provisional equidistance line is the large disparity between the coastal length of Pratas Island and the relevant coast of the Philippines. One circumstance in establishing the amount to which the provisional line should be shifted is the presence of the island of Taiwan (and possibly the Chinese mainland coast). Any shift in a provisional equidistance line should leave Pratas Island at least some limited maritime zone beyond an equidistance line between the Philippines and these other coasts.[104] The relatively large distance between Pratas Island and the Philippines would be another argument for not shifting a provisional equidistance line too far in the direction of Pratas Island.

A second delimitation concerns Scarborough Reef. As was argued above, Scarborough Reef probably is a rock in the sense of Article 121(3) of the LOS Convention, obviating a need to delimit the EEZ or continental shelf. If Scarborough Reef does not fall under the sovereignty of the Philippines, the reef is entitled to a 12 nautical miles territorial sea enclaved within the EEZ of the Philippines.

The Paracel Islands are in dispute between China and Vietnam. A resolution of this sovereignty dispute might require a delimitation between the islands and the mainland coasts of one of these states or both states if the islands were to be divided between them. A delimitation between the Paracel Islands and either of the mainland coasts would start with the establishment of a provisional equidistance line. The principal factor for shifting such a provisional equidistance line would be the large disparity between the coasts of the Paracel Islands and the relevant mainland coasts. One circumstance in establishing the amount to which the provisional line should be shifted is the fact that the maritime zones of the mainland coasts not only overlap with those of the Paracel Islands, but also with each other. Any shift in a provisional equidistance line should leave the Paracel Islands at least some maritime zone beyond this latter equidistance line. This consideration would be mostly relevant in the area between the islands and the mainland coasts.

The EEZs of the Spratly Islands overlap with those of five mainland coasts (Brunei Darussalam, Indonesia, Malaysia, Philippines, and Vietnam). The starting point of any of these delimitations would be to establish a provisional equidistance line. To establish these equidistance lines only those islands not falling under Article 121(3) should be taken into consideration.[105] Any island in the Spratly Islands falling under Article 121(3) of the LOS Convention situated beyond this provisional equidistance line has a 12 nautical mile territorial sea forming an enclave in the EEZ of the mainland coast concerned. Submerged banks in the Spratly Islands are irrelevant for delimitation purposes.

In establishing the shift of a provisional equidistance line to arrive at the boundary, the most significant relevant circumstance is once more the large disparity in coastal lengths. Such a shift would be larger (at least in relative terms) in areas where the islands and the mainland coasts are at a shorter distance. This general proposition is indicated by both the case law and state practice. For instance, if a delimitation between the Spratly Islands and the Philippines were to be required, a boundary might consist of a number of lines connecting points on the outer limits of territorial seas of those islands that have an EEZ. In relation to Vietnam, a delimitation might be effected by a shift of a provisional equidistance line that, at points closest to islands, would still be some distance from the outer limit of their 12 nautical mile territorial sea. It is not without interest that the area that thus would be attributed to the Spratly Islands in any case would in large part appertain to them because it is beyond 200 nautical miles of the mainland coast and/or part of their territorial sea.

One circumstance of a nongeographical nature that might be invoked in connection with a delimitation are hydrocarbon concessions.[106] However, the circumstances surrounding the issuing of licenses do not seem to be of such a nature as to be relevant for establishing the location of a maritime boundary.[107] Another relevant circumstance, which has been invoked from time to time by states, are lines that have been applied for defining the extent of territory or maritime zones. The practice of the states in the South China Sea does not suggest that any such lines have been accepted as representing the extent of historic claims or as representing an equitable boundary for delimiting maritime zones under the LOS Convention.[108]

One final issue of relevance for the delimitation of the maritime zones of the islands in the South China Sea is that the continental shelf of the mainland coasts may extend beyond 200 nautical miles.[109] For instance, it has been submitted that the continental shelf of Vietnam may extend to 350 nautical miles from its baselines.[110] This raises the question whether this should result in a continental shelf boundary different from the EEZ boundary.

One important implication of the existence of continental shelf rights beyond 200 nautical miles in the southern part of the South China Sea would be that these not only can be claimed from the mainland coasts, but also from the Spratly Islands, as in this case they would be situated on the same continental shelf as the mainland coasts. In other words, this does not concern a situation in which a continental shelf beyond 200 nautical miles of a mainland coast has to be delimited against a 200 nautical mile zone from the islands, but a situation in which there is equal entitlement of both of these coasts. This would suggest that in this case, again, the starting point of a delimitation should be a provisional equidistance line between the relevant coasts and that in general the same arguments apply as set out above in connection with the delimitation of the EEZ. However, one implication of continental shelf entitlement could be that a shift in a provisional median line could result in a continental shelf boundary that in some areas is only within 200 nautical miles from the coasts of the islands, but beyond 200 nautical miles from the mainland coasts. This implies that it would differ from the EEZ boundary.

Conclusions

If anything, the present analysis indicates the complexity of establishing the extent of the maritime zones of the islands in the South China Sea under the law of the sea. In part, this is due to the fact that a number of provisions of the LOS Convention are open to different interpretations. State practice, which may contribute to the clarification of these provisions, is not always abundant.

Although the LOS Convention does not provide a clear-cut answer to some of the law of the sea aspects of the disputes in the South China Sea, it narrows down the available options and interpretations considerably. A legal regime raising certain controversy, which to a large extent is inevitable in view of the complexities of coastal geography, is to be preferred to a situation in which there is no legal restraint on the kind of maritime claims states can advance.

The most important issue in respect of baselines concerns Article 121(3) of the LOS Convention. Although there is a considerable amount of uncertainty concerning the interpretation and application of this provision, it seems that at least some of the islands in the South China Sea have an EEZ and continental shelf. Other insular formations can almost certainly be considered to fall under the sway of Article 121(3). States may also differ over other baseline issues. This concerns, for instance, the question of what reefs can be considered to be fringing reefs in the sense of Article 6 of the LOS Convention. The LOS Convention indicates that the role of low-tide elevations is limited in establishing entitlement to maritime zones and that the submerged banks in the South China Sea do not have any role to play in this respect. It is also unlikely that there exists any historic claim to the waters overlying these banks.

The entitlement of some of the islands to an EEZ and continental shelf severely limits (or may even cancel altogether) the extent of the high seas and the Area in the South China Sea. The parts of the maritime zones of the islands that do not overlap with those of the mainland coasts cannot be the subject of delimitation. On the other hand, in areas of overlap of the EEZ and continental shelf of the islands with those of the mainland coasts there is a need for delimitation. A delimitation between these zones of the islands and the mainland coasts under maritime delimitation law should, in any case, not result in a boundary that coincides with the 200 nautical mile limit of the mainland coast, leaving the islands only the remaining maritime areas.[111] Although at first glance this would seem to greatly enhance the significance of the islands, it should be recognized that a large part of the area bounded by the delimitation lines suggested in this article would also be part of their maritime zones if they would not be given any weight in a delimitation with the mainland coasts. A large part of the area involved is only within 200 nautical miles from the islands and cannot be claimed as part of the EEZ of the mainland coasts. Areas within 12 nautical miles from the baselines of the islands, also those which are rocks in the sense of Article 121(3) of the LOS Convention, are part of their territorial sea. The presence of low-tide elevations and fringing reefs makes such areas quite extensive.

If it is possible to claim a continental shelf beyond 200 nautical miles under Article 76 of the LOS Convention a number of complications would arise. The Rules of Procedure of the CLCS seem to exclude any submission from being considered without the prior consent of all the states involved in the disputes concerning the South China Sea. The existence of a continental shelf beyond 200 nautical miles would not lead to substantially different outcomes of maritime delimitation between the islands and the mainland coasts. However, there could be a divergence between the EEZ and continental shelf boundaries in certain areas, implying that one state may have jurisdiction over the water-column (EEZ) and another state may have jurisdiction over the seabed and its subsoil (continental shelf).

One might lament the present conclusions, as they point to the importance of some of the islands in the South China Sea. This may strengthen the resolve of the states involved to hold on to or further acquire these island possessions. However, these conclusions follow from an analysis of the LOS Convention, which is generally acknowledged—including by the coastal states of the South China Sea—to be the constitution for the oceans. Any claims that can be validly made on the basis of this instrument should be taken into consideration in working toward a long-term solution for the disputed islands in the South China Sea.

Notes

1. Unless explicitly stated otherwise, all references to the mainland coasts of the South China Sea include the major islands surrounding the South China Sea (i.e., Hainan, Taiwan, Luzon, Mindoro, the Calawan Group, Palawan, Kalimantan (Borneo), and the Natuna Islands).

2. China also claims the waters around Macclesfield Bank. On this issue and submerged banks in general, see infra. There also are a number of small islands off the coast of Vietnam, such as Dao Bach Long Vi in the Gulf of Tonkin and the Catwick Islands in the South China Sea proper. The Gulf of Tonkin falls outside the scope of the present paper. The offshore islands of Vietnam in the South China Sea proper will be taken into consideration in assessing the delimitation between the Vietnamese mainland coast and the Spratly Islands.

3. The United Nations Convention on the Law of the Sea (hereinafter the LOS Convention) of 10 December 1982 (entered into force on 16 November 1994), 21 *International Legal Materials* 1982, p. 1261 distinguishes two areas beyond national jurisdiction. The high seas include all parts of the sea beyond the EEZ (LOS Convention, Article 86). The "Area" is defined as the sea-bed and ocean floor and subsoil thereof beyond the limits of national jurisdiction (LOS Convention, Article 1). As the continental shelf in some areas extends beyond the outer limit of the EEZ, the high seas can overlay either the continental shelf or the Area.

4. See B. Claggett, "Competing Claims of Vietnam and China in the Vanguard Bank and the Blue Dragon Areas of the South China Sea: Part I," 13 *Oil and Gas Law and Taxation Review* 1995, pp. 375–388, at p. 377; L. G. Cordner, "The Spratly Islands Dispute and the Law of the Sea," 25 *Ocean Development and International Law* 1994, pp. 61–74, at p. 69; B. Hart Dubner, "The Spratly 'Rocks' Dispute—A 'Rockapelago' Defies the Norms of International Law," 9 *Temple International and Comparative Law Journal* 1995, pp. 291–331, at p. 323; M. J. Valencia, J. M. Van Dyke and N. A. Ludwig, *Sharing the Resources of the South China Sea* (Martinus Nijhoff Publishers, The Hague, 1997), at pp. 43–44; and D. Whiting, "The Spratly Islands Dispute and the Law of the Sea," 26 *Denver Journal of International Law and Policy* 1998, pp. 897–915, at p. 905.

5. B. Claggett, "Competing Claims of Vietnam and China in the Vanguard Bank and the Blue Dragon Areas of the South China Sea: Part II," 13 *Oil and Gas Law and Taxation Review*

1995, pp. 419–435, at p. 432. See also J. I. Charney, "Central East Asian Maritime Boundaries and the Law of the Sea," 89 *American Journal of International Law* 1995, pp. 724–749, at pp. 741 and 748; J. Greenfield, "China and the Law of the Sea," in J. Crawford and D. R. Rothwell (eds.), *The Law of the Sea in the Asia Pacific Region* (Martinus Nijhoff Publishers, Dordrecht, 1995), pp. 21–40, at pp. 36–37; Valencia et al., supra note 4, at p. 54; and J. M. Van Dyke and D. L. Bennett, "Islands and the Delimitation of Ocean Space in the South China Sea," 10 *Ocean Yearbook* 1993, pp. 54–89, at p. 89.

6. On the sovereignty disputes, see M. Bennett, "The People's Republic of China and the Use of International Law in the Spratly Islands Dispute," 28 *Stanford Journal of International Law* 1992, pp. 425–450; J. Greenfield, *China's Practice in the Law of the Sea* (Clarendon Press, Oxford, 1992), pp. 150–167; I. Scobbie; "The Spratly Islands Dispute: An Alternative View," 14 *Oil and Gas Law and Taxation Review* 1996, pp. 173–183, at pp. 175–178; Teh-Kuang Chang, "China's Claim of Sovereignty over Spratly and Paracel Islands: A Historical and Legal Perspective," 23 *Case Western Reserve Journal of International Law* 1991, pp. 399–420; Valencia et al., supra note 4, at pp. 17–40; G. M. C. Valero, "Spratly Archipelago Dispute; Is the Question of Sovereignty Still Relevant?," 18 *Marine Policy* 1994, pp. 314–344; Van Dyke and Bennett, supra note 5, at pp. 61–75; and Whiting, supra note 4.

7. On the resource potential of the maritime zones of the Spratly Islands, see Valencia et al., supra note 4, at pp. 9–11 and 187–190.

8. See D. Ong, "The Spratlys Dispute over Marine Resources: Time for a New Approach?," 13 *Oil and Gas Law and Taxation Review* 1994, pp. 352–356, at p. 353.

9. See Valencia et al., supra note 4, at p. 264, Plate 11, which indicates the 200 nautical mile limit in the South China Sea without taking into account the Paracel Islands, the Spratly Islands, and Scarborough Reef.

10. On the implications of Article 76, *see infra*.

11. For a detailed description of the Spratly Islands, see D. Hancox and V. Prescott, *A Geographical Description of the Spratly Islands and an Account of Hydrographic Surveys Amongst those Islands* (IBRU, Maritime Briefing, Vol. 1, No. 6 (1995)).

12. Brunei Darussalam ratified the Convention on 5 November 1996; China on 7 June 1996; Indonesia on 3 February 1986; Malaysia on 14 October 1996; Philippines on 8 May 1984; and Vietnam on 25 July 1994. Taiwan cannot become a party to the LOS Convention. The fact that six of the coastal states of the South China Sea are a party to the LOS Convention makes the question whether there are any differences between the convention and customary international law of limited significance.

13. LOS Convention, Article 309.

14. Article 310 of the convention allows states to make declarations and statements. China, Malaysia, Philippines, and Vietnam have made such declarations upon ratification of the convention. See *The Law of the Sea; Declarations and Statements with respect to the United Nations Convention on the Law of the Sea and to the Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea* (United Nations, New York, 1997), at pp. 23, 32, 40, and 45. These declarations make some reference to the issues under examination here. However, in view of Article 309 of the convention, these declarations do not affect the impact of the convention's provisions concerning entitlement to and delimitation of maritime zones.

15. See infra.

16. On this claim, see Charney, supra note 5, at pp. 736–737 and, more specifically, Z. Keyuan, "Historic Rights in International Law and in China's Practice," 32 *Ocean Development and International Law* 2001 (this issue).

17. Articles 10(6) and 15 of the LOS Convention in this respect reflect, respectively, Articles 7(6) and 12 of the convention on the Territorial Sea and the Contiguous Zone, of 29 April 1958, entered into force on 10 September 1964 *United Nations Treaty Series*, Vol. 516, p. 205. There is no precursor to Article 46(b) in the 1958 Convention.

18. *Case Concerning the Continental Shelf (Tunisia/Libyan Arab Jamahiriya)*, Judgment of 24 February 1982; *ICJ Reports* 1982, at p. 18.

19. Ibid., at p. 74, para. 100.

20. Ibid. In view of the court's delimitation method, no finding on the validity of the Tunisian historic rights claim in the context of the continental shelf delimitation was necessary. Ibid., at p. 77, para. 105 and at p. 86, para. 121.

21. On the role of acquiescence and recognition in this respect, see Y. Z. Blum, *Historic Titles in International Law* (Martinus Nijhoff, The Hague, 1965), at pp. 38–98; I. Brownlie, *Principles of International Law*; Fourth Edition (Clarendon Press, London, 1993), at pp. 159–161; and N. S. Marques Antunes, *Estoppel, Acquiescence and Recognition in Territorial and Boundary Dispute Settlement* (IBRU, Boundary and Territory Briefings, Vol. 2, No. 8 (2000)).

22. *Fisheries Case (United Kingdom v. Norway)*, Judgment of 18 December 1951 *ICJ Reports* 1951, at p. 116, at p. 133. See also *North Sea Continental Shelf Cases (Federal Republic of Germany v. Denmark; Federal Republic of Germany v. the Netherlands)*, Judgment of 20 February 1969, *ICJ Reports* 1969, at p. 51, para. 96 and *Case Concerning the Aegean Sea Continental Shelf (Greece v. Turkey)*, Judgment of 19 December 1978, *ICJ Reports* 1978, at p. 36, para. 86.

23. LOS Convention, Article 5. The convention also provides for the possibility of drawing straight lines which can be used as the baseline from which the breath of maritime zones can be measured (Articles 7, 9, 10, and 47). However, these lines in general are generated from the low-water line along the coast. These provisions on straight lines are not of fundamental importance for establishing the extent of the maritime zones of the islands under review in this article.

24. LOS Convention, Article 121(1).

25. LOS Convention, Article 13. Moreover, in certain instances low-tide elevations can be used for establishing straight (archipelagic) baselines (Articles 7(4) and 47(4)).

26. LOS Convention, Article 6.

27. LOS Convention, Article 60(8); see also LOS Convention, Article 11.

28. For a discussion of this provision, see J. I. Charney, "Rocks that Cannot Sustain Human Habitation," 93 *American Journal of International Law* 1999, pp. 863–877; R. Kolb, "L'Interprétation de l'Article 121, Paragraphe 3, de la Convention de Montego Bay sur le Droit de la Mer: Les <<Rochers qui ne se Prêtent pas à l'Habitation Humaine ou à une Vie Économique Propre. . .>>," *40 Annuaire Français de Droit International* 1994, pp. 876–909; and B. Kwiatkowska and A. H. A. Soons, "Entitlement to Maritime Areas of Rocks which Cannot Sustain Human Habitation or Economic Life of Their Own," 21 *Netherlands Yearbook of International Law* 1990, pp. 139–181.

29. See further, A. G. Oude Elferink, "Is it Either Necessary or Possible to Clarify the Provision on Rocks of Article 121(3) of the Law of the Sea Convention?," *The Hydrographic Journal*, No. 92, April 1999, pp. 9–16.

30. For the drafting history of Article 121(3), see S. N. Nandan and S. Rosenne (eds.), *United Nations Convention on the Law of the Sea, 1982; A Commentary, Volume III* (Martinus Nijhoff Publishers, Dordrecht, 1995), at pp. 321–339. The discussion on Article 121 at the Third United Nations Conference on the Law of the Sea suggests that proposals to limit the extent of maritime zones of certain islands served two distinct purposes. One was to deny small islands any entitlement to an EEZ and continental shelf. The other was to deny such islands a role in the delimitation of these zones with neighboring states. The outcome of the discussion between the opponents and proponents of these separate issues is contained in the single provision which became Article 121(3) of the LOS Convention. See also Kwiatkowska and Soons, *supra* note 28, at pp. 180–181.

31. R. R. Churchill and A. V. Lowe, *The Law of the Sea* (3rd edition) (Manchester University Press, Manchester, 1999), at p. 50; D. M. Johnston, *The Theory and History of Ocean Boundary-Making* (McGill-Queen's University Press, Kingston, 1988), at p. 119; L. Lucchini and M. Vœlckel, *Droit de la Mer; Tome 1; La Mer et son Droit; Les Espaces Maritimes* (Pedone, Paris, 1990), at pp. 343–344; Charney, supra note 28, at p. 869; A. H. A. Soons, "The Effects of a Rising Sea Level on Maritime Limits and Boundaries," 37 *Netherlands International Law Review* 1990, pp. 207–232, at p. 218; and C. R. Symmons, *The Maritime Zones of Islands in International Law* (Martinus Nijhoff Publishers, The Hague, 1979), at p. 41.

32. See E. D. Brown, *Sea-Bed Energy and Minerals: The International Legal Regime; Volume 1: The Continental Shelf* (Martinus Nijhoff Publishers, Dordrecht, 1992), at p. 39; Churchill and Lowe, supra note 31, at p. 50 and Symmons, supra note 31, at p. 41.

33. See J. M. Van Dyke and R. A. Brooks, "Uninhabited Islands: Their Impact on the Ownership of the Oceans' Resources," 12 *Ocean Development and International Law* 1983, pp. 265–300, at pp. 286–287. See also the remark in the text at infra notes 38 and 39.

34. Kolb, supra note 28, at p. 906.

35. Kwiatkowska and Soons, supra note 28, at pp. 163–165.

36. Article 31(1) of the 1969 Vienna Convention on the Law of Treaties provides that "[a] treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to terms of the treaty in their context and in the light of its object and purpose." Vienna Convention on the Law of Treaties of 23 May 1969, entered into force on 27 January 1980, 8 *International Legal Materials* 1969, p. 679.

37. Brown, supra note 32, at p. 38 and Kwiatkowska and Soons, supra note 28, at pp. 167–168.

38. See Kolb, supra note 28, at pp. 903 and 906 and Van Dyke and Brooks, supra note 33, at p. 288.

39. Kolb, supra note 28, at p. 901 and Van Dyke and Brooks, supra note 33, at p. 288.

40. See Nandan and Rosenne, supra note 30. See also Charney, supra note 28, at pp. 865–866; S. Karagiannis; "Les Rochers qui ne se Prêtent pas à l'Habitation Humaine ou à une Vie Économique Propre et le Droit de la Mer," 29 *Revue Belge de Droit International* 1996, pp. 559–624, at p. 623; and J. R. Stevenson and B. H. Oxman, "The United Nations Conference on the Law of the Sea: the 1974 Caracas Session," 69 *American Journal of International Law* 1975, pp. 1–30, at pp. 17 and 24–25.

41. Karagiannis, supra note 40, at pp. 573–574.

42. Kwiatkowska and Soons, supra note 28, at pp. 160–161.

43. See Kolb, supra note 28, at p. 899. In principle, state practice is more important for interpreting treaty provisions than legal doctrine.

44. See Oude Elferink, supra note 29, at pp. 9–10. The fact that limited or no weight has been given to islands in the delimitation of maritime boundaries between states does not imply an assessment of whether or not Article 121(3) is applicable.

45. Federal Act relating to the Sea of 8 January 1986, Articles 51 and 63 reprinted in *The Law of the Sea; Current Developments in State Practice* (New York, United Nations, 1987), at p. 56.

46. Symmons, supra note 31, at pp. 125–126. See also W. van Overbeek, "Article 121(3) LOSC in Mexican State Practice in the Pacific," 4 *International Journal of Estuarine and Coastal Law* 1989, pp. 252–267, at p. 262. It seems that the Mexican baselines are under review at the present time.

47. Also, it seems that the United Kingdom did not take into account Shag Rocks and Black Rock in establishing a 200 nautical mile limit off South Georgia in 1993. Although this is not apparent from the relevant legislation (Proclamation (Maritime Zone) No. 1 of 1993 reprinted in *Law of the Sea Bulletin*, No. 24, at pp. 47–48 and The South Georgia and South Sandwich Islands (Territorial Sea) Order 1989 (Statutory Instrument 1989 No. 1995 and Explanatory Note), the chart depicting this outer limit reportedly reflects this treatment of these rocks. See also R. R. Churchill, "Falkland Islands—Maritime Jurisdiction and Co-operative Arrangements with Argentina," 46 *International and Comparative Law Quarterly* 1997, pp. 463–477, at pp. 473–474.

48. Statement by the Foreign and Commonwealth Secretary, cited in D. H. Anderson, "British Accession to the UN Convention on the Law of the Sea," 46 *International and Comparative Law Quarterly* 1997, pp. 761–786, at p. 778. The limit of the fishery zone was redefined accordingly through the Fishery Limits Order 1997 (Statutory Instrument 1997 No. 1750 of 22 July 1997).

49. LOS Convention, Articles 3 and 57.

50. LOS Convention, Article 76(1).

51. The continental shelf can either extend to 350 nautical miles from the relevant baselines or 100 nautical miles beyond the 2500 meter isobath LOS Convention, Article 76(5).

52. LOS Convention, Article 76(4).

53. For an overview of the activities of the CLCS since it became operational in 1997, see Oceans and the Law of the Sea, Reports of the Secretary-General (1999), UN Doc A/54/429, paras. 51–61; (1998), UN Doc A/53/456, paras. 55–69 and (1997), UN Doc A/52/487, paras. 43–53.

54. Rules of Procedure of the Commission on the Limits of thc Continental Shelf, UN Doc. CLCS/3/Rev. 2 of 4 September 1998, rule 44(1).

55. Ibid., Annex I, para. 5(a).

56. It may not always be clear if a submission involves a land or maritime dispute and which are the states involved in such a dispute. In the South China Sea, any submission would seem to touch upon the existing land and maritime disputes. The cautious approach the CLCS has taken in formulating its Rules of Procedures on this point suggests that it would likely reach such a conclusion.

57. Such a delimitation would not have legal consequences for these other states and would not resolve the question of establishing the outer limit of the continental shelf in conformity with the LOS Convention.

58. LOS Convention, Articles 56 and 77.

59. On this parallelism between the EEZ and continental shelf, see B. Kwiatkowska, *The 200 Mile Exclusive Economic Zone in the Law of the Sea* (Martinus Nijhoff Publishers, Dordrecht, 1989), at pp. 6–19.

60. See *Case Concerning Delimitation of the Maritime Boundary in the Gulf of Maine Area (Canada/United States of America)*, Judgment of 12 October 1984, *ICJ Reports* 1984, at p. 267, para. 27 and at p. 291, para. 84.

61. The United Kingdom and Denmark, and Australia and Indonesia have set up such regimes in bilateral delimitation treaties. Agreement between the Government of the Kingdom of Denmark together with the Home Government of the Faroe Islands, on the one hand, and the Government of the United Kingdom of Great Britain and Northern Ireland, on the other hand, relating to the Maritime Delimitation between the Faroe Islands and the United Kingdom of 18 May 1999, reprinted in 14 *International Journal of Marine and Coastal Law* 1999, p. 551 and Treaty between the Government of Australia and the Government of the Republic of Indonesia Establishing an Exclusive Economic Zone Boundary and Certain Seabed Boundaries of 14 March 1997, reprinted in 12 *International Journal of Marine and Coastal Law* 1997, p. 535.

62. For an overview of relevant state practice and case law, see A. G. Oude Elferink, "Does Undisputed Title to a Maritime Zone Always Exclude its Delimitation: The Grey Area Issue," 13 *International Journal of Marine and Coastal Law* 1998, pp. 143–192, at pp. 153–154, 159–160, and 164–165. This proposition was reconfirmed in the *Award of 17 December 1999 in Phase II (Maritime Delimitation) of the Eritrea/Yemen Arbitration*, see especially, Chapter V, paras 160–161, available at www.pca-cpa.org/erye2toc.htm.

63. See *Case Concerning the Maritime Delimitation in the Area between Greenland and Jan Mayen (Denmark v. Norway)*, Judgment of 14 June 1993, *ICJ Reports* 1993, at pp. 62–63, paras. 54–57.

64. For an in-depth review of the law of maritime delimitation as applied by the ICJ and international tribunals, see L. Lucchini and M. Vœlckel, *Droit de la Mer; Tome 2, Volume 1; Délimitation* (Pedone, Paris, 1996) and P. Weil, *The Law of Maritime Delimitation—Reflections* (Grotius Publications Limited, Cambridge, 1989).

65. As the delimitations between the islands and the mainland coasts in the South China Sea all concern opposite coasts, only this situation is considered here.

66. In the *Case Concerning the Continental Shelf (Libyan Arab Jamahiriya/Malta)*, Judgment of 3 June 1985, *ICJ Reports 1985*, the Court at p. 47, para. 62 noted that "it is in fact a delimitation exclusively between opposite coasts that the Court is, for the first time, asked to deal with. It is clear that, in these circumstances, the tracing of a median line between those coasts, by

way of a provisional step in a process to be continued by other operations, is the most judicious manner of proceeding with a view to the eventual achievement of an equitable result." See also *North Sea Continental Shelf Cases*, supra note 22, at p. 36, para. 56 and the *Jan Mayen Case*, supra note 63, at pp. 60–62, paras. 51–53. In cases involving adjacent coasts, the ICJ and arbitral tribunals have directly indicated a boundary, without first establishing a provisional line, which is subsequently shifted to account for the relevant circumstances of the case.

67. Nonetheless, from a doctrine point of view a provisional equidistance line should be preferred over a provisional line coinciding with the 200 nautical mile limit of one of the states involved. The first of these methods is directly linked to the essential task of delimitation, i.e., dividing areas of overlapping claims, whereas the second is not.

68. For a detailed discussion of relevant circumstances see Lucchini and Vœlckel, supra note 64, at pp. 232–282 and P. Weil, supra note 64, at pp. 213–268.

69. *Gulf of Maine Case*, supra note 60, at pp. 336–337, para. 222.

70. *Libya/Malta Continental Shelf Case*, supra note 66, at pp. 49–53, paras. 66–73.

71. *Jan Mayen Case*, supra note 63, at pp. 67–69, paras. 66–70.

72. *Libya/Malta Continental Shelf Case*, supra note 66, at p. 45, para. 58.

73. See *Gulf of Maine Case*, supra note 60, at pp. 336–337, para. 222; *Libya/Malta Continental Shelf Case*, supra note 66, at pp. 49–53, paras. 66–73; and *Jan Mayen Case*, supra note 63, at pp. 67–69, paras. 66–70. For the present analysis it is noteworthy that in the *Jan Mayen Case*, which involved a large difference in coastal lengths, the difference between the ratio of relevant coasts and the maritime zones attributed to each of the parties was very considerable. According to a calculation presented in the dissenting opinion of Judge ad-hoc Fischer, the decision of the court resulted in a 3 to 1 ratio between the maritime zones of Denmark and Norway, whereas the ratio between the relevant coasts was slightly more than 9 to 1. *Jan Mayen Case*, supra note 63, at p. 309, para. 13. In the *Case Concerning the Delimitation of the Maritime Areas between Canada and France*, 31 *International Legal Materials* 1992, p. 1149, at p. 1176, para. 93, there was an even larger disproportion between the relevant coasts as defined by the court. In this case the ratio between the maritime areas of Canada and France was almost equal to the ratio between the relevant coasts. However, the geographical situation of this case is fundamentally different from either the *Jan Mayen Case* or the South China Sea. See also Scobbie, supra note 6, at p. 179. The *Jan Mayen Case* suggests that in a case of an even larger disproportion between the relevant coasts, such as that involving the islands in the South China Sea, the difference between these two ratios can be even greater.

74. See *Canada-France Arbitration*, supra note 73, at p. 1176, para. 93 and *Tunisia/Libya Continental Shelf Case*, supra note 18, at p. 91, para. 131.

75. *Eritrea/Yemen Arbitration*, supra note 62, at Chapter V, paras. 165–168. The tribunal may have chosen to present these calculations because they indicate that the two ratios are nearly similar, making this an argument that indicates to both parties the equitableness of the award. At the same time, the Tribunal stressed that the test of proportionality was not an independent mode or principle of delimitation. Ibid., at para. 165.

76. *Gulf of Maine Case*, supra note 60, at pp. 339–340, paras. 230–231.

77. *Libya/Malta Continental Shelf Case*, supra note 66, at p. 55, para. 75.

78. The factual information on the islands and other features in the South China Sea is based upon Valencia et al., supra note 4, at pp. 227–235; British Admiralty Charts 94 (printed 18 March 1999) and 1201 (printed 15 October 1997); and the map annexed to *Limits in the Seas: No. 99 Straight Baselines: Vietnam* (U.S. Department of State, 1983).

79. This concerns, for instance, the straight baselines established by Vietnam. See Churchill and Lowe, supra note 31, at p. 39; Ong, supra note 8, at p. 353 and J. A. Roach and R. W. Smith, *United States Responses to Excessive Maritime Claims* (Martinus Nijhoff Publishers, The Hague, 1996), at pp. 101–103.

80. Valencia et al., supra note 4, at pp. 227–234.

81. LOS Convention, Article 60(5). Safety zones around artificial islands, installations, and structures are not to exceed a distance of 500 meters around them, except as authorized by

generally accepted international standards or as recommended by the competent international organization.

82. See Charney, supra note 5, at pp. 736–738 and Scobbie, supra note 6, at pp. 174–175.

83. But, see supra note 25.

84. LOS Convention, Article 13 is applicable to all islands, including those falling under the scope of Article 121(3) of the LOS Convention.

85. See the British Admiralty Charts, supra note 78 and Hancox and Prescott, supra note 11, at pp. 3 et seq.

86. P.D. Beazley, "Coral Reefs and the 1982 Convention on the Law of the Sea," in G. H. Blake (ed.), *Maritime Boundaries* (Routledge, London, 1994), at p. 66; S. N. Nandan and S. Rosenne (eds.), *United Nations Convention on the Law of the Sea, 1982; A Commentary, Volume II* (Martinus Nijhoff Publishers, Dordrecht, 1993), at p. 94 and *The Law of the Sea: Baselines: An Examination of the Relevant Provisions of the United Nations Convention on the Law of the Sea* (United Nations, New York, 1989), at p. 12.

87. *The Law of the Sea: Baselines*, supra note 86, at p. 12.

88. On Scarborough Reef, see J. R. V. Prescott, *Maritime Jurisdiction in Southeast Asia: A Commentary and Map* (East-West Center, Honolulu, 1981), at pp. 20–21. Although such rocks do not have an EEZ and continental shelf, they should, in principle, receive at least the same treatment as low-tide elevations in establishing the baselines for measuring the breadth of these zones. See Kolb, supra note 28, at p. 899; Kwiatkowska and Soons, supra note 28, at pp. 147–148; and Nandan and Rosenne, supra note 30, at p. 338.

89. See Scobbie, supra note 6, at p. 181. For further information on the characteristics of the islands involved, see the literature cited in supra note vi. Reference is made to inter alia various economic uses of some of these islands and (temporary) habitation. The reported area of these islands is (other figures have also been given): Itu Abu, 0.46 km^2; Spratly Island, 750 by 400 meters; and Thi Tu, 0.22 km^2. Pratas and the largest islands in the Paracel group are somewhat larger that these islands in the Spratly group.

90. If the competing sovereignty claims did not exist, the definition of certain islands as rocks in the sense of Article 121(3) of the LOS Convention would only have a relatively limited influence on the extent of the outer limit of maritime zones of the Paracel and Spratly Islands and the delimitation between these island groups and the mainland coasts. However, if in a division of the islands one of the claimant states would only be attributed features that are likely to be classified as rocks, its part in the maritime zones in the South China Sea would be severely limited.

91. Any potential delimitation between any of these islands (e.g., between Pratas Island and the Paracel Islands or between islands within the Paracel Islands or the Spratly Islands) would start by establishing a provisional equidistance line. The coastal geography of the islands involved in general would suggest only a need for a limited shift in such a provisional line to arrive at a boundary. The presence of other relevant circumstances might also have an impact in this respect.

92. See *North Sea Continental Shelf Cases*, supra note 22, at p. 36, para. 57; *Libya/Malta Continental Shelf Case*, supra note 66, at p. 48, para. 64; and *Eritrea/Yemen Arbitration*, supra note 62, at Chapter V, paras. 147–148.

93. See *North Sea Continental Shelf Cases*, supra note 22, at p. 36, para. 57; *Libya/Malta Continental Shelf Case*, supra note 66, at p. 48, para. 64 and *Eritrea/Yemen Arbitration*, supra note 62, at Chapter V, paras. 147–148.

94. See Scobbie, supra note 6, at p. 179.

95. *Libya/Malta Continental Shelf Case*, supra note 66, at p. 48, para. 64.

96. Subsequently, the court shifted the provisional equidistance line north to such an extent that the initial discounting of Filfla can be considered to be inconsequential in practical terms. For the method applied by the Court to effect this shift, see ibid., at pp. 50–52, paras. 69–73.

97. Moreover, in certain areas such an equidistance line would lie beyond 200 nautical miles from the relevant mainland coasts, making it inappropriate as a boundary for the EEZs of the mainland coasts.

98. See Claggett, supra note 5, at p. 432. See also Charney, supra note 5, at pp. 741 and 748 and Valencia et al., supra note 4, at p. 54.

99. See text supra note 69 et seq. This indicates that calculations making a comparison between the ratios of coastal lengths and maritime spaces cannot be used as a legal argument supporting a division of the South China Sea without giving any weight to the islands under consideration. See Scobbie, supra note 6, at 179. Examples of such calculations are provided by Claggett, supra note 5, at 433 and Valencia et al., supra note 4, at 136. Moreover, these calculations involve all the mainland coasts surrounding the South China Sea and all of the South China Sea, whereas the maritime zones of, for instance, the Spratly Islands do not overlap with those of the Chinese mainland and the island of Taiwan.

100. *Jan Mayen Case*, supra note 63, at p. 69, para. 70. See also the separate opinion of Vice-President Oda in this case, ibid., at p. 101, paras. 44–46.

101. See *North Sea Continental Shelf Cases*, supra note 22, at p. 36, para. 57 and at p. 53, para. 101 and *Gulf of Maine Case*, supra note 60, at p. 313, para. 157 and at p. 328, para. 197. See also Weil, supra note 64, at pp. 58–59.

102. See *Gulf of Maine Case*, supra note 60, at p. 313, para. 157.

103. In some cases this may still be the outcome of a delimitation, for instance, if there is a very limited amount of overlap of maritime zones and a very large difference between the relevant coasts.

104. Support for this approach can be found in the *Libya/Malta Continental Shelf Case*, *supra* note 66, at pp. 50–52, paras. 69–73.

105. Apart from some of the features in the Spratly Islands, this might also concern the Catwick Islands off the Vietnamese coast. Moreover, the Vietnamese system of straight baselines might not be taken into consideration. As the ICJ has indicated, this would not involve a finding on the legality of the system of straight baselines. *Libya/Malta Continental Shelf Case*, supra note 66, at p. 48, para. 64.

106. See *Tunisia/Libya Continental Shelf Case*, *supra* note 18, at pp. 83–84, paras. 117–118 and *Eritrea/Yemen Arbitration*, supra note 62, at Chapter III. In this latter award, the tribunal rejected the relevance of concessions for a maritime boundary because they did not take into account certain islands which had previously been in dispute. The Tribunal considered that some weight had to be accorded to these islands once sovereignty had been determined, certainly in respect of their territorial sea. Ibid., at para. 83. In the *Tunisia/Libya Continental Shelf Case*, the ICJ did take the extent of the concessions into account because they centered around a line, which was also indicated by other circumstances, such as coastal geography. Ibid., at pp. 84–85, paras. 119–120.

107. Concession areas in the South China Sea overlap to a considerable extent. See Valencia et al., supra note 4, at pp. 10–12 and 255.

108. For a discussion of practice pertaining to one such line, see 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," 14 *International Journal of Marine and Coastal Law* 1999, pp. 27–55. See also Keyuan, supra note 16.

109. If there is no legal continental shelf beyond 200 nautical miles, the above arguments concerning the delimitation of the EEZ are equally applicable to the delimitation of the continental shelf.

110. Claggett, supra note 5, at pp. 428–430 and Cordner, supra note 4, at p. 69.

111. This conclusion may be somewhat surprising in view of the considerable number of articles arguing against such an outcome. Part of an explanation may be that certain dicta and precedents of the case law have been transposed to the South China Sea without considering the implications of a different factual background.

Annex 279(bis)

Pakjuta Khemakorn, *Sustainable Management of Pelagic Fisheries in the South China Sea Region* (2006)

Sustainable Management of Pelagic Fisheries in the South China Sea Region

by

Pakjuta Khemakorn
United Nations – The Nippon Foundation Fellow

New York, November 2006

DISCLAIMER

The views expressed herein are those of the author and do not necessarily reflect the views of the Government of Thailand, the United Nations, the Nippon Foundation of Japan or the University of Wollongong.

Acknowledgements

The academic part of my fellowship was undertaken at the Centre for Maritime Policy, University of Wollongong, Australia. I wish to extend my sincere thanks to my supervisor, Prof. Martin Tsamenyi, Director of the Centre for Maritime Policy for his support and professional guidance during the six months of my academic studies. Many thanks to Myree Mitchell for the valuable assistances as well as the warm hospitality she has provided. Also thanks to the students of the Centre for Maritime Policy who have been my good friends and supporters.

I would like to deeply thank Dr. Francois Bailet, the programme advisor, for his valuable assistance, guidance and all dedicated time.

I also must thank the officers and staff, of the United Nations Division for Ocean Affairs and the Law of the Sea for all of their support and specially the opportunity for me to learn and understand the important role of the Division in providing advice, studies, assistance and research on the implementation of the Law of the Sea Convention.

Lastly, special thanks to The Nippon Foundation of Japan for its kind support to this fellowship program.

Contents

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Acronyms

APFIC	Asia-Pacific Fishery Commission
AQD	Aquaculture Department
ASEAN	Association of Southeast Asian Nations
COFI	FAO Committee on Fisheries
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
GIWA	Global International Waters Assessment
IPOA	International Plan of Action
ITLOS	International Tribunal for the Law of the Sea
IUU	Illegal Unreported and Unregulated
LME	Large Marine Ecosystem
LOSC	Law of the Sea Convention
MCS	Monitoring, Control and Surveillance
MFRD	Marine Fisheries Research Department
MFRDMD	Marine Fishery Resources Development and Management Department
MSY	Maximum Sustainable Yield
PRC	The People’s Republic of China
RFMOs	Regional Fisheries Management Organizations
SAR	Stock Assessment Report
SCS	South China Sea
SEAFDEC	Southeast Asian Fisheries Development Center
TACs	Total Allowable Catches
TD	Training Department
UN	United Nations
UNCED	United Nations Conference on Environmental and Development
UNCLOS III	Third United Nations Conference on the Law of the Sea
UNEP	United Nations Environment Programme

Sustainable Management of Pelagic Fisheries in the South China Sea Region

Abstract

The South China Sea (SCS) is one of the most important and abundant commercial fisheries areas in the world. Fisheries play a critical role in the food security and the economies of the States in the SCS region. Many of the pelagic fish stocks in this area are straddling fish stocks. In principle, no single State owns these common pool resources, which renders fisheries management in the region very difficult. The fishing capacity in the SCS is in excess, and the fishery resources are in a severe state of overexploitation. Thus, it is imperative for the pelagic fish stocks in the SCS to be managed at a regional level. However, disputes over fisheries resources in the region have made it more difficult to jointly manage such resources in a sustainable manner. The paper examines the geo-political situation in the SCS region, analyses the pelagic fisheries profile and sustainable management of pelagic fisheries in the area, as well as proposes solutions to achieve the sustainable management of such fisheries in the SCS region. It is maintained that fisheries management in the SCS region must focus on both the dynamics of the fisheries resources and address issues relating to other aspects of fisheries management including the resolution of delimitation problems. The conservation and management approaches under the Law of the Sea Convention, and other related international instruments, also play a significant role towards the sustainable management of pelagic fisheries in the SCS region.

Introduction

Fisheries resources, if properly managed, can produce long-term sustainable yields ensuring continuous economic activities and employment. However, research in fisheries management has usually focused on the dynamics of the fish resource while issues relating to other aspects of management have often played lesser roles. This is also the case for the South China Sea (SCS) region which is rich in both renewal fisheries resources and hydrocarbon resources. Fisheries resources, particularly pelagic resources, are very important not only as food supply for people but also as valuable export products of the States in this region. However, due to the open-access nature of fisheries, the fishing capacity in the SCS is in excess.[1] Furthermore, the destructive fishing practices have made it worse. The fisheries are in a severe state of overexploitation.[2] Many of the coastal pelagic and demersal fish stocks are fully exploited or overfished. This is evident in the increasing proportion of low-value species and juveniles of high-value species being caught.[3] Furthermore, some of the large pelagic in the area are considered as migratory fish stocks which need to be managed at the regional level. However, territorial disputes, such as the Spratlys disputes[4], as well as various conflicts in the SCS region have also made it more difficult to manage the fisheries in a regional and sustainable manner. Moreover, there is increased Illegal, Unreported and Unregulated (IUU) fishing because of the absence of maritime boundaries as well as fisheries monitoring, control and surveillance (MCS). Therefore, in absence of regional agreements, the Law of the Sea

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[1] Peter Manning, *Control and Reduction of Fishing Capacity* (1998 [cited 1 May 2006]); available from http://www.oceansatlas.com/world_fisheries_and_aquaculture/html/issues/govern/overcap/control.htm#topofdocument.

[2] GIWA, "Preliminary Results for the Scoping and Assessment of the South China Sea and Sulu-Celebes Seas," (Global International Waters Assessment, 2001).

[3] Manning, op cit, note 1.

[4] Jonathan I. Charney, "Central East Asian Maritime Boundaries and the Law of the Sea," *The American Journal International Law* 89 (1995); Liselotte Odgaard, "Deterrence and Co-Operation in the South China Sea," *Contemporary Southeast Asia* 23, no. 2 (2001); Shicum Wu and Huaifeng Ren, "More Than a Declaration: A Commentary on the Background and the Significance of the Declaration on the Conduct of the Parties in the South China Sea," *Chinese Journal of International Law* 2 (2003).

Convention (LOSC)[5] and other related international instruments are left to play a significant role in sustainable fisheries management in the SCS region.

This paper examines the geo-political situation in the SCS region, analyzes the pelagic fisheries profile of the SCS region, and proposes solutions to achieve sustainable management of the pelagic fishery resources in the SCS region - in particular management approaches stipulated within the LOSC and other related international instruments.

5 United Nations, *The Law of the Sea. United Nations Convention on the Law of the Sea* (New York: United Nations, 1982).

Part I The Geo-political Situation in the South China Sea Region

A. Geography of the South China Sea region

The SCS region comprises the marine, coastal and hinterland river catchments of nine States: Brunei, Cambodia, China, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam, which have the highest coastal zone population growth of the world (Figure 1).

The SCS is recognized as a Large Marine Ecosystem (LME)[6] with specific characteristics of oceanography, biography and ecology. Much of the southern half of the SCS lies on the Sunda Shelf, and its coastal waters are shallow (< 200 meters deep) and influenced by both marine and river/terrestrial inputs. Further north, the SCS Basin and the Palawan Trough are much deeper (> 1,000 meters) and are bounded by the shallower continental margins and shelves of China, Vietnam, Cambodia, Thailand, Malaysia, Indonesia and the Philippines. The major gulfs and bays of the region are the Gulf of Thailand, Gulf of Tonkin, Lingayen Gulf and Manila Bay.[7] The SCS is considered a semi-enclosed sea under the LOSC[8], which describes such seas as:

> enclosed or semi-enclosed sea means a gulf, basin or sea surrounded by two or more States and connected to another sea or

[6] LMEs are regions of ocean and coastal space that encompass river basins and estuaries and extend out to the seaward boundary of continental shelves and the seaward margins of coastal current systems. LMEs are relatively large regions that have been delineated according to continuities in their physical and biological characteristics, including *inter alia*: bathymetry, hydrography, productivity and trophically dependent populations. United Nations Atlas of the Oceans, *Large Marine Ecosystems (LMEs)* (2006 [cited 10 October 2006]); available from http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xMjcyNyZjdG5faW5mb192aWV3X3NpemU9Y3RuX2luZm9fdmlld19mdWxsJjY9ZW4mMzM9KiYzNz1rb3M~

[7] Wilkinson C. et al., *Global International Waters Assessment. South China Sea, GIWA Regional Assessment 54* (University of Kalmar on behalf of United Nations Environment Programme, 2005).

[8] United Nations, op cit, note 5, Article 122.

> the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States.

The SCS covers an area of around 3,500,000 square kilometers of the Pacific Ocean. Within this sea, there are over 200 identified islands and reefs. It is, however, generally agreed that most of these features are not suitable for human habitation but may be of vital economic, strategic, political and legal importance to the States of the region and beyond.

Figure 1: The South China Sea region.

Source: *South China Sea-Reference Map-Us CIA* ([cited 31 July 2006]); available from http://community.middlebury.edu/~scs/maps/South%20China%20Sea-reference%20map-US%20CIA.jpg.

These islands are grouped into four mid-ocean groups of islands, namely: (i) the Pratas Islands, (ii) the Paracel Islands; (iii) the Spratly Islands, and (iv) Macclesfield bank.[9] Most of the islands are within the Spratly Islands group which spreads over an 810 by 900 square kilometer area covering some 175 identified insular features. The largest one is Taiping Island (Itu Aba) at just over 1.3 kilometers long and with its highest elevation at 3.8 meters.[10]

B. The importance of the South China Sea region

a) Strategic points

The SCS contains some of the world's busiest international sea lanes[11] which link Northeast Asia and the Western Pacific to the Indian Ocean and the Middle East (Figure 2). More than 41,000 ships a year pass through the SCS.[12] Over half of the world's annual merchant-fleet tonnage passes through the region's waters. Tanker traffic through the Strait of Malacca at the Southwestern end of the SCS is more than three times greater than the Suez Canal traffic, and well over five times more than the traffic of the Panama Canal.[13] More than 80 percent of the oil imported by Japan, South Korea, and Taiwan transits through this area[14] and oil consumption among developing States is expected to rise annually on average. Almost all of this additional Asian oil demand, as well as Japan's oil needs, will need to be imported from the Middle East and Africa, most of which will pass through the strategic Strait of

[9] Christopher C. Joyner, *Toward a Spratly Resource Development Authority: Procursor Agreements and Confidence Building Measures*, ed. Myron H. Norquist and John Norton Moroe, *Security Flashpoints: Oil, Islands, Sea Access and Military Confrontation* (1997).
[10] Stein Tonnesson, "Locating the South China Sea," in *Locating Southeast Asia: Geographies of Knowledge and Politics of Space*, ed. Paul Kratoska, Henk Schulte Nordholt, and Remco Raben (Ohio University Press, March 2005).
[11] David Rosenberg, "Environmental Pollution around the South China Sea: Developing a Regional Response," *Contemporary Southeast Asia* 21, no. 1 (1999).
[12] Ji Guoxing, "Rough Waters in the South China Sea: Navigation Issues and Confidence-Building Measures," (East-West Center, 2001).
[13] Erik Kreil, *South China Sea* (March 2006 [cited 24 April 2006]); available from http://www.eia.doe.gov/emeu/cabs/South_China_Sea/pdf.pdf.
[14] Scott Snyder, Brad Glosserman, and Ralph A. Cossa, "Confidence Building Measures in the SCS," *Issue and Insights* 2 (2001).

Malacca into the SCS. Supertankers going to Japan will pass through the wider Lombok Straight east of Bali. This adds to the strategic importance of the SCS which also contains oil

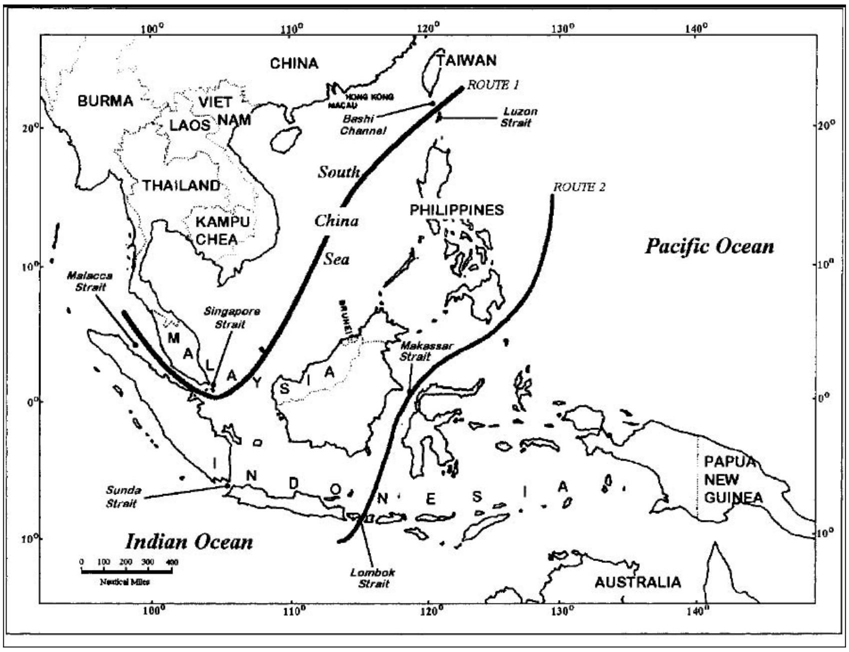

Figure 2: The two main traffic routes in the SCS region linking Europe and the Middle East to Asia.

Source: Joseph Morgan and Mark Valencia, eds., *Atlas for Marine Policy in Southeast Asian Seas* (Berkeley, CA: University of California Press, 1983).

and gas resources located near large energy-consuming States.[15] Therefore, exercising sovereign control over some of the islands in the area creates the opportunity for gaining a central and commanding position in the region. For this reason, the Pratas Islands, the Paracel Islands and the Spratly Islands are the most strategically important island groups in the SCS.[16]

In addition to the importance of the SCS for international trade and commerce, the sea lanes of communication in the SCS are also utilized for military purposes. The United States has always recognized and defended the traditional freedoms of navigation and over flight on

[15] David Rosenberg, *Environmental Pollution around the South China Sea: Developing a Regional Response to a Regional Problem*, ed. Anne Casson, vol. 20, *Resource Management in Asia-Pacific Working Paper* (Canberra: Resource Management in Asia-Pacific Project, Division of Pacific and Asian History, Research School for Pacific and Asian Studies, The Australian National University, 1999).

[16] Kuan-Hsiung Wang, "Bridge over Troubled Waters: Fisheries Cooperation as a Resolution to the South China Sea Conflicts," *The Pacific Review* 14, no. 4 (2001).

and over the world's oceans for military and commercial purposes.[17] For more than 20 years, the U.S. Freedom of Navigation Program has ensured that excessive coastal State claims over the world's oceans and airspace are repeatedly challenged.[18] For the United States, freedom and safety of navigation and over flight in the SCS region are critical strategic interests because the SCS can be used as a transit point and operating area for the United States Navy and Air Force between military bases in Asia and the Indian Ocean as well as the Persian Gulf areas.[19]

b) Hydrocarbon resources

Hydrocarbon resources are the most important non-living resources in the SCS. It is widely known for its rich oil and gas reservoirs which have been discovered in most parts of the SCS[20] (Figure 3). The discovery in the region has made Indonesia one of the world's leading oil exporting States, and the combination of onshore and offshore petroleum has given Brunei the highest per capita gross national production in the region.[21] For the other States, the revenue from oil and gas activities has also contributed considerably to the continuous increase in their national economic growth. Accordingly, these high rates of economic growth naturally lead to a corresponding increase in resource consumption.[22] However, the extent of hydrocarbon resource deposits remains unclear. This is primarily due to the absence of a full assessment, particularly in the Spratly Islands area, the biggest group of islands. Nevertheless, a 1995 study by Russia's Research Institute of Geology of Foreign Countries estimates that an equivalent of 6 billion barrels of oil might be located in the Spratly Islands area, of which 70 percent would be natural gas. On the other hand, Chinese media have referred to the SCS as

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[17] National Oceanic and Atmospheric Administration, *Freedom of Navigation* (16 August 2006 [cited 17 November 2006]); available from http://www.publicaffairs.noaa.gov/oceanreport/freedomnav.html

[18] William S. Cohen, "Annual Report to the President and the Congress," (Washington D.C., 2000).

[19] Dong Manh Nguyen, "Settlement of Disputes under the 1982 United Nations Convention on the Law of the Sea: The Case of the South China Sea Dispute," (New York: UN-Nippon Foundation Fellowship on the Law of the Sea, 2005).

[20] Robert Catley and Makmur Keliat, *Spratlys: The Dispute in the South China Sea* (Brookfield: Ashgate, 1997).

[21] Mark Valencia and Douglas M. Johnston, *Pacific Ocean Boundary Problems: Status and Solutions* (Martinus Nijhoff, April 1991).

[22] Nguyen, op cit, note 19.

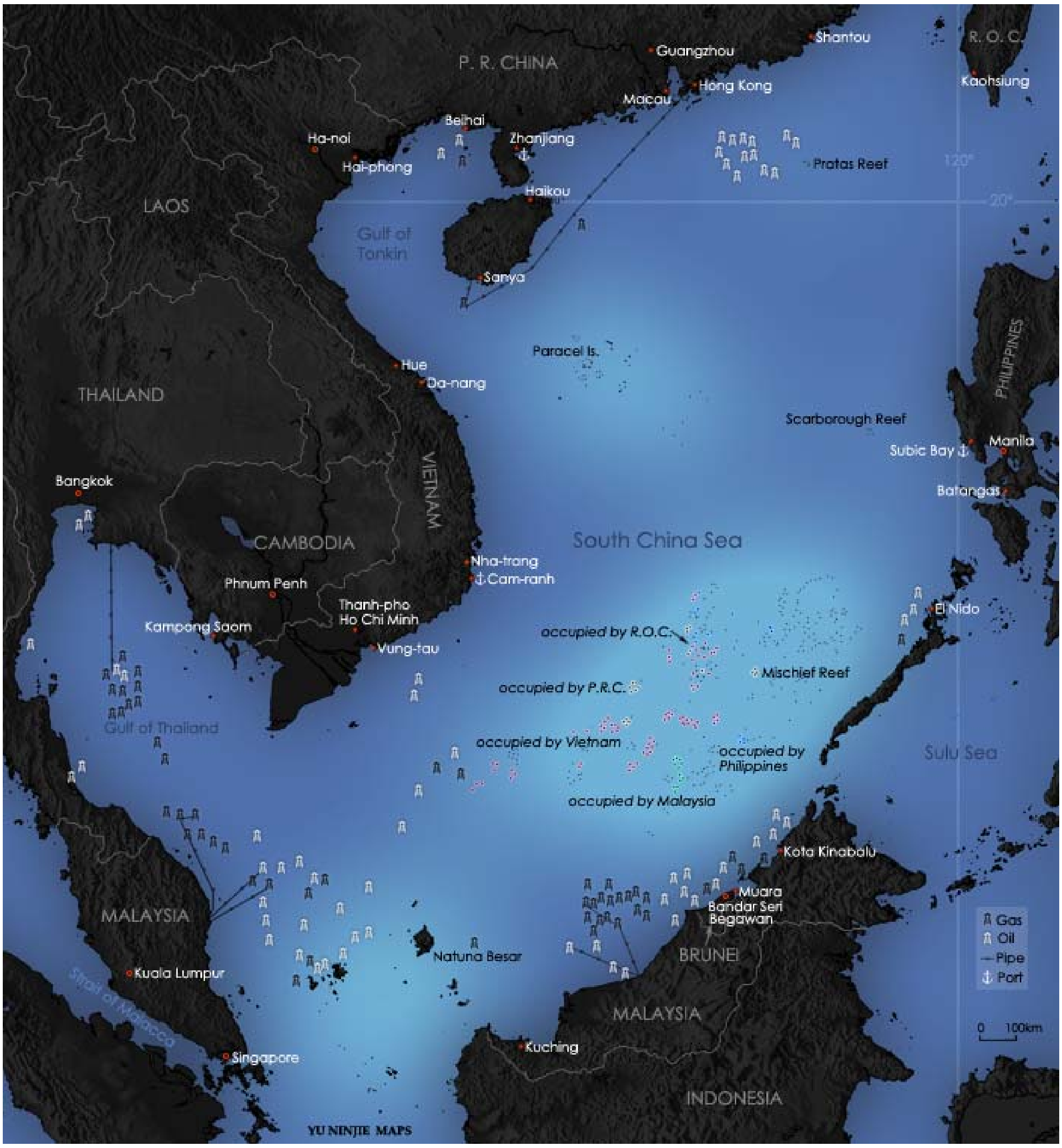

Figure 3: Drilling sites in the SCS region.

Source: Yu Ninjie, "South China Sea," (National Geographic, 1998).

"the second Persian Gulf," and some Chinese specialists have asserted that the SCS could contain as much as 130 billion barrels of oil and natural gas.[23]

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[23] Scott Snyder, *The South China Sea Dispute. Prospects for Preventive Diplomacy* (August 1996 [cited 13 March 2006]); available from http://www.usip.org/pubs/specialreports/early/snyder/South_China_Sea1.html.

It is for these reasons that many littoral States have tried to occupy islands in the area in order to claim rights for future negotiations to these hydrocarbon resources. Competition for them could conceivably trigger war.[24]

c) Fisheries resources

Because of the extensive continental shelves, relatively shallow depths, and the influx of numerous large continental rivers, the SCS is a highly productive body of water in terms of fisheries and other marine living resources.[25] In addition to this, habitats in the SCS include mangrove forests, seagrass beds, coral reefs and soft-bottom communities, all of which may host highly productive ecosystems. The SCS is considered a Class II, moderately high productivity (150-300 gC/m^2-yr) ecosystem based on Sea-viewing Wide Field-of-view Sensor (SeaWiFS[26]) global primary productivity estimates.[27] High productivity levels are found in gulfs, along the coast, and in reef and seagrass areas, commonly in the Philippines portion of the LME.[28]

The SCS has also the world's highest level of bio-diversity.[29] According to a Chinese study, species abundance in the SCS region includes: 1,027 fish, 91 shrimp and 73 cephalopod species in the Northern continental shelf; approximately 205 fish and 96 shrimp species in the continental slope, and more than 520 fish species around the islands and reefs of the Southern

[24] Wang, op cit, note 16.
[25] Stephen W. Ritterbush, "Marine Resources and the Potential for Conflict in the South China Sea," *The Fletcher Forum* 2 (1978).
[26] SeaWiFS Project is to provide quantitative data on global ocean bio-optical properties to the Earth Science Community by deriving the concentration of phytoplankton which is primary producer from satellite observation and quantification of ocean color, i.e. the more phytoplankton present, the greater the concentration of plant pigments and the greener the water which also means the higher productivity. NASA, *Background of the SeaWiFS Project* (2006 [16 October 2006]); available from http://oceancolor.gsfc.nasa.gov/SeaWiFS/BACKGROUND/SEAWIFS_BACKGROUND.html
[27] LME, *LME 36: South China Sea. Large Marine Ecosystems of the World* (2 March 2004 [cited 28 April 2006]); available from http://na.nefsc.noaa.gov/lme/text/lme36.htm.
[28] Ibid.
[29] Talaue-McManus L., *Transboundary Diagnostic Analysis for the South China Sea*, vol. 14, *EAS/RCU Technical Report Series* (Bangkok, Thailand: UNEP, 2000).

waters.[30] The fisheries resources of the SCS are of great local, national and international importance as well as being a major contributor to both food and income.[31] In total, the SCS produces around 5 million tones of catch each year, some 10% of the total global catch.[32]

According to Food and Agriculture Organization (FAO) fishery statistics, the SCS is grouped in Area 71 which is dominated by a large continental shelf area (Figure 4). Area 71 is bordered in the North by Southeast Asian States and in the Southeast by Indonesia and Australia. The majority of this shelf area lies within the EEZ's of Southeast Asian States, reflected in the major contribution these States make to the total production of the area.[33] The total fishery production from Area 71 States in the SCS region during the period 1994-2003 is summarized in Figure 5 and Annex 1. It is obvious that the production has continuously increased over the years, which manifests its importance as an economic sector in the region.

[30] Jin Xianshi, "Marine Fishery Resources and Management in China" (paper presented at the ICFO Seminar, Qingdao, China, 25-29 October 2000).
[31] Wilkinson C. et al., *Global International Waters Assessment. South China Sea, GIWA Regional Assessment 54*.
[32] LME, op cit, note 27.
[33] Fishery Resources Division FAO Marine Resources Service, *Review of the State of World Fishery Resources: Marine Fisheries*, vol. 920, *FAO Fisheries Circular* (Rome: FAO, 1997).

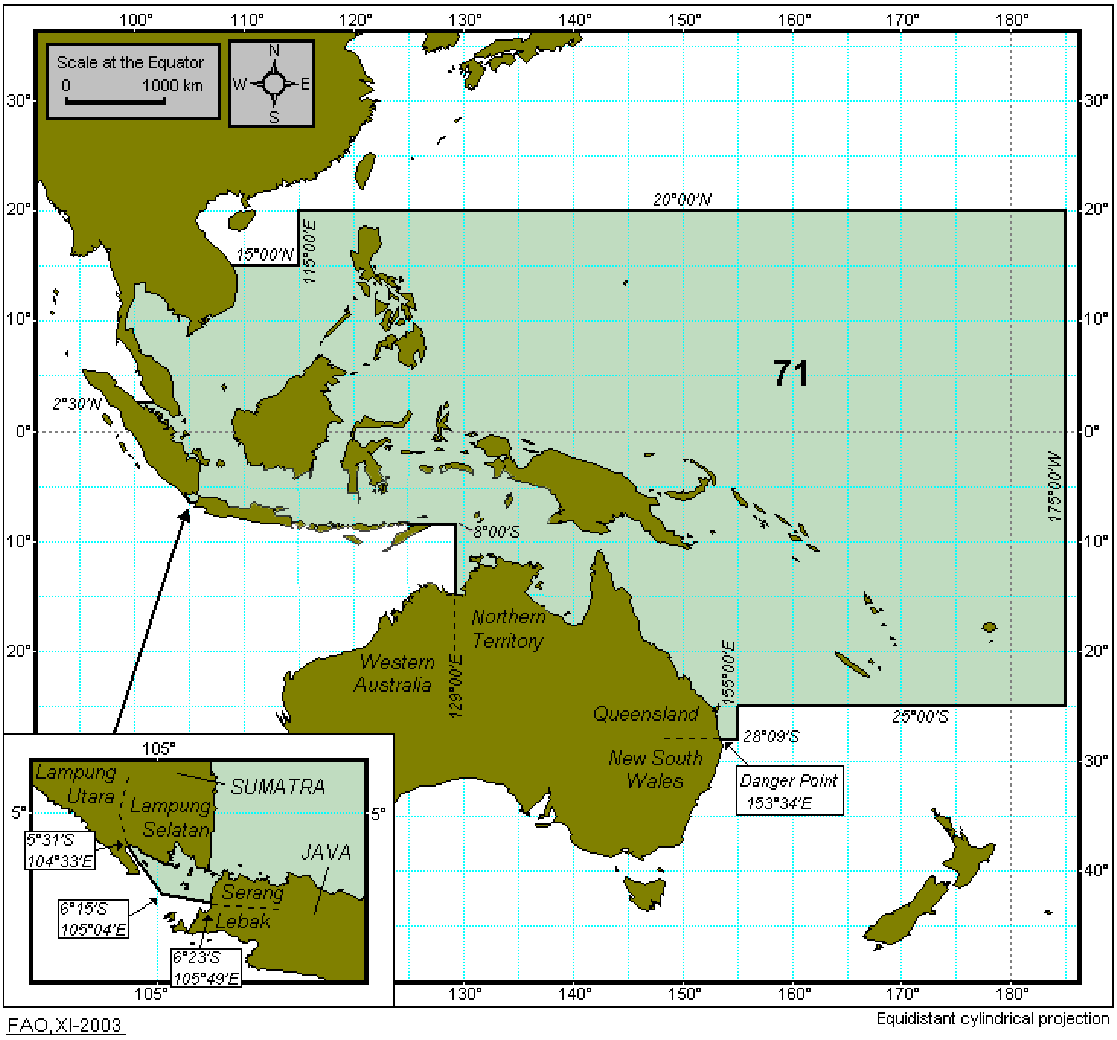

Figure 4: Western Central Pacific, Area 71, of FAO fishery statistic.

Source: FAO, *Area 71: Pacific Western Central* (2003 [cited 25 June 2006]); available from http://www.oceansatlas.com/servlet/CDSServlet?status=ND0zMTIyLjMxNDAmNj1lbiYzMz13ZWItc2l0ZXMmMzc9aW5mbw~~.

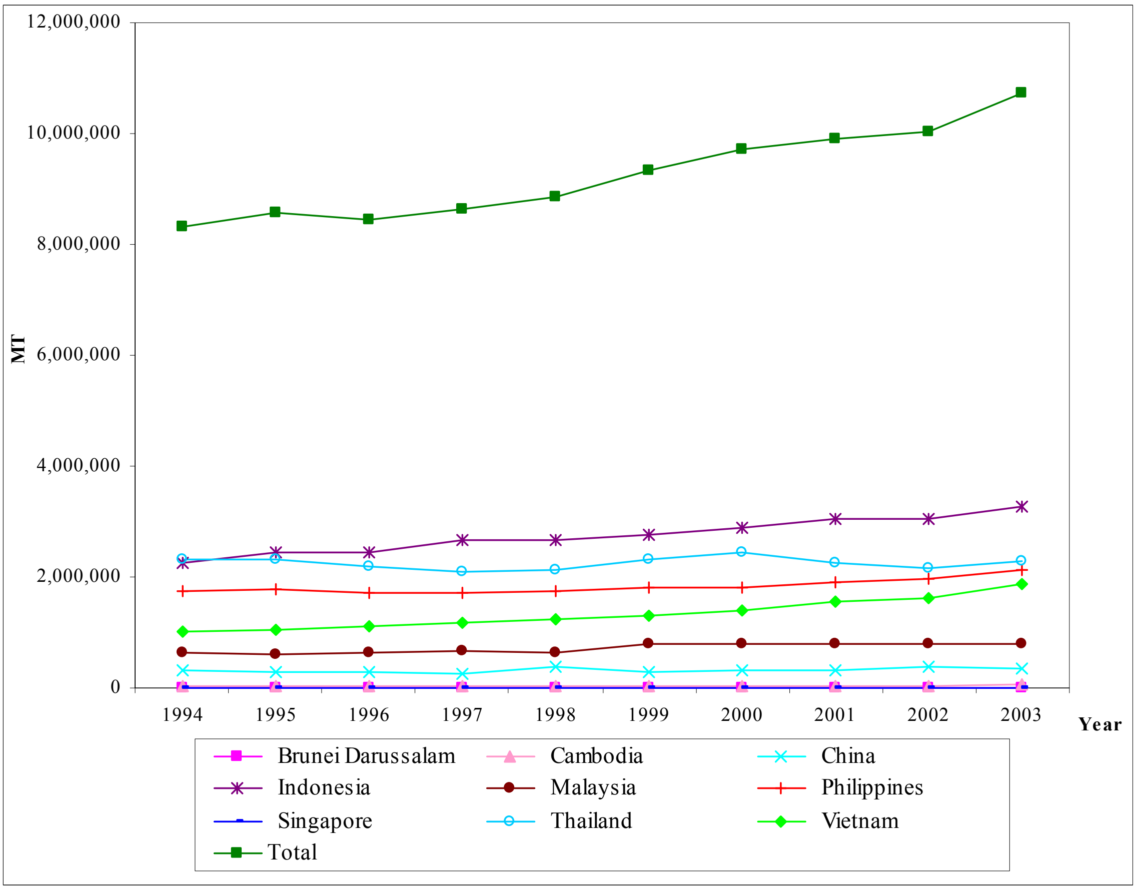

Figure 5: Total fishery production (Metric tones) obtained from the Western Central Pacific by States in the SCS region.

Source: FAO, *FAOStat Data - Fish Production* (23 August 2005 [cited 8 May 2006]); available from http://faostat.fao.org/faostat/form?collection=Fishes& Domain= FishCatch& servlet=1&hasbulk=0&version=ext&language=EN

C. The disputes in the South China Sea region

The SCS disputes fall in two categories: maritime boundary disputes and territorial disputes.[34] Because the LOSC allows for a State's Exclusive Economic Zone (EEZ) to extend 200 nautical miles from the territorial sea baseline (Figure 6), States surrounding the SCS wish to avail themselves of the largest possible area of jurisdiction. Competing maritime boundary and territorial claims over the SCS and its resources are numerous; especially for the People's Republic of China (PRC) which claims almost the entire SCS (Figure 7). Territorial issues in the SCS, especially in the Spratly Islands and Paracel Islands, can be summarized as follows:

Brunei: Brunei, the latest State to become involved with the SCS disputes, does not claim any of the islands, but does claim part of the SCS as its continental shelf and EEZ on the basis of the LOSC. In 1984, it declared an EEZ that includes Louisa Reef which is in the Southern part of the Spratly Islands.[35]

Cambodia: Cambodia does not claim any of the islands but claims part of the Gulf of Thailand as its continental shelf and EEZ, a claim which overlaps with Thailand's claim. As of September 2006, this dispute has not been settled.[36]

People's Republic of China: China refers to the Spratly Islands as the Nansha Islands and claims sovereignty over the islands and most of the SCS based on historical grounds, by referring to archaeological finds and ancient documents.[37] These include the naval expeditions to the Spratly Islands by the Han Dynasty in 111 AD and the Ming Dynasty from 1403-1433 AD. Chinese fishermen and merchants have worked in the region over time. In the 19th and early 20th century, China asserted claims to the Paracel Islands. During World War II, the islands were claimed by the Japanese. In 1947, China produced a map with 9 undefined dotted lines, and claimed all of the islands within these lines.

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[34] Nguyen, op cit, note 19.
[35] United States Energy Information Administration, "South China Sea Region," (1998).
[36] Tonnesson, op cit, note 10.
[37] Stein Tonnesson, "The History of the Dispute," in *War or Peace in the SCS*, ed. Timo Kivimaki (2002).

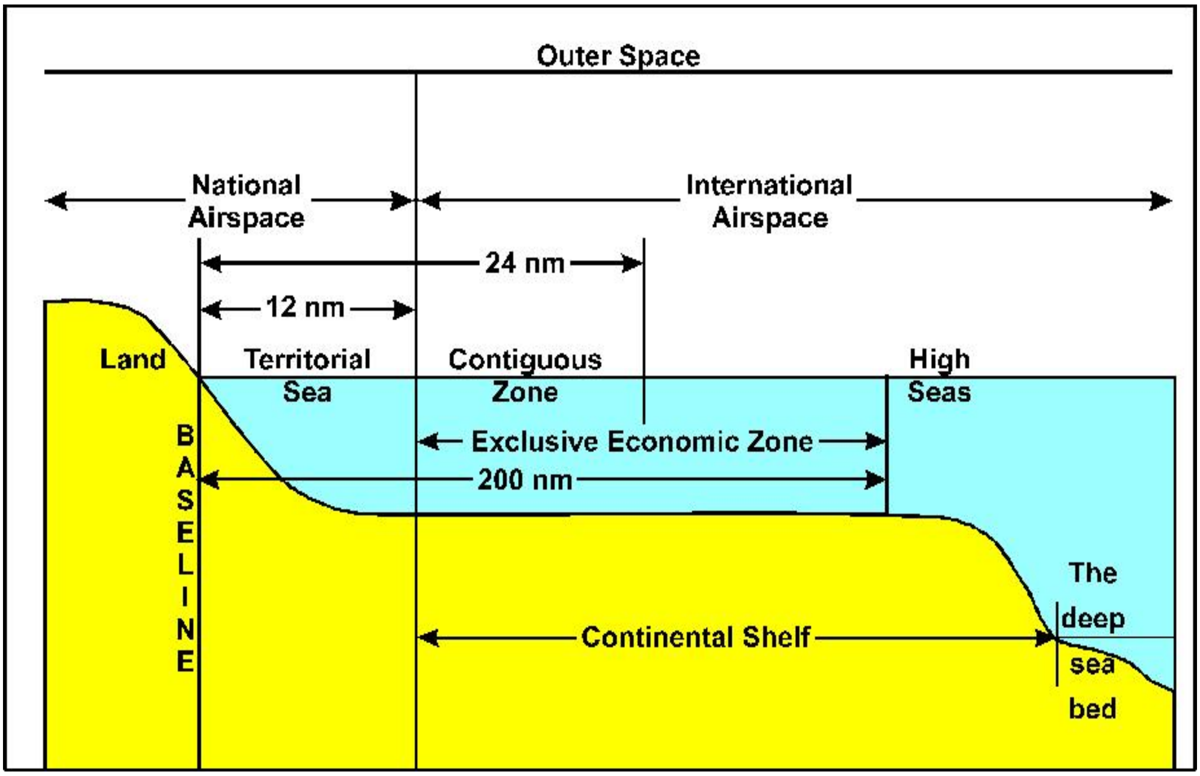

Figure 6: Zones delimitation according to the LOSC (Part V).

Source: Martin Tsamenyi, "Zones delimitation according to the LOSC" (Slide presented on "The Law of the Sea" course at the University of Wollongong, Australia, 26-30 June 2006).

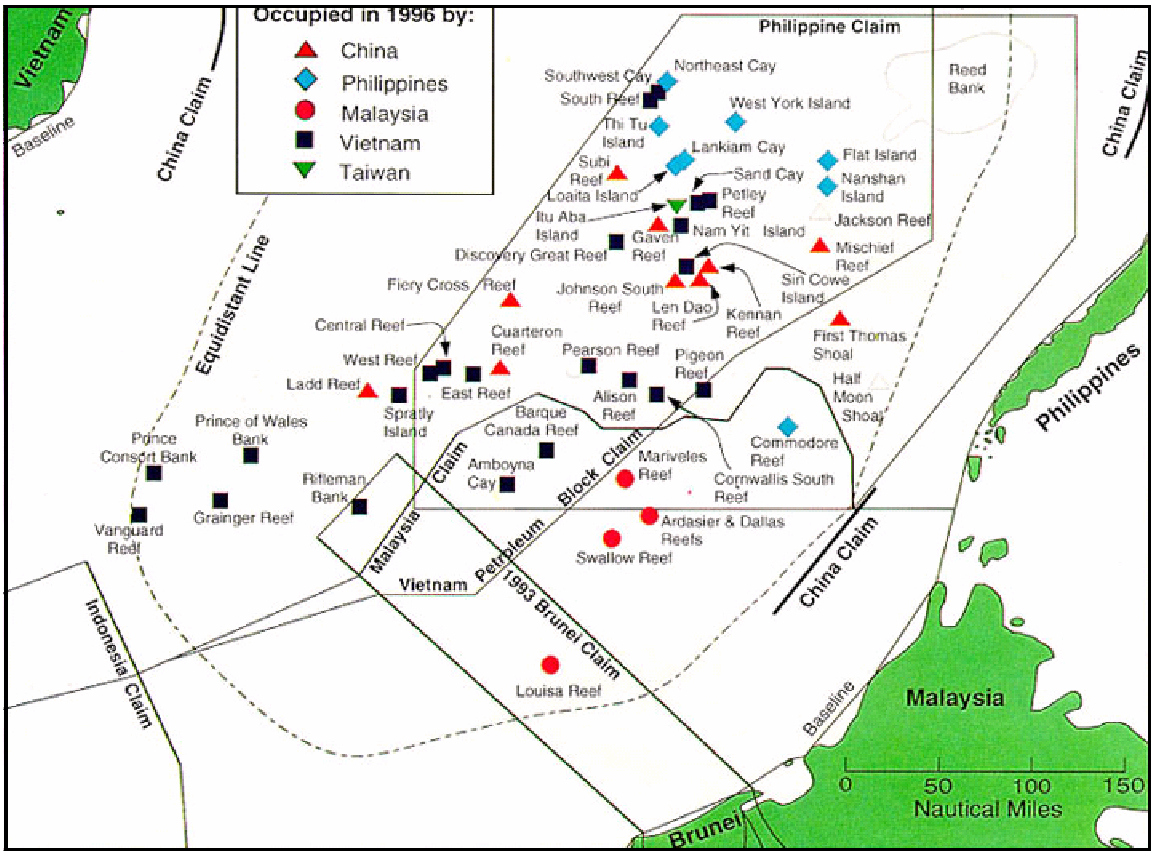

Figure 7: Claimants of Spratly Islands.

Source: Mark J. Valencia, Jon M. Van Dyke, and Noel A. Ludwig, *Sharing the Resources of the South China Sea* (The Hague; Boston: Cambridge, MA: M. Nijhoff Publishers; Sold and distributed in the U.S.A. and Canada by Kluwer Law International, c1997), p. 254.

A 1992 Chinese law restated its claims in the region. China refers to the Paracel Islands as the Xisha Islands, and includes them as part of its Hainan Island Province.[38] Its claims have been disputed with many States in the region.

Indonesia: Indonesia does not claim any of the Spratly Islands.[39] Its ownership of the natural gas-rich fields offshore of the Natuna Islands was undisputed until China released an official map with unclear maritime boundaries indicating that Chinese claimed waters in the SCS which may extend into Indonesia's EEZ and continental shelf, including the waters Northeast of the

[38] Greg Austin, *China's Ocean Frontier: International Law, Military Force, and National Development* (Allen & Unwin, 1998); United States Energy Information Administration, op cit, note 35.
[39] United States Energy Information Administration, op cit, note 35.

Natuna Islands.[40] In 1996, Indonesia responded by choosing the Natuna Islands region as the site of its largest military exercises to date. Since then, drilling in the natural gas fields has proceeded without protest from China.[41]

Malaysia: The Malaysian claims in the SCS are based on the continental shelf principle of the LOSC and have clearly defined coordinates. Malaysia has occupied three of these islands that it considers situated on its continental shelf[42] although boundary lines are simply drawn perpendicularly from two extreme points on the Brunei coastlines.[43] It has tried to build up one atoll by bringing soil from the mainland and has built a hotel.[44]

Philippines: The Philippine claims have clearly defined coordinates, both based upon proximity and the explorations of a Philippine explorer in 1956. In 1971, the Philippines officially claimed 8 islands that it refers to as the Kalayaan, partly on the basis of this exploration. It asserted that those islands were not part of the Spratly Islands and had not belonged to anybody, thus were open to be claimed. They were designated as part of Palawan Province in 1972.[45] The Philippines also has a dispute with PRC over the Malampaya and Camago gas fields and Scarborough Shoal.[46]

Singapore: Singapore claims sovereignty over Pulau Pedra Branca or Pulan Batu Putin, a claim which overlaps with Malaysia's. The disputes had been brought to the International Court of Justice in February 2003. After consideration, the Court found Singapore's claim to effective occupation and control from 1965 (its date of independence) to the date Malaysia's protest in 1979 to be legitimate. In addition, the Court also found that having built a light house, under British rule in 1851, demonstrated that British Singapore did have a physical presence, and it is true that Malaysia did not have a clear relationship with the islands for the entirety of the

[40] Austin, op cit, note 38; United States Energy Information Administration, op cit, note 35.
[41] Kreil, op cit, note 13.
[42] Austin, op cit, note 38; United States Energy Information Administration, op cit, note 35.
[43] Hasjim Djalal, "South China Sea Island Disputes," *Raffles Bulletin of Zoology* Supplement No.8 (2000).
[44] United States Energy Information Administration, op cit, note 35.
[45] Austin, op cit, note 38; United States Energy Information Administration, op cit, note 35.
[46] Tonnesson, op cit, note 10.

relevant period of time. For those reasons the Court unanimously found that Singapore reserves sovereignty over Pulau Pedra Branca.[47]

Taiwan: Taiwan's claims in the SCS are similar to those of China and are based on the same principles.[48] Taiwan has occupied Itu Aba for two decades but has not expanded its occupation.[49] As with China, Taiwan's claims are also not clearly defined.[50]

Thailand: Thailand does not claim any of the islands in the SCS, but has had disputes over some parts of the Gulf of Thailand with Cambodia and Vietnam with respect to overlapping EEZ and continental shelf claims.[51] Overlapping claims between Thailand and Vietnam were settled on 9 August 1997, when Thailand signed an agreement with Vietnam on the delimitation of the maritime boundary in the Gulf of Thailand. This agreement was protested by Cambodia, through a note of verbal of the Ministry of Foreign Affairs and International Cooperation addressed to the Secretary General of the United Nations and dated 28 May 1998. The note outlined the position of Cambodia on the delimitation of the maritime boundary between Thailand and Vietnam. The note stated that Cambodia has never accepted the maritime boundary delimitation proclaimed by Thailand and Vietnam and that the latter constituted a violation of Cambodian sovereignty and its right in its EEZ and on its continental shelf in this part of the Gulf of Thailand. Accordingly, the maritime delimitation is without prejudice to, and does not affect the rights and legitimate interests of Cambodia in the area.[52] This principle is codified by Article 34 of the 1969 Vienna Convention on the Law of Treaties, which prescribes

[47] International Court of Justice, *Sovereignty Over Pedra Branca/Pulau Putch, Middle Rocks and South Ledge, Malaysia/Singapore* (20 November 2005 [cited 12 October 2006]); available from http://www.amun.org/final/05/ICJ-ICJOpinion-25.pdf#search=%22american%20model%20united%20nations%20international%20court%20of%20justice%20november%2020%22

[48] Djalal, op cit, note 43; United States Energy Information Administration, op cit, note 35.

[49] Djalal, op cit, note 43.

[50] David Rosenberg, *The South China Sea* (1999 [cited 13 March 2006]); available from http://community.middlebury.edu/~scs/why.html.

[51] Kreil, op cit, note 13; Poungthong Onoora, *Handbook for Enforcement of International Fisheries Law*, vol. 5, *Technical Paper* (Bangkok, Thailand: Department of Fisheries, 2004).

[52] Mom Ravin, "Law of the Sea: Maritime Boundaries and Dispute Settlement Mechanisms," (New York: UN-Nippon Foundation Fellowship on the Law of the Sea, 2005).

that "treaty does not create either obligations or rights for a third State without its consent."[53] As of date, the claims have not yet been resolved with Cambodia[54] (Figure 8).

Figure 8: EEZ claims in the Gulf of Thailand.

Source: Bradley, R.E., Pratt, M.A. and Schofield, C.H. "Jane's Exclusive Economic Zones 2002-2003, Coulsdon: Jane's Information Group (year book, M.A. Pratt editor), p. 43.

[53] United Nations, *Treaty Series*, vol. 1155, p. 331.
[54] Onoora, op cit, note 51.

Vietnam: Vietnamese claims are based on history and the continental shelf principle of the LOSC.[55] It claims the entire Spratly Islands as an offshore district of province Khanh Hoa. The Vietnamese have followed the Chinese in using archaeological evidence to bolster sovereignty claims. In 1930, France claimed the Spratly Islands and Paracel Islands on behalf of its then-colony Vietnam.[56] Vietnam has occupied a number of the Spratly Islands as well as the Paracel Islands which were seized by the PRC in 1974.[57] However, Vietnam and the PRC have resolved their disputes over areas in the Gulf of Tonkin to the South of China's Guangdong Province. In December 2000, they signed an agreement which delineated the boundary between their EEZs, opening the way for oil and gas exploration.[58]

Association of South East Asian Nations (ASEAN) in general, and Malaysia in particular, have been keen to ensure that the territorial disputes within the SCS do not escalate into armed conflict. Joint Development Authorities have been setup in areas of overlapping claims to jointly develop as well as explore the areas and ensure profit shoring without settling the issue of sovereignty over the area[59] particularly in the Gulf of Thailand where the cooperative agreements were signed for the Malaysia-Thai and Malaysia-Vietnam Joint Development Areas.[60]

[55] Austin, op cit, note 38.
[56] United States Energy Information Administration, op cit, note 35.
[57] Rosenberg, op cit, note 50.
[58] Kreil, op cit, note 13.
[59] Tonnesson, op cit, note 10.
[60] Kreil, op cit, note 13.

Part II Pelagic Fisheries in the South China Sea Region

A. Fisheries status in the South China Sea region

Fisheries play a very important role in the food security and economies of the majority of States in the SCS region. The average per capita consumption of fish in East and Southeast Asia during the period 2000-2003 was 26.1 kg/year. This is much higher than the world average of 16.3 kg/year (Table 1). This reflects the importance of fish in food security, as well as the general preference for fish as a source of protein in the region.

Fisheries also contribute to the employment and income of millions of people in the region. In 1994, the estimated numbers of full and part-time fishers engaged in marine and inland fisheries were 8.7 million and 1.7 million, respectively. According to FAO's findings, around 85% of the world's fishers are concentrated in Asia, particularly in the SCS region, compared to 77% in 1970. China has the largest number of fishers followed by Vietnam, Indonesia and the Philippines. In total, at least 31 million people are engaged in the fisheries sector (including aquaculture) and related industries in the region.[61]

Furthermore, fisheries play an important role in the economies and international trade of many States in the SCS region. Development of fisheries in the region has been much influenced by the global market. This has been reflected by the rapid development of trawl fisheries in Southeast Asia in the 1970s targeting shrimp for export, the relatively fast development in the early 1980s of purse seine fisheries targeting tuna for canning, and of tuna longlining since the mid 1980s which target tuna for the fresh sashimi markets.[62] During the period 2001-2003, China and Thailand, respectively were the top two global exporters of fishery commodities.

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[61] FAO, *Numbers of Fishers, 1970-1995*, 2 ed., vol. 929, *FAO Fisheries Circular* (1999).
[62] Fishery Resources Division FAO Marine Resources Service, op cit, note 33.

Table 1: Fish as seafood supply per capita by States in the SCS region.

Fish, Seafood Supply/Capita/Year (Kilogram)	Year			
	2000	**2001**	**2002**	**2003**
Brunei Darussalam	39	27	26.4	25.8
China	25.7	25.8	25.6	25.4
Cambodia	21	28.4	27.8	27.1
Indonesia	20.3	21	20.8	20.5
Malaysia	60.4	58.1	57	55.9
Philippines	29.7	29.8	29.3	28.8
Thailand	30.6	31.3	30.9	30.6
Vietnam	19	17.9	17.7	17.5
East & South East Asia	25.3	26.7	26.3	26
World	16.2	16.5	16.3	16.1

Source: FAO, *FAOStat Data - Food Supply* (3 March 2006 [cited 29 May 2006]); available from http://faostat.fao.org/faostat/form?collection=FS.NonPrimaryLivestockAnd Products&Domain=FS&servlet=1&hasbulk=0&version=ext&language=EN.

In addition, some States in the region are in the top world group of exporters, namely: Vietnam, Indonesia, and Taiwan. The total value of average annual fishery commodities exported by States in the region was more than 15 billion USD.[63] However, there are also a number of States that rely on imported fish and fishery products to serve their domestic demands.[64]

Since 1945, fisheries - in particular marine capture fisheries - have developed significantly and have rapidly expanded in many developing States of the region, especially China. This development is due to the following factors:

- The introduction of modern technologies and techniques for fishing such as the widely used monofilament nylon gill net in the small-scale fisheries and the trawl net in the commercial fisheries sub-sectors;
- The increased motorization of fisheries boats;
- Technical assistance rendered by donors and multilateral agencies such as FAO;

[63] FAO Fisheries Department, *Yearbooks of Fishery Statistics: Summary Tables* (FAO, 2003 [cited 8 June 2006]); available from ftp://ftp.fao.org/FI/STAT/summary/default.htm.
[64] Deb Menasveta, *APFIC : Its Changing Role*, vol. 5, *Rap Publication* (Bangkok, Thailand: APFIC, 2000).

- Inflow of capital investment for required infrastructures;
- The discovery of new fishing grounds in offshore waters; and
- The recognition of the fisheries contributions by Governments and their common policy of strengthening the fisheries sector. [65]

The fishing gears employed in the SCS are many and varied, including several kinds of trawlers, purse seines, other encircling nets, lift nets, gill nets, bagnets, castnets, beach seines, surface longlines, bottom longlines, hook and line, trolling lines, several kinds of stake traps, fish pots, etc.[66]

According to the University of British Columbia Fisheries Center, the landing fish catch statistics in the SCS region shows a 10-year trend increase in total catch, from 4.7 million tons in 1994 to 5.6 million tons in 2003 (Figure 9 and Annex 2). The average level is about 5 million tons. Four of the States in the region - China, Indonesia, Thailand and Vietnam - are among the top 5 shrimp producers of the world.[67] There is also a high catch percentage for miscellaneous coastal fishes and pelagic fishes (tuna, yellowfin, big eye and skipjack).[68] Global International Waters Assessment (GIWA[69]) characterizes the SCS as severely impacted in terms of overfishing, with severe socioeconomic and community consequences, excessive bycatch and discards, and destructive fishing practices, which include cyanide and dynamite fishing, and the use of small-meshed nets. These impacts show no change.[70]

[65] Deb Menasveta, "Fisheries Management in the Exclusive Economic Zones of Southeast Asia before and after Rio and the Prospects for Regional Cooperation," *Foreign Relation Journal* 9, no. 2 (1994).

[66] John C. Marr, *Fishery and Resource Management in Southeast Asia* (Washington: Resources for the Future, 1976).

[67] GLOBEFISH, *World Shrimp Markets 2004* (October 2004 [cited 6 Jun 2006]); available from http://www.globefish.org/files/SHRIMPMadrid_171.pdf.

[68] FAO, *Trends in Oceanic Captures and Clustering of Large Marine Ecosystems-2 Studies Based on the FAO Capture Database*, vol. 435, *FAO Fisheries Technical Paper* (FAO, 2003).

[69] GIWA is a water program led by the United Nations Environment Program (UNEP) and has the objective to produce a comprehensive and integrated global assessment of international waters.
GIWA, *GIWA in brief* (8 July 2004 [cited 12 October 2006]); available from http://www.giwa.net/giwafact/giwa_in_brief.phtml

[70] GIWA, *Challenges to International Waters; Regional Assessments in a Global Perspective* (United Nations Environment Programme, 2006).

In addition to the above, 2/3 of the major fish species are overexploited. The carefully constructed fishing regimes could result in increased catches.[71] However, there are the deeper coralline areas and those situated in the central part of the sea that is currently exploited, and thus there is potential to increase production despite the certain difficulties posed by fishing in these areas.[72]

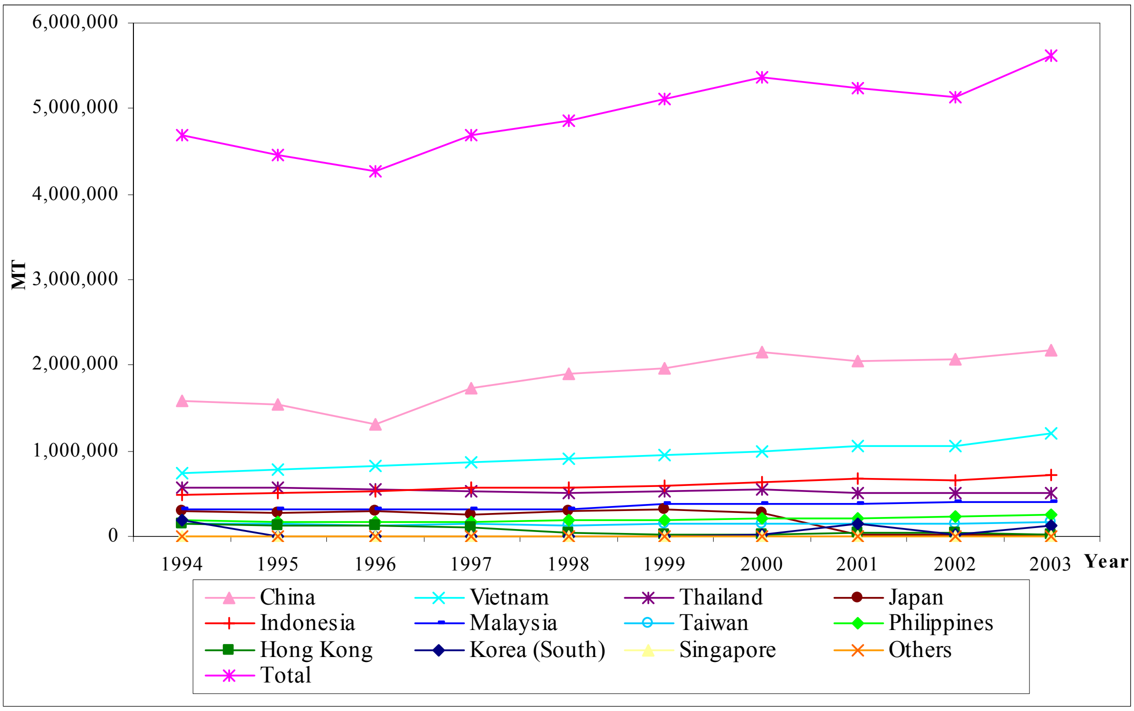

Figure 9: Landing fish catch (Metric tones) in the SCS region.

Source: University of British Columbia Fisheries Center, *Landings in South China Sea* (2005 [cited 17 May 2006]); available from http://saup.fisheries.ubc.ca/TrophicLevel/LMETaxon.aspx?lme=36&fao=0&Name=South%20China%20Sea&typeOut=4.

[71] Daniel Pauly and Villy 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*, ed. Kenneth Sherman (Washington, D.C.: American Association for the Advancement of Science, 1993).

[72] Alcala A.C., "Fish Yields of Coral Reefs of Sumilon Island, Central Philippines," *Nat. Resource Counc. Philipp. Res. Bull.* 36, no. 1 (1981); White A.T., "Two Community-Based Marine Reserves: Lessons for Coastal Management," in *Coastal Area Management in Southeast Asia: Policies, Management Strategies and Case Studies*, ed. T.E. Chua and D. Pauly, *ICLARM Conference Proceedings* (1989).

B. Status of pelagic resources and fisheries in the South China Sea region

The SCS is one of the most important and abundant commercial fisheries in the world. Shared stocks of pelagic fish such as scads and mackerels, and highly migratory species such as tuna and tuna-like stocks are the most common commercial stocks in this region.[73]

In the SCS, there are 28 potential shared fish stocks, several of which are fished by two or more States. They are mainly neritic and small pelagic species, including scads (*Decapterus* spp.), trevallies (*Caranx* spp.), torpedo scad (*Megalaspis cordyla*), sardines (*Sardinella* spp.), anchovies (*Stolephorus* spp.), Spanish mackerel (*Scomberomorus* spp.) and mackerels (*Rastrelliger* spp.).[74] Major small pelagic species in the SCS are outlined in Annex 3.

The small pelagic fish production obtained from the Western Central Pacific, which mainly includes the SCS, by the States of the region has increased continuously from about 1.4 million tones in 1994 to about 1.9 million tones in 2003 (Figure 10 and Annex 4). Indonesia, the Philippines and Thailand have been the most important producers. The main fishing gear for small pelagic fish in this region is the purse seine, followed by the paired trawler. However, in a study of small pelagic fisheries, it was found that most of these straddling stocks shared among the States in the SCS reached their maximum sustainable yield in 1987.[75] The straddling stocks are the stocks occurring within the EEZs of two or more coastal States, or both within the EEZ and in an area beyond and adjacent to it.[76]

In the SCS, tuna fisheries are the major larger pelagic fisheries. The main tuna fisheries are carried out by means of longlines, purse seines and pole-and-line fishing, or live-bait fishing. Longlines tend to catch the older, larger, non-schooling, subsurface swimming tunas,

[73] Wang, op cit, note 16.
[74] Yanagawa H., "Status of Fisheries and Stocks of Small Pelagic Fishes in the South China Sea Area," in *Report of Third Regional Workshop on Shared Stocks in the South China Sea Area* (Kuala Terengganu, Malaysia: Marine Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center, 1997).
[75] Ibid.
[76] United Nations, op cit, note 5, Article 63.

whereas purse seines and pole-and-line fishing tend to catch the younger, smaller, schooling, surface-swimming tunas.[77]

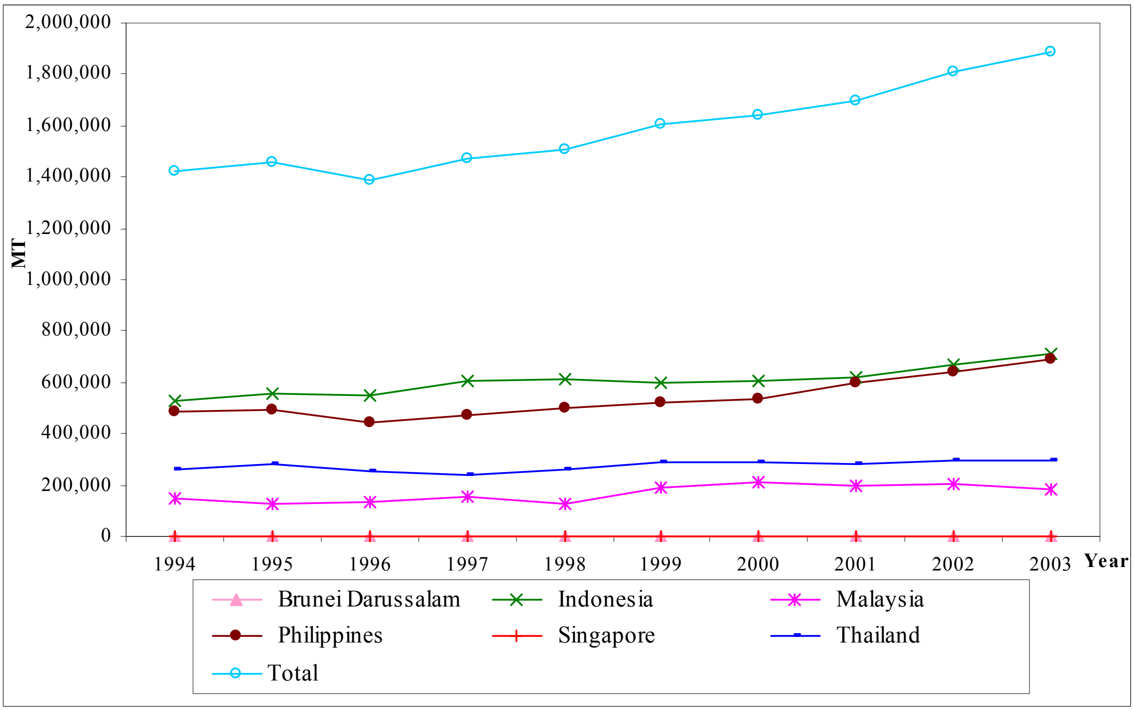

Figure 10: Total miscellaneous pelagic fish production obtained from the Western Central Pacific (SCS, Celebes Sea, Northern Australia) by States in the SCS region.

Source: FAO, *FAOStat Data - Fish Production* (23 August 2005 [cited 8 May 2006]); available from http://faostat.fao.org/faostat/form?collection=Fishes&Domain=FishCatch&servlet=1&hasbulk=0&version=ext&language=EN.

[77] Marr, op cit, note 66.

Longlines, exceedingly lengthy lines (tens of kilometers), bear baited hooks, which are suspended below the surface by means of buoys and lines. The bait is frozen fish taken aboard in port, so that longlines boats are independent of land except for normal bunkering requirements. Purse seines are very long (hundreds of meters) and deep (tens of meters) sheets of netting, which are set in a circle around schools at the surface. The netting has floats along one side and weights along the other, so that, after it is set, the net hangs down from the surface in the form of the cylinder. The bottom of the cylinder is then “pursed” by a cable drawn through rings attached to the bottom of the net, and the fish, if they have not already escaped, are trapped at this point in the process. Like longline boats, purse seiners are independent of land beyond the normal operational requirements.[78]

Live-bait fishing is carried out by throwing overboard small fishes, carried alive in bait tanks and bait wells on the fishing boats, to attract tuna, usually skipjack or yellowfin, to the vessel and to bring about the “feeding frenzy”. At this time, the tuna are easily caught on unbaited barbless hooks attached by relatively short lines to sturdy poles by which the tuna are flipped aboard the vessel. Thus, live-bait fishing is really a combination of two fisheries, one for live bait and one for tuna. Although the tunas may be (but are not necessarily) found well offshore on the high seas, the bait species occur in inshore waters. The inshore component of this fishery thus mainly occurs within the territorial seas of the coastal States, and thus subjected to a licensing regime, including fees. The bait fish used in the SCS, which is similar to the bait species available in Hawaii, is much smaller than the species used in the eastern Pacific and Japan. Tuna fisheries have been considered to be managed on a regional or worldwide basis because[79]:

- The demand continues to exceed the sustainable production;
- Of the high-seas nature of some tuna resources;
- Of the wide distribution and highly migratory nature of some species[80]; and

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[78] Ibid.
[79] Ibid.
[80] Gomez E. D., "Is the Degradation of Resources in the South China Sea Reversible? Approaches to Sustainable Management" (paper presented at the International Symposium on Protection and Management of Coastal Marine Ecosystem, Bangkok, Thailand, 12-13 December 2000).

- The mobility of the tuna fleets can be shifted from one place to another.

Moreover, some developing States have an interest in the tuna fisheries as a potential source of foreign currency so they have tended to regard themselves as coastal states with respect to the high-sea tuna fisheries, although the fisheries may be far offshore in many cases. However, the tuna fisheries of the SCS are not presently overexploited, as distant water fishing States are not be able to compete with the lower labor costs of the SCS States and increased fuel costs will also favor boats from local bases within the SCS. In addition, the almost certain extension of fishery jurisdiction resulting from the eventual resolution of the region's boundary issues, will close the SCS to unrestricted fishing by non-SCS States. Thus, the skipjack tuna resource, which its production has the greatest potential to increase in the area, may be largely available only in the internal waters of Indonesia and the Philippines.[81]

The landings of tuna production from the Western Central Pacific by States in the SCS area have also increased from about 1 million tones in 1994 to more than 1.5 million tones in 2003. The main producers are Indonesia, the Philippines and China (Figure 11 and Annex 5).

[81] Marr, op cit, note 66.

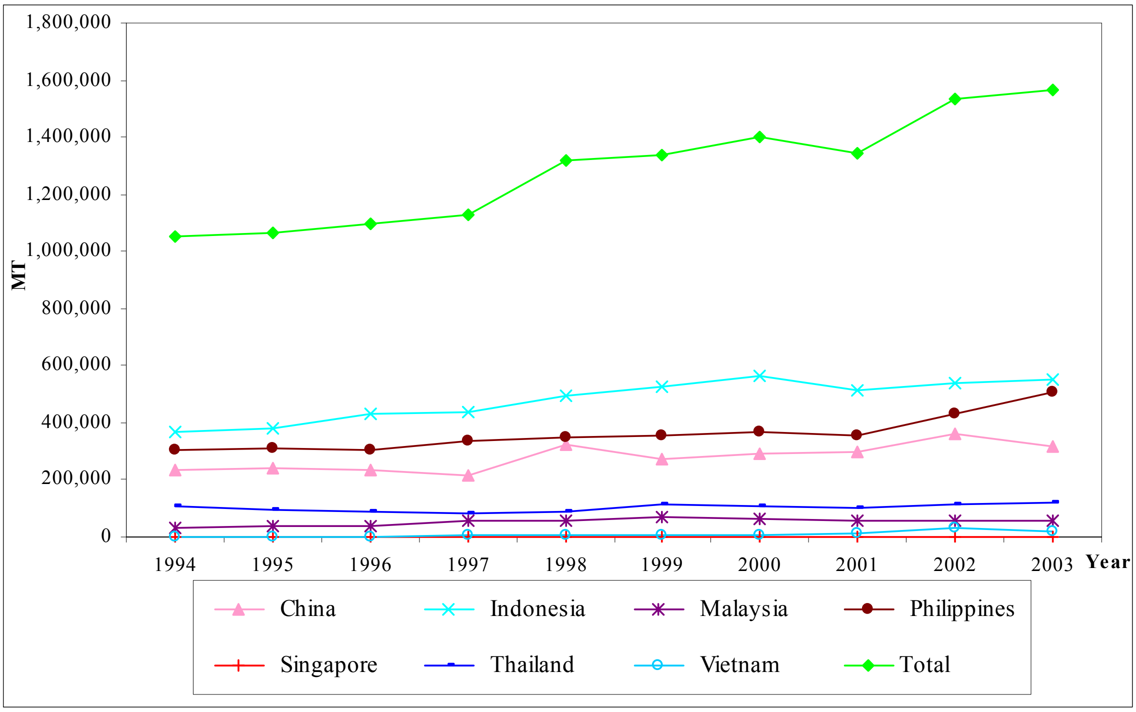

Figure 11: Total tunas, bonitos, billfishes production obtained from the Western Central Pacific (SCS, Celebes Sea, Northern Australia) by States in the SCS region.

Source: FAO, *FAOStat Data - Fish Production* (23 August 2005 [cited 8 May 2006]); available from http://faostat.fao.org/faostat/form?collection=Fishes&Domain=FishCatch&servlet=1&hasbulk=0&version=ext&language=EN.

Part III Sustainable Management of Pelagic Fisheries in the South China Sea Region

A. Aspects of pelagic fisheries management problems in the South China Sea region

- **Resource aspects**

The resource and fishery management in the region must give due regard to the multiplicity of species in the SCS. The importance of such a holistic approach is increasingly being recognized by practitioners and the international community as ecosystem approaches to management emerge. This has several implications that are almost not considered in single-species fisheries management approaches. In the SCS region, the information commonly necessary for management is not adequate. However, even if the production of such information were possible, it would be of little or no value if provisions were not made for an acceptable political mechanism with a rational management framework. Moreover, even if the necessary management information was available, and there were a rational management mechanism, management would not be possible on the species-by-species basis since so many species are taken in a single fishery.[82]

The lack of resource knowledge, in particular the lack of updated information on the distribution or range of the self-perpetuating population units, must also be indicated. According to the FAO Species Identification Sheets for Fishery Purposes, there are only 3 of 324 commercially important species which are restricted to one State, and only 9 species restricted to 2 States. Thus, 312 or 96 percent are found in 3 or more States.[83] The lack of resource knowledge can also be the obstacle for effective implement of ecosystem based management, which is one of important management approaches.

This situation is further amplified due to the fact that the maximum sustainable yield (MSY) continues to be used as the default biological reference point for determining the

[82] Ibid.
[83] Ibid.

allowable catch of harvested marine species, including within the EEZ[84] and the high seas.[85] Problems regarding MSY as a biological reference point include[86]:

- It is species specific rather than ecosystem based;
- It can not be properly defined until the overall catch begins to decline, thus leading to over-exploitation[87]; and
- It may result in excessive reduction in mean size, mean age and catch rate for the target population, thus making the stock more susceptible to the effects of environmental fluctuation on breeding success.[88]

- **EEZ delimitation aspects**

The States in the SCS region are expanding their fishing efforts and these have been increasing largely due to the continuously increasing population growth in the SCS States as well as the importance of marine fisheries as an economic sector in the region. The disputed EEZ claims among the SCS States[89], outright poaching, and the ambiguity regarding the extent to which coastal States can govern the passage of foreign vessels in their EEZs, are all key factors which are contributing to the rise in fishing disputes.[90] The coastal States assert that the LOSC grants them sovereign rights over living and non-living resources in their EEZs,[91] and

[84] United Nations, op cit, note 5, Article 62(3). It indicates that "In giving access to other States to its exclusive economic zone under this article, the coastal State shall take into account all relevant factors, including, inter alia, the significance of the living resources of the area to the economy of the coastal State concerned and its other national interests,…".

[85] Ibid., Article 119. It indicates that "1. In determining the allowable catch and establishing other conservation measures for the living resources in the high seas, States shall: (a) take measures which are designed, on the best scientific evidence available to the States concerned, to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors, including the special requirements of developing States,…".

[86] Martin Tsamenyi and Felicity Woodhill, *Sustainable Use of Large Migratory Fish in the Southern and Indian Oceans: Gaps in the International Legal Framework* (Wollongong, Australia: October 1999).

[87] Caddy J. F. and Mahon R., *Reference Points for Fisheries Management*, vol. 347, *FAO Fisheries Technical Paper* (Rome: Food and Agriculture Organization of the United Nations, 1995).

[88] Ibid.

[89] Jorge R. Coquia, "Maritime Boundary Problems in the South China Sea," *University of British Columbia Law Review* 24 (1990).

[90] Guoxing, op cit, note 12.

[91] United Nations, op cit, note 5, Article 56(1(a)). It indicates that "(a) sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and 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 wind;".

the authority to prohibit foreign vessels from fishing without their express permission. The increasing trend in the number of purse seines and fishing grounds is most destructive since most of the pelagic species in the region are straddling fish stocks and highly migratory fish stocks.

The problem has persisted for decades, and fishers have been frequently arrested and their equipments have been confiscated by the coast guard authorities in the region.[92] Some of the incidents which have occurred in the region include frequent sightings of Chinese fishing boats off Palawan, which is situated east of the disputed Spratly Islands. Furthermore, in March 2001, Vietnamese fishers were arrested by the Philippine Navy and Coast Guard on Fearless Shoal, which is near the Southern tip of Palawan; and on 25 June 2001, a Malaysian vessel suspected of illegal fishing in Indonesian waters was reported by an Indonesian Navy boat. These fishing disputes clearly contribute to the difficulties in establishing effective fisheries management in the region.

- **Fisheries aspects**

  - **Overexploitation and overfishing**

Overexploitation occurs when living resources are caught at a rate that exceeds the maximum harvest that allows the population to be maintained by reproduction.[93] One of the main factors causing overexploitation is overfishing. Overfishing was identified as the priority concern in many pasts of the East Asia region. It is primarily caused by the excessive fishing effort of industrial fishing fleets, but small-scale fishers also overexploited near shore fish stocks. It is also often in combination with destructive fishing practices. Excessive by-catch and discards aggravate overfishing because they change the age structure of fish populations, disrupt food webs and threaten endangered species. Discards also create major inter-fishery problems if the discards from one fishery include species which are valuable to another.[94]

[92] Guoxing, op cit, note 12.
[93] GIWA, op cit, note 70.
[94] Ibid.

Throughout the SCS region, the reduction and collapse of the fisheries has led to a widespread loss of income and employment. In many areas, particularly around the Philippines and Indonesia, where fish are mostly exported thus causing local fish consumption to decline.[95] The fisheries depend on the small pelagic fishes more than the species with long life span which have been depleted.

The fisheries are common pool resources[96] and commonly open access, thus they are difficult to protect. Many fish stocks in the SCS, particularly pelagic stocks which are straddling fish stocks, do not belong to a single State, but are fished by many States in the region. Moreover, the fishers lack awareness of the impacts of destructive fishing practices and have the view that if they do not exploit the fisheries then others will. These attitudes therefore result in overfishing and a lack of interest in maintaining fish habitats.[97]

In addition, fishing regulations, such as property rights, quotas, protected areas and bans on destructive practices, are difficult to enforce for any Government and are especially problematic for developing States. Insufficient enforcement is therefore also identified as a cause of overexploitation.[98]

- **Excess fishing capacity**

Excess capacity not only includes vessels that are larger than they need to be to catch and land fish which is currently available, but also includes the vessels' ability to harvest stocks beyond the stock's ability to recover. This threatens the sustainability of fish stocks being exploited and constitutes a potential threat to other stocks as well. Overcapacity has resulted from investors purchasing additional vessels to generate more income even if the vessel size is not optimal from a socio-economic point of view. In some States, these vessels

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95 Ibid.
96 Ibid.
97 Ibid.
98 Ibid.

are bought with public funds, in the form of subsidies, although FAO studies indicate that this trend is declining.[99]

Excess fishing capacity continues to be a significant issue in most regions of the world, including the SCS region. This results in the full, or over exploitation, of many coastal pelagic and demersal fish stocks. Due to the open-access nature of fisheries, it remains very difficult to control fishing capacity, particularly in the high seas.[100] Thus, fishing capacity continues to increase unchecked.

- **Illegal, Unreported and Unregulated Fishing**

In the last two decades, attention to the problems caused by inadequate controls over fishing effort has increased all over the world. The problems of dealing with fishing operations that take place outside relevant management arrangements, or beyond the effective control of flag States, have attracted considerable attention. These are known as Illegal, Unreported and Unregulated Fishing (IUU fishing)[101], which has been defined as follows:[102]

Illegal fishing refers to activities:

- Conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations;
- Conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law; or
- In violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organization.

[99] Manning, op cit, note 1.
[100] Ibid.
[101] Alex G. Oude Elferink and Donald R. Rothwell, eds., *Oceans Management in the 21st Century: Institutional Frameworks and Responses* (Leiden; Boston: Martinuss Nijhoff, c2004).
[102] FAO, *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing* (Rome, Italy: FAO, 2001).

Unreported fishing refers to fishing activities:

- Which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or
- Undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization.

Unregulated fishing refers to fishing activities:

- In the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization; or
- In areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law.

IUU fishing can take place in all capture fisheries and in all waters. The practice is problematic in inland fisheries as well as in marine capture fisheries, both in zones of national jurisdiction and on the high seas.[103]

In the SCS region, IUU fishing is also a serious concern due to the increasing level of exploitation of marine resources and the lack of effective control over ships and maritime areas. Both local and foreign fishing vessels conduct IUU fishing such as coral reef fishing, use of explosives and poisonous substances, capture of sea mammals, use of highly efficient fishing gears and use of small mesh-sized nets particularly in territorial waters and EEZs. Indeed, in zones of national jurisdiction, IUU fishing by small-scale fishers and by commercial vessels is common, while it is mostly undertaken by foreign vessels in EEZs. There is also substantial IUU fishing in the high seas, which lack effective management arrangements and suffer from weak flag State control.[104] These activities undermine efforts to conserve and manage fish stocks in not only pelagic fisheries, but all capture fisheries. The national and

[103] David J. Doulman, *Illegal, Unreported and Unregulated Fishing: Mandate for an International Plan of Action* (Rome, Italy: FAO, 2000).
[104] Ibid.

regional fisheries management organizations in the region can easily fail to achieve management goals when faced with IUU fishing. This situation leads to the loss of both short and long-term social and economic opportunities, as well as lead to negative effects on food security and environmental protection.[105] Moreover, IUU fishing can lead to the eventual collapse of a fishery, or seriously impair efforts to rebuild stocks that have already been significantly depleted. The impacts of IUU fishing can also extend beyond the target fish stocks, negatively affecting other marine species and damaging the wider marine ecosystem. High levels of by-catch of both juvenile fish and non-target species by IUU fishing represent just one of the numerous counter-conservation management impacts.[106]

In some SCS States, such as the Philippines and Indonesia, there has been some analysis of the economic losses resulting from IUU fishing with differing valuations from certain types of IUU fishing. In the Philippines, it is estimated that the annual loss caused by IUU fishing activities is PhP 50 billion or almost USD 894 million.[107] The World Resource Institute estimates the total net loss from blastfishing alone is PhP 67.2 billion or about USD 1.2 billion.[108] On the other hand, the Philippine Navy reports that the annual loss to illegal fishing activities is estimated at only PhP 11 billion or USD 196.5 million.[109] For Indonesia, around USD 4 billion is lost annually to illegal fishing activities.[110] Those estimates reveal the impacts of IUU fishing from the value of the fish, but do not reflect the actual loss which effect fish habitats and the marine environment, such as the resulting loss of ecosystem health and services.

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[105] FAO, op cit, note 102.
[106] Environmental Justice Foundation, *EJF Summary Conclusions on IUU Fishing* (March 2006 [cited 24 June 2006]); available from http://www.ejfoundation.org/pdf/hstf_submission.pdf.
[107] Porfirio Alino, "Fisheries Resources of the Philippines" (paper presented at the Australian Consultation with the Philippines and Indonesia on the Identification of Researchable Options for the Development of Policy and Management Frameworks to Combat Illegal, Unreported and Unregulated (IUU) Fishing Activities in Indonesian and Philippine Waters, Wollongong, Australia, March 2002).
[108] Laureta Burke, Elizabeth Selig, and Mark Spalding, *Reefs at Risk in Southeast Asia* (Washington: World Resource Institute, 2002).
[109] Vice Admiral Emesto H De Leon AFP, "The Role of the Philippine Navy in Protecting the Country's Maritime Interest Particularly the Fishing Industry" (paper presented at the 6th National Tuna Congress, General Santos City, 2-3 September 2004).
[110] "Illegal Fishing Still Rampant in Ri Waters," *Jakarta Post*, 20 August 2002.

B. Regional instruments related to the sustainable management of pelagic fisheries in the South China Sea region

Regional instruments are intended to address international fisheries management and conservation issues at the regional level. The regional fisheries management organizations (RFMOs) play a very important role at this stage.

In the SCS region, the RFMO which plays a very significant role is the Southeast Asian Fisheries Development Center (SEAFDEC). SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote fisheries development in Southeast Asia. SEAFDEC aims specifically to develop the fishery potentials of the region through training, research and information services to improve the food supply by rational utilization and development of the fisheries resources. Its services cover the broad areas of fishing gear technology, marine engineering, fishing ground surveys and stock assessment, post-harvest technology as well as development and improvement of aquaculture techniques.[111]

SEAFDEC currently consists of 11 member States, namely: Brunei, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. The Council of Directors, composed of nominees from Member States, is the policy-making body that provides directives and guidance on activities of SEAFDEC. SEAFDEC has a Secretariat as an administrative unit, and four technical Departments, namely: the Training Department (TD) in Thailand, the Marine Fisheries Research Department (MFRD) in Singapore, the Aquaculture Department (AQD) in the Philippines, and the Marine Fishery Resources Development and Management Department (MFRDMD) in Malaysia.[112]

SEAFDEC has conducted several programs for sustainable management of marine fisheries resources in the SCS region. The most important program regarding pelagic fisheries is named: *Information Collection for Sustainable Pelagic Fisheries in the South China Sea Program*. This Program is a collaborative program undertaken by SEAFDEC, financed by

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[111] Southeast Asian Fisheries Development Center, *About SEAFDEC* (2004 [cited 12 July 2006]); available from http://www.seafdec.org/aboutus.htm.
[112] Ibid.

Japan, and executed by MFRDMD, MFRD and TD together with an overall coordination by the SEAFDEC Secretariat. Participating States include Brunei, Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam.[113]

The Program has three components:

- Component I (MFRDMD, MFRD and TD) aims to finalize the overall framework and mechanism of the Program, responsibilities of SEAFDEC Departments and participating States, and methodologies of pilot data collection and analyses and observation of the current status of landing and processing;
- Component II aims to carry out the pilot data collection and analyses on the basis of the decision of the Technical Meeting. This will be undertaken by MFRDMD and TD. The survey of the actual status of operation and catches of purse seine fishery as well as the fish biology studies plan to be conducted; and
- Component III focuses on examination to maximize pelagic fish resources utilization. This is to be undertaken by MFRD.[114]

The program has been conducted for 5 years (2002-2006), and the final result of the program will be presented at a conference at the end of 2006.

C. International instruments related to the sustainable management of pelagic fisheries in the South China Sea region

Since the end of the 20th Century, world fisheries have been in a crisis, with many regional fisheries regarded as being in extreme danger of collapse. International laws as well as international instruments have an important role to play in dealing with this crisis.[115]

The LOSC, which came into force in 1994, has drastically changed the concept of ocean governance and set forth new legal frameworks for marine fisheries and environmental protection. In response to the rapid change in the global fisheries situation, especially during the past decade, and in order to facilitate the effective implementation of the LOSC, a number

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113 Southeast Asian Fisheries Development Center, *Information Collection for Sustainable Pelagic Fisheries in the South China Sea* (7 July 2006 [cited 10 July 2006]); available from http://www.seafdec.org/program/program14.htm.
114 Ibid.
115 Stuart Kaye, *International Fisheries Management* (Boston: Kluwer Law International, 2000).

of international instruments and initiatives have been adopted by the international community.[116] Notable instruments of particular relevance to fisheries management include:

- The 1995 Agreement for the Implementation of the Provision 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;
- The 1993 Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas;
- The 1995 Code of Conduct for Responsible Fisheries; and
- FAO International Plans of Action addressing specific key issues of the 1995 Code of Conduct for Responsible Fisheries.

These instruments, as well as the LOSC itself, play a very important role in marine fisheries management including the management of pelagic fisheries in the SCS.

1. The 1982 United Nations Convention on the Law of the Sea

The LOSC was adopted by the Third United Nations Conference on the Law of the Sea (UNCLOS III) in New York on 30 April 1982 after nine years of negotiations which aimed to erect a comprehensive constitution for the oceans.[117] The LOSC was concluded and opened for signature on 10 December 1982 at Montego Bay, Jamaica.[118] It has been signed by 157 States and as at 8 November 2006, 152 States are Parties. These States include all of the China Seas States except Cambodia, Thailand and North Korea (Table 2).

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[116] Menasveta, op cit, note 64.

[117] United Nations, *The United Nations Convention on the Law of the Sea (a Historical Perspective)* (United Nations, 2006 [cited 15 June 2006]); available from http://www.un.org/depts/los/convention_agreements/convention_historical_perspective.htm.

[118] United Nations, *United Nations Convention on the Law of the Sea of 10 December 1982: Overview and Full Text* (United Nations, 16 March 2006 [cited 15 June 2006]); available from http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm.

Table 2: Status of the China Seas States to the LOSC and the related Agreements, as at 8 November 2006.

State or Entity	United Nations Convention on the Law of the Sea[119] (in force as from 16 November 1994)		Agreement relating to the implementation of Part XI of the Convention[120] (in force as from 28 July 1996)		Agreement for the implementation of the provisions of the Convention relating to the conservation and management of straddling fish stocks and highly migratory fish stocks[121] (in force as from 11 December 2001)		Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas[122] (in force as from 24 April 2003)	
	✍ Signature 🗎 Declaration	Ratification/ Accession (a)/ 🗎 Declaration	✍ Signature	Ratification/ Accession (a)/ Content to be bound (p)	✍ Signature 🗎 Declaration	Ratification/ Accession 🗎 Declaration	✍ Signature	Ratification/ Accession (a)
TOTALS	**157 (🗎 35)**	**152 (🗎 58)**	**79**	**126**	**59 (🗎 5)**	**62 (🗎 27)**	**35**	**35**
Brunei	✍	5 November 1996		5 November 1996 (p)				
Cambodia	✍							
China	✍	🗎 7 June 1996	✍	7 June 1996 (p)	🗎			
Indonesia	✍	3 February 1986	✍	2 June 2000	✍			
Japan	✍	20 June 1996	✍	20 June 1996	✍	7 August 2006	✍	20 June 2000
Malaysia	✍	🗎 14 October 1996	✍	14 October 1996 (p)				
North Korea	✍							
Philippines	🗎	🗎 8 May 1984	✍	23 July 1997	✍			
Singapore	✍	17 November 1994		17 November 1994 (p)				
South Korea	✍	29 January 1996	✍	29 January 1996	✍		✍	24 April 2003
Thailand	✍							
Vietnam	✍	🗎 25 July 1994		27 April 2006 (a)				

[119] United Nations, *Table Recapitulating the Status of the Convention and of the Related Agreements* (8 November 2006 [cited 27 November 2006]); available from http://www.un.org/Depts/los/reference_files/status2006.pdf.
[120] Ibid.
[121] Ibid.
[122] FAO, *Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas - Status* (November 2006 [cited 27 November 2006]); available from http://www.fao.org/Legal/treaties/012s-e.htm.

At the time of its adoption, the LOSC embodied in one instrument traditional rules governing oceans uses, and at the same time introduced new legal concepts and regimes addressing new concerns. The LOSC also provided a framework for further development of specific areas of the Law of the sea. Today, it is the globally recognized regime - the framework convention for all matters relating to the Law of the Sea.[123]

The LOSC comprises 320 articles and 9 annexes, governing all aspects of ocean space, such as delimitation, environmental control, marine scientific research, economic and commercial activities, transfer of technology and the settlement of disputes relating to ocean matters.[124] The EEZ is one of its most revolutionary features, and one which already has had a profound impact on the management and conservation of the resources of the oceans including pelagic fisheries in the SCS. The desire of coastal States to control fish harvest in adjacent waters was a major driving force behind the creation of the EEZ.[125] The adoption of the EEZ within the framework of the LOSC has placed 90 percent of the world's fisheries under national jurisdiction.[126] The EEZ is defined as "an area beyond and adjacent to the territorial sea"[127] that "shall not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured".[128] The prescribed management regime applicable to the EEZ is very important because more than 80 percent of all commercial stocks are caught within 320 kilometers of coastal shores.[129] In the EEZ, coastal States exercise sovereign rights for the purpose of exploring and exploiting, conserving and managing the living and non-living natural resources of the area.[130] The LOSC also requires coastal

[123] United Nations, op cit, note 118.
[124] Ibid.
[125] United Nations, op cit, note 117.
[126] FAO, *UNCED and Its Implications for Fisheries*, vol. 8, *Cofi/93/Inf.* (Rome, Italy: FAO, 1993).
[127] United Nations, op cit, note 5, Article 55. It indicates that "The exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States are governed by the relevant provisions of this Convention.".
[128] United Nations, op cit, note 5, Article 57. It indicates that "The exclusive economic zone shall not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.".
[129] McGinn A. P., "Chapter 4: Promoting Sustainable Fisheries," in *State of the World 1998: A Worldwatch Institute Report on Progress Towards a Sustainable Society* (New York, USA: Norton, 1998).
[130] United Nations, op cit, note 31.

States to implement conservation measures applicable to fishing vessels in their EEZs.[131] It reflects the interests of coastal States with regard to natural resources, certain economic activities and the exercise of jurisdiction over marine science research and environmental protection.

The other important key features related to the marine resource management are those concerning the resources of the high seas.[132] The LOSC stipulates that all States which enjoy the traditional freedoms of scientific research and fishing on the high seas are obliged to adopt, or cooperate with other States in adopting, measures to manage and conserve living resources. Under the LOSC, highly migratory species of fish, which are mostly pelagic species as specified in Annex I of the LOSC,[133] are accorded special protection.[134]

With respect to territorial sea and internal waters, States are provided with no provisions regarding management regimes, leaving them absolute and unfettered control over the management scheme they might wish to implement.[135]

Although States bordering enclosed or semi-enclosed seas are expected to cooperate in managing living resources, environmental and research policies and activities because those activities taken by one State may have a direct impact on the rights, obligations, and interests of other States.[136] However, the LOSC created important dispute resolution regimes and

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131 United Nations, op cit, note 5, Article 62(4). It indicates that "4. Nationals of other States fishing in the exclusive economic zone shall comply with the conservation measures and with the other terms and conditions established in the laws and regulations of the coastal State…".
132 United Nations, op cit, note 5, Article 118. It indicates that "States shall cooperate with each other in the conservation and management of living resources in the areas of the high seas. States whose nationals exploit identical living resources, or different living resources in the same area, shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned. They shall, as appropriate, cooperate to establish subregional or regional fisheries organizations to this end.".
133 United Nations, op cit, note 5, Annex I.
134 United Nations, op cit, note 5, Article 64(1). It indicates that "1. The coastal State and other States whose nationals fish in the region for the highly migratory species listed in Annex I shall cooperate directly or through appropriate international organizations with a view to ensuring conservation and promoting the objective of optimum utilization of such species throughout the region, both within and beyond the exclusive economic zone…".
135 Kaye, op cit, note 115.
136 United Nations, op cit, note 5, Article 123. It indicates that "States bordering an enclosed or semi-enclosed sea should cooperate with each other in the exercise of their rights and in the performance of their duties under this Convention…".

mechanisms[137], including the International Tribunal for the Law of the Sea (ITLOS)[138], in order to settle disputes regarding jurisdiction over resources and related issues that might occur among coastal States.

2. The 1995 Agreement for the Implementation of the Provision 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 the last two decades, straddling fish stocks and highly migratory fish stocks became a target for certain distant water fishing vessels. Since the adoption of the LOSC, and the establishment of the EEZ by a large number of coastal States, relocation of some major distant water fisheries vessels to areas adjacent to EEZ has taken place. This has resulted in an increase in catches of straddling fish stocks and highly migratory fish stocks. The LOSC, having been negotiated as part of a package agreement, contains provisions that call for cooperation among States in this regard. However, these provisions are too general and are widely regarded by many to be insufficient and ineffective to prevent many problems resulting from such unregulated fisheries. As a response to this shortcoming, the United Nations Conference on Environmental and Development (UNCED), held in Rio in 1992, called for the convening of a specialized conference on straddling fish stocks and highly migratory fish stocks.

On 4 August 1995, the Conference adopted the Agreement for the Implementation of the Conservation Provision 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.[139]

The 1995 UN Fish Stocks Agreement is an implementation agreement for the LOSC with respect to issues not adequately addressed at the time of UNCLOS III: the conservation and

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[137] United Nations, op cit, note 5, Part XV. It mainly indicates that States Parties shall settle any dispute between them concerning the interpretation or application of LOSC by peaceful means chosen by the Parties.
[138] United Nations, op cit, note 5, Annex VI.
[139] Jean-Pierre Levy and Gunnar G. Schram, *United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks : Selected Documents* (The Hague ; Boston: Martinus Nijhoff Publishers, c1996); hereinafter referred to as “the 1995 UN Fish Stocks Agreement”

management of straddling fish stocks and highly migratory fish stocks. In particular, the 1995 UN Fish Stocks Agreement provides for an implementation framework for Articles 63 and 64 and relevant provisions made in Part VII of the LOSC.[140]

Straddling fish stocks are those that straddle the boundary of a State's EEZ and the high seas (some stocks straddle 'out' of an EEZ while others straddle 'into' an EEZ), while highly migratory fish stocks are those that generally roam over large distances and maybe found in numerous EEZ jurisdictions and the high seas. Highly migratory species are defined by a listing in Annex 1 of the LOSC.[141]

The main provision of the 1995 UN Fish Stocks Agreement can be summarized as follows:

- Elaborates general principles concerning conservation and management of straddling fish stocks and highly migratory fish stocks;
- Applies the concept of the precautionary approach to the conservation and management of these stocks;
- Emphasizes the special role of RFMOs in the conservation and management of straddling fish stocks and highly migratory fish stocks;
- Elaborates upon the obligation of states to cooperate in the conservation and management of straddling fish stocks and highly migratory fish stocks. This includes a duty upon States not to authorize vessels to fish for such fish stocks unless the States are party to, or co-operate with, any sub-regional or regional fisheries management organization or arrangement which has competence to establish conservation and management measures for the stock concerned;
- Elaborates upon the obligations of states with respect to vessels flying their flag on the high seas;
- Introduces innovative enforcement provisions for the high seas; and
- Introduces provisions with respect to the requirements of developing States. [142]

The 1995 UN Fish Stocks Agreement is binding only upon those States that are party to it. As at 8 November 2006, there are 62 States party to the Agreement. None of the States in SCS

[140] Grant Bryden, *United Nations Fish Stocks Agreement* ([cited 17 May 2006]); available from http://www.oceansatlas.com/world_fisheries_and_aquaculture/html/govern/instit/intlinstr/unfsa.htm.
[141] United Nations, op cit, note 133.
[142] Bryden, op cit, note 140.

region is a party to the Agreement (Table 2). They, however, sent representatives to attend the informal consultation meetings of State Parties to the 1995 UN Fish Stocks Agreement in order to prepare for the Review Conference of the Agreement which was convened by the Secretary-General of the United Nations from 22 to 26 May 2006, at the United Nations Headquarters in New York. [143]

At the Review Conference, delegations recalled that all provisions of the Agreement shall be interpreted and applied in the context of and in a manner consistent with the LOSC. RFMOs and arrangements were recognized as the primary mechanism for international cooperation in conserving and managing straddling fish stocks and highly migratory fish stocks. The Review Conference encouraged States, as appropriate, to recognize that the general principles of the Agreement should apply to discrete fish stocks in the high seas as well. The Review Conference also strongly recommended that States individually and collectively through RFMOs should strengthen their commitment to adopt and fully implement conservation and management measures for straddling fish stocks and highly migratory fish stocks. Furthermore, the Review Conference recommended to urge all States with an interest in fisheries for straddling fish stocks and highly migratory fish stocks that have not yet done so to become parties to the Agreement as soon as possible and disseminate information about the Agreement, including its objective and the rights and duties it provides.[144]

[143] United Nations, *Fifth Round of Informal Consultations of States Parties to the 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* (New York: United Nations, 2006); United Nations, *Fourth Informal Consultations of States Parties to the 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* (New York: United Nations, 2005).

[144] United Nations, *Report of the Review Conference on the 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* (New York: United Nations, 2006).

3. The 1993 Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas[145]

According to the LOSC, the high seas include "all parts of the sea that are not included in the EEZ, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State".[146] In the case of the SCS, it is not clear if there are any areas which could fall beyond areas of national jurisdiction. This is because of the territorial disputes among many coastal States over sovereign claims on the Spratly Islands and the Paracels Islands. However, if hypothetical EEZs are drawn from these coastal States' baselines, ignoring both the Spratly Islands and the Paracels Islands, the area enclosed by the line in the middle of Figure 12 will be the high seas in the SCS. But if only the Spratly Islands are ignored, the potential high seas area would be reduced to the area depicted in the middle of Figure 13. On the other hand, if the effect of extending EEZs from the Spratly Islands is considered, the potential to eliminate all high seas in the SCS can be seen in Figure 14.

[145] Hereinafter referred to as "the Compliance Agreement".
[146] United Nations, op cit, note 5, Article 86. It indicates that "The provisions of this Party apply to all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State…".

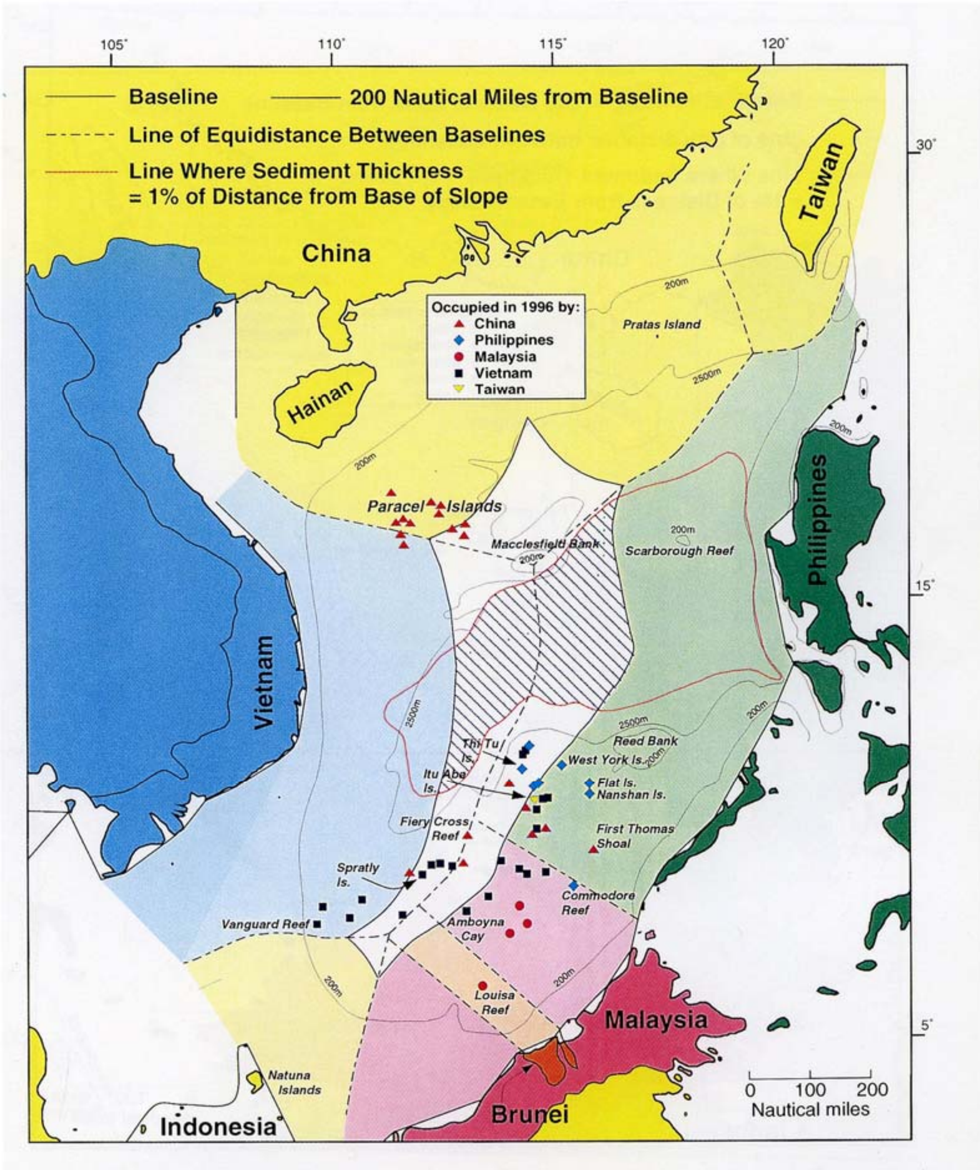

Figure 12: Allocation of the SCS and features out 200 nautical miles from defensible baselines, ignoring both the Spratly Islands and the Paracel Islands.

Source: Mark J. Valencia, Jon M. Van Dyke, and Noel A. Ludwig, *Sharing the Resources of the South China Sea* (The Hague; Boston: Cambridge, MA: M. Nijhoff Publishers; Sold and distributed in the U.S.A. and Canada by Kluwer Law International, c1997), p. 264.

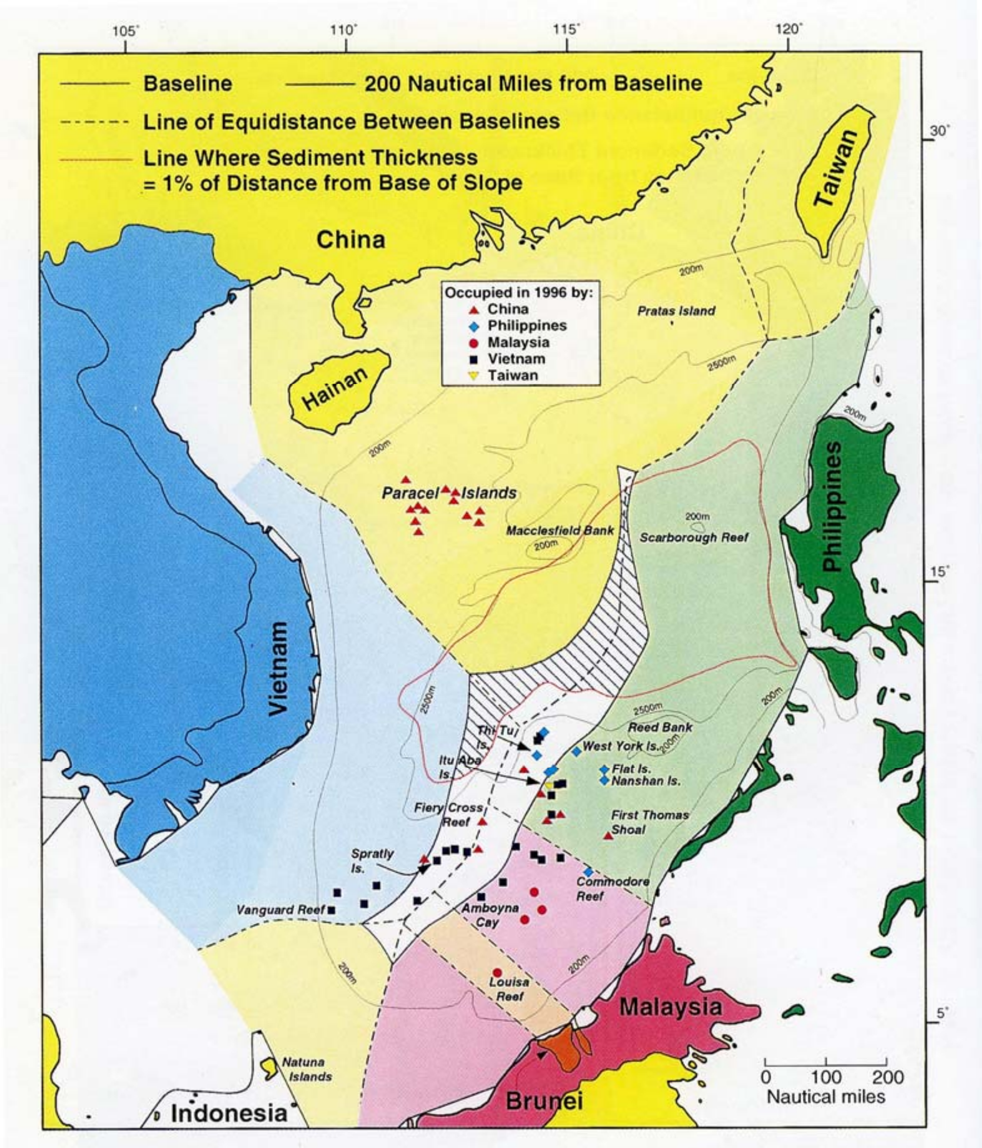

Figure 13: Allocation of the SCS and features out 200 nautical miles, ignoring the Spratly Islands but giving full effect to the Paracel Islands based on defensible baseline claims.

Source: Mark J. Valencia, Jon M. Van Dyke, and Noel A. Ludwig, *Sharing the Resources of the South China Sea* (The Hague; Boston: Cambridge, MA: M. Nijhoff Publishers; Sold and distributed in the U.S.A. and Canada by Kluwer Law International, c1997), p. 265.

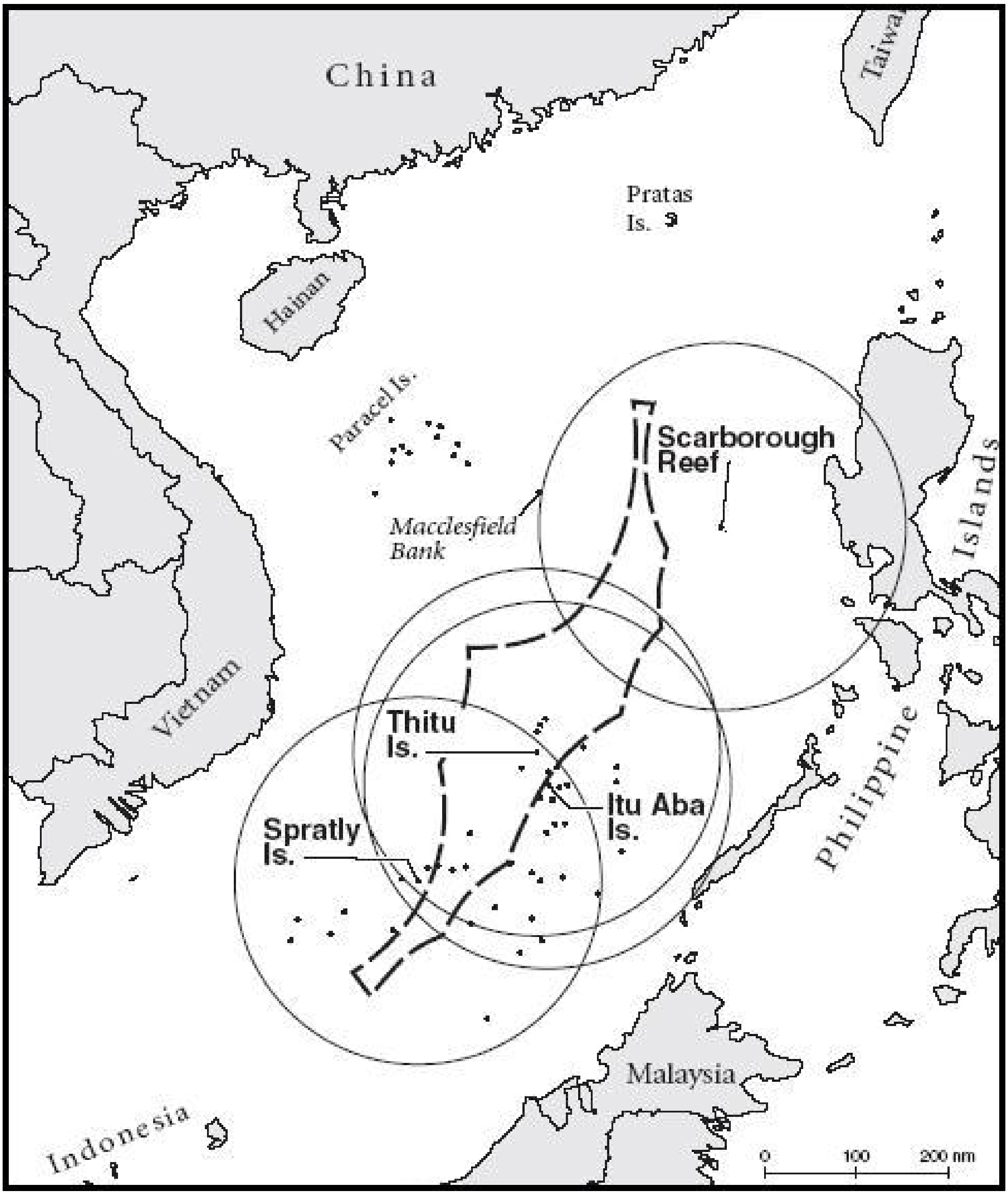

Figure 14: The circles drawn to show the effect of extending 200 nautical miles EEZs from the Spratly Islands.

Source: Ji Guoxing, "Rough Waters in the South China Sea: Navigation Issues and Confidence-Building Measures," (East-West Center, 2001).

As previously stated, as the various territorial disputes of the SCS remain currently unresolved, it is assumed that the SCS contains a maritime area which can be considered as high seas. This makes the Compliance Agreement a significant international instrument for pelagic fisheries management in the region.

The Compliance Agreement was approved by the FAO Conference at its twenty-seventh session in Rome on 24 November 1993. It entered into force on 24 April 2003, upon receipt by the Director-General of the FAO of the twenty-fifth instrument of ratification. The Compliance Agreement is an important international agreement that fits within a framework of multilateral, regional, and bilateral agreements on the conservation and management of high sea fisheries. It is consistent with the LOSC, and in certain respects, overlaps with the 1995 Fish Stocks Agreement. The Compliance Agreement forms a central element of the FAO Code of Conduct for Responsible Fisheries, which sets out principles and standards of behavior for responsible fishing.[147]

The intent of the Compliance Agreement is to deter the practice of re-flagging fishing vessels as a means of avoiding compliance with international conservation and management measures, i.e. re-flagging fishing vessels to States that do not effectively control their vessels and/or that do not participate in, or cooperate with, RFMOs. This practice is commonly associated with IUU fishing, which is a problem that continues to present a serious threat to global fisheries and marine ecosystems. Re-flagging and the broader practice of IUU fishing, seek to avoid compliance with international conservation and management measures. Such practices have very negative impacts on the long-term sustainability of fish stocks, compromise the effectiveness of RFMOs, and undermine the rights and interests of responsible fishing States.[148]

The Compliance Agreement seeks to address this problem by strengthening the responsibilities of flag States over their vessels that fish on the high seas. Specifically, it requires flag States to implement authorization and recording procedures for high seas fishing vessels. States are required to ensure that they can legally exert control over a vessel before authorizing it to

[147] Primary Production Committee, "International Treaty Examination of the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Sea," in *Report of the Primary Production Committee* (New Zealand).
[148] Ibid.

fish on the high seas, and are prohibited from authorizing vessels with a history of fisheries-related non-compliance. The Compliance Agreement also sets forth procedures for exchange of information on high seas fishing vessels, and provides the basis for improved international cooperation with regard to IUU fishing.[149] These measures contribute to the elimination of IUU fishing and assist in insuring the long-term sustainability of fish stocks and protection of biodiversity from the adverse impacts of fishing on the high seas.[150]

As at 8 November 2006, there are 35 States party to the Agreement but none of the States in the SCS region is a party. In fact, there were only two China Seas States which signed the Agreement: Japan and South Korea (Table 2).

4. The 1995 Code of Conduct for Responsible Fisheries

The 1995 Code of Conduct for Responsible Fisheries[151] was adopted by FAO membership on 31 October 1995[152] during the 28th Session of the FAO Conference held in Rome between 20 October and 2 November 1995.[153] More than 170 FAO members States adopted the Code by consensus. It was recognized that fisheries, which include the management, catching, processing, marketing of fish stocks and aquaculture, provide an important source of food, employment, and income for people throughout the world. Therefore everyone involved in fishing must help conserve and manage the world fisheries.[154] The Code, which is voluntary rather than mandatory, aims to establish principles for responsible fishing, in accordance with the relevant rules of international law, and to serve as an instrument of reference to help States establish or improve the legal, institutional and managerial arrangements required for responsible and sustainable fishing. It applies globally to all fisheries, including fisheries within the EEZ and the territorial sea, as well as

[149] Ibid.
[150] Ibid.
[151] Hereinafter referred to as "the Code".
[152] Christopher Hedley, *FAO Code of Conduct for Responsible Fisheries* ([cited 5 August 2006]); available from http://www.intfish.net/treaties/summaries/3308.htm.
[153] Tsamenyi and Woodhill, op cit, note 86.
[154] FAO, *What Is the Code of Conduct for Responsible Fisheries?* (Rome, Italy: FAO, 2001).

those on the high seas, and to all stages of the fishing process, including capture, post-harvest production and trade.[155]

The main provisions of the Code are summarized as follows[156]:

- Implementation of management measures to ensure the sustainable use of marine living resources;
- Conservation of target species, species belonging to the same ecosystem or associated and dependent species;
- Prevention of overfishing and excess fishing capacity;
- Support for fisheries management decisions with the best available scientific evidence;
- Application of the precautionary approach to fisheries conservation and management;
- Protection of endangered species;
- Promotion of selective and environmentally safe fishing gear and practices;
- Protection and rehabilitation of critical fisheries habitats;
- Promotion of international cooperation to facilitate conservation and management of living aquatic resources, especially straddling stocks and highly migratory stocks, throughout their range of distribution;
- The adoption of compatible conservation measures in areas under national jurisdiction and on the high seas; and
- Development of effective monitoring, control and surveillance measures.

According to the FAO, 52 of its member States report having fisheries management plans in place that incorporate elements of the Code, including measures to promote use of selective fishing gear, to prohibit destructive practices and to ensure that permitted catch-levels reflect the state of stocks and allow depleted populations to recover. Fifty States are taking steps to make sure that their ships fishing in the EEZs of other States are properly authorized, and to better monitor foreign

[155] Hedley, op cit, note 152.
[156] Tsamenyi and Woodhill, op cit, note 86.

vessels operating in their own EEZs. Forty-nine States have implemented policies aimed at limiting accidental by-catch and reducing discards.[157]

In addition, to fulfill the obligation and to operationalize the Code in Southeast Asian States which all are located in the SCS region, SEAFDEC has initiated a comprehensive project on the Regionalization of the Code of Conduct for Responsible Fisheries. This project aims to address lacunas in State implementation, and to clarify provisions of the Code which are critical to the fisheries development of Southeast Asia. This project has established four phases of regionalization exercises, namely:

- Fishing Operations (Phase I);
- Aquaculture Development (Phase II);
- Fisheries Management (Phase III); and
- Fisheries Post-Harvest Technology and Trade (Phase IV).

To achieve the goals set for the regionalization exercises, a series of processes and activities have been undertaken such as the identification of regional core experts and advisors; organization of workshops and technical meetings to elicit national views on the global Code; the mobilization of core experts workshops for the preparation of the regional technical; and the drafting of the regional guidelines. At present, SEAFDEC has completed regionalization exercises for Responsible Fishing Operations[158] and Aquaculture Development[159] and elaborated the respective regional guidelines. In the pipeline is the regionalization of Fisheries Management[160] including the harmonization of Integration of Fisheries into Coastal Area Management[161] with Fisheries Management.[162]

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[157] FAO, *Progress Reported in Implementation of International Fishing Code* (2005 [cited 5 August 2006]); available from http://www.fao.org/newsroom/en/news/2004/45169/index.html.
[158] FAO, *Code of Conduct for Responsible Fisheries* (Rome, Italy: 1995), Article 8.
[159] Ibid., Article 9.
[160] Ibid., Article 7.
[161] Ibid., Article 10.
[162] Southeast Asian Fisheries Development Center, *Regionalization of the Code of Conduct for Responsible Fisheries* (2006 [cited 5 August 2006]); available from http://www.seafdec.org/program/program11.htm.

5. FAO International Plans of Action addressing specific key issues of the 1995 Code of Conduct for Responsible Fisheries[163]

Even after the Code was adopted in 1995, members of the FAO Committee on Fisheries (COFI) determined that the implementation of the Code's provisions would be greatly reinforced by a set of voluntary International Plans of Action (IPOA). Three such plans, each addressing a specific issue, were developed in 1998 and adopted by the twenty-third session of COFI in February 1999, after which they were endorsed by the FAO Council at its June 1999 session. The three IPOAs are as follows:

- The IPOA for reducing incidental catch of seabirds in longline fisheries[164];
- The IPOA for the conservation and management of sharks[165]; and
- The IPOA for the management of fishing capacity.[166]

In addition to the three IPOAs enumerated, the twenty-third session of COFI (1999) called for the elaboration of a fourth IPOA, namely:

- The IPOA to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.[167]

This IPOA was developed in 2000, adopted by consensus at the 24th session of COFI on 2 March 2001, and endorsed by the 120th session of the FAO Council on 23 June 2001. The four IPOAs are summarized as follows:

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[163] Hereinafter referred to as "FAO-IPOA".
[164] FAO, *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries, International Plan of Action for the Conservation and Management of Sharks, International Plan of Action for the Management of Fishing Capacity* (Rome, Italy: FAO, 1999).
[165] Ibid.
[166] Ibid.
[167] FAO, *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing* (Rome, Italy: FAO, 2001).

- **The IPOA for reducing incidental catch of seabirds in longline fisheries**[168]

The IPOA-SEABIRDS is a voluntary instrument that applies to all States whose fishermen engage in longline fisheries.[169] Key longline fisheries in which incidental catch of seabirds are known to occur are: tuna, swordfish and billfish in certain regions of the oceans.[170] The IPOA-SEABIRDS sets out the activities which implementing States are expected to carry out, including an assessment of weather a problem exists with respect to the incidental catch of seabirds in its longline fishery, adopting a National Plan of Action for reducing in incidental catch of seabirds in longline fisheries (NPOA-SEABIRDS) and the elaboration of procedures for national reviews and reporting requirements.[171]

In the SCS region itself, the incidental catch of seabirds in longline fisheries has not been observed. The species of seabirds most frequently taken are albatrosses and petrels in the Southern Ocean, northern fulmars in the North Atlantic and albatrosses, gulls and fulmars in the North Pacific fisheries.[172] According to FAO, only a few States have official schemes in place to prevent bird deaths, but many have indicated that steps to tackle the problem are being adopted on an individual basis in their fisheries sectors.[173] However, all of the concerned States are encouraged to implement the IPOA-SEABIRDS, particularly those who operate longline fisheries in the mentioned oceans.

- **The IPOA for the conservation and management of sharks**[174]

The IPOA-SHARKS is a voluntary instrument that applies to all States whose fishermen engage in shark fisheries. It sets out the activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to sharks, adopting a

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168 Hereinafter referred to as "IPOA-SEABIRDS".
169 FAO, op cit, note 164.
170 FAO, *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries* (5 August 2006 [cited 5 August 2006]); available from http://www.fao.org/figis/servlet/static?xml=ipoa_seabirds.xml&dom=org&xp_nav=2.
171 FAO, op cit, note 164.
172 FAO, op cit, note 170.
173 FAO, op cit, note 157.
174 Hereinafter referred to as "IPOA-SHARKS".

National Plan of Action for the conservation and management of sharks (NPOA-SHARKS), as well as procedures for national reviews and reporting requirements.[175]

The fishers of the SCS region have conducted fisheries for sharks in coastal waters for decades. During recent years, the increase in effort and yield of shark catches, as well as the expansion of the fishing grounds, has taken place. Generally, conservation and management of sharks is impaired by the lack of accurate data on catch, effort, discard, and trade data, as well as limited information on the biological parameters of many species and their identification.[176] However, to date, there is no Stock Assessment Report (SAR) for sharks in the SCS region, although SEAFDEC has developed a research project on the biology and conservation of sharks which may form a basis for the formulation of SAR. Indonesia has also carried out studies in 2000 and 2001 on shark biology and shark fisheries.[177] According to FAO, plans addressing shark fishing now exist in six States, with ten other States close to finalizing them.[178] But, as of date, there is no NPOA-SHARKS in the SCS region.[179]

- **The IPOA for the management of fishing capacity**[180]

The IPOA-CAPACITY is a voluntary instrument that applies to all States whose fishermen engage in capture fisheries. The immediate objective of the IPOA-CAPACITY is for the States and RFMOs to put in place an efficient, equitable and transparent management of fishing capacity by 2003, and not later than 2005.[181] It also enumerates urgent actions to be taken by States and identifies mechanisms in order to promote their implementation. The urgent actions are as follows:

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[175] FAO, op cit, note 164.
[176] FAO, *The International Plan of Action for the Conservation and Management of Sharks* (5 August 2006 [cited 5 August 2006]); available from http://www.fao.org/figis/servlet/static?dom=org&xml=ipoa_sharks.xml.
[177] IUCN Species Survival Commission's Shark Specialist Group and TRAFFIC, *Report on Implementation of the International Plan of Action for Sharks (IPOA-Sharks): AC18 DOC. 19.2* (8-12 April 2002 [cited 5 August 2006]); available from http://www.cites.org/common/com/ac/18/E18i-10.doc.
[178] FAO, op cit, note 157.
[179] IUCN Species Survival Commission's Shark Specialist Group and TRAFFIC, op cit, note 177.
[180] Hereinafter referred to as "IPOA-CAPACITY".
[181] FAO, *International Plan of Action for the Management of Fishing Capacity* (5 August 2006 [cited 5 August 2006]); available from http://www.fao.org/figis/servlet/static?xml=ipoa_capacity.xml&dom=org&xp_nav=2&xp_banner=fi.

- Assessment and monitoring of fishing capacity which includes measurement of fishing capacity, urgent measurement of diagnosis and identification of fisheries and fleets as well as establishment of records of fishing vessels;

- Preparation and implementation of national plans by development of national plans and policies, giving subsidies and economic incentives and having regional considerations; and

- Having international considerations as well as the immediate actions for major international fisheries requiring urgent measures. [182]

So far, FAO reports that nine States have national plans in place to limit excess fishing capacity, and another 42 States are in the processes of drafting such plans including some States in the SCS region.[183]

- **The IPOA to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing**[184]

The IPOA-IUU is also a voluntary agreement, within the framework of the Code, which applies to all States and entities and to all fishers. It contains proposed measures to prevent, deter and eliminate IUU fishing. These measures focus on all State responsibilities, including flag State responsibilities, coastal State measures, port State measures, internationally agreed market-related measures, research and regional fisheries management organizations. Special requirements of developing States are also considered, as are reporting requirements and the role of FAO.[185] The measures proposed by IPOA-IUU are summarized as follows:

- All States responsibilities which include 2 parts which are international instruments and national legislation.

  For international instruments, States are encouraged, as a matter of priority, to ratify, accept or accede to, as appropriate, the LOSC, the 1995 UN Fish Stocks Agreement and the 1993 FAO Compliance Agreement. Also, States should fully and effectively implement the Code and its associated International Plans of Action.

[182] FAO, op cit, note 164.
[183] FAO, op cit, note 157.
[184] Hereinafter referred to as "IPOA-IUU".
[185] FAO, op cit, note 167.

With respect to national legislation, States should address in an effective manner all aspects of IUU fishing. States should develop and implement their National Plans of Action which address State control over nationals, vessels without nationalities, legal sanctions with sufficient severity, non cooperating States, economic incentives and MCS of fishing activities.

- Flag State responsibilities, including the requirement for the establishment of fishing vessel registries, record of fishing vessels, issue authorization to fish as well as the control of transhipment and support activities.

- Coastal State responsibilities include the implementation of effective MCS, cooperation with other States and information exchange, the regulation of foreign fishing access and the application of legal sanctions of sufficient severity.

- Port State measures which are to deny port access to IUU fishing boats (except for vessels in distress), port inspection of vessel documents and catch, collect and exchange of information, cooperation with flag and coastal States, as well as cooperation with regional fisheries management organizations.

- Internationally-agreed market measures that include import and export control, catch documentation and certification requirements, pre-shipment inspection, labeling, self requirement and paper trails for the fish trade.

- Implications of non-compliance should include multilateral bans on import of fisheries products, ban on high seas fishing, sanctions against non-compliant fishing vessels, loss of access to waters of other States, to avoid collapse of resources and loss of revenues.[186]

According to FAO, thirty-five Sates have developed plans to curtail IUU fishing including some States in the SCS region.[187]

[186] Ibid; Martin Tsamenyi and Ron West, "International Requirements to Prevent, Deter, and Eliminate Illegal, Unreported, and Unregulated (IUU) Fishing" (paper presented at the National Workshop on IUU Fishing, Jakarta, Indonesia, 28 April 2005).
[187] FAO, op cit, note 157.

Part IV Potential Approaches towards the Sustainable Management of Pelagic Fisheries in the South China Sea Region

Since pelagic stocks in the SCS region are mainly straddling fish stocks and highly migratory fish stocks, their sustainable management at the national level is obviously not enough. A comprehensive management regime at the international level needs to be further developed and implemented to be more effective. However, at the international level, sustainable use approaches, which are recognized as fundamental to the management of renewable resources, need to be applied within specific fisheries instruments and implemented at all levels.[188] The potential approaches for sustainable management of pelagic fisheries in the SCS, therefore, should include the following:

a. Ratification and implementation of the international fishery instruments

To apply internationally agreed standards for responsible and sustainable marine resources management, including the elimination of IUU fishing in both waters under national jurisdiction and the high seas, the SCS States should be seriously encouraged to ratify or accept and implement effective international fishery instruments including:

- The LOSC;
- The 1995 UN Fish Stocks Agreement;
- The Compliance Agreement;
- The Code; and
- The four FAO international plans of action (IPOA-SEABIRDS, IPOA-SHARKS, IPOA-CAPACITY, IPOA-IUU).

In particular, States should ratify the LOSC which is one of the most comprehensive international treaties and the framework convention for the other international agreements enumerated above. All SCS States should be a party to the LOSC. The LOSC provides the legal

[188] Tsamenyi and Woodhill, op cit, note 86.

framework absolutely necessary for sustainable management of pelagic fisheries in the SCS region. The LOSC grants coastal States sovereign rights over living resources in their EEZs as well as provides the legal regime for their protection and conservation. The LOSC also provides a comprehensive framework for marine conservation that coastal States are specifically required to conserve living resources in their EEZs. In addition, the LOSC promotes scientific research and protects the right to conduct it.

Currently, there are only two States in the SCS region, Cambodia and Thailand, who are not parties to the LOSC. Their non-party status has constantly brought them some disadvantages both in international fisheries as well as in the exercise of the freedom of navigation for commercial vessels, particularly when dealing with the States who are parties to the LOSC. For instance, Thailand can not submit disputes with Malaysia regarding the freedom of navigation for Thai fishing vessels in Malaysia's EEZ to ITLOS. This has seriously disadvantaged Thailand in its negotiations with Malaysia.

The States of the SCS region should also be strongly encouraged to ratify or accept and implement other international instruments mentioned above. At present, none of the SCS States are parties to them. These instruments collectively support and elaborate the rights and obligations under the LOSC, which are also necessary for sustainable management of pelagic fisheries in the SCS region.

b. Cooperation in the conservation and management of marine resources

The majority of the States in the SCS region have enclosed or semi-enclosed seas. Article 123 of the LOSC, provides that States bordering an enclosed or semi-enclosed sea should cooperate with each other in the exercise of their rights and in the performance of their duties under the LOSC. This imposes upon the littoral States bordering the SCS region the duty to coordinate the management, conservation, exploration and exploitation of marine living resources as well as to coordinate their scientific research policies and undertake appropriate joint programs. This cooperation can be undertaken directly or through an appropriate regional organization.

It is clear that the SCS States should cooperate directly or through an appropriate regional organization in many matters relating to fisheries. The management measures taken by one State should be compatible with similar measures adopted by other States, particularly when they fish the same stocks. Moreover, cooperation through regional institutions should reduce the likelihood of States becoming involved in fisheries disputes. RFMOs should also aim to recover the cost of conservation, management and research activities from their members.[189] To date, SEAFDEC is the only effective RFMO which conducts research on pelagic fisheries in the SCS region. However, its projects now focus more on scientific research, particularly on the fisheries biology of pelagic resources in the SCS region. Future tasks for the SCS States themselves, as well as the RFMOs, include the development of collaborative agreements on how to exploit the shared stocks rationally, with careful consideration of catch allocation, fishing regulation, surveillance and fisheries laws. This undertaking may require the assistance of impartial bodies such as FAO and the Asia-Pacific Fishery Commission (APFIC). The collaborative agreements may also help to abate active disputes, particularly territorial disputes among the States in the SCS region.

c. Ecosystem management approach

There is no single internationally agreed definition of “ecosystem management approach” but the concept is generally associated with management based on the best understanding of the ecological interactions and processes necessary to sustain ecosystem structure and function.[190] Ecosystem management approach requires holistic decision-making. That is, the impact of an activity on one element in the ecosystem may have consequences on other components of the same system.[191] The ultimate goal of an ecosystem management approach is to promote sustainable development. The application of it to oceans involves the maintenance of ecosystem integrity, functioning and health in order to ensure the sustainable use of ocean resources for present and future generations.[192]

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[189] FAO, op cit, note 154.
[190] United Nations, *Ocean and the law of the sea, Report of the Secretary-General* (New York: United Nations, 2006).
[191] Kaye, op cit, note 115.
[192] United Nations, op cit, note 190.

The ecosystem management approach requires that the components of an ecosystem, the phenomena and activities that affect it and the legislative and policy frameworks be coordinated in a systematic manner to address interactions and cumulative effects. This may require the creation of new institutional frameworks, as well as appropriate coordination and collaboration among the various sectors involved, and perhaps new policy and legislative instruments. The ecosystem approach is science-based. However, scientific understanding of ocean ecosystems, particularly of the SCS, is still very limited. Thus, the application of the precautionary approach is essential. Monitoring the state of the ecosystem over time to evaluate the effects of both natural changes and management measures is also necessary.[193] The application of such an approach generally includes the following steps:

(a) Identification of the geographical scope for the application of the ecosystem management approach;

(b) Scientific research and analysis of the components of the ecosystem, their interaction and functioning;

(c) Assessment of the condition of the ecosystem;

(d) Establishment of ecological and operational objectives to maintain biodiversity, productivity, water quality and habitat quality in a given ecological region;

(e) Identification of pressures and impacts on the ecosystems;

(f) Selection of ecological indicators to ensure that ecological objectives are being met;

(g) Analysis of existing legal framework and identification of gaps, overlaps and inconsistencies;

(h) Management of human activities that affect or might affect the ecosystem;

(i) Monitoring of natural changes in ecosystems and the effects of management measures through ecological indicators;

(j) Adjustment of the management system, if necessary; and

(k) Management structures.[194]

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[193] Ibid.
[194] Ibid.

In order to avoid excess fishing capacity of pelagic resources that will severely affect to the ecosystem in the SCS region, the SCS States should have resource exploitation governed by adequate fisheries laws and regulations, as well as monitored through a reliable fisheries data collection system. The SCS States should support monitoring of pelagic fishery resources and the marine environment, which is fundamental to the conservation and rational utilization of fishery resources.

Moreover, the dissemination of information regarding relevant international and national laws and regulations will raise awareness and will make all stakeholders conscientious in protecting the fishery resources and the marine environment in the SCS region. In developing and managing the pelagic fisheries, the SCS States also have to consider an institutional mechanism in order to see whether the existing mechanism has been satisfactory or still sufficient to cope with the increasing problems of implementation.

It will also be important to promote independent scientific studies and reviews of pelagic stocks in the SCS region, the results of which will facilitate the work of RFMOs and provide a point of comparison with analysis provided by RFMOs.

Conclusion

The SCS region, composed of nine coastal States which have the highest population growth in the world, is a LME with unique oceanographic, biographic and ecological characteristics. The SCS region is very important, mainly for strategic reasons, both in the economic and the military senses. In addition, there are rich hydrocarbon deposits as well as pelagic and other fisheries resources in the SCS region. However, the maritime boundary and territorial disputes among the coastal States of the SCS region seriously undermine the peaceful and optimal utilization of these resources.

The important role of fisheries in the food security and economy of the majority of States in the SCS region cannot be overemphasized. Fisheries contribute to the employment and income of people in this region as well as to the international trade of these States. Pelagic resources, both small pelagic species such as scads and mackerels, and large pelagic species such as tunas, are considered significant.

The goal of sustainable fisheries management in the SCS region is hindered by several pelagic fisheries management problems pertaining to resource issues, issues with respect to EEZ delimitation, and fisheries issues, notably overfishing. It is obvious that IUU fishing is an important root problem. However, many national and international instruments, if properly implemented, offer solutions to these issues and the joint development zones should be strongly considered among the SCS States, particularly in the conflicted areas.

In the SCS region, SEAFDEC plays a very important role as an RFMO for pelagic fisheries management. At the international level, there are several notable effective fisheries instruments such as the LOSC, the 1995 UN Fish Stocks Agreement, the Compliance Agreement, the Code of Conduct and the four IPOAs of FAO. However, the frameworks provided under these international instruments will depend on the extent to which States are willing to become parties and implement their provisions.[195]

[195] Tsamenyi and Woodhill, op cit, note 86.

Although there are management activities already initiated by a number of States in the region and by regional bodies such as SEAFDEC, they are currently confined to developing statistical databases and collecting biological and bio-economic information on the exploited pelagic stocks. These undertakings are intended to gain more knowledge of the stocks and their distribution as well as to assess the state of their exploitation. The direction of future tasks to be assisted by impartial bodies such as FAO and APFIC should be towards the development of collaborative agreements on the rational exploitation of shared stocks, with careful consideration of catch allocation, fishing regulation, surveillance and fisheries laws.[196] Any management system must require compliance to operate effectively.

At present, those available instruments are creative. The SCS States should underline the importance of capacity-building as well as confidence-building in implement them. If they are successfully implemented they would provide a reliable system of sustainable resources management not only for pelagic fisheries in the SCS region but also all marine fisheries resources in the world.

[196] Menasveta, op cit, note 64.

Bibliography

Alcala A.C. "Fish Yields of Coral Reefs of Sumilon Island, Central Philippines." *Nat. Resource Counc. Philipp. Res. Bull.* 36, no. 1 (1981): 1-7.

Alino, Porfirio. "Fisheries Resources of the Philippines." Paper presented at the Australian Consultation with the Philippines and Indonesia on the Identification of Researchable Options for the Development of Policy and Management Frameworks to Combat Illegal, Unreported and Unregulated (IUU) Fishing Activities in Indonesian and Philippine Waters, Wollongong, Australia, March 2002.

Austin, Greg. *China's Ocean Frontier: International Law, Military Force, and National Development*: Allen & Unwin, 1998.

Bradley, R. E., Pratt, M. A. and Schofield, C. H. "Jane's Exclusive Economic Zones 2002-2003." In *Coulsdon: Jane's Information Group, Year book*, edited by Pratt M. A., p. 43, 2002.

Bryden, Grant. *United Nations Fish Stocks Agreement* [cited 17 May 2006]. Available from http://www.oceansatlas.com/world_fisheries_and_aquaculture/html/govern/instit/intlinstr/unfsa.htm.

Burke, Laureta, Elizabeth Selig, and Mark Spalding. *Reefs at Risk in Southeast Asia*. Washington: World Resource Institute, 2002.

Caddy, J. F., and Mahon R. *Reference Points for Fisheries Management*. Vol. 347, *FAO Fisheries Technical Paper*. Rome: Food and Agriculture Organization of the United Nations, 1995.

Catley, Robert, and Makmur Keliat. *Spratlys: The Dispute in the South China Sea*. Brookfield: Ashgate, 1997.

Charney, Jonathan I. "Central East Asian Maritime Boundaries and the Law of the Sea." *The American Journal International Law* 89 (1995): 724.

Cohen, William S. "Annual Report to the President and the Congress." Washington D.C., 2000.

Coquia, Jorge R. "Maritime Boundary Problems in the South China Sea." *University of British Columbia Law Review* 24 (1990): 117-25.

Devaraj M., and P. Martosubroto, eds. *Small Pelagic Resources and Their Fisheries in Asia-Pacific Region*. Vol. 31, *The APFIC Working Party on Marine Fisheries, First Session*. Bangkok, Thailand: RAP Publication, 13-16 May 1997.

Djalal, Hasjim. "South China Sea Island Disputes." *Raffles Bulletin of Zoology* Supplement No.8 (2000): 9-21.

Doulman, David J. *Illegal, Unreported and Unregulated Fishing: Mandate for an International Plan of Action*. Rome, Italy: FAO, 2000.

Elferink, Alex G. Oude, and Donald R. Rothwell, eds. *Oceans Management in the 21st Century: Institutional Frameworks and Responses*. Leiden ; Boston: Martinuss Nijhoff, c2004.

Environmental Justice Foundation. *EJF Summary Conclusions on IUU Fishing* March, 2006 [cited 24 June 2006]. Available from http://www.ejfoundation.org/pdf/hstf_submission.pdf.

FAO. *Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas - Status* November, 2006 [cited 27 November 2006]. Available from http://www.fao.org/Legal/treaties/012s-e.htm.

———. *Area 71: Pacific Western Central*, 2003 [cited 25 June 2006]. Available from http://www.oceansatlas.com/servlet/CDSServlet?status=ND0zMTIyLjMxNDAmNj1lbiYzMz13ZWItc2l0ZXMmMzc9aW5mbw~~.

———. *Code of Conduct for Responsible Fisheries*. Rome, Italy, 1995.

———. *FAOStat Data - Fish Production* 23 August, 2005 [cited 8 May 2006]. Available from http://faostat.fao.org/faostat/form?collection=Fishes&Domain=FishCatch&servlet=1&hasbulk=0&version=ext&language=EN.

———. *FAOStat Data - Food Supply* 3 March, 2006 [cited 29 May 2006]. Available from http://faostat.fao.org/faostat/form?collection=FS.NonPrimaryLivestockAndProducts&Domain=FS&servlet=1&hasbulk=0&version=ext&language=EN.

———. *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries* 5 August, 2006 [cited 5 August 2006]. Available from http://www.fao.org/figis/servlet/static?xml=ipoa_seabirds.xml&dom=org&xp_nav=2.

———. *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries, International Plan of Action for the Conservation and Management of Sharks, International Plan of Action for the Management of Fishing Capacity*. Rome, Italy: FAO, 1999.

———. *The International Plan of Action for the Conservation and Management of Sharks* 5 August, 2006 [cited 5 August 2006]. Available from http://www.fao.org/figis/servlet/static?dom=org&xml=ipoa_sharks.xml.

———. *International Plan of Action for the Management of Fishing Capacity* 5 August, 2006 [cited 5 August 2006]. Available from http://www.fao.org/figis/servlet/static?xml=ipoa_capacity.xml&dom=org&xp_nav=2&xp_banner=fi.

———. *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing*. Rome, Italy: FAO, 2001.

———. *Numbers of Fishers, 1970-1995*. 2 ed. Vol. 929, *FAO Fisheries Circular*, 1999.

———. *Progress Reported in Implementation of International Fishing Code*, 2005 [cited 5 August 2006]. Available from http://www.fao.org/newsroom/en/news/2004/45169/index.html.

———. *Trends in Oceanic Captures and Clustering of Large Marine Ecosystems-2 Studies Based on the FAO Capture Database*. Vol. 435, *FAO Fisheries Technical Paper*: FAO, 2003.

———. *UNCED and Its Implications for Fisheries*. Vol. 8, *COFI/93/INF*. Rome, Italy: FAO, 1993.

———. *What Is the Code of Conduct for Responsible Fisheries?* Rome, Italy: FAO, 2001.

FAO Fisheries Department. *Yearbooks of Fishery Statistics: Summary Tables* FAO, 2003 [cited 8 June 2006]. Available from ftp://ftp.fao.org/FI/STAT/summary/default.htm.

FAO Marine Resources Service, Fishery Resources Division. *Review of the State of World Fishery Resources: Marine Fisheries*. Vol. 920, *FAO Fisheries Circular*. Rome: FAO, 1997.

GIWA. *Challenges to International Waters; Regional Assessments in a Global Perspective*: United Nations Environment Programme, 2006.

———. *GIWA in brief* 8 July, 2004 [cited 12 October 2006]. Available from http://www.giwa.net/giwafact/giwa_in_brief.phtml

———. "Preliminary Results for the Scoping and Assessment of the South China Sea and Sulu-Celebes Seas." Global International Waters Assessment, 2001.

GLOBEFISH. *World Shrimp Markets 2004* October, 2004 [cited 6 Jun 2006]. Available from http://www.globefish.org/files/SHRIMPMadrid_171.pdf.

Gomez E. D. "Is the Degradation of Resources in the South China Sea Reversible? Approaches to Sustainable Management." Paper presented at the International Symposium on Protection and Management of Coastal Marine Ecosystem, Bangkok, Thailand, 12-13 December 2000.

Guoxing, Ji. "Rough Waters in the South China Sea: Navigation Issues and Confidence-Building Measures." East-West Center, 2001.

Hedley, Christopher. *FAO Code of Conduct for Responsible Fisheries* [cited 5 August 2006]. Available from http://www.intfish.net/treaties/summaries/3308.htm.

"Illegal Fishing Still Rampant in Ri Waters." *Jakarta Post*, 20 August 2002.

International Court of Justice. *Sovereignty Over Pedra Branca/Pulau Putch, Middle Rocks and South Ledge, Malaysia/Singapore* 20 November, 2005 [cited 12 October 2006]. Available from http://www.amun.org/final/05/ICJ-ICJOpinion-25.pdf#search=%22american%20model%20united%20nations%20international%20court%20of%20justice%20november%2020%22

IUCN Species Survival Commission's Shark Specialist Group and TRAFFIC. *Report on Implementation of the International Plan of Action for Sharks (IPOA-Sharks): AC18 DOC. 19.2* 8-12 April, 2002 [cited 5 August 2006]. Available from http://www.cites.org/common/com/ac/18/E18i-10.doc.

Joyner, Christopher C. *Toward a Spratly Resource Development Authority: Procursor Agreements and Confidence Building Measures*. Edited by Myron H. Norquist and John Norton Moroe, *Security Flashpoints: Oil, Islands, Sea Access and Military Confrontation*, 1997.

Kaye, Stuart. *International Fisheries Management*. Boston: Kluwer Law International, 2000.

Kreil, Erik. *South China Sea* March, 2006 [cited 24 April 2006]. Available from http://www.eia.doe.gov/emeu/cabs/South_China_Sea/pdf.pdf.

Levy, Jean-Pierre, and Gunnar G. Schram. *United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks : Selected Documents*. The Hague ; Boston: Martinus Nijhoff Publishers, c1996.

LME. *LME 36: South China Sea. Large Marine Ecosystems of the World* 2 March, 2004 [cited 28 April 2006]. Available from http://na.nefsc.noaa.gov/lme/text/lme36.htm.

Manning, Peter. *Control and Reduction of Fishing Capacity*, 1998 [cited 1 May 2006]. Available from http://www.oceansatlas.com/world_fisheries_and_aquaculture/html/issues/govern/overcap/control.htm#topofdocument.

Marr, John C. *Fishery and Resource Management in Southeast Asia*. Washington: Resources for the Future, 1976.

McGinn A. P. "Chapter 4: Promoting Sustainable Fisheries." In *State of the World 1998: A Worldwatch Institute Report on Progress Towards a Sustainable Society*, 58-78. New York, USA: Norton, 1998.

Menasveta, Deb. *APFIC : Its Changing Role*. Vol. 5, *RAP Publication*. Bangkok, Thailand: APFIC, 2000.

———. "Fisheries Management in the Exclusive Economic Zones of Southeast Asia before and after Rio and the Prospects for Regional Cooperation." *Foreign Relation Journal* 9, no. 2 (1994): 107.

Morgan, Joseph, and Mark Valencia, eds. *Atlas for Marine Policy in Southeast Asian Seas*. Berkeley, CA: University of California Press, 1983.

NASA. *Background of the SeaWiFS Project*, 2006 [cited 16 October 2006]. Available from http://oceancolor.gsfc.nasa.gov/SeaWiFS/BACKGROUND/SEAWIFS_BACKGROUND.html

National Oceanic and Atmospheric Administration. *Freedom of Navigation* 16 August, 2006 [cited 17 November 2006]. Available from http://www.publicaffairs.noaa.gov/oceanreport/freedomnav.html

Nguyen, Dong Manh. "Settlement of Disputes under the 1982 United Nations Convention on the Law of the Sea: The Case of the South China Sea Dispute." New York: UN-Nippon Foundation Fellowship on the Law of the Sea, 2005.

Ninjie, Yu. "South China Sea." National Geographic, 1998.

Odgaard, Liselotte. "Deterrence and Co-Operation in the South China Sea." *Contemporary Southeast Asia* 23, no. 2 (2001): 292-306.

Onoora, Poungthong. *Handbook for Enforcement of International Fisheries Law*. Vol. 5, *Technical Paper*. Bangkok, Thailand: Department of Fisheries, 2004.

Pauly, Daniel, and Villy 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*, edited by Kenneth Sherman, 148-74. Washington, D.C.: American Association for the Advancement of Science, 1993.

Primary Production Committee. "International Treaty Examination of the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Sea." In *Report of the Primary Production Committee*, 8. New Zealand.

Ravin, MOM. “Law of the Sea: Maritime Boundaries and Dispute Settlement Mechanisms.” New York: UN-Nippon Foundation Fellowship on the Law of the Sea, 2005.

Ritterbush, Stephen W. "Marine Resources and the Potential for Conflict in the South China Sea." *The Fletcher Forum* 2 (1978): 64-85.

Rosenberg, David. "Environmental Pollution around the South China Sea: Developing a Regional Response." *Contemporary Southeast Asia* 21, no. 1 (1999): 119-45.

———. *Environmental Pollution around the South China Sea: Developing a Regional Response to a Regional Problem*. Edited by Anne Casson. Vol. 20, *Resource Management in Asia-Pacific Working Paper*. Canberra: Resource Management in Asia-Pacific Project, Division of Pacific and Asian History, Research School for Pacific and Asian Studies, the Australian National University, 1999.

———. *The South China Sea*, 1999 [cited 13 March 2006]. Available from http://community.middlebury.edu/~scs/why.html.

Snyder, Scott. *The South China Sea Dispute. Prospects for Preventive Diplomacy* August, 1996 [cited 13 March 2006]. Available from http://www.usip.org/pubs/specialreports/early/snyder/South_China_Sea1.html.

Snyder, Scott, Brad Glosserman, and Ralph A. Cossa. "Confidence Building Measures in the Scs." *Issue and Insights* 2 (2001).

South China Sea-Reference Map-US CIA [cited 31 July 2006]. Available from http://community.middlebury.edu/~scs/maps/South%20China%20Sea-reference%20map-US%20CIA.jpg.

Southeast Asian Fisheries Development Center. *About SEAFDEC*, 2004 [cited 12 July 2006]. Available from http://www.seafdec.org/aboutus.htm.

———. *Information Collection for Sustainable Pelagic Fisheries in the South China Sea* 7 July, 2006 [cited 10 July 2006]. Available from http://www.seafdec.org/program/program14.htm.

———. *Regionalization of the Code of Conduct for Responsible Fisheries*, 2006 [cited 5 August 2006]. Available from http://www.seafdec.org/program/program11.htm.

Talaue-McManus L. *Transboundary Diagnostic Analysis for the South China Sea*. Vol. 14, *EAS/RCU Technical Report Series*. Bangkok, Thailand: UNEP, 2000.

Tennesson, Stein. "Locating the South China Sea." In *Locating Southeast Asia: Geographies of Knowledge and Politics of Space*, edited by Paul Kratoska, Henk Schulte Nordholt and Remco Raben, 203-33: Ohio University Press, March 2005.

Tonnesson, Stein. "The History of the Dispute." In *War or Peace in the Scs*, edited by Timo Kivimaki, 2002.

Tsamenyi, Martin. " Zones delimitation according to the LOSC." Slide presented on “The Law of the Sea" course at the University of Wollongong, Australia, 26-30 June 2006.

Tsamenyi, Martin, and Ron West. "International Requirements to Prevent, Deter, and Eliminate Illegal, Unreported, and Unregulated (IUU) Fishing." Paper presented at the National Workshop on IUU Fishing, Jakarta, Indonesia, 28 April 2005.

Tsamenyi, Martin, and Felicity Woodhill. *Sustainable Use of Large Migratory Fish in the Southern and Indian Oceans: Gaps in the International Legal Framework*. Wollongong, Australia, October 1999.

United Nations. *Fifth Round of Informal Consultations of States Parties to the 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*. New York: United Nations, 2006.

———. *Fourth Informal Consultations of States Parties to the 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*. New York: United Nations, 2005.

———. *Ocean and the law of the sea, Report of the Secretary-General*. New York: United Nations, 2006.

———. *Report of the Review Conference on the 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.* New York: United Nations, 2006.

———. *The Law of the Sea. United Nations Convention on the Law of the Sea*. New York: United Nations, 1982.

———. *Table Recapitulating the Status of the Convention and of the Related Agreements* 8 November, 2006 [cited 27 November 2006]. Available from http://www.un.org/Depts/los/reference_files/status2006.pdf.

———. *The United Nations Convention on the Law of the Sea (a Historical Perspective)* United Nations, 2006 [cited 15 June 2006]. Available from http://www.un.org/depts/los/convention_agreements/convention_historical_perspective.htm.

———. *United Nations Convention on the Law of the Sea of 10 December 1982 : Overview and Full Text* United Nations, 16 March, 2006 [cited 15 June 2006]. Available from http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm.

———. *Treaty Series*, vol. 1155, p. 331.

United Nations Atlas of the Oceans. *Large Marine Ecosystems (LMEs)* 2006 [cited 10 October 2006]. Available from http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xMjcyNyZjdG5faW5mb192aWV3X3NpemU9Y3RuX2luZm9fdmlld19mdWxsJjY9ZW4mMzM9KiYzNz1rb3M~

United States Energy Information Administration. "South China Sea Region." 1998.

University of British Columbia Fisheries Center. *Landings in South China Sea*, 2005 [cited 17 May 2006]. Available from http://saup.fisheries.ubc.ca/TrophicLevel/LMETaxon.aspx?lme=36&fao=0&Name=South%20China%20Sea&typeOut=4.

Valencia, Mark J., Jon M. Van Dyke, and Noel A. Ludwig. *Sharing the Resources of the South China Sea*. The Hague ; Boston : Cambridge, MA: M. Nijhoff Publishers ; Sold and distributed in the U.S.A. and Canada by Kluwer Law International, c1997.

Valencia, Mark, and Douglas M. Johnston. *Pacific Ocean Boundary Problems: Status and Solutions*: Martinus Nijhoff, April 1991.

Vice Admiral Emesto H De Leon AFP. "The Role of the Philippine Navy in Protecting the Country's Maritime Interest Particularly the Fishing Industry." Paper presented at the the 6th National Tuna Congress, General Santos City, 2-3 September 2004.

Wang, Kuan-Hsiung. "Bridge over Troubled Waters: Fisheries Cooperation as a Resolution to the South China Sea Conflicts." *The Pacific Review* 14, no. 4 (2001): 531-51.

White A.T. "Two Community-Based Marine Reserves: Lessons for Coastal Management." In *Coastal Area Management in Southeast Asia: Policies, Management Strategies and Case Studies*, edited by T.E. Chua and D. Pauly, 85-96, 1989.

Wilkinson C., DeVantier L., Talaue-McManus L., Lawrence D., and Souter D. *Global International Waters Assessment. South China Sea, GIWA Regional Assessment 54*: University of Kalmar on behalf of United Nations Environment Programme, 2005.

Wu, Shicum, and Huaifeng Ren. "More Than a Declaration: A Commentary on the Background and the Significance of the Declaration on the Conduct of the Parties in the South China Sea." *Chinese Journal of International Law* 2 (2003): 331.

Xianshi, Jin. "Marine Fishery Resources and Management in China." Paper presented at the ICFO Seminar, Qingdao, China, 25-29 October 2000.

Yanagawa H. "Status of Fisheries and Stocks of Small Pelagic Fishes in the South China Sea Area." In *Report of Third Regional Workshop on Shared Stocks in the South China Sea Area*, 165-202. Kuala Terengganu, Malaysia: Marine Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center, 1997.

Annex 1: Total fishery production (Metric tones) obtained from the Western Central Pacific by States in the SCS region.

Total Fishery Production	Year									
Western Central Pacific	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Brunei Darussalam	4,497	4,796	7,489	4,630	5,157	3,282	2,558	1,537	2,112	2,053
Cambodia	30,578	31,231	31,800	30,066	33,715	38,812	36,428	42,537	46,317	55,364
China	306,027	292,448	277,926	258,753	369,179	292,187	318,121	332,811	393,320	360,031
Indonesia	2,238,967	2,445,702	2,448,173	2,661,538	2,667,397	2,766,205	2,877,433	3,041,324	3,038,851	3,268,721
Malaysia	632,859	611,995	639,478	678,701	649,560	784,487	792,634	785,297	797,296	778,320
Philippines	1,756,999	1,792,015	1,717,389	1,713,937	1,757,388	1,799,585	1,823,681	1,896,415	1,976,565	2,119,419
Singapore	13,638	13,661	13,422	13,223	11,089	9,932	9,823	7,083	7,180	6,507
Thailand	2,330,535	2,329,304	2,204,966	2,101,214	2,121,308	2,320,823	2,453,792	2,253,504	2,156,334	2,287,526
Vietnam	1,001,010	1,058,886	1,115,488	1,163,542	1,228,393	1,302,230	1,410,579	1,557,002	1,608,209	1,866,277
Total	**8,315,110**	**8,580,038**	**8,456,131**	**8,625,604**	**8,843,186**	**9,317,543**	**9,725,049**	**9,917,510**	**10,026,184**	**10,744,218**

Source: FAO, *FAOStat Data - Fish Production* (23 August 2005 [cited 8 May 2006]); available from: http://faostat.fao.org/faostat/form?collection=Fishes&Domain=FishCatch&servlet=1&hasbulk=0&version=ext&language=EN.

Note: Graph of the data presented on p. 21.

Annex 2: Landing fish catch (Metric tones) in the SCS region.

Year	China	Vietnam	Thailand	Japan	Indonesia	Malaysia	Taiwan	Philippines	Hong Kong	Korea (South)	Singapore	Others	Total
1994	1,593,624	740,691	564,494	299,295	486,299	324,483	142,946	200,239	138,282	181,510	7,364	7,081	4,686,309
1995	1,549,766	771,296	574,581	271,915	502,991	316,495	140,475	175,510	131,483	2,696	6,814	6,966	4,450,988
1996	1,307,154	829,997	546,116	291,922	521,062	321,150	134,645	168,801	120,847	1,896	6,669	9,277	4,259,536
1997	1,740,940	860,403	518,989	251,826	563,129	313,803	141,513	168,902	115,908	1,917	6,147	6,605	4,690,081
1998	1,904,794	902,272	499,019	305,633	564,525	323,302	131,188	185,822	37,692	2,066	5,041	6,898	4,868,252
1999	1,971,002	952,685	521,150	306,394	596,373	390,017	139,337	199,977	26,188	4,687	4,273	5,662	5,117,745
2000	2,151,217	1,003,225	541,945	265,842	627,534	388,973	140,908	204,740	30,722	11,507	3,438	3,378	5,373,428
2001	2,044,325	1,063,177	512,524	14,185	681,163	387,437	140,224	212,102	33,151	147,051	2,061	2,326	5,239,726
2002	2,069,590	1,060,428	510,047	14,266	664,976	393,672	144,374	226,871	32,613	12,154	1,691	2,942	5,133,623
2003	2,180,771	1,204,167	517,458	14,227	724,373	398,411	170,449	243,443	29,244	126,913	1,282	2,620	5,613,358

Source: University of British Columbia Fisheries Center, *Landings in South China Sea* (2005 [cited 17 May 2006]); available from: http://saup.fisheries.ubc.ca/TrophicLevel/LMETaxon.aspx?lme=36&fao=0&Name=South%20China%20Sea&typeOut=4.

Note: Graph of the data presented on p. 32.

Annex 3: Major small pelagic resources in the SCS region.

No.	Species Group	Being exploited by coastal States	Potential transboundary
1.	Mackerels: - *Rastrelliger* spp. - *Scomber japonicus*		x
2.	Scads: - *Decapterus* spp. - *Selar* spp. - *Atule* spp.		x
3.	Torpedo Scad (*Megalaspis cordyla*)		x
4.	Sardines: - *Sardinella* spp. - *Dussumieria* spp. - *Sardinops* spp.		x
5.	Jacks: - *Caranx* spp. - *Trachurus* spp.		x
6.	Spanish mackerel (*Scomberomorus* spp.)		x
7.	Small tunas: - *Auxis* spp. - *Euthunnus* spp. - *Thunnus tonggol*		x
8.	Anchovies (*Stolephorus* spp.)	x	
9.	Bombay-duck (*Harpadon nehereus*)	x	
10.	Hairtails (*Trichiurus* spp.)	x	
11.	Wolf-herring (*Chirocentrus* spp.)	x	
12.	Barracudas (*Sphyraena* spp.)	x	

Annex 3: Major small pelagic resources in the SCS region. (Cont.)

No.	Species Group	Being exploited by coastal States	Potential transboundary
13.	Pomfrets: - *Formio niger* - *Stromateus* spp.	x	
14.	Flyingfishes (*Hirundichthus* spp.)	x	
15.	Mullets: - *Mugil* spp. - *Liza* spp.	x	

Source: Devaraj M. and P. Martosubroto, eds., *Small Pelagic Resources and Their Fisheries in Asia-Pacific Region*, vol. 31, *The APFIC Working Party on Marine Fisheries, First Session* (Bangkok, Thailand: RAP Publication, 13-16 May 1997).

Annex 4: Total miscellaneous pelagic fish production obtained from the Western Central Pacific (SCS, Celebes Sea, Northern Australia) by States in the SCS region.

Miscellaneous pelagic fishes (Metric tones)	Year									
Western Central Pacific	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Brunei Darussalam	0	0	0	0	0	0	33	0	8	8
Indonesia	529,887	553,832	552,655	609,120	613,957	599,107	602,807	622,073	667,742	711,970
Malaysia	145,369	129,190	136,050	155,923	126,323	188,346	214,566	197,959	205,019	186,434
Philippines	489,106	492,507	445,355	468,584	501,937	524,573	535,448	597,939	642,851	692,916
Singapore	1,175	977	858	837	909	689	574	386	307	263
Thailand	259,743	281,919	252,492	236,983	261,234	291,220	290,672	278,934	296,849	295,559
Total	**1,425,280**	**1,458,425**	**1,387,410**	**1,471,447**	**1,504,360**	**1,603,935**	**1,644,100**	**1,697,291**	**1,812,776**	**1,887,150**

Source: FAO, *FAOStat Data - Fish Production* (23 August 2005 [cited 8 May 2006]); available from: http://faostat.fao.org/faostat/form?collection=Fishes&Domain=FishCatch&servlet=1&hasbulk=0&version=ext&language=EN.

Note: Graph of the data presented on p. 34.

Annex 5: Total tunas, bonitos, billfishes production obtained from the Western Central Pacific (SCS, Celebes Sea, Northern Australia) by States in the SCS region.

Tunas, bonitos, billfishes (Metric tones)	Year									
Western Central Pacific	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
China	234,289	241,639	235,872	217,654	323,100	269,897	294,174	298,717	358,595	314,181
Indonesia	367,607	380,363	427,886	438,101	495,880	524,527	563,436	510,694	539,916	552,250
Malaysia	34,336	37,256	41,154	54,640	54,871	67,485	62,399	58,934	59,792	55,808
Philippines	303,563	307,423	304,665	335,192	349,114	356,167	366,858	353,884	430,026	507,181
Singapore	96	81	81	118	82	102	80	56	44	41
Thailand	109,737	97,605	88,832	80,559	88,312	112,532	108,027	102,617	115,161	117,820
Vietnam	0	0	0	3,200	7,400	7,000	6,500	15,800	30,900	17,500
Total	**1,049,628**	**1,064,367**	**1,098,490**	**1,129,464**	**1,318,759**	**1,337,710**	**1,401,474**	**1,340,702**	**1,534,434**	**1,564,781**

Source: FAO, *FAOStat Data - Fish Production* (23 August 2005 [cited 8 May 2006]); available from: http://faostat.fao.org/faostat/form?collection=Fishes&Domain=FishCatch&servlet=1&hasbulk=0&version=ext&language=EN.

Note: Graph of the data presented on p. 37.

Annex 715

Intentionally Omitted

Annex 716

Robert W. Smith, "Maritime Delimitation in the South China Sea: Potentiality and Challenges", *Ocean Development and International Law*, Vol. 41, No. 3 (2010)

Ocean Development & International Law, 41:214–236, 2010

ISSN: 0090-8320 print / 1521-0642 online
DOI: 10.1080/00908320.2010.499315

Maritime Delimitation in the South China Sea: Potentiality and Challenges

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The South China Sea potentially is rich in hydrocarbon resources, but until such time that there is certainty of which country has exclusive maritime jurisdiction over what part of the seabed little or no exploitation will occur. Maritime boundary delimitation or some form of joint resource development is hampered by a legacy of sovereignty disputes over miniscule pieces of territory that are scattered throughout this water body. Unfortunately, the UN Convention on the Law of the Sea does not address how to resolve sovereignty disputes. The small disputed islands have no intrinsic value other than possibly providing the territorial basis from which to make the maritime claims. Given the nationalism associated with the territorial claims, any viable long-term solution will have to address how to discount these features and the States will have to have the political will to push their sovereignty claims aside in order to move forward towards some sort of joint development arrangements.

Keywords island sovereignty disputes, Article 121 (3), maritime boundary delimitation, South China Sea

Introduction

Among the many headlines pertaining to the South China Sea during the spring and summer of 2009 were: "New Philippine Border Law Re-ignites Territorial Disputes in South China Sea,"[1] "Taiwan Reaffirms Sovereignty over South China Sea Islands,"[2] "China Tells Neighbours to Keep Off Disputed Islands,"[3] "South Korea, Vietnam: A Deal to Explore Contested Waters,"[4] and "US Reaffirms Its Rights to Operate in South China Sea."[5] So, what has happened to reignite the long-standing disputes in the South China Sea?

Pursuant to the provisions of the United Nations Convention on the Law of the Sea (LOS Convention)[6] all States that were party to the LOS Convention prior to 1999 were to make their continental shelf submission to the Commission on the Limits of the Continental Shelf (CLCS) by 13 May 2009. This pertained to all the States surrounding the South China Sea: Brunei, China, Malaysia, the Philippines, and Vietnam.[7]

An assertion to exclusive jurisdiction over the continental shelf must originate from territory, be it from a continental mainland or from an island over which a country has

Received 1 March 2010; accepted 30 March 2010.

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clear ownership. In its decision in the *North Sea Continental Shelf Cases* in 1969, the International Court of Justice (ICJ) stated that

> the rights of the coastal State in respect of the area of the continental shelf that constitutes a natural prolongation of its land territory into and under the sea exist ipso facto and ab initio, by virtue of its sovereignty over the land.[8]

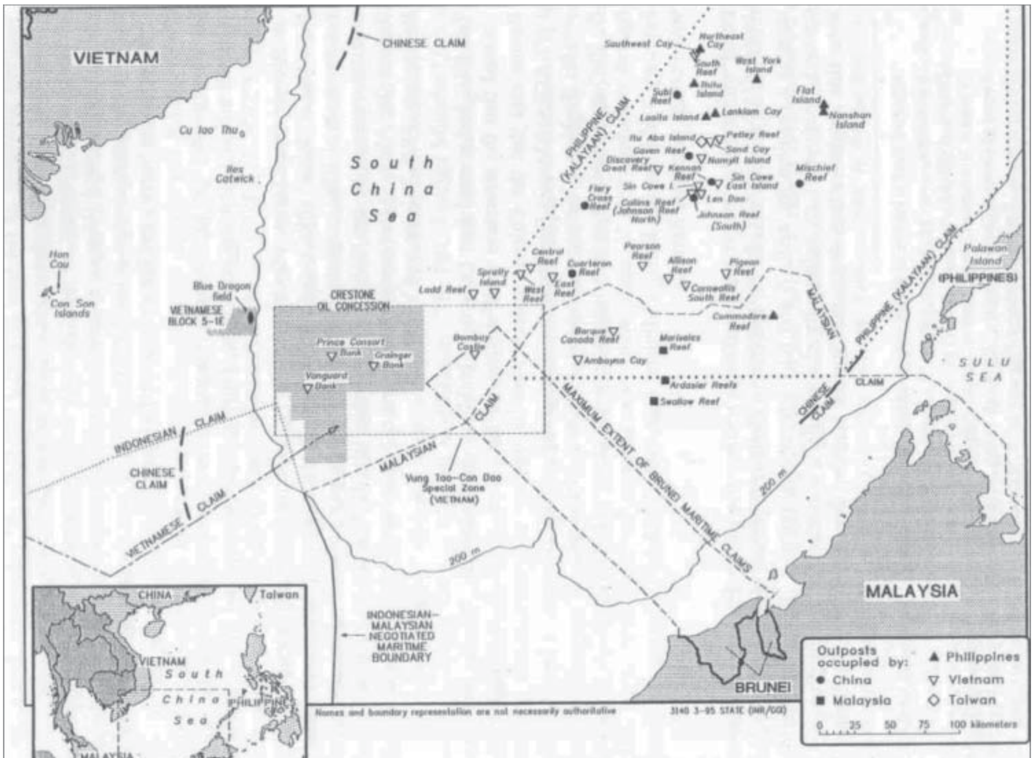
Surrounding the South China Sea are the undisputed land territories of Brunei, China, Malaysia, the Philippines, Taiwan, and Vietnam. But, scattered throughout the region are approximately 160 features—small islands, cays, and drying reefs. According to one analyst, these small features are found in a marine area covering approximately 900 kilometers by 360 kilometers (an area of 240,000 square kilometers).[9] And, in the northern part of the South China Sea, there are the Paracel Islands (or Xisha Qundao, Haoang Sa in Vietnamese) and the Pratas Islands (or Dongsha Qundao). In order to enjoy exclusive rights to the continental shelf in this area, the claimant countries believed it was important to reiterate their sovereignty claims to many, or all, of these small features that speckle the South China Sea. Jurisdiction over the water column would be affected as well.

The intent of this article is not to discuss in detail the history of the sovereignty claims or the respective legal merits of these claims. Rather, a brief overview will be provided as to the current state of affairs. Then, some thoughts will be given as to possible actions that could be taken by the countries, or even by the international community, to prevent these disputes from escalating into something more serious and to find a meaningful long-term solution(s) to the situation. In the short term, the recent public attention being given to the statements by the countries likely will prevent any meaningful discussions to occur to resolve these disputes. Possible solutions, however, may be possible in the long term when the parties realize that creative compromises will be needed to exploit the living and nonliving resources throughout much of the region.

Geographical Scope

The insular territorial features, for the purposes of analysis, can be grouped into two general areas: the Paracel Islands, in the northern South China Sea; and the many small islands and cays in the south that generically have been labeled over the years as the Spratly Islands (or Nansha Qundao), even though Spratly Island (or Nanwei Dao) is but one island.[10] It should be noted that many of these small islands, reefs, and atolls are not well surveyed and, over the years, issues have arisen as to whether or not a given feature is even above water at high tide. Knowledge of the tidal datum is important since a claim to offshore maritime jurisdiction must originate from terra firma, a piece of land that is above water at all times.

The sovereignty over the Paracel Islands is disputed between the two Chinas and Vietnam, whereas the numerous islands in the central part of the South China Sea are disputed, at least in part, among the following political entities: China, Malaysia, the Philippines, Taiwan, and Vietnam. As shown on a map produced by the U.S. Department of State, these small pieces of territory are occupied, in no particular geographic pattern, by the People's Republic of China (PRC), Malaysia, the Philippines, the Republic of China (ROC), and Vietnam. (See Figure 1.)[11] Brunei's claim to a continental shelf, based on an extension of the inshore limits created by the British in 1958, incorporates Louisa Reef (or Nantung Chiao), a feature that has a couple of rocks that are above high tide and "a navigational



Source: US Department of State, Office of the Geographer and Global Issues.

Figure 1. Claims in the South China Sea.

light maintained by Malaysia."[12] There are no communities, in the traditional sense, on these features. Several of these small pieces of territory support some people representing a particular claimant country for which food and water must be brought in. Several features have been enlarged to accommodate an airstrip for small planes to bring in supplies and people. The islands themselves essentially have no intrinsic value. It is the maritime area that possibly could be generated from them that creates the potential value. The word "possibly" is used because, under the international law of the sea (LOS Convention, Article 121(3)), it is questionable whether or not a country would have entitlement to an exclusive economic zone (EEZ) or continental shelf from these small islands, cays, rocks, and atolls.

A recent article in the *Los Angeles Times*, for example, reported on the Philippines' attempts to populate its Pagasa Island (a name in Tagalog, or Zhongye Dao, Thi Tu Island in English).[13] According to the article, in 2002 "the Philippines decided to establish a small colony of hardy civilian settlers on the island augmenting the two dozen military workers who earn special 'loneliness pay' to live on the far-off spot and bolstering its claim that possession is nine-tenths of the law." These inhabitants spend 3 months at a time on this 75-acre property. This is the only Philippine claimed possession in the South China Sea that has a year-round population. As an example of life on this island, the article states that "telephones and satellite TV are powered by generators that run only part time. Air conditioning is nonexistent, and on the hottest days many wonder why they ever came in the first place."

Geologists speculate that the South China Sea seabed could offer commercially viable oil and gas deposits. In addition to possible hydrocarbon resources, the region has productive fishing grounds. The region also provides vital shipping routes for trade to and from East Asia to all parts of the world. It is the resource potential that is the root of most, if not all, the current interest in claiming exclusive national jurisdiction over the waters and seabed of the South China Sea. This jurisdiction must emanate from undisputed territory.

For any of these countries to exploit the natural resources of the South China Sea, there is a need for certainty over jurisdiction of the maritime space. For example, oil companies will not spend large amounts of money to explore an area to determine the likelihood of oil and gas deposits if they are not certain that they will enjoy the right to exploit the resource if any are found. Oil and gas exploitation is a complicated process involving several steps, including: research and development, bidding, and securing a license for a particular location and a set time frame during which to set up the infrastructure to drill and to transport the oil either to a tanker or a land-based terminal. This process just will not happen in a disputed area.

This certainty could be brought about in one of two ways. First, there could be a clearly defined maritime boundary established by treaty, which is not contested by a third party, that delimits the national maritime jurisdiction for each State. Following the entry into force of such a treaty, the counties could proceed with exploration and exploitation on their side of the boundary in a manner in which they choose. Included in such a boundary agreement could be provisions for joint development or unitization over the resources in the boundary area, particularly for resources that may straddle the boundary. There could also be an international agreement involving the affected parties that clearly sets forth the duties, responsibilities, and rights for each State in a defined area.

Until there is an element of certainty, there will be little, if any, exploratory work conducted in the core region of the South China Sea where there are multiple overlapping claims. There appears to be some activity by the countries to enter into joint exploration agreements, for example, among China, the Philippines, and Vietnam (an agreement signed on 14 March 2005).[14] If there is work done in the disputed area, it likely will be done under the protest of the other countries.

In the South China Sea, from the Spratly Islands north, there is only one maritime treaty that has been concluded. By a treaty signed 25 December 2000 (which entered into force on 30 June 2004), China (PRC) and Vietnam delimited the territorial sea, EEZ, and continental shelf in the Gulf of Tonkin.[15] (See Figure 2.) The boundary terminates before entering into the South China Sea. The treaty contains provisions on fishing activities in the boundary area. This treaty represents China's first maritime boundary agreement concluded with any of its neighbors. Although each side had put forth historic arguments to support its respective boundary position, it appears that both sides based the agreement on the LOS Convention, which emphasizes achieving an equitable solution.[16] The treaty did not address their sovereignty disputes over the Paracel Islands or the Spratly Islands.

There may be another boundary agreement. In its Preliminary Information submission to the CLCS Brunei made the following statement:

> The maritime boundaries between Brunei and Malaysia out to 200 nautical miles have been delimited by two series of agreements.
>
> First, the territorial sea and continental shelf between Brunei and Malaysia were delimited as far as the 100 fathom isobath by two 1958 British Orders in Council.

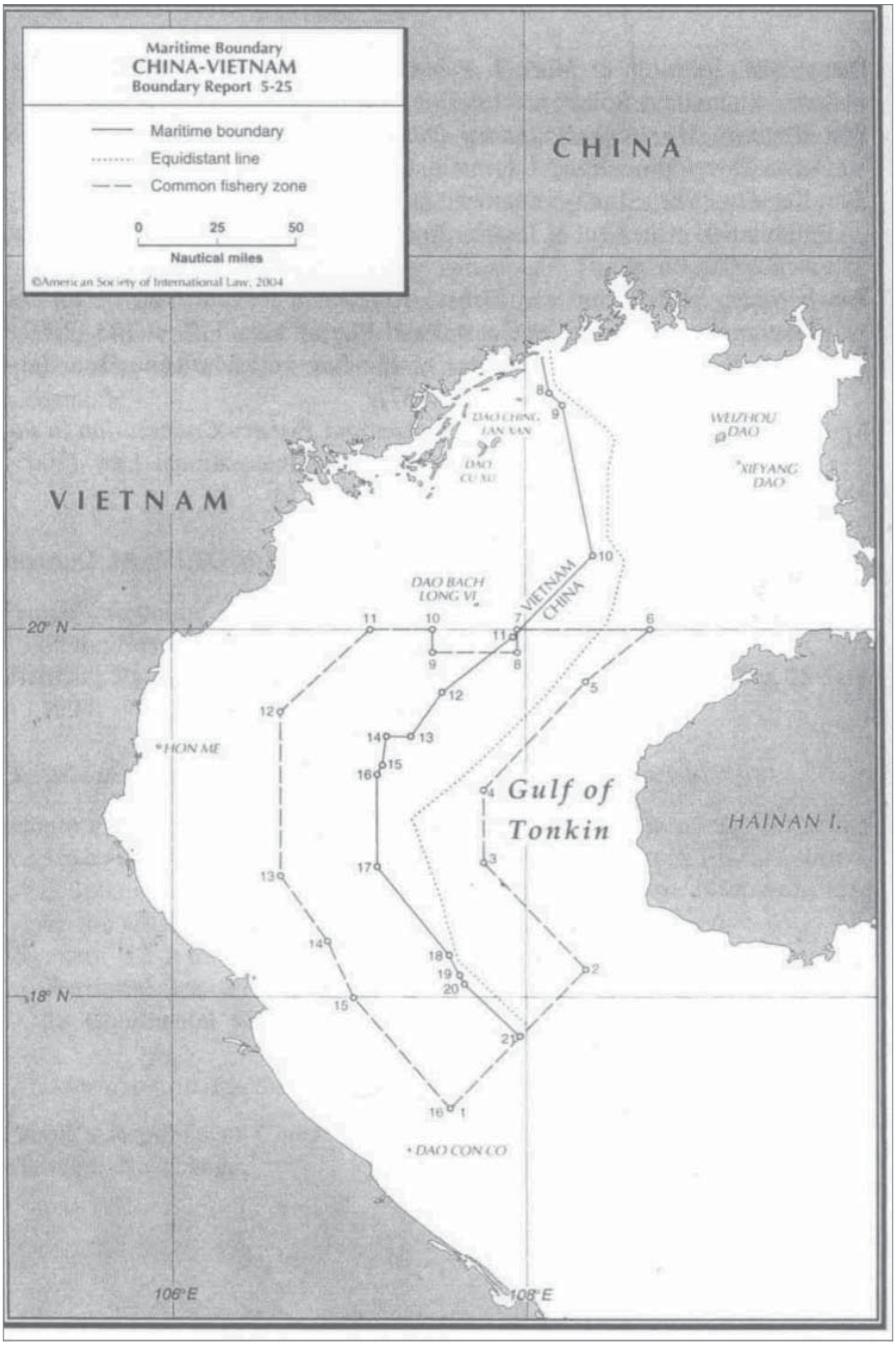


Figure 2. China-Vietnam maritime boundary. (*Source:* David Colson and Robert Smith (eds), International Maritime Boundaries, Volume V, American Society of International Law, 2005, p. 3754. Reprinted with permission.)

> Second, the territorial sea, the Exclusive Economic Zone and the continental shelf out to a distance of 200 nautical miles were delimited by an Exchange of Letters dated 16 March 2009.[17]

The substance and legal validity of the 16 March Exchange of Letters between Brunei and Malaysia are unclear at this point. Does the exchange of letters constitute a maritime boundary agreement with specific lines delimiting, or merely an agreement on intent to reach an agreement? In its joint submission with Vietnam to the CLCS, Malaysia, for instance, did not show boundaries with Brunei beyond the 100-fathom depth contour (e.g., what was established by the British in 1958).[18] Brunei, on the other hand, in 1988 legislation published what it unilaterally believed to be its maritime boundaries with Malaysia.[19]

The LOS Convention

The South China Sea coastal States that are members of the United Nations are all party to the LOS Convention. Table 1 lists the dates on which each State became party.

The LOS Convention provides the bases by which States have entitlement to offshore areas. It addresses all aspects associated with national maritime claims: baselines, territorial sea, contiguous zone, EEZ, continental shelf, and bilateral boundaries (territorial sea, EEZ, and continental shelf). With the exception of baseline claims, of which several States in this region have enacted laws that exceed the provisions of the LOS Convention, the laws implemented by these coastal States, for the most part, have been made in accordance with the Convention. It is not the place here to review in detail all the national maritime claims. It should be pointed out, however, that should any of the States enter into boundary talks, then certain straight baseline claims could complicate negotiations.

One piece of national legislation worth citing is the 2009 Philippine law that established its archipelagic straight baselines.[20] Prior to this law, in 1961, the Philippines claimed straight baselines around its islands, a claim that clearly exceeded the provisions of international law.[21] The 1961 claim was based on the limits set forth in Article III of the Treaty of Paris Between the United States and Spain of 10 December 1898.[22] The 2009 law that the Philippines enacted is in accordance with the LOS Convention provisions on archipelagic straight baselines. It meets the water:land ratio and the length of the baselines are within the guidelines set forth in the LOS Convention.[23]

Knowing the political sensitivities surrounding the multiple claims to the Spratly Islands, the Philippines Government purposely did not include any of those contested

Table 1
Dates the South China Sea States became party to the 1982 United Nations Convention on the Law of the Sea

State	Date
Brunei	5 November 1996
China	7 June 1996
Malaysia	14 October 1996
Philippines	8 May 1984
Vietnam	25 July 1994

islands within its archipelagic claim. Even so, prior to passing the archipelagic straight baseline bill into law, it took the Philippines Congress months of debate over whether or not the law would adversely affect the Philippines position with regard to its neighbors on the ongoing sovereignty dispute over the South China Sea islands. As the clock was ticked toward 13 May, the Philippines wanted to use the archipelagic straight baselines as part of its continental shelf submission to the CLCS.[24] The final law did state that the islands of Kalayaan and Scarborough Shoal were "a regime of islands under the Republic of the Philippines."[25]

The Philippine law met with protests from China, Taiwan, and Vietnam, which added to the 2009 turmoil of reiteration of claims, counterclaims.[26]

The LOS Convention and Island Sovereignty Disputes

As discussed in one study, disputes involving islands fall under two major categories:[27]

- a dispute over the sovereignty of the island(s) itself; and,
- a dispute over the affect the island(s) may have on the delimitation of adjacent maritime space.

There are important distinctions to be made between these two categories in the relationship between the particular type of dispute and the role the LOS Convention may, or may not, have on bringing about resolution. Whereas the LOS Convention addresses boundary delimitation situations where there are overlaps between respective territorial seas (Article 15), the EEZ (Article 74), and the continental shelf (Article 83), there are no provisions that address how to resolve sovereignty disputes. While the LOS Convention provides for several international bodies to adjudicate disputes, and for the CLCS to give recommendations for national limits to continental shelves beyond 200 nautical miles, there is nothing in the body of the Convention that deals with sovereignty issues. States have turned to various forms of dispute settlement to resolve sovereignty disputes, but these have been bilateral agreements between the claimants and not necessarily tied to the LOS Convention.

As noted above, the application of the LOS Convention is premised on the assumption that a particular State has undisputed title over the territory from which the maritime zone is claimed. Any attempt to conduct activities in a disputed offshore marine area, or to enforce against a country having a competing claim, likely will be met with diplomatic protests and perhaps even confrontation.

Article 121 of the LOS Convention

An article in the LOS Convention that could affect a possible solution to the Spratly Islands sovereignty disputes is Article 121, on the regime of islands, and specifically Article 121, paragraph 3 which addresses "rocks." First, Article 121, paragraph 1 states that an island "is a naturally formed area of land, surrounded by water, which is above water at high tide." Paragraph 2 of this article states that, with the exception of the paragraph 3 provision, an island is entitled to a territorial sea, contiguous zone, EEZ, and continental shelf. Paragraph 3 of Article 121 states:

> Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf.

The intent of the negotiators of this provision was to prevent a country from claiming a large area of ocean space and seafloor based on a very small feature located off its coast in a mid-oceanic location. For example, a mere point of a feature above water at high tide could generate a 200-nautical-mile zone of 125,600 square nautical miles (430,796 square kilometers) if there were no overlap with a neighboring State. The drafters of the LOS Convention believed this to be unfair as that very small piece of territory would receive a disproportionate amount of ocean space and seafloor, given its miniscule size. Thus, Article 121, paragraph 3 was drafted and accepted.

However, what does this paragraph mean and how can its terms be applied in the real world? When this language first appeared, as Article 132 of Working Paper 8, in the Informal Single Negotiating Text in May 1975[28] (the first text produced during the Third United Nations Conference on the Law of the Sea), the following basic problems of interpretation and definition were immediately identified:

> (1) what constitutes a "rock" as a form of an island? And (2) what is meant by "cannot sustain human habitation or economic life of their own"?[29]

Various authors and organizations have attempted to place an area measurement to the various terms. Hodgson (a former geographer of the U.S. Department of State), for example, when analyzing rocks on the question of "special circumstances" in relation to maritime boundary delimitation, characterized islands as follows:

1. Rocks, less than .001 square miles 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.[30]

In the Hodgson system, those features with an area of .001 square miles or less, or 2,590 square meters or less, would be a "rock." If this size is what the negotiators had in mind, then this type of island would measure about 51 meters on a side or, if circular, have a radius of approximately 28.7 meters.[31] Unfortunately, the LOS Convention is silent on size. There is no objective means by which to measure a given geographical feature to determine that it is an Article 121, paragraph 3 rock.

The question of what is meant by "cannot sustain human habitation or economic life of their own" is equally void of any objective test in the LOS Convention. There is no guidance given to clearly and unequivocally say a certain feature meets that statement. The definition, for example, does not refer to uninhabited rocks, but rather to uninhabitable rocks. What is now uninhabited could possibly sustain human habitation should people care to live there, and if people or countries are willing to import potable water and food.[32]

On the idea of having an economic life of its own, does having a lighthouse (manned or not manned) give the feature an economic life since it has value to shipping? If a feature is an important nesting ground for marine life or birds, is that an economic life? If the feature has a natural beauty that attracts tourists in boats (thus generating income) to view it from the sea, is that an economic life? It is possible that the drafters of the LOS Convention may have had in mind the idea that if potable water did not exist on the feature or if there was no soil to grow anything, then that was an Article 121, paragraph 3 rock. But, this clarification or objective standard is not written in the Convention.

Hodgson and Smith conducted an analysis of where Article 121, paragraph 3 rocks may possibly exist worldwide.[33] If the Hodgson size criterion were accepted, then most of these small features would be located immediately offshore coastal States. As an example, thousands exist along the coasts of Alaska, Chile, Australia, China, Korea, and Cuba. Few, if any, of these features if discounted with respect to delimiting the State's EEZ or continental shelf would adversely impact that State's entitlement to those zones. Other non-Article 121, paragraph 3 features nearby would be influential. In reality, most of these coastal States would opt to enclose these small features within a straight baseline system and the overall issue would be moot.

A few noncoastal, mid-oceanic rocks do exist that would have a significant impact on adding ocean area to a country's marine jurisdiction. Perhaps the most famous rock and one in which the negotiators had in mind when crafting Article 121, paragraph 3 is Rockall. This is a small (approximately 624 square meters; 0.000241 square miles) feature owned by the United Kingdom that is situated about 162 nautical miles northwest of Scotland. The United Kingdom is the only State that has made a public statement that a feature belonging to them, Rockall, is an Article 121, paragraph 3 rock and therefore does not enjoy an EEZ or continental shelf.[34] Moreover, the United Kingdom does claim a 12-mile territorial sea from Rockall's baseline.

Other possible rocks cited by Hodgson and Smith are Maro Reef, in the Hawaiian island chain of the United States, although larger islands and reefs are nearby thereby minimizing the adverse impact on the U.S. EEZ area if Maro Reef was not used; and Brazil's St. Peter and St. Paul's Rocks (approximately 0.0016 square miles) and New Zealand's L'Esperance Rock (about 0.01875 square miles), which are a bit larger than the Hodgson size criterion. Those authors' recommendation that, due to the difficulty in interpreting and applying this provision,[35] it could be deleted from the negotiating text was ignored and Article 121, paragraph 3 exists today.

The difficulties associated with applying this provision continue. One feature receiving recent attention is Japan's Okinotorishima Atoll. This feature is but a seamount breaking the ocean's surface. The Japanese Government has built a wall around this natural feature, and enclosed it as a tomb, in order to preserve it from disappearing from natural forces.[36] This is a good example of a singular feature generating a 125,600-square-mile EEZ. The PRC has protested Japan's right to claim a 200-mile EEZ and continental shelf from Okinotorishima.[37] South Korea also has submitted a letter to the CLCS objecting to Japan's use of the feature in its continental shelf submission.[38] At the 2009 Meeting of States Parties to the LOS Convention, China attempted to get the issue of Article 121, paragraph 3 on the agenda, but it was unsuccessful.[39]

Article 121, Paragraph 3 and the South China Sea

How may an application of Article 121, paragraph 3 impact national maritime claims in the South China Sea and, subsequently, maritime boundary delimitations? One analyst has noted that, while there may be more than 170 features in the South China Sea, most are submerged banks and shoals and perhaps only about 36 tiny islands are above water at high tide.[40] The largest of these islands is Itu Aba (or Tai-Ping, occupied by Taiwan), which is approximately 1.4 kilometers long and 400 meters wide (0.56 square kilometers or 0.163 square nautical miles). This size would fall into the "islet" category under the Hodgson tabulation. Thitu Island (or Zhongye Dao, Pagasa Island in Tagalog), occupied by the Philippines, is the second largest island with an area of approximately 0.27 square kilometers. It is likely that most of these atolls, while small in comparison to most islands in the world, would be larger than a "rock" using most definitions.

One could certainly question whether these small features, which are scattered throughout the south central part of the South China Sea, can "sustain human habitation or economic life of their own." Granted, even if some of the 36 features (be they named islands, atolls, islets, etc.) have people on them, food and water must be transported in from the claimant country. For many of these islands, it has become difficult to distinguish what is the natural feature and what is man-made. Several of the countries have built up an island by importing sand, gravel, and cement to create airstrips, harbors, and other installations. Under the LOS Convention man-made structures, unless a part of harbor works, cannot be used as a baseline from which to determine offshore limits.[41]

An interesting situation is developing with regard to China's position toward Article 121, paragraph 3 rocks. It has protested Japan's use of Okinotorshima as a basepoint from which to claim an EEZ and continental shelf. In a note dated 9 February 2009, China stated that it "wishes to draw the attention of the members of the Commission, the States Parties to the Convention as well as Members of the United Nations to the inconformity with the Convention with regard to the inclusion of the rock of Oki-no-tori in the Japanese Submission."[42] Yet, if China claims all the islands in the Spratly group with a view to claiming EEZs and continental shelves from them, then there must be some inconsistency in its position on Article 121, paragraph 3.

Continental Shelf Submissions and the South China Sea

Table 2 shows the dates when countries either made their submission or preliminary information to the CLCS with respect to their proposed outer limit of the continental shelf beyond 200 nautical miles. Malaysia,[43] the Philippines,[44] and Vietnam[45] all have made partial submissions, while Brunei[46] and China[47] have provided the CLCS with preliminary information. With their preliminary information submissions, neither Brunei nor China provided any maps or geographic coordinates for their continental shelf limits in the South China Sea. The Philippines' partial submission, concerned its continental shelf limits for the Benham Rise region, to the east of the Philippine islands. No limits were put forward for its South China Sea continental shelf.

Malaysia and Vietnam have made a joint submission for their respective continental shelves in the southern part of the South China Sea. As expected, this action generated several diplomatic notes to the United Nations from China,[48] Malaysia,[49] and Vietnam.[50] China protested the joint submission and reasserted its sovereignty over all the islands in the South China Sea. The PRC letter included a map that showed the dashed lines around the perimeter of the South China Sea indicating it claimed all the islands. In its note, China stated that it

Table 2
Continental shelf actions by the South China Sea States

State	Date of submission	Date of preliminary information	Comments
Brunei		12 May 2009	
China		11 May 2009	
Malaysia	6 May 2009		South China Sea; joint with Vietnam
Philippines	8 April 2009		Benham Rise region
Vietnam	6 May 2009		South China Sea; joint with Malaysia
	7 May 2009		In "North Area"

> has indisputable sovereignty over the islands of 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. . . . The above position is widely known by the international community.[51]

On 8 May 2009, Vietnam submitted to the Secretary-General a note rejecting China's claims as having no "legal, historical, or factual basis."[52] Vietnam reiterated its "indisputable sovereignty" over the Hoang Sa (Paracels) and Truong Sa (Spratly) archipelagoes. On 20 May 2009, Malaysia submitted a note to the United Nations in which it acknowledged that the "Joint Submission is made without prejudice to the question of delimitation of the continental shelf between States with opposite or adjacent coasts."[53] Malaysia stated that it had informed China of the joint submission prior to it being submitted to the United Nations.

Although the ROC is unable to make a formal submission or present preliminary information to the CLCS or to deliver a diplomatic note to that body or to the United Nations, its Ministry of Foreign Affairs issued a formal statement regarding Taiwan's position toward the submissions made by the countries surrounding the South China Sea. This statement is found in Appendix 1.

The CLCS has no authority to make recommendations on bilateral maritime boundaries. Thus, it has to defer any recommendations on the limits of the continental shelf where disputes exist. As a result, the entire South China Sea will be off limits to this body for years to come. Resolution to the numerous issues in this region will have to be found elsewhere.

Allocation Lines: Not Boundaries or Claim Limits

There are several "lines" that have appeared on maps and charts over the years that have caused confusion as to what exactly is being claimed in the South China Sea. The map that China attached to its 2009 note in which it protested the Joint Submission by Malaysia and Vietnam is one example.[54] (See the PRC map in Hu's article.[55]) This map has created confusion among scholars and Governments for decades. One analyst provided a succinct history of this line that first appeared on Chinese maps in 1947.[56] This dashed line has been labeled a "historic claim line" or "traditional sea boundaries line."[57] What is clear is that the Chinese Government has never published a law or decree giving these dashed lines any domestic legal significance.

These dashed lines that extend around the perimeter of the South China Sea can best be labeled as lines of allocation. The intent of these lines is to surround those islands and cays that China claims. It does not apply to the waters or seabed within these dashed lines. Any sovereign or jurisdictional rights must come from ownership of the islands, not from the dashed lines. The dashed lines do not imply any maritime boundary claim by China. Thus, these lines that have appeared on Chinese maps for more than 60 years merely reflect China's long-standing claim of sovereignty over all the geographical features within the dashed lines in the South China Sea. They have no significance in resolving any maritime boundary dispute.

Another set of lines that has caused confusion in the South China Sea has been the Philippine "treaty limits" and the "Kalayaan claim" line. (See Figure 3.) Treaties between Spain and the United States (1898 and 1900) and between the United Kingdom and the United States in 1930 defined what was to become the Republic of the Philippines in 1946.[58] The limits established by these treaties were lines of allocation; inside the lines defined in these treaties were the Philippine islands. The limits did not establish any sovereignty,

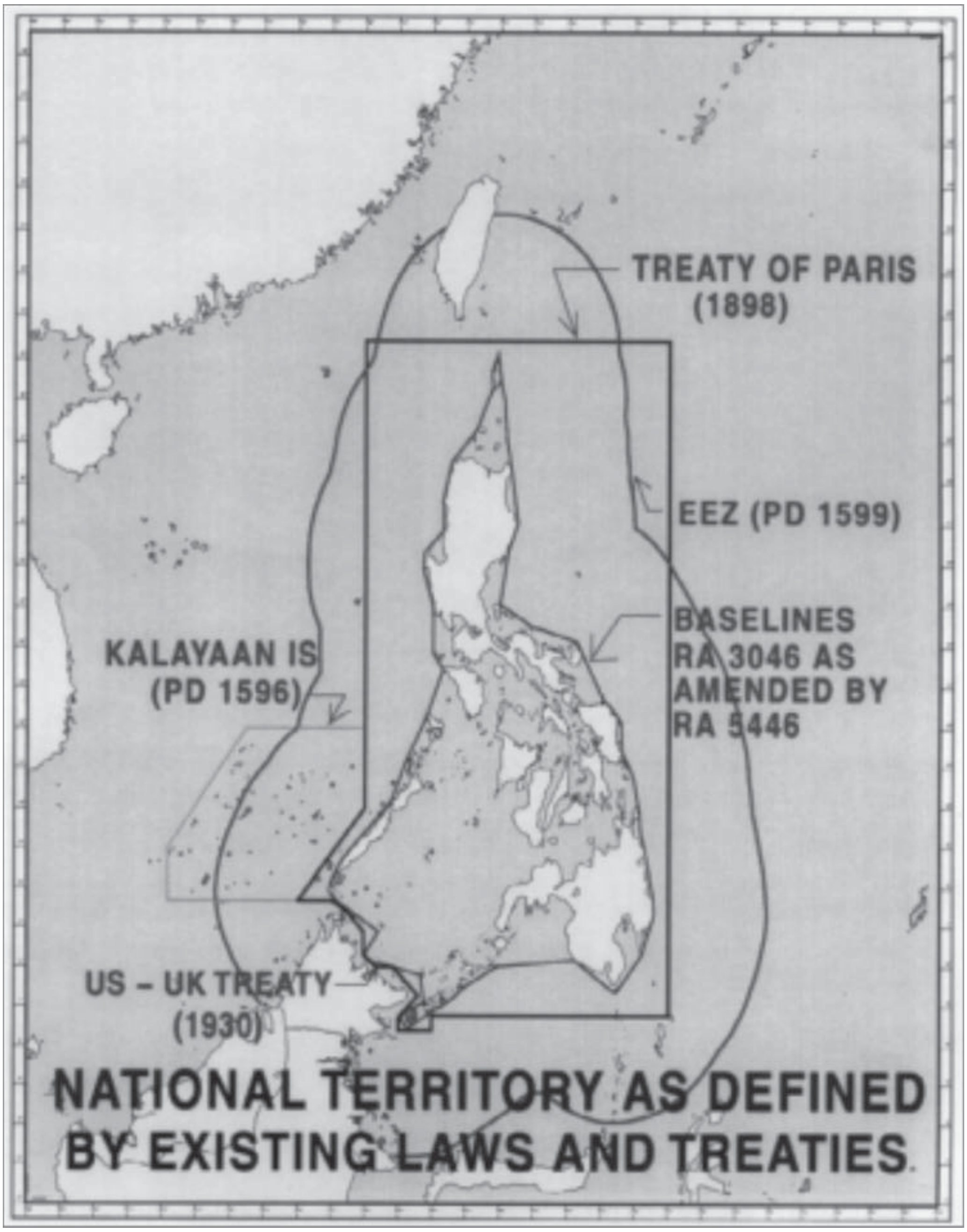


Figure 3. Philippine claims: Kalayaan Claim, Treaty of Paris and Archipelagic Straight Baselines.

sovereign rights, or exclusive jurisdiction over the waters, seabed, or air space. However, subsequent to its independence, the Philippines enacted laws that have treated the waters inside these limits as Philippine territory. It has been unclear as to whether they considered them internal waters or territorial seas.

Except for the area in the southwest, the "treaty limits" is essentially a rectangle that Spain and the United States found convenient in late nineteenth century to define the Philippine territory. There is no relationship, under modern international law of the sea principles, of this treaty box to maritime zones. During, and following, the Third United Nations Conference on the Law of the Sea, the Philippines Government knew it had a dilemma as to how to disavow the treaty limits in favor of maritime limits drawn in accordance with the law of the sea. It is a situation where the public had come to believe that Philippine sovereignty extended to these limits.

In 1961, the Philippines enacted its territorial sea law. It was based on the Treaty of Paris limits that resulted in the outer limit varying, up to about 285 nautical miles from the coast. The United States protested this claim saying, in part: "[I]ts purpose is to reduce to Philippine sovereignty large areas of sea which are regarded by the United States and all other nations as part of the High Seas."[59]

In 1984 when the Philippines deposited its instrument of ratification with the United Nations becoming party to the LOS Convention it appended a Declaration that stated, in part:

> By signing the Convention the Government of the Republic of the Philippines shall not in any manner impair or prejudice the sovereign rights of the Republic of the Philippines under and arising from the Constitution of the Philippines.[60]

In January 1986, the United States protested this Declaration stating, in part, that,

> with respect to other States and the nationals of such other states, the rights and duties of states are defined by international law, both customary and conventional. The rights of States under international law cannot be enlarged by their domestic legislation, absent acceptance of such enlargement by affected States.[61]

As of mid-2009, the Philippines had not retracted its claim based on the treaty limits. It did not have to address this discrepancy between the international law of the sea and its interpretation of earlier treaties when it made its partial continental shelf submission to the CLCS.[62] That area applied only to the Benham Rise, to the northeast of Luzon. The continental shelf can be considered distinct from its EEZ claim, made in 1978. However, at some point the Philippines will have to distinguish its maritime jurisdiction claimed under the LOS Convention and those limits emanating from the earlier treaties, which have no relevance to modern-day international law.

The other non-LOS–related limit found on Philippine maps is the Kalayaan line.[63] This is also a line of allocation based on a claim first asserted by Thomas Cloma, a Philippine citizen, in 1956 to islands in the South China Sea, adjacent to the Philippine islands. Cloma came up with the name Kalayaan (Freedomland). The claim included about 33 islands and reefs, but not Spratly Island itself, which is located to the west of Kalayaan. The Philippine Government has not used this limit for any official claim.

Malaysia's Continental Shelf Claim

Malaysia is the only claimant that has produced an official map depicting its continental shelf claim, at least as it was defined in 1979 when the map was produced. There is no Malaysian law or decree associated with the map that depicts Malaysia's continental shelf limit. This map was produced following a 1978 visit by Malaysian troops to some of the southern South China Sea islands. In 1983, Malaysian troops again went to the area and landed on Swallow Reef. Malaysia has maintained a base there since that time. It is unclear how Malaysia views that 1979 map in light of the LOS Convention and its Joint Submission with Vietnam in May 2009.

Thoughts on South China Sea Boundary Delimitations

It may be premature to title this section "Thoughts on Possible Solutions" because it seems that, in 2009, tensions have been raised as a result of the 13 May continental shelf submission deadline. Thus, it is instead titled "Thoughts on South China Sea Boundary Delimitations." Each country likely is reflecting on what next steps should and can be taken. There is much at stake: natural resources, national pride, foreign relations, and regional stability. If compared to land-based territorial disputes elsewhere in the world, the claims made by each of these countries to these dot-like features are very recent and somewhat weak. It is questionable exactly when some of these islands were first occupied, if there has been continuous occupation, and if some of these islands are even islands at all (e.g., above water at high tide). The charting and surveying of many of these islands are quite poor.

The real boom in asserting sovereignty claims to these features came only in the mid-1960s when reports were published suggesting a distinct possibility that hydrocarbons may exist in the seabed underlying the South China Sea. A few years later, the 200-nautical-mile EEZ became an internationally accepted regime giving coastal States the right to claim exclusive jurisdiction over economic activities (e.g., fishing and exploiting the seabed resources). Thus, control and sovereignty over any piece of territory meant large areas of ocean space and seabed.

Reviewing the status of the claims, statements, and actions of each party shows that only the two Chinas and Vietnam have claimed all the islands and reefs in the South China Sea. The Philippines claims most, but not all, of the islands. It does not claim the Paracel Islands or Spratly Island itself and several islands in that immediate vicinity. Malaysia asserts sovereignty over only a few southern islands and Brunei's claim (an extension of its 1958 boundaries seaward) includes perhaps one small reef and continental shelf in the southern area.

How should these countries proceed? In the past year or so, there have been attempts by certain countries to enter into joint survey projects. The Philippines and China expressed an interest in jointly conducting survey work. South Korea and Vietnam have announced a similar plan to jointly survey a part of the South China Sea. While cooperation is a good thing, what happens if any of these surveys discover a worthy-looking geological area? Tensions would likely arise, competing claims reiterated, and so forth. It might be a wiser step for the States to put in motion a reasonable plan to identify and agree on certain areas where particular countries will jointly work before the next Persian Gulf is discovered in their own backyard.

A starting proposal would be "to agree to disagree" on who owns all the small islands in the South China Sea and to ignore the features. It is highly unlikely any boundaries can be negotiated in the near future. It is possible that partial boundary treaties may be concluded, delimiting lines on the fringe of South China Sea such as short continuation of the China-Vietnam boundary from the Gulf of Tonkin. However, the States need to look for ways to carve up, or jointly develop, the region without using any of these small islands. As can be seen in Figure 1, if 200-nautical-mile limits were drawn from the "mainlands," ignoring the small islands in the South China Sea, then there would be a donut hole in the middle.

Many law of the sea experts would argue that most, if not all, the islands in the South China Sea should be considered Article 121, paragraph 3 rocks, and thus should not receive any EEZ or continental shelf. Even if the argument is persuasive that a given island is an island and not a rock, it is likely that the feature may be discounted, or given less than full consideration, in a maritime boundary delimitation. When reviewing the State practice of how States have negotiated maritime boundary treaties, it becomes apparent that a key element is one of geographic balance between the coastlines of two States. In situations where an island of one State is situated in front of the other State, it often is given less than full consideration. This would be the situation in the South China Sea.

One long-term solution scenario would be to identify areas of the South China Sea over which only two countries dispute the area. For example, in the north, the two Chinas and Vietnam are the only claimants to the Paracel Islands. To the north and east of the Paracel Islands, the area would involve only the two Chinas and the Philippines.

The interests of Brunei and Malaysia would be kept to some designated area in the southern part of the South China Sea. The possibility exists that, depending on how Malaysia and Brunei resolve their dispute, Brunei's maritime jurisdiction may not even reach the area where the other States claim. The tricky part comes in the center of the South China Sea, and here the players would be China, Taiwan, Vietnam, and the Philippines. Proximity as a criterion in any proposed solution puts China and Taiwan at a disadvantage because most of the disputed parcels of territory are closer to Vietnam and the Philippines. But, a tri- or quadruple-State commission (China-Taiwan-the Philippines-Vietnam) could be established to create a development strategy by which shares in certain areas could be based on nondistance criteria.

To begin this process, the States may wish to call in an outside entity (an organization, Government, group of experts) which could offer nonbinding advice and recommendations on how to allocate the area to the respective States, or to create joint development schemes. In addition to developing the nonliving resources, other aspects requiring cooperation among the parties would be: fishing, navigation, surveying, weather alerts (tsunamis), environment protection, and so forth. The opportunities are endless for these countries to work together and to enjoy the fruits of what the waters and seabed have to offer. The political will of all entities involved needs to be present for any scenario to have a chance of succeeding.

Postscript: The View of the United States

The United States has a vested interest in a stable East Asian region. All the countries are trading partners of the United States, and key commercial and military shipping plies the waters of the South China Sea. On 15 July 2009, Ambassador Scot Marciel, deputy assistant secretary of state for East Asian and Pacific affairs, appeared before the Senate Foreign Relations' East Asian and Pacific Affairs Subcommittee to give a statement on "Maritime Issues and Sovereignty Disputes in East Asia."[64] The fact that Ambassador Marciel appeared before this subcommittee to present the State Department's views on the South China Sea signals the importance that the United States gives to this region. The thrust of the statement is that the United States has vital interests in the region, that stability and peace here serves the entire international community including U.S. interests. Marciel referred to the 2002 Declaration on the Conduct of the Parties in the South China Sea[65] as a key document with useful principles such as that all claimants should "resolve disputes . . . by peaceful means" and "exercise self-restraint." Ambassador Marciel has put the U.S. Congress on notice as well as the countries surrounding the South China Sea that the U.S. Government places a high priority on this region and that it urges the claimant States to seek a peaceful resolution to the dispute claims.

Notes

1. Heda Bayron, "New Philippine Border Law Re-ignites Territorial Disputes in the South China Sea," 17 March 2009, Voice of America, available at www.voanews.com/english/archive/2009-03.

2. Central News Agency, 9 May 2009, www.etaiwannews.com/etn/print.php. (This URL no longer exists.)

3. Reuters, 12 May 2009, available at www.reuters.com/article/oilRpt/idINPEK14634720090512.

4. 2 June 2009, Stratfor Global Intelligence, available at www.us.mc01g.mail.

5. Gabe Joselow, 16 July 2009, available at www.voanews.com/english/2009-07-16.

6. 1833 *U.N.T.S.* 397.

7. Currently the "two Chinas," the Republic of China (ROC, or Taiwan) and the People's Republic of China (PRC, or mainland China), possess the same position on their common claims in the South China Sea. It is noted that there are special international issues pertaining to the role Taiwan can play in international organizations and conventions. Since both Chinas make the same claims, references in this article to "Chinese claims" apply to both the ROC and PRC.

The "China" claim to islands, rocks, and shoals was first claimed, and illustrated, in a 1946 map produced by the Government of the ROC's Department of the Territories and Boundaries of the Ministry of the Interior. It designated its claim to the territories by depicting a "U-shaped" discontinuous line around the perimeter of the South China Sea. After 1949, the PRC has succeeded the ROC's claims to the South China Sea islands with a similar U-shaped discontinuous line on maps. The ROC has maintained its claims. See the 1946 ROC Map and the recent PRC Map attached to its 2009 Note CML/17/2009 in Nien-Tsu A. Hu, "South China Sea: Troubled Waters or a Sea of Opportunity?" in this Special Issue.

8. *North Sea Continental Shelf Cases*, [1969] *I.C.J. Reports*, 22 (emphasis added).

9. Daniel J. Dzurek, "The Spratly Islands Dispute: Who's on First?" *Maritime Briefing*, Vol. 2, No. 1, International Boundaries Research Unit, 1996, 1.

10. Spratly Island is located at approximately 8°38.5′ N, 111°55′ E and is situated in the southwest portion of these features. Vietnam occupies the island.

11. The map can be found in Dzurek, supra note 9, at 38.

12. *Ibid.*, at 48.

13. John M. Glionna, "Squatters in Paradise Say It's Job from Hell," 26 July 2009, available at www.latimes.com/news/nationworld/world/la-fg-paradise-prison26-2009jul26,0,7243566.story.

14. Tripartite Agreement for Joint Marine Seismic Undertaking in the Agreement Area in the South China Sea, 2004. See Nguyen Hong Thao and Ramses Amer, "A New Legal Arrangement for the South China Sea," *Ocean Development and International Law* 40 (2009): 339.

15. For the treaty and analysis, see T. L. McDorman, "People's Republic of China-Vietnam," in *International Maritime Boundaries*, Vol. V, eds. David A. Colson and Robert W. Smith (Leiden, the Netherlands: Martinus Nijhoff, 2005), 3745–3758.

16. *Ibid*., at 3746.

17. Brunei Darussalau, Preliminary Submission Concerning the Outer Limits of the Continental Shelf, May 2009, available at the Web site of the Commission on the Limits of the Continental Shelf at www.un.org/Depts/los/clcs_new/clcs_home.htm.

The North Borneo (Definition of Boundaries) Order in Council, 1958, Statutory Instruments 1958 No. 1517; and the Sarawak (Definition of Boundaries) Order in Council, 1958, Statutory Instruments 1958 No. 1518.

18. Malaysia-Vietnam, Joint Submission to the Commission on the Limits of the Continental Shelf in Respect of the Southern Part of the South China Sea, Executive Summary, May 2009, available at the Web site of the Commission, supra note 17.

19. R. Haller-Trost, "The Brunei-Malaysia Dispute over Territorial and Maritime Claims in International Law," *Maritime Briefing*, Vol. 1, No. 3, International Boundaries Research Unit, 1994, 4–5.

20. The Philippines, 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, and for Other Purposes, approved 10 March 2009, available at the Web site of the Philippine Law and Jurisprudence Database at www.lawphil.net/statutes/repacts/ra2009/ra_9522_2009.html (accessed 8 August 2009). See also the Philippines, "PGMA Signs Baselines Bill into Law," 11 March 2009, available at the official Government portal of the Philippines at (accessed 8 August 2009).

21. See J.Ashley Roach and Robert W. Smith, *United States Responses to Excessive Maritime Claims*, 2d ed. (The Hague: Martinus Nijhoff, 1996), 216–217.

22. Treaty of Peace Between the United States and Spain, 10 December 1898, 187 *Consolidated Treaty Series* 100.

23. It should be noted, however, that specific archipelagic sea-lanes have not been designated by the Philippines.

24. The Philippines, A Partial Submission of Data and Information on the Outer Limits of the Continental Shelf of the Republic of the Philippines Pursuant to Article 76(8) of the United Nations Convention on the Law of the Sea, Executive Summary, May 2009, available at the Web site of the Commission, supra note 17.

25. An Act to Amend Republic Act No. 3046, supra note 20, sec. 2.

26. See People's Republic of China, Letter to Secretary-General of the United Nations, Doc. CML/12/2009, New York, 13 April 2009, available at the Web site of the UN Division on the Law of the Sea at www.un.org/Depts/los/LEGISLATIONANDTREATIES/Statefiles/Phil.htm; Vietnam, Permanent Mission to the United Nations, "Vietnam's Response to Philippine President's Signing of Baseline Act," 13 March 2009, available at www.vietnam-un.org/en/news.php?id=77&act=print; and Bayron, supra note 1.

27. Robert W. Smith and Bradford L. Thomas, "Island Disputes and the Law of the Sea: An Examination of Sovereignty and Delimitation Disputes," *Maritime Briefing*, Vol. 2, No. 4, International Boundaries Research Unit, 1998.

28. Informal Single Negotiating Text, Doc. A/Conf.b2/WP. 8, 7 May 1975, in Third United Nations Conference on the Law of the Sea, *Official Records*, Vol. IV (New York), 170–171.

29. Robert D. Hodgson and Robert W. Smith, "The Informal Single Negotiating Text (Committee II): A Geographical Perspective," *Ocean Development and International Law Journal* 3 (1976): 230.

30. Robert D. Hodgson, "Islands: Normal and Special Circumstances," in *Law of the Sea; Emerging Regime of the Oceans, Proceedings of the Law of the Sea Institute*, eds. J. K. Gamble and G. Pontecorvo (Cambridge, MA: Ballinger, 1974), 150–151.

31. *Ibid.*, at 231.

32. It is noted in Hodgson and Smith, supra note 29, at 231, that there are many mainland coastal areas and larger islands that are uninhabited due to arid conditions, but they clearly can generate an EEZ or continental shelf.

33. *Ibid.*, at 232.

34. See D. H. Anderson, "British Accession to the UN Convention on the Law of the Sea," *International and Comparative Law Quarterly* 46 (1977): 778.

35. Hodgson and Smith, supra note 29, at 233.

36. See, generally, Yann-huei Song, "Okinotorishima: A 'Rock' of an 'Island'? Recent Maritime Boundary Controversy Between Japan and Taiwan/China," in *Maritime Boundary Disputes, Settlement Processes, and the Law of the Sea*, eds. Seoung-Yong Hong and Jon M. Van Dyke (Leiden, the Netherlands: Martinus Nijhoff, 2009), 151–161.

37. People's Republic of China, Letter to the Secretary-General of the United Nations, Doc. CML/2/2009, New York, 6 February 2009.

38. Korea, Letter to the Secretary-General of the United Nations, Doc. MUN/046/09, New York, 27 February 2009, available at the Web site of the Commission, supra note 17.

39. See Report of the Nineteenth Meeting of the States Parties, Doc. SPLOS/203, 24 July 2009, paras. 70–79 and 106–108.

40. Dzurek, supra note 9, at 1.

41. LOS Convention, supra note 6, art. 11.

42. It should be noted that the Commission has no competence to make judgments or recommendations on a coastal State's baseline.

43. Malaysia-Vietnam Joint Submission, supra note 18.

44. The Philippines Partial Submission, supra note 24.

45. Malaysia-Vietnam Joint Submission, supra note 18; and Vietnam 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 Vietnam's Extended Continental Shelf: North Area (VNM-N), Executive Summary, April 2009, available at the Web site of the Commission, supra note 17.

46. Brunei Preliminary Submission, supra note 17.

47. People's Republic of China, Preliminary Information Indicative of the Outer Limits of the Continental Shelf Beyond 200 Nautical Miles, May 2009, available at the Web site of the Commission, supra note 17.

48. People's Republic of China, Letter to Secretary-General of the United Nations, Doc. CML/17/2009, New York, 7 May 2009; and Letter to Secretary-General of the United Nations, Doc. CML/18/2009, New York, 7 May 2009, available at the Web site of the Commission, supra note 17.

49. Malaysia, Letter to Secretary-General of the United Nations, Doc. HA 24/09, New York, 20 May 2009, available at the Web site of the Commission, supra note 17.

50. Vietnam, Letter to Secretary-General of the United Nations, Doc. No. 86/HC-2009, New York, 8 May 2009, available at the Web site of the Commission, supra note 17.

51. PRC Letters, supra note 48, para. 2.

52. Vietnam Letter, supra note 50, para. 3.

53. Malaysia Letter, supra note 49, para. 3.

54. PRC Letters, supra note 48.

55. See Figure 1 in Nien-Tsu Alfred Hu, "South China Sea: Troubled Waters or a Sea of Opportunity?" (in this Special Issue).

56. Dzurek, supra note 9, at 11–15.

57. *Ibid.*

58. For a review of the history of the Philippine claim, see Dzurek, supra note 9, at 21; and J. R. V. Prescott, *The Maritime Political Boundaries of the World* (New York: Methuen, 1985), 217–225.

59. U.S. Embassy in Manila, Diplomatic Note No. 836 of 18 May 1961, State Department File No. 796.022/5-2461. On this topic, see Roach and Smith, supra note 21, at 216–222.

60. See Roach and Smith, supra note 21, at 220–221.

61. *Ibid.*, at 221.

62. The Philippines Partial Submission, supra note 24.

63. See Dzurek, supra note 9; and Prescott, supra note 58, for further historic analysis of the Philippine claim.

64. See Appendix 2.

65. Declaration on the Conduct of Parties in the South China Sea, 4 November 2002, available at the Web site of ASEAN at www.aseansec.org/13163.htm.

Appendix 1

Declaration of the Republic of China on the Outer Limits of Its Continental Shelf

No. 003 12 May, 2009
(ROC Ministry of Foreign Affairs, at www.mofa.gov.tw/webapp/fp.asp?xItem=38077&ctnode=1901.)

The Republic of China (ROC), as a Contracting Party to the 1958 Geneva Convention on the Continental Shelf, enjoys sovereign rights over its continental shelf under international law. The principles of the 1958 Convention have been incorporated into the relevant provisions of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). Moreover, customary international law also confirms that coastal States possess sovereign rights over the exploration of continental shelf and the exploration of natural resources thereof. This Government has long supported such basic tenets. As a matter of fact, this Government promulgated the Law on the Exclusive Economic Zone and Continental Shelf of the Republic of China on 21 January 1998, in which Article 2 stipulates that the continental shelf of the Republic of China is the submerged area that extends throughout the natural prolongation of its land territory to the outer edge of the continental margin.

The Government of the Republic of China reiterates that the Diaoyutai Islands, Nansha Islands (Spratly Islands), Shisha Islands (Paracel Islands), Chungsha Islands (Macclesfield Islands), and Tungsha Islands (Pratas Islands) as well as their surrounding waters are the inherent territories and waters of the Republic of China based on the indisputable sovereignty titles justified by historic, geographic and international legal grounds. Under international law, the Republic of China enjoys all the rights and interests over the foregoing islands, as well as the surrounding waters and sea-bed and subsoil thereof. The claims made or occupation undertaken over them by any other State for whatever reason and by whatever means will be void and null in the eyes of international law.

As a coastal State, the Republic of China since 2006 has actively initiated an investigation and related preparatory work for collecting the scientific data needed to establish its claims over the outer limits of its continental shelf in accordance with Article 76 of the UNCLOS as well as the requirements of the Scientific and Technical Guidelines of the Commission on the Limits of the Continental Shelf.

As indicated by the materials collected through the said investigation undertaken by this Government, the continental margin to the east of Taiwan and the continental margin along the East China Sea to the northeast of Taiwan can be used by this country to claim its extended continental shelf. The related scientific evidence proves that the span of natural prolongation of the continental shelf of this country goes beyond 200 nautical miles from the territorial sea baselines in the "Eastern Taiwan Waters" and the "East China Sea Waters." Parts of such extended continental shelf overlap with the continental shelf claimed by the neighboring countries of the Republic of China.

This Government has recruited experts in the legal, policy, scientific and technical fields to make every endeavor in the preparatory work for the drawing up of the outer limits of the continental shelf of the ROC. As this Country was not invited to participate in the negotiation and signing of the UNCLOS, it was unable to become a party State to the UNCLOS. As a result, this Government is not legally bound by the SPLOS/72 and SPLOS/183 decisions made by the Meetings of the Contracting Parties to the UNCLOS. Accordingly, the making of claims over the extended continental shelf by this country is not constrained by the date of 12 May 2009. After this date, this country shall remain entitled to make claims on the outer limits of its extended continental shelf beyond 200 nautical miles with respect to the waters of the East China Sea, the Eastern Taiwan, and the South China Sea.

Article 76, paragraph 10 of the UNCLOS provides, "[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." Since this country and its neighboring countries have not reached any agreements on the maritime delimitation of the surrounding waters, the resolution of the issues regarding the maritime delimitation between this country and its neighboring countries should be made in accordance with international law and the equitable principle through the conclusion of an agreement. Pending the conclusion of such an agreement, the Government of the Republic of China calls upon all concerned parties in the region to assist in preserving the regional maritime legal order. Together we should maintain regional peace and stable development and substantively promote positive relations under the principle of "joint exploitation and resources-sharing."

Appendix 2

Statement by U.S. Department of State
Deputy Assistant Secretary Scot Marciel
Bureau of East Asian and Pacific Affairs
Statement Before the Subcommittee on East Asian and Pacific Affairs
Senate Foreign Relations Committee, Washington, D.C.
July 15, 2009
Maritime Issues and Sovereignty Disputes in East Asia

(U.S. State Department, at www.state.gov/p/eap/rls/rm/2009/07/126076.htm)

Chairman Webb and Members of the Committee, I am pleased to testify before you today on maritime and sovereignty issues in East Asia. The sea lanes that run through East Asia are some of the world's busiest and most strategically important. They serve as the prime arteries of trade that have fueled the tremendous economic growth of the region and brought prosperity to the U.S. economy as well. Billions of dollars of commerce—much of Asia's trade with the world, including the United States—flows annually through those waters. Over half of the world's merchant fleet by tonnage sails through the South China Sea alone each year.

The United States has long had a vital interest in maintaining stability, freedom of navigation, and the right to lawful commercial activity in East Asia's waterways. For decades, active U.S. engagement in East Asia, including the forward-deployed presence of U.S. forces, has been a central factor in keeping the peace and preserving those interests. That continues to be true today. Through diplomacy, commerce, and our military presence, we have protected vital U.S. interests. Our relationships with our allies remain strong, the region is at peace, and—as you know well—the U.S. Navy continues to carry out the full range of missions necessary to protect our country and preserve our interests.

Our presence and our policy have also aimed to support respect for international maritime law, including the UN Convention on the Law of the Sea. Although the United States has yet to ratify the Convention, as you know Mr. Chairman, this Administration and its predecessors support doing so, and in practice, our vessels comply with its provisions governing traditional uses of the oceans.

Issues surrounding maritime and sovereignty disputes in East Asia are multifaceted and complex. With your indulgence, Mr. Chairman, I am going to focus on three topics:

—First, the multiple sovereignty disputes in the South China Sea;
—Second, recent incidents involving China and the activities of U.S. naval vessels in international waters within that country's Exclusive Economic Zone (EEZ);
—And finally, the strategic context of these distinct topics and how the United States should respond.

China, Vietnam, Taiwan, the Philippines, Malaysia, Indonesia, and Brunei each claim sovereignty over parts of the South China Sea, including its land features. The size of each party's claim varies widely, as does the intensity with which they assert it. The claims center on sovereignty over the 200 small islands, rocks and reefs that make up the Paracel and Spratly Islands chains.

Sovereignty disputes notwithstanding, the South China Sea is largely at peace. Tensions among rival claimants rise and fall. To date, the disputes have not led to sustained military conflict. In 2002, the ASEAN countries and China signed the "Declaration on the Conduct of Parties in the South China Sea." While non-binding, it set out useful principles, such as that all claimants should "resolve disputes . . . by peaceful means" and "exercise self-restraint," and that they "reaffirm their respect for and commitment to the freedom of navigation in and overflight above the South China Sea, as provided for by the universally recognized principles of international law, including the 1982 UN Convention on the Law of the Sea."

More importantly, the 2002 document signaled a willingness among claimants to approach the dispute multilaterally. We welcomed this agreement, which lowered tensions among claimants and strengthened ASEAN as an institution. It has not eliminated tensions, nor has it eliminated unilateral actions by claimants in the South China Sea, but it's a start, and a good basis on which to address conflict in the region diplomatically.

U.S. policy continues to be that we do not take sides on the competing legal claims over territorial sovereignty in the South China Sea. In other words, we do not take sides on the claims to sovereignty over the islands and other land features in the South China Sea, or the maritime zones (such as territorial seas) that derive from those land features. We do, however, have concerns about claims to "territorial waters" or any maritime zone that does not derive from a land territory. Such maritime claims are not consistent with international law, as reflected in the Law of the Sea Convention.

We remain concerned about tension between China and Vietnam, as both countries seek to tap potential oil and gas deposits that lie beneath the South China Sea. Starting in the summer of 2007, China told a number of U.S. and foreign oil and gas firms to stop exploration work with Vietnamese partners in the South China Sea or face unspecified consequences in their business dealings with China.

We object to any effort to intimidate U.S. companies. During a visit to Vietnam in September 2008, then-Deputy Secretary of State John Negroponte asserted the rights of U.S. companies operating in the South China Sea, and stated that we believe that disputed claims should be dealt with peacefully and without resort to any type of coercion. We have raised our concerns with China directly. Sovereignty disputes between nations should not be addressed by attempting to pressure companies that are not party to the dispute.

We have also urged that all claimants exercise restraint and avoid aggressive actions to resolve competing claims. We have stated clearly that we oppose the threat or use of force to resolve the disputes, as well as any action that hinders freedom of navigation. We would like to see a resolution in accordance with international law, including the UN Convention on the Law of the Sea.

There are various other maritime-related disputes in East Asia. Japan and China have differences over EEZ limits in the East China Sea, and sovereignty over the Senkaku Islands. These disputes have drawn less attention than those in the South China Sea. We continue to monitor developments on all of these maritime disputes, as quarrels over sovereignty can escalate quickly in a region where nationalist sentiment runs strong.

I would now like to discuss recent incidents involving China and the activities of U.S. vessels in international waters within that country's Exclusive Economic Zone (EEZ). In March 2009, the survey ship *USNS Impeccable* was conducting routine operations, consistent with international law, in international waters in the South China Sea. Actions taken by Chinese fishing vessels to harass the *Impeccable* put ships of both sides at risk, interfered with freedom of navigation, and were inconsistent with the obligation for ships at sea to show due regard for the safety of other ships. We immediately protested those actions to the Chinese Government, and urged that our differences be resolved through established mechanisms for dialogue—not through ship-to-ship confrontations that put sailors and vessels at risk.

Our concern over that incident centered on China's conception of its legal authority over other countries' vessels operating in its Exclusive Economic Zone (EEZ) and the unsafe way China sought to assert what it considers its maritime rights.

China's view of its rights on this specific point is not supported by international law. We have made that point clearly in discussions with the Chinese and underscored that U.S. vessels will continue to operate lawfully in international waters as they have done in the past. I would note that there have been no further incidents of harassment by Chinese fishing vessels since mid-May.

In closing, I would like to look at both these concerns—the EEZ concerns with China and the overlapping South China Sea claims—in a broader strategic context. Specifically, what do these issues signify for international law and for the evolving power dynamics in East Asia, and how should the United States respond?

The *Impeccable* incident and the sovereignty disputes in the South China Sea are distinct issues that require distinct policy responses from the United States. On a strategic level, to an extent, both issues highlight a growing assertiveness by China in regard to what it sees as its maritime rights. In some cases, we do not share or even understand China's interpretation of international maritime law.

We believe that there are constructive ways, however, to tackle these difficult issues. With respect to freedom of navigation in the EEZ by U.S. naval vessels, we have urged China to address our differences through dialogue. Last month at the Defense Consultative Talks in Beijing, Under Secretary of Defense for Policy Michele Flournoy raised this issue, and the Chinese agreed to hold a special session of our Military Maritime Consultative Agreement (signed in 1998) to take up this issue and seek to resolve differences.

In the case of the conflicting sovereignty claims in the South China Sea, we have encouraged all parties to pursue solutions in accordance with the UN Convention on the Law of the Sea, and other agreements already made between ASEAN and China.

The assertions of a number of claimants to South China Sea territory raise important and sometimes troubling questions for the international community regarding access to sea-lanes and marine resources. There is considerable ambiguity in China's claim to the South China Sea, both in terms of the exact boundaries of its claim and whether it is an assertion of territorial waters over the entire body of water, or only over its land features. In the past, this ambiguity has had little impact on U.S. interests. It has become a concern, however, with regard to the pressure on our energy firms, as some of the offshore blocks that have been subject to Chinese complaint do not appear to lie within China's claim. It might be helpful to all parties if China provided greater clarity on the substance of its claims.

We need to be vigilant to ensure our interests are protected and advanced. When we have concerns, we will raise them candidly, as we have done over the pressuring of our companies.

We note that China has taken a more conciliatory approach to resolving some disputes over its land borders. Last year, for example, China and Vietnam concluded a land border demarcation agreement. China's general diplomatic approach to Southeast Asia has emphasized friendship and good-neighborliness. Likewise, China's anti-piracy deployment to the Gulf of Aden has been a positive contribution to a common international concern. We are encouraged by these steps, and hope that China will apply the same constructive approach to its maritime rights and boundaries.

We have a broad relationship with China, Mr. Chairman, which encompasses many issues of vital strategic importance to both countries. We agree closely on some issues; on others, we frankly have differences. Our bilateral relationship can accommodate and respect those differences, and address them responsibly through dialogue.

Thank you for your time, and I am pleased to answer your questions.

Annex 717

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

Ocean Development & International Law, 32:191–204, 2001

0090-8320/01 $12.00 + .00

The Spratlys: Are They Rocks or Islands?

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The South China Sea is a multilateral battlefield of conflicting claims to sovereignty over island features and vast areas of maritime jurisdiction. In the middle of the South China Sea lies the Spratly archipelago—some 150 small island features to which six states have made claims. The core of the SCS dispute is access to natural resources, and the rivalling claims to sovereignty over islands are largely based on the assumption that whoever has sovereignty to the features can also claim large areas of ocean space attached to them. The United Nations Convention on the Law of the Sea has codified the regimes of the continental shelf and the exclusive economic zone, and it is accepted that islands, as well as continental territory, generate such zones of maritime jurisdiction. However, one category of islands cannot generate these extensive maritime zones. Article 121(3) of the convention states that "rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf." This provision, if applied to certain features, has the potential to significantly change the scope of the conflict in the Spratlys.

Keywords islands, rocks, Spratly Islands, South China Sea

Introduction

For decades the regime of islands has been an issue of great interest. It is, therefore, no surprise that the issue was given special attention during the Third United Nations Conference on the Law of the Sea (UNCLOS III). After nine years of negotiations, the conference adopted a single provision concerning the islands: Article 121 of the United Nations Convention on the Law of the Sea (the LOS Convention).[1]

> Regime of Islands
>
> 1. An island is a naturally formed area of land, surrounded by water, which is above water at high tide.

Received 21 August 2000; accepted 12 November 2000.

This article is based on the author's master's thesis, "The Legal Regime of Islands in the South China Sea," which is available at www.sum.uio.no/southchinasea. The author would like to thank Professor Stein Tønnesson for his invaluable comments and suggestions on earlier drafts of this article.

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> 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.

This provision provides rules for the identification of an island and for the generation of maritime space of islands. The complexity and problems concerning "insular formations"[2] have not, however, come to an end as a result of this provision. Many issues remain to be settled, and the provision of the LOS Convention is subject to different interpretation by states, thus making the regime of islands a continuing question of complexity. Furthermore, the international legal process does not support swift change, the development of international law is a drawn-out process.

Article 121(1), the legal definition of an island, was adopted unchanged from the 1958 Convention on the Territorial Sea and the Contiguous Zone[3] and sets the conditions for a feature to be classified as an island in the legal sense. This definition is subject to controversy especially in regard to the high tide criterion, however, the major controversies have arisen in connection to the entitlement of maritime zones of islands, regulated by paragraphs 2 and 3 of Article 121.

In general, according to Article 121(2) of the LOS Convention, islands can generate ocean space in the same manner as continental landmasses. Any island coming within the "island definition" in Article 121(1) is entitled to its own territorial sea stretching to a maximum of 12 nautical miles measured from the baseline and a contiguous zone stretching to a maximum of 24 nautical miles measured from that same baseline.[4] The normal baseline, according to Article 5 of the LOS Convention, is "the low-water line along the coast as marked on large-scale charts officially recognised by the coastal State." The normal baseline may, however, be subject to modifications due to certain geographical conditions.[5] Since the maritime zones are measured from the baseline, the latter must be properly drawn before any maritime zone can be delineated. The proper way of drawing baselines is in itself a contested issue. Several states in the South China Sea area have drawn straight baselines along their coasts and around islands. However, none of the claimant states has yet drawn baselines in the Spratly area.

The entitlement to the more extensive zones, i.e., the 200-nautical-mile exclusive economic zone (EEZ) and the continental shelf, does not follow automatically from island status as defined in Article 121(1). An exception is provided in Article 121(3). The salience of the Spratly islands in disputes over maritime territory in the South China Sea will, to a great extent, hinge on their capacity to generate an EEZ and a continental shelf. If they cannot generate such zones, then most of the South China Sea will be delineated in accordance with distance to the mainland coasts and their offshore islands, and an area of High Seas will remain in the middle of the South China Sea. Moreover, the Spratlys will then not have any effect in the delimitation of maritime zones beyond 12 (or 24) nautical miles from their shores. In this case it will be possible to undertake the overall delimitation without necessarily resolving the sovereignty issue first. If, on the one hand, any of the Spratly Islands have a right to an EEZ and continental shelf, then the high seas area will disappear or at least be significantly reduced. In addition, the islands will probably be given a partial effect in the delimitation of maritime zones between them and the coasts of Vietnam, East Malaysia, Brunei, and the Philippines. This means that the delimitation will depend on resolution of the sovereignty dispute.

For these reasons the interpretation of Article 121(3) is of fundamental importance to the overall conflict in the South China Sea.

Before applying Article 121(3) to the various insular features of the Spratly group, the proper content of the rule must be determined. The obvious starting point in this regard is the Vienna Convention on the Law of Treaties.[6] Article 31.1, the general rule of interpretation, states that "a treaty should 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"* (italics added). Supplementary means of interpretation are set out in Article 32, which refers to the preparatory works of the treaty and the circumstances of its conclusion, and Article 33 which refers to treaties authenticated in more than one language.

Defining a Rock under Article 121(3)

Although the term *rock* is not defined in the LOS Convention, it appears from the context of the treaty that a rock is a particular type of island. We can assume that ordinary definitions of both rock and island are applicable. Unfortunately, dictionary definitions are ambiguous and do not independently bring consensus as to the meaning of rock in the context of Article 121(3). It might be argued that the term rock should be given a purely geological definition. Such a strictly literal interpretation would limit the coverage of paragraph 3 to formations that are actually rocks without any accompanying land. Other barren and uninhabitable insular formations, such as cays and atolls, would in this case be considered islands no matter how small they are and would generate an EEZ regardless of whether they can sustain habitation or economic life.[7] Since this result is manifestly absurd, the purely geological definition of rock must be rejected in the interpretation of Article 121(3). It would be unreasonable, and not in consonance with the intention of the parties to UNCLOS III, if one geological type of uninhabitable tiny insular formation should be excluded from rights to which other types of uninhabitable tiny insular formations are entitled. Thus, logic seems to require that the term rock be given a definition that is not strictly geological.

It is disputed whether or not the term rock can be seen as an isolated part of Article 121(3). A 1996 judgement of the Supreme Court of Norway certainly treated this condition independently.[8] One of the arguments of the appellants in this case was that the baseline, from which the outer limit of the fishery zone of Svalbard was measured, was not in accordance with international law on three counts. One of them was that Abel Island, on which a basepoint was located, was an uninhabitable rock within the meaning of Article 121(3) of the LOS Convention. The court held that Abel Island, an island of 13.2 square km, was too large to be a rock, and that this independently had to exclude Abel from being a rock within the meaning of Article 121(3). The court further stated that it found support for this in state practice.[9]

The ruling of the Norwegian court was obviously inspired by the International Court of Justice (ICJ) ruling in the *Jan Mayen Case,* where the ICJ stated that because of its size alone Jan Mayen is not a "rock," in the legal sense of the term, and for that reason the court considered the question of habitation and economic life irrelevant. The court's reasoning was based on the fact that Jan Mayen is 54.8 km long, far larger than the types of features under consideration at UNCLOS III for inclusion in Article 121(3).[10] It may thus be argued that the requirement of rock has an independent meaning and that it applies to all kinds of features smaller than a certain size. What this size limit may be is difficult to clarify, but a rock as defined in Article 121(3) must apparently be smaller than the island of Jan Mayen.

A recent paper prepared by a U.S. law firm employed by Vietnam asserted that "the overwhelming majority of commentators have argued that the term should be interpreted as including any small island."[11] This is in full accordance with the conclusion reached here.

Having said that the term rock in Article 121(3) denotes any type of small island, it is important not to lose sight of the fact that rocks must still comply with the requirements of the definition of an island found in Article 121(1). There is no difference between rocks and islands in respect of the requirement that they must be "naturally formed" and "surrounded by water and above water at high tide."

If, then, the difference between an island and a rock is to be based on the broader concept of "land," is the difference then to be founded in size and the geological substance? A number of suggestions for how to define islands, islets, and rocks on the basis of size were submitted during the UNCLOS III, but none attained sufficient support for inclusion in the final text.

Article 121(3) of the LOS Convention includes the phrase "sustain human habitation or have economic life of its own." This phrase also gives rise to various questions of interpretation. It indicates that two categories of "rocks" exist: (1) those that cannot sustain human habitation or economic life of their own; and (2) those that can sustain either or both.[12] However, what does it take for a rock to sustain human habitation or have economic life of its own?

The concept of the extended maritime zones was accepted in the 1982 Law of the Sea Convention because it seemed appropriate to allow coastal populations to have a primary right and responsibility to exploit and manage resources in the waters and on the continental shelf adjacent to their coasts. Where there is no indigenous population, this logic does not seem to apply, and the extended maritime zones should not be permitted. This underlying purpose of the development of the extensive maritime zones indicates that it is not reasonable to accept a category of islands that can sustain economic life if the islands cannot also sustain human habitation. The object of the conventional rule in Article 121(3) might have been to establish the sustainability of human habitation as an obligatory, minimum requirement for small islands. To accord an uninhabitable small island a right to an EEZ on the basis of an ability to sustain an economic life of its own would mean that this economic life would have to be carried out by people living elsewhere. This would not be in accordance with the purpose of the EEZ regime, which is to accord rights and responsibilities to the populations of the lands that generate the zones.

It should be noted in this regard that the Norwegian translation of Article 121(3) differs from the official texts of other languages[13] due to the presence of one, but only one, comma.[14] This one comma could be interpreted to imply that the conditions of human habitation and economic life must *both* be fulfilled. Some discussion arose on this among the Norwegian translators. However, the sentence could not be written in proper Norwegian grammar without any comma, and if two commas had been employed, then the sentence would have indicated far more clearly than the English version that the two requirements are alternative.[15] The translators seem to have decided that the language differences justified the amendment and that the Norwegian language did not allow the retention of the vagueness in the English text.[16] Moreover, we find from the *travaux preparatoires* that the phrase read "human habitation *and* economic life" (italics added) in the early stages of the UNCLOS negotiations. Thus, the choice of "or" in Article 121(3) appears to have been deliberate. This admittedly weakens the argument above and provides support to the view that a feature does not need to sustain human habitation if it can have an economic life of its own without such habitation.[17]

The criterion "sustain human habitation" may not inevitably require that an insular feature should have been, or currently be, inhabited. The *ability* to sustain habitation seems to be enough. However, the only practicable and equitable way of judging such ability is to look at past and present habitation. With the use of sophisticated techniques it will be possible in the future to sustain habitation on any kind of feature. But, we need to define the minimum size of a "population." One term that can provide a good indication of the required size of human habitation used recently by many commentators is "stable community."[18] A common sense approach to this term would give some indication of what is expected. The authors of this term argue that five persons would clearly be too few, but that a population of fifty could very well be seen as enough. It is interesting to note that Gidel, in 1934, gave a somewhat more specific description of habitability.[19] In his definition, an island had to have "natural conditions" that permitted "stable residence of organised groups of human beings." This definition certainly seems to require the presence of fresh water, cultivable soil, and perhaps even other resources.

An argument supportive of claiming the presence of fresh water, soil, and other resources in order for a small island to generate a right to an EEZ is the fact that historic use of surrounding waters can provide a good indication of a population's reliance on the area and may serve to block competing claims. It seems clear, however, that a population residing in the territory that generates the claims must have undertaken this utilization. In the *Fisheries Case* of 1951, Norway argued that the adjacent waters of the Norwegian coast were historically relied upon by the local population. The court accepted this reasoning and Norway was granted full jurisdiction to the vast ocean areas that fell inside its then-controversial straight baselines.[20]

One view that is not in accordance with that of Gidel and that appears somewhat radical is that of Johnson.[21] He suggests that, for example in the case of a lighthouse, the fact that it is actually inhabited enhances its island status. Johnson's view does not seem to be practically applicable in the clarification of the habitation condition given the fact, mentioned above, that it clearly is possible to actually inhabit any kind of rocky feature if a nation is willing to expend sufficient resources.[22] Further, the fact that a criterion of actual habitation was not explicitly included in Article 121(3) indicates that Johnson's reasoning found little support.

Another question in regard of habitation is whether or not the sort of population matters. One might argue that the profession and employment of the inhabitants are irrelevant, but one might, on the other hand, require that the people living on the island be supported by the natural resources of the feature itself and not be dependent on the provision of necessities from the outside. This would require that at least some of the population be at least partially employed in the primary sector (agriculture, fishing, and water supply). The above-noted paper prepared by a U.S. law firm asserts that the "human habitation" formula requires at least the possibility of a permanent civilian population and that soldiers and lighthouse keepers are not sufficient.[23] The UNCLOS III *travaux preparatoires* seem also to support the interpretation that personnel stationed on an island for preservation and scientific purposes should not be taken into account. On the other hand, the *travaux preparatoires* do *not* require that human beings reside permanently on the feature.[24] The object and purpose of the EEZ regime being that the coastal population seems best suited to manage and preserve the natural resources of the adjacent area also supports the interpretation that personnel stationed for preservation and scientific purposes should be disregarded.

The habitability requirement does not, however, require that the island must have an actual habitation, only that habitation is possible. Thus, an island will not automatically be disqualified from generating an EEZ by the fact that only scientific personnel inhabit it. It must be argued that the island cannot sustain other kinds of habitation. Further controversy can arise with regard to the length of time that human beings need to reside on a feature for this to be called habitation. It may be argued that fishers who use an island as shelter during the fishing season do not qualify as inhabitants. They merely use it as a "pit stop," and if one were to argue that every feature that could give shelter to human beings would qualify under Article 121(3), the wording would lose meaning. Human habitation must mean more than just shelter.

The actual content of the "sustain human habitation" requirement has not yet been clarified. Still it should be possible to rule out some rocks. In order to prove that an island is habitable, it ought to be possible to prove some kind of physical presence of human beings, either in the past or the present, and not only of scientific personnel or military troops. Although actual habitation is not necessary, some kind of practical test must be fulfilled to prove habitability. In addition to proof of physical presence, this presence should be of a kind that makes it reasonable to assume that a "stable community" of human beings could live permanently on the island. This means in turn that the most essential needs for the survival for human beings must be available. The essential needs are food, fresh water, and shelter. The availability of food, fresh water, and shelter may thus be chosen as the main characteristic of an island that is capable of sustaining human habitation.

The other requirement in Article 121(3), "economic life of its own," adds even more ambiguity to the question of what it takes for an island to have a right to an EEZ and a continental shelf. Does the "of its own" phrase refer to economic life on the island itself, or can resources in the adjacent waters and the subsoil be taken into account? Further, what is a proper definition of *economic life*? Does any kind of economic activity count? Moreover, as with the human habitation requirement, the question is whether the island should be required to have sustained economic life in the past or present or if it would be enough to make it seem likely that it can sustain economic life in the future.

To add a test of economic viability to the requirements that an island must fulfil in order to generate an EEZ may cause problems, since the adjacent waters of a feature may serve as a basis for economic life and thus may convert an otherwise useless piece of land into a territory of great economic importance. Logically, therefore, an economic viability test may cause injustice by its preclusive application.[25] This, for example, was evident from statements at UNCLOS III by representatives from certain Pacific islands. The Fijian delegate pointed out that in certain parts of the world remote islands might have no viable land-based economy, but could have significant economic development based uniquely on their fishing industry.[26] The "economic life of its own" criterion might therefore well be said to be fulfilled if the waters around a certain island provide sufficient fishing opportunities.

A strict literary interpretation of 121(3) would indicate that fisheries do not qualify. An island or rock must of its own be capable of sustaining economic life. Further, the use of the present tense in the article—"cannot" sustain economic life—supports an interpretation that focuses on the present situation, meaning that if the resources are proven to be present but are not currently in use, the feature fails to qualify. However, the words "able to sustain" must indicate that actual use of the resources is not necessary and that the presence of resources that can support an economic life is sufficient. Moreover, the fact that the word rock was used in 121(3) might imply that the restrictions given in the requirements on habitation or economic viability should not be emphasized too much because there already exists a curtailment in the use of the word rock instead of island. Hence, one might conclude that the requirements are not vested in past or present, nor even future actual occurrences, but in an evaluation of the island as a physical feature. Actual occurrences are not in themselves proof of anything, but can be used as arguments that islands pass certain tests. Supportive of this view is the aforementioned Judgement of the Supreme Court of Norway.[27] The court stated that Abel Island did not fall within the scope of the exceptions of Article 121(3), partly because it would be able to support a significant polar bear hunt if such hunting had not been prohibited for conservation reasons. The court further stated that the requirement could hardly be fulfilled, when it was the prohibition as such and not the physical opportunities on the island, that prevented it from sustaining an economic life of its own.[28]

The mere existence of a natural resource cannot, however, be enough. It must be argued that the resource can represent economic value over a certain period of time. If not, then a state could sell an otherwise useless piece of rock to a private person who wanted to own an isolated island and then claim that the price paid represented proof of economic life. It would also be possible to break off and sell coral from an otherwise worthless, uninhabitable reef and claim that this was proof of economic life. If such sales would help an island satisfy the economic life criterion, then the whole concept of Article 121(3) would be undermined. Thus, there needs to be some kind of restriction as to the kind of economic activity required. The UNCLOS III *travaux preparatoires* mention that military or other governmental installations do not satisfy the requirement of economic life.[29] A more complex question is tourism, since in this case an island is not sold only once and not (necessarily) destroyed, as when coral is broken off, but can be utilized repeatedly over a long period of time by people who pay to just look.

Because "economic life" and "human habitation" are directly linked to human activities and developments that may vary over time, it follows that the meaning of Article 121(3) is likely to do the same. Consequently, some features that would have previously been entitled to extended maritime zones may today fail the requirements of Article 121(3) and vice á versa. The point may be best illustrated by imagining a small island in the middle of an ocean where huge amounts of exploitable hydrocarbon resources are being discovered under the seabed within that island's 12-nautical-mile territorial waters. Prior to the discovery, the feature would fail to pass the economic life requirement in Article 121(3). However, the new circumstances will, if the natural resources can be exploited, provide the island with an ability to sustain an economic life of its own for a long period of time. If, however, there do not exist techniques to exploit the resource, the island seemingly will be categorized as an Article 121(3) rock because the classification depends upon the circumstances at the moment of the claim. Paradoxically, the presence of exploitable hydrocarbon resources within an island's 12-nautical-mile territorial zone could be helpful in meeting the economic life criterion so the island would gain a right to a full 200-nautical-mile continental shelf and EEZ, and thus in turn become an economic goldmine. This paradox could be a serious matter in the case of the Spratlys. If some of the claimant states expect or hope to discover oil in the immediate vicinity of the islands they claim, then they may hope to gain a significant extra bonus in the form of a continental shelf and EEZ. In such a situation they will have no incentive to clarify their maritime zone claims or resolve disputes over maritime delimitation before the oil has been found. This danger would have been eliminated if 121(3) had said "and" instead of "or"; then the economic life requirement would not have been a sufficient condition for gaining a right to extended maritime zones, and small islands would have needed to satisfy both the human habitation and economic life requirement.

Fish, tourism, and oil are not the only disputable sources of economic life. A small island can also gain economic value from utilization for navigation, communication, or as a weather station. And in the age of the internet and satellite communication, it might be possible to set up a lucrative software business, for instance, a virtual casino, anywhere. This latter argument should, however, be rejected, since again it would remove all meaning from Article 121(3). Moreover, in this case, it is not the island itself or its territorial waters that serve as the basis for the economic life. The same business could be set up anywhere. The words "of its own" suggest that the island's own resources must provide at least part of the basis for its economic life. This does not, of course, mean that the feature must have complete self-sufficiency.[30] If an island is uninhabited but has natural resources that may be exploited, and such exploitation requires human activities on the island itself or in its territorial waters, it seems that the "economic life" criterion is being fulfilled.[31] Support from the outside must be allowed in order to realize the economic value that an island may hold.

The main requirement within "economic life of its own" must be that the feature itself represents economic value in the sense that it has resources that are utilized for economic activity. In this connection the reference to the island must include its 12-nautical-mile territorial sea since this will belong to the island regardless of whether it satisfies Article 121(3) or not.

In the past many states have adopted inconsistent positions with regard to their various island possessions.[32] Much of their inconsistency can be explained by the location of the islands in question. The case law dealing with the issue has shown that location is a highly relevant factor, at least when settling overlapping maritime boundaries.[33] It can be suggested that the same norms will apply where there are no overlapping claims. However, nations tend to assert broad claims to extended maritime zones based on small islands, especially when the islands are contiguous or near the nation's mainland.

Van Dyke and Brooks[34] have come to the conclusion that it would have been desirable for the negotiators at UNCLOS III to have examined the issue of islands more carefully before settling for the vague text of Article 121. The vagueness must probably be ascribed to the fact that many nations possessed uninhabited islands and thus had no incentive to limit the possible gains from possessing such islands. Vagueness was therefore preferred. Hodgson[35] has pointed out that many of the isolated islands of the world are either uninhabited or populated by nonindigenous inhabitants. He found that the Howland, Jarvis, and Baker islands belonging to the United States could not sustain a permanent population due to the lack of drinkable water and fertile soil. He also pointed out the problems in definitional aspects concerning similar other remote islands that merely have caretaker populations, i.e., are inhabited by only military or scientific personnel. However, he did not say how these islands should be treated. Van Dyke, Morgan, and Gurish, in a survey of the northwestern Hawaiian Islands, concluded that the U.S. position, that every insular formation is entitled to generate an EEZ, was not consistent with Article 121(3) and further argued that the habitability requirement should be interpreted as "supporting a stable community of permanent residents."[36]

Because "it seems as though article 121, paragraph 3, was drafted with the following idea: 'I cannot exactly define what I mean, but show me an offshore territory and I will let you know if it is a paragraph 3 rock',"[37]—the article needs to be interpreted with a certain amount of discretion. The solution may be found in the general rules of treaty interpretation, notably that any interpretation must be made in good faith and take all relevant circumstances into account. The lack of objectivity in the drafting of the "rocks" paragraph will probably lead to further disputes rather than solutions. However, some guidelines can be suggested regarding how the terms of Article 121(3) should be interpreted. First, there seems to be a limitation in the use of the word rock in the sense that some islands, viz. Jan Mayen, will not need to satisfy Article 121(3) because of their size. Second, since the word "and" in the early drafts of the convention text was replaced by "or" in the final text, it seems clear that each of the "human habitation" and "economic life" criteria are, in themselves, sufficient and that it is not necessary to satisfy both. Third, neither of these two requirements needs to be fulfilled in practice; it suffices to pass a test that proves they can be fulfilled. Fourth, when applying Article 121(3) one should submit islands to certain tests. The key tests are if it can provide fresh water, food, and shelter to human inhabitants and if the island possesses sufficient resources of its own to sustain economic life. Fifth, some sort of outside support should be allowed in realizing an island's economic opportunities, since in most cases this is necessary in order to realize an economic potential. Sixth, inhabitants such as lighthouse keepers, weather personnel, and scientific personnel stationed for preservation and scientific purposes cannot be accepted as proof of sustainable habitation. Seventh, some kinds of "economic" activity, such as government-paid military occupation or scientific work, navigational aid, and activities that in no way use local resources, cannot be accepted as proof of economic viability. And eighth, the status of features may vary over time because the criteria in Article 121(3) will themselves be subject to change as new technologies and life conditions emerge.

Application to the Spratlys

The Spratlys consist of about 150 features scattered throughout the South China Sea, and each one must be examined independently in order to determine its capacity to generate maritime zones. The first task is to decide how many islands there are in the Spratlys which satisfy the requirement of Article 121(1) of the LOS Convention. Estimates vary between 20 and 46.[38] Without precise geographic information, it is ill-advised to discuss the question of which of the Spratly features qualify as islands, but there can be no doubt that a certain number of them are "islands" in the legal sense of the term. On the other hand, it is also clear that they are not (such as Jan Mayen) big enough to escape the requirements defined in Article 121(3). The islet features in the Spratly Islands are very small islands that, in accordance with the argument made in the beginning of this paper, must be seen as analogous to what Article 121(3) defines as rocks. The interpretation derived from the Jan Mayen example does not give any precise indication as to the size needed for an island to escape the requirements defined in Article 121(3). Jan Mayen is 373 square km. The largest feature in the Spratlys, Itu Aba, is only about 0.5 square km. None of the Spratly features has an elevation of more than 6–8 m, whilst the highest point on Jan Mayen is 2,277 m. Thus, it cannot with any convincing effect be argued that islands in the Spratly area fall within the same category as Jan Mayen. It will therefore be necessary for those Spratly features that satisfy Article 121(1), and thus qualify as "islands," to also satisfy one or the other of the two requirements in Article 121(3).

Even though it is not necessary for an island to actually be or to have been inhabited in order to satisfy the "sustain human habitation" requirement, it will be easier to argue that an island can sustain human habitation if it has actually been inhabited. On at least one of the Spratly islands there are reported findings of old houses and tombstones, a clear indication that there has been some population there in the past.[39] The presence of houses and tombstones does not, however, prove that there was permanent habitation. This only proves that human beings found shelter and that some died on the island and were buried by others still alive. It might furthermore be argued that since habitation at some point clearly ceased, it was hardly sustainable in the first place. Even if it is acknowledged that the status of features may vary over time and if the argument is added that the test is referring to the time of the claim, indications of human presence in the past is certainly not sufficient to prove habitability.

It is well known that soldiers are stationed on many of the Spratly islands (and also on several features that are not above water at high tide). The presence of military personnel could perhaps be seen as an indication that an island can sustain human habitation.[40] One should bear in mind, however, that the mere fact of inhabitants cannot be sufficient. Moreover, as derived from the UNCLOS III *travaux preparatoires* and the object and purpose of Article 121, the requirement of human habitation can and should be interpreted so as to disregard personnel stationed on an island for sovereignty or scientific purposes. It must be concluded that the requirement of human habitation is not fulfilled by the presence of soldiers since they obviously have a sovereignty purpose. It can also be argued that soldiers are not sufficient because they are not civilians. To interpret the habitability requirement to mean that the feature must be able to sustain a "stable population of civilians" is perhaps to move too far from the textual meaning of the provisional wording. However, in light of the object and purpose of the provision, this interpretation seems reasonable. If an island should be attributed large areas of maritime jurisdiction because it is reasonable to allow its indigenous inhabitants to exploit and preserve the area because they seem best suited to do so, huge areas of maritime jurisdiction should not apply to islands where there is no such population.

It has been reported that one of the Spratly islands is being used for tourism. Can this island be said to sustain human habitation? We will return to the question of whether or not it satisfies the economic life criterion. Suffice to say that the "hotel" which might have been constructed cannot be said to sustain an indigenous habitation on the island if the personnel working at the hotel are being recruited on a temporary basis and are domiciled elsewhere. Moreover, it has not been confirmed what kind of building was created; it might be a barrack for soldiers.[41]

It is known that there is a weather station and that some meteorologists inhabit the second biggest island in the Spratly group, Thitu (or Pagasa) Island. Although the weather personnel are civilians, they are clearly stationed on this island for scientific purposes. Thus, it can be argued that their presence does not affect the classification of the feature under Article 121(3) because such personnel are to be disregarded in the meaning the Article. It has also been reported that a couple of the features are or have been occasionally inhabited by fishers. Those inhabitants are civilians and cannot be disregarded in the same way as the other groups. It is also clear that fishers found shelter on the islands long before the sovereignty to the islands became disputed. The question is then if the fishers are only finding shelter on the islands for a certain period of the year or if they live there permanently. A key to resolving this question might be to examine if whole families are living on the islands or if fishers go back regularly to see their families who live elsewhere.

If we assume that the fishers do not live permanently on the Spratly Islands with their families and the tourist industry relies on temporarily employed staff from the outside rather than sustaining a local population on the island itself, then the actual presence of human beings in the Spratlys, past and present, does not seem to validate the point that these islands can sustain human habitation. This does not necessarily mean that the features lack capacity to sustain human habitation. Even though the volatile habitation does not positively prove that the features have capacity to sustain human habitation, it may be possible to argue that they can do so. To validate such arguments it is necessary to examine if the islands have fresh water, can produce food, and can provide shelter. Some vegetation is reported on several of the features. However, it seems doubtful that any of them has tillable soil that can allow the production of food to sustain a human habitation. A problem is that during the monsoon, waves regularly wash over the islands. Historically, this seems to have led visitors to avoid staying there during that time of the year. The most necessary means for sustaining human habitation is the presence of fresh water. Reportedly only two of the Spratly islands have fresh water.[42] The existence of fresh water is an indication that human habitation may be sustainable. It cannot, however, be seen as sufficient proof.

On the basis of what has just been said it is not possible to draw a definitive conclusion, but it seems doubtful that a court would find any of the Spratly islands to be capable of sustaining human habitation.

The next question is whether the Spratly islands can satisfy the other criterion in Article 121(3): "sustain . . . economic life of their own." Here again, government-sponsored military and scientific activities can be dismissed. They were clearly excluded in the UNCLOS III *travaux préparatoires*.

Many of the Spratly islands are generously endowed with guano deposits, which various companies have tried to exploit economically at least since the 1870s, but apparently without much success. The cost of recovering and transporting the guano to the fertilizer markets seems to be prohibitive. Thus, and because the application is connected to the time of the claim, even if guano may perhaps have been exploited profitably at some time in the past, most likely by a Japanese company in the 1920s, the guano deposits cannot sustain economic life today.

A more difficult question is fisheries, tourism, and the production of oil. They all clearly use local resources. Diving from coral reefs provide rich opportunities for tourism. The fish stocks in the Spratly area remain extremely important and there could possibly be abundant quantities of oil and gas under the Spratly islands themselves or within their 12-nautical-mile territorial zones. Thus, it seems fully possible that the area can or could sustain an economic life. The question is if this economic life can be said to be generated by the island "of its own" or if the island, as such, does not have a necessary role to play in the economic activities. If a factory ship, a hotel built on stilts on a submerged reef, or an oil platform could serve the purpose as well—or better—then it seems doubtful that it is the island that generates the economic life of its own.

Conclusion

This article has identified the criteria that may reasonably be used when applying Article 121(3). However, since the status of features may vary over time, so will the result of an application. It is likely that the provision will excite controversy when applied to specific features. In regard to the Spratly features, it seems that none of the features can at present be said to have been proven capable of sustaining human habitation or economic life of their own. It thus seems quite likely that if some of the claimant states should succeed in their quest for sovereignty, they would gain little from the victory in terms of recognized maritime zones.

Most analyses of the South China Sea dispute agree that all the sovereignty claims to the Spratly islands have weaknesses. Each nation must therefore know that its claim may not ultimately or completely prevail if the dispute were to be referred to arbitration. Thus, and because of widespread distrust of Western-dominated international law, some of the claimants may prefer the status quo, seek a military solution, or attempt to resolve the dispute through bilateral or multilateral negotiations. It is highly unlikely that they will be willing to risk all in a third-party tribunal ruling that may tend to create winners and losers. However, this does not rule out the possibility that a tribunal could be used in order to resolve some distinct questions. The question of whether or not any of the features has the capacity to generate extensive maritime zones certainly is one such question. If the ICJ or the International Law of the Sea Tribunal in Hamburg were asked to resolve this question, its ruling would at the same time be likely to clarify one of the most ambiguous articles in the LOS Convention.

Notes

1. U.N. Doc. A/CONF.62/122, (1982), United Nations, Official Text of the United Nations Convention on the Law of the Sea with Annexes and Index.

2. Offshore features that qualify as islands under the legal definition are often referred to as having "insular status."

3. The UN Convention on the Territorial Sea and the Contiguous Zone, Geneva 29 April 1958, 516, *U.N.T.S.* 205.

4. Articles 3 and 33 of the LOS Convention. Note, however, that national jurisdiction in the contiguous zone is limited to exercising rights concerning customs, fiscal issues, and immigration or sanitary laws and regulations.

5. Articles 7 and 47 of the LOS Convention (Straight and Archipelagic Baselines).

6. Vienna Convention on the Law of Treaties, opened for signature May 23, 1969, U.N. Doc. A/Conf.39/27, reprinted in 63 *American Journal of International Law* 875 (1969).

7. Robert D. Hodgson and Robert W. Smith, "The Informal Negotiating Text (Committee II): A Geographical Perspective," 3 *Ocean Development & International Law* 225 (1976).

8. Supreme Court of Norway, Judgement of 7 May 1996, Rt. 1996, p. 624.

9. Ibid. Unfortunately the reasoning in the judgement stops at this point with no further references to the alleged practice.

10. *Case Concerning Maritime Delimitation in the Area between Greenland and Jan Mayen (Denmark v. Norway)*, *ICJ Reports 1993*, p. 38, para. 61.

11. Brice M. Clagett, "Competing Claims of Vietnam and China in the Vanguard Bank and Blue Dragon Areas of the South China Sea" (1995), *Oil and Gas Law and Taxation Review* at 375.

12. Jon M. Van Dyke and Dale Bennett, "Islands and the Delimitation of Ocean Space in the South China Sea," 10 *Ocean Yearbook*, at 78 (1993).

13. The French and the Spanish texts have the same grammar as the English.

14. The Norwegian translation reads: "Klipper som ikke kan gi grunnlag for menneskelig bosetting eller selvstendig næringsvirksomhet, skal ikke ha noen eksklusiv økonomisk sone eller kontinentalsokkel."

15. The sentence would then have read: "Klipper som ikke kan gi grunnlag for menneskelig bosetting, eller selvstendig næringsvirksomhet, skal ikke ha noen eksklusiv økonomisk sone eller kontinentalsokkel."

16. Informal talk with Mr. Fife at the Dept. of Foreign Affairs, Norway, 07.03.00.

17. UNCLOS III, *Official Records*, Vol. III at 195. The word "or" was introduced only during the third session of the conference in the Informal Single Negotiation Text. In a later session one state suggested that the word "or" should be interpreted as "and" but the suggestion was disregarded.

18. Van Dyke and Bennett, supra note 12, at 79; Jenny Heins, "The Role of Insular Formations in the Generation and Delimitation of Maritime Zones," *Sea Changes* (Cape Town) No. 2, (1985).

19. Clive R. Symmons, *The Maritime Zones of Islands in International Law* (The Hague: Martinus Nijhoff, 1979) at 46 referring to B. Gidel, *Le Droit international public de la mer* (1934), at 684.

20. *Fisheries Case (UK v. Norway)*, *ICJ Reports 1951*, p. 116, paras. 140–143. See Article 15 of the LOS Convention respecting delimitation of the territorial sea between states with opposite or adjacent coasts, where it states that the median line principle applies except were " it is necessary by reason of [. . .] to delimit the territorial seas of the two states in a way which is at variance therewith."

21. D. H. N. Johnson, "Artificial Islands," 4 *International Law Quarterly,* 205 (1951).

22. *International Law Commission Yearbook 1954*, Vol. 1, at 93. Francois, the special rapporteur of the I.L.C., expressly disagreed with the British proposal of "effective occupation and use" because, in his view, any rock could be used as a weather observation post or a radio station, and in this sense all rocks are capable of occupation and control.

23. Clagett, supra note 11, at 375.

24. UNCLOS III, *Official Records,* Vol. III, at 71.

25. Symmons, supra note 19, at 53.

26. UNCLOS III, *Official Records*, Vol. II, at 283.

27. Supreme Court of Norway, Judgment of 7 May 1996, Rt. 1996, p. 624.

28. Ibid.

29. UNCLOS III, *Official Records*, Vol. III at 284.

30. UNCLOS III, *Official Records,* Vol. III at 288. In statements from several states it was strongly suggested that self-sufficiency was not required by the provision.

31. In the *Jan Mayen Case*, supra note 10, the Norwegian fishing fleet were exploiting the waters around the uninhabited island of Jan Mayen.

32. Mexico has laid claim to a 200-nautical-mile zone around the Revilla Gigedo Island group, which includes the uninhabited Clarion Island, also known as Santa Rosa. This island is some 5 miles (8 km) long, 1.8 miles (3 km) wide and rises to an altitude of 388 feet (118 m). It faces the open Pacific Ocean, and if permitted to generate an EEZ, would generate a large sea area unobstructed by other maritime claims in the west. In contrast to this claim, however, Mexico does not take into account the Alijos Rocks to the north of the Revilla, which rises only to an altitude of 12 feet (4 m). Thus, Mexico appears to endorse Article 121(3) with respect to smaller rocky insular formations, but not larger ones. See J. Carter, ed. *Pacific Islands Yearbook*, 370 (1984).

33. See the *Jan Mayen Case*, supra note 10, and *Libya Malta Case*, *ICJ Reports 1985*, 13.

34. Jon M. Van Dyke and Robert A. Brooks, "Uninhabited Islands: Their Impact on the Ownership of the Oceans' Resources," 12 *Ocean Development & International Law Journal* 288 (1983).

35. Robert D. Hodgson, "Islands, Normal and Special Circumstances," in J. K. Gamble and G. Pontecorvo (eds.) *Law of the Sea: The Emerging Regime of the Oceans*, U.S.A., 1973, at 148.

36. Jon Van Dyke, Joseph Morgan, and Jonathan Gurish, "The Exclusive Economic Zone of the Hawaiian Islands: When do Uninhabited Islands Generate an EEZ?" 25 *San Diego Law Review,* 425 (1988).

37. Robert W. Smith, "The Effect of Extended Maritime Jurisdiction," in Albert W. Koers and Bernhard H. Oxman, eds. *The 1982 Convention on the Law of the S*ea (The Law of the Sea Institute, University of Hawaii: Honolulu, 1984), at 345.

38. David Hancox and Victor Prescott, "A Geographical Description of the Spratly Islands and an Account of Hydrographic Surveys Amongst Those Islands," *IBRU Maritime Briefing*, Vol. 1, No. 6 (1995); Ji Guoxing, "The Spratly Disputes and Prospects for Settlement," *Institute of Strategic and International Studies (ISIS) Issue Paper* (Kuala Lumpur, Malaysia, 1992); and

Michael Bennett, "The People's Republic of China and the Use of International Law in the Spratly Island Dispute," 28 *Stanford Journal of International Law* 425–450 (1992).

39. R. Haller-Trost, *The Contested Maritime and Territorial Boundaries of Malaysia* (The Hague: Kluwer Law International, 1998), at 302.

40. See Mark J. Valencia, Jon M. Van Dyke, and Noel A. Ludwig, *Sharing the Resources of the South China Sea* (Hague: Martinus Nijhoff, 1997), Appendix 1.

41. A room-resort is reportedly being built on Swallow reef which is naturally a treeless cay; however, soil and trees have been planted there in recent times.

42. Valencia et al., supra note 40, Appendix 1 and J. R. V. Prescott, "Maritime Jurisdiction in the South East Asia: Commentary and Map," *East West Centre Environment and Policy Institute Research Report*, No. 2, Honolulu (1981).

Annex 718

Edward J. Goodwin, *International Environmental Law and the Conservation of Coral Reefs* (2011)

International Environmental Law and the Conservation of Coral Reefs

Edward J. Goodwin

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

Annex 718

First published 2011 by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publication Data
Goodwin, Edward J.
International environmental law and the conservation of coral reefs/Edward J. Goodwin.
p.cm.
ISBN 978-0-415-48980-5
1. Coral reef conservation – Law and legislation.
2. Environmental law, International. I Title
K3485.G66 2011
346.04'695'5316 – dc22 2010051269

ISBN13: 978-0-415-48980-5 (hbk)
ISBN13: 978-0-203-81688-2 (ebk)

Typeset in Baskerville
by Swales & Willis Ltd, Exeter, Devon

MIX
Paper from responsible sources
FSC® C004839

Printed and bound in Great Britain by
CPI Antony Rowe, Chippenham, Wiltshire

1 Coral reefs

1 Introduction

It has been estimated that tropical coral reefs occupy 284,300 sq km of the planet's surface.[1] This is less than 0.1 per cent of the total surface area.[2] Despite this relative scarcity, in practical and economic terms, the contribution of these reefs is great. Ecosystem values range from the provision of protein, coastal protection from wave energy, land formation where coral rubble and sand has helped to raise land above sea level enabling human habitation, and acting as a natural wonder, attracting tourists from around the globe.[3] To those in need, reefs may also bring relief from medical conditions, as scientists explore new organic chemicals present in the coral reef ecosystem.[4] Indeed, estimates suggest that coral reefs contribute the equivalent of US$375 billion per year as part of a global total ecosystem value of US$33,268 billion per year.[5] Therefore, based on these estimates, coral reefs contribute 1.13 per cent of the annual total.

Complex natural processes around tropical coral reefs govern the ecosystem, involving predation, climate and erosion. Over time this has meant that the individual coral polyps, the reefs they help build through the deposition of calcium carbonate, and the diversity of life thriving in the myriad niches on offer in the ecosystem, have ebbed and flowed in abundance and geographic distribution.[6] But natural processes are increasingly being disturbed by anthropogenic interference and pressure. Uncontrolled fishing has directly and indirectly harmed coral

1 MD Spalding and others, *World Atlas of Coral Reefs* (University of California, 2001), 17

2 UNEP/WCMC Press Release, *New Atlas Maps the World's Fast Disappearing Coral Reefs*, 11 September 2001

3 CRC Sheppard and others, *The Biology of Coral Reefs* (OUP, 2009), 32

4 Spalding (n 1), 9

5 R Costanza and others, 'The value of the world's ecosystem services and natural capital' (1997) 387 Nature 253, 256. This figure reflects contributions towards disturbance regulation, waste treatment, biological control, habitat/refugia, food production, raw materials, culture and recreation. *See also* ML Martinez and others, 'The coasts of our world: Ecological, economic and social importance' (2007) 63 Ecological Economics 254, 257

6 NE Chadwick-Furman, 'Reef coral diversity and global change' (1996) 2 Global Change Biology 559, 559

reef ecosystems.[7] Growing coastal populations (both permanent and transient), together with the attendant development of urban areas, tourist accommodation and agricultural production, have increased the scale of pollution and sedimentation with which coral reefs must contend.[8] On a wider scale it is estimated that rising water temperatures destroyed 16 per cent of coral reefs worldwide in 1998.[9] Indeed, it is predicted that anthropogenically fuelled climate change will cause the greatest mortality of corals in the coming years through increased coral bleaching, particularly where coral reef ecosystems are also subject to other anthropogenic stresses.[10] The vast economic benefits of tourism come at an additional price as some divers and boats cause physical damage to reefs, while the fish stocks are utilised further to feed visitors and produce curios.[11]

Much scientific energy and effort has now been put into understanding coral reefs and resolving these problems. However, as society comes to better understand these ecosystems and their significance, so it becomes more apparent how urgent it is to take steps to conserve them. What is more, as Mark Spalding observes:

> One of the saddest facts about the demise of reefs is that it is utterly nonsensical. Protecting and managing reefs is not just for the good of the fishes, in every case it also leads to economic and social benefits for local communities.[12]

2 Scope of the study: hermatypic corals and tropical coral reefs

This book considers the progress to date under international law for promoting the conservation of tropical, shallow-water coral reefs. An ecological limitation has therefore been placed on the scope of the research in that deep-water coral reef habitats are not going to be covered. A brief account of the biology of warm-water corals and the reefs these creatures form, highlighting the differences with their cold-water cousins, will help to clarify the implications of this limitation.[13]

Corals, as a biological order, are found throughout the earth's oceans from the tropics to the polar regions. Belonging to the same phylum as jellyfish (Cnidaria) and the same class as anemones (Anthozoa), there is significant variety amongst coral species. Corals can be found both in the cold waters of the oceanic depths and in the shallows of warm tropical seas. Individual corals found in both cold and

7 Direct impacts include dynamite fishing whilst indirect impacts relate to the composition and size of catch; *see* S Jennings and NVC Polunin, 'Impacts of fishing on tropical reef ecosystems' (1996) 25(1) Ambio 44, 44
8 C Wilkinson, 'Status of coral reefs of the world: summary of threats and remedial action' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 23–25
9 C Wilkinson, 'Executive summary' in C Wilkinson (ed), *Status of Coral Reefs of the World* (GCRMN, 2008), 14
10 *Id.*, 7
11 G Jobbins, 'Tourism and coral reef-based conservation: can they co-exist?' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 239–241
12 Quoted in UNEP/WCMC Press Release (n 2)
13 For readers seeking expert coverage of coral reef biology *see* Sheppard (n 3), and JW Nybakken and MD Bertness, *Marine Biology: An Ecological Approach* (6th edn., Benjamin Cummings, 2005) Chapter 9

warm water are capable of depositing calcium carbonate. By increment this contributes either entirely or predominantly to the formation of carbonate skeletons and reef structures.

Some species of coral capable of surviving in the cold, dark waters of the deep oceans can be encountered on the shallower tropical reefs.[14] Nevertheless, there remain significant differences between the two, as listed by Corcoran and Hain.[15] For example, there are only six species of reef-building cold-water corals compared to 800 warm-water corals.[16] Further, calcification rates are much slower for cold-water corals: 25mm/yr^{-1} compared to 150mm/yr^{-1} for warm-water corals.[17]

That greater ability to calcify is the result of one of the most important distinctions between the two groups of corals. The fixing of calcium carbonate from marine water requires the coral polyp to produce large amounts of energy to drive the process. Cold-water corals derive this energy from capturing and consuming zooplankton and other dissolved organic matter carried on the ocean currents.[18] Tropical waters, however, are more barren in terms of readily available food for the corals to capture. Consequently, these warm-water corals have developed a symbiotic relationship with tiny plants called 'zooxanthellae', which live in the coral's cells. The noted shortfall of food is then compensated for by the transfer of energy-rich organic compounds (e.g. sugars, carbohydrates, amino acids) from the zooxanthellae. This energy is produced by the zooxanthellae through photosynthesis.[19] Marine biologists are therefore able to divide corals between those that are host to zooxanthellae and those that are not. They refer to the former as hermatypic corals and to the latter as ahermatypic. Cold-water corals are all ahermatypic whilst warm-water corals are hermatypic.[20]

The reefs constructed by ahermatypic corals in the dark, cold waters of the ocean depths attract fish and invertebrates, resulting in localised abundance. For those with the technology and finances to fish at such depths, they are attractive locations. These reefs are, however, very fragile and susceptible to destruction by trawlers and climate change. Recovery of these habitats is then difficult given the timescales over which calcification is possible. Whilst their presence was known to trawler captains and a few scientists in the mid-nineteenth and early twentieth century,[21] it has only been since the turn of this century that concern for, research into and action to protect these ecosystems has increased.[22]

14 Sheppard (n 3), 46
15 E Corcoran and S Hain, 'Cold-water coral reefs: status and conservation' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 118–119
16 *Id.*
17 *Id.*
18 A Freiwald and others, *Cold-Water Coral Reefs: Out of Sight – No Longer Out of Mind* (UNEP/WCMC Biodiversity Series, 2004), 18
19 L Muscatine and E Cernichiari, 'Assimilation of photosynthetic products of zooxanthellae by a reef coral' (1969) 137 Biological Bulletin 506, 506
20 Corcoran (n 15), 118
21 CM Roberts, *The Unnatural History of the Sea* (Gaia, 2007), 307–308
22 TF Hourigan, 'The status of cold-water coral communities of the world: A brief update' in C Wilkinson (ed), *Status of Coral Reefs of the World* (GCRMN, 2008), 57

Regrettably, coverage of how international law is lending assistance to such scientific endeavour and protection is not possible in this book. The location of these habitats in parts of the high seas where no one state exercises jurisdiction, creates distinct legal problems in comparison to tropical coral reefs, which are not found in these maritime areas. Space and time constraints mean that this book cannot deal with those legal issues as well. There has therefore been a need to prioritise tropical, warm, shallow-water coral reefs and defer an investigation into cold-water reefs.

Prioritising tropical coral reefs for treatment at this time is justified if a little thought is devoted to the distribution of these habitats. There is a mounting sense around the world that tropical coral reefs will be the first major ecosystem to be destroyed because of climate change unless states agree on effective action against this phenomenon and ensure the health of corals so that they can cope with the inevitable changes that are already taking place.[23] Any such loss would have a significant impact on many of the poorest nations. The abundance of life on coral reefs is staggering, given the poor nutrient levels of tropical oceans in general.[24] The gross primary production of nutrients in open tropical oceans is estimated as between 18–50g C/m²/yr.[25] In contrast, tropical coral reefs are one of the most productive of all marine ecosystems, with gross primary productivity estimated at between 1–5kg C/m²/yr.[26] It is this productivity that ensures the survival of many local people.[27] What is more, this productivity is practicably accessible for people with limited resources. This is significant given that the people who live in close proximity to tropical reefs, and rely on their economic and life support functions, are predominantly from poorer developing countries.[28]

3 Reef building and reef distribution

Given this book's prioritisation of warm-water coral reefs, Mark Spalding's definition for these habitats can be adopted. Thus when discussing coral reefs in this

23 D Adam, 'How global warming sealed the fate of the world's coral reefs', *The Guardian* (London, 2 September 2009) <http://www.guardian.co.uk/environment/2009/sep/02/coral-catastrophe-future> accessed 5 October 2009

24 Life on earth depends almost entirely upon inorganic compounds being converted into energy-rich organic compounds, predominantly through the process of photosynthesis by plants and animals. The energy-rich organic material that is not used by the plants and animals responsible for this primary production is released and made available to other organisms or transferred to other organisms when directly consumed. Such gross primary productivity (i.e. before consumption by the primary producers) is measured in terms of grams of carbon produced per square metre per year (C/m/yr). *See further* Nybakken and Bertness (n 13), 64

25 Nybakken and Bertness (n 13), 423

26 T Austin and others, *The Exploitation of Coral Reefs* (Field Studies Council, 1996), 3. Nybakken and Bertness use a slightly more conservative estimate of between 1.5–5kg C/m²/yr, *id.*

27 O Hoegh-Guldberg, 'Climate change, coral bleaching and the future of the world's coral reefs' (1999) 50 Marine Freshwater Research 839, 839

28 Sheppard (n 3), 13

book, reference is being made to: 'a physical structure which has been built up, and continues to grow, over decadal time scales, as a result of the accumulation of calcium carbonate laid down by hermatypic corals and other organisms.'[29]

The most important of the organisms Spalding refers to are coralline algae and the corals themselves. However, whilst coralline algae play an important role in cementing the reef structure together, corals are the principal biological medium through which calcification occurs.[30] Corals, utilising the energy supplied through their symbiotic relationship with zooxanthellae, secrete calcium carbonate created by drawing upon the calcium and carbon dioxide held in solution in the ocean. It has been estimated that in so doing, corals remove about 700 billion kg of carbon per year.[31]

The calcium carbonate skeletons of corals grow at different rates depending upon species, the continued presence of zooxanthellae, age and location. For example, branching corals grow relatively quickly (15cm per year) compared with others types, such as brain corals.[32] Such growth is balanced by erosion, both in the form of bio-erosion – which is the action of various organisms degrading the calcareous substrates – and through other forces of nature, for example wave action or storm damage.[33] The rubble and sand produced by such erosion either fall into fissures in the coral reef (where they may be cemented into the structure by calcium carbonate produced by algae) or are washed inshore to form beaches and other important coastal habitats. Consequently, the net growth or retreat of coral reefs is very slow and takes place over geological timescales.[34]

Tropical coral reefs are not distributed evenly or found throughout the oceans (see Figure 1). They predominate in coastal tropical areas, i.e. between latitudes 25°S and 25°N and in two main swathes: (a) the Caribbean and (b) the Western Pacific and Indian Ocean. The factors that limit reef building by corals and therefore determine the distribution patterns of coral reefs are as follows.

3.1 Temperature

Whilst a few corals can survive at lower temperatures, reef building in shallow, tropical marine areas only occurs where the temperature of the water ranges from a minimum of 18°C to a maximum of 30°C.[35] This limiting factor explains why

29 Spalding (n 1), 16. Note that the term 'reef' has also been used in a maritime context to refer to a shallow ridge of rocks. Such formations are not the subject of this study

30 *Id.*, 15

31 Nybakken and Bertness (n 13), 407

32 Spalding (n 1), 15. One 70-year-old brain coral specimen from Bermuda was estimated to have grown at a rate of 2mm per year; A Cohen and M McCartney, *Seasonally Resolved Records of Surface Ocean Conditions in Brain Coral from Bermuda* (1999) in Papers on Atlantic Climate Variability, Atlantic Climate Change Program, Office of Global Programs, NOAA <http://www.whoi.edu/page.do?pid=30619> accessed 10 August 2010

33 Nybakken and Bertness (n 13), 418

34 Spalding (n 1), 15. Sheppard suggests that net vertical reef growth of 1–10mm per year is commonly cited; Sheppard (n 3), 63

35 Hoegh-Guldberg (n 27), 841

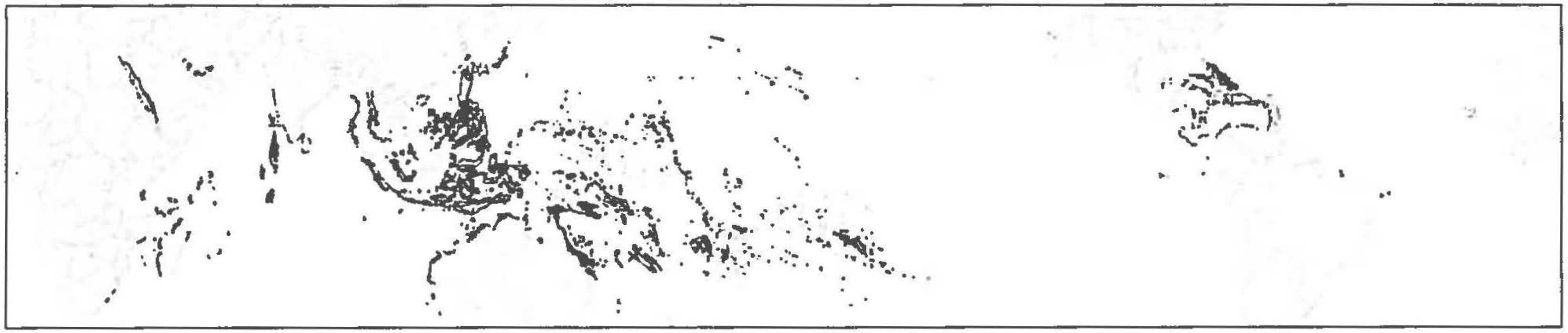

Figure 1 The distribution of coral reefs around the world
Key: Coral reefs are indicated as black areas.

This diagram has been adapted from a map produced by UNEP-WCMC using tools available at http://www.unep-wcmc.org/

coral reefs lie within the 20°C isotherm (i.e. within the boundaries of the tropical biogeographical zone). It also explains, *inter alia*, why shallow reefs are not found on the west coasts of Africa and Central/Southern America, as these coastal areas are cooled by the action of northerly currents and upwelling of cold waters from deeper waters.

3.2 Light and depth

The availability of light is of paramount importance to the development of coral reefs. Whilst corals can survive for short periods of time without zooxanthellae, it is this symbiotic relationship that is the main source of energy for calcification.[36] Insufficient light has the effect of reducing energy supply from the zooxanthellae and accordingly inhibits the ability of corals to secrete calcium carbonate and thus build reefs. Given that light decreases with depth, reef formation is correspondingly limited. Reef building undertaken by warm-water corals therefore flourishes in water depths of less than 25m.[37] and ceases altogether beyond 100m.[38] Reduction in the intensity of light by sedimentation in the water (turbidity) will logically bring the limits of such reef building closer to the surface.

3.3 Sedimentation

Sedimentation can prevent reef formation in two ways. First, coral reproduction through the production and release of coral larvae depends upon the larvae being able to settle upon solid substrata in order to fix themselves to a firm foundation – something which will not be present if sedimentation covers the sea floor with a fine mud.[39] Further, once a colony has been established, subsequent sedimentation may cause corals to become smothered. Corals have a natural mechanism for removing small amounts of sediment (as mucus can be secreted to carry it away) but this response cannot cope with larger quantities since this clogs the corals' feeding structures.[40]

3.4 Salinity

Being marine animals, corals require salinity levels that do not differ far from the norm.[41] It is for this reason that reefs do not form where rivers discharge fresh water into the ocean. Consequently, reefs do not form on the coast of South America where the Orinoco and Amazon flow into the sea, or on the west coast of Africa

36 Hoegh-Guldberg (n 27), 859
37 Nybakken and Bertness (n 13), 109
38 Austin (n 26), 1
39 Spalding (n 1), 22
40 H Schuhmacher, 'Ability in fungiid corals to overcome sedimentation' (1977) Proceedings, Third International Coral Reef Symposium 503, 503
41 DW Souter and O Linden, 'The health and future of coral reef systems' (2000) 43 Ocean and Coastal Management 657, 657

where the Congo and Niger discharge fresh water and sediments. On a smaller scale, small breaks in fringing coral reefs can be observed in the tropics where streams or smaller rivers flow into the sea and thus lower salinity levels.

3.5 Low tide levels and exposure to air

The last limit to coral reef development is that of exposure to air, which is in turn linked to the level of the lowest tide. Stark illustration of this factor was provided when reefs around Sumatra and the Andaman Islands were pushed up out of the ocean and died following the earthquake that triggered the tsunami in December 2004.[42] That said, corals can withstand short periods of time exposed to the air (1–2 hours) since the previously mentioned mucus mechanism can also provide protection at such times against drying and therefore dying.[43]

4 Coral reef ecosystems: a marine oasis

Life on earth does not exist in isolation – species interact with each other and their physical environment in order to survive. The term 'ecosystem' is used to describe the interactions between biotic (living) and abiotic (non-living) components.[44] The term 'coral reef ecosystem' in this study is therefore defined by: (a) the community of organisms interacting with and (directly or indirectly) dependent upon each other and the reef environment and (b) the coral reef in which they live. In this way, threats to coral reef ecosystems include threats to the reef itself as well as the corals and other reef inhabitants.

Where conditions are suitable, coral reefs form the foundations for what is one of the most diverse ecosystems on the planet. It is an often repeated cliché that coral reef ecosystems are the rainforest of the sea, yet statistics support such a comparison.[45] There are an estimated 4,000 species of coral reef fish worldwide (one quarter of all marine fish species), which is comparable to the variety of birds found in rainforests.[46] The total number of species of animals and plants found on coral reefs is estimated at between 600,000 and 9 million.[47]

42 Wilkinson (n 9), 10

43 C Wild and others, 'Coral mucus functions as an energy carrier and particle trap in the reef ecosystem' (2004) 428 Nature 66, 66. For an example of mortality caused by low tides *see* Y Loya, 'Recolonization of Red Sea corals affected by natural catastrophes and man-made perturbations' (1976) 57 Ecology 278, 279

44 The essence of such interactions lie at the heart of some significant definitions of an ecosystem, for example, the Convention on Biological Diversity defines an ecosystem as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'; 1992 Convention on Biological Diversity (adopted 5 June 1992, entered into force 29 December 1993) 31 ILM (1992), 818, Article 2

45 Spalding (n 1), 27

46 *Id.*

47 Sheppard (n 3), 13

Of course, diversity within coral reef ecosystems varies throughout the oceans.[48] Austin observes that records of coral diversity show a pattern of concentration centred on South-East Asia (particularly the triangle bounded by Indonesia, the Philippines and northern Australia), in contrast to much lower levels of diversity in the Atlantic and Caribbean.[49] The reason for the pattern is principally linked to tectonic and climatic history. Oceans became isolated by the movement of continents and glaciations affected some areas more than others.[50]

With such an abundance of life found on coral reefs, many species have had to adapt to living within small niches; both physical niches and through focusing effort towards specialised diets. Further, the interactions between the resident species are highly complex. A few of these relationships merit discussion so as to inform this study's later discussion on human impacts on reef ecosystems.

5 Interaction, predation and grazing upon corals and algae

Corals are in constant competition with each other to dominate space on the reef and receive light. For example, as already noted, some corals grow faster than others, such as the branching corals. Such accelerated growth helps these species to outrun others into the prime positions. That said, the continued existence of the slower-growing massive corals indicates that these species have developed responses enabling them to compete with their faster-growing relatives. One such method is the extension of filaments from the gastro-vascular cavities that are capable of killing tissues of competing coral species in close proximity.[51]

These competitive interactions between coral species are further complicated by the impact of other species. For example, corals are in competition with other invertebrates, especially algae. Algae are of particular importance to the coral reef ecosystem.[52] Red coralline algae secrete calcium carbonate and, as they are spread out over the reef in a thin layer, cement together various pieces of calcium carbonate into the coral reef structure.[53] In so doing, the entire reef is strengthened and reinforced. However, if left unchecked, algae can advance over much of a reef, smothering coral polyps and preventing their growth and dispersal.[54] This state of affairs is primarily avoided through intensive grazing on the algae by fish and sea urchins who, it is estimated, jointly remove in excess of half of the algal cover on a reef.[55] Removing such species can therefore have disastrous consequences for the health of a reef ecosystem.

48 Here, diversity refers to the variability amongst the living organisms found within the coral reef ecosystem
49 Austin (n 26), 3
50 For an in-depth discussion *see* Chadwick-Furman (n 6), 559; Sheppard (n 3), 10–17
51 Nybakken and Bertness (n 13), 429; Sheppard (n 3), 44–45
52 Sheppard, (n 3), 57–59
53 Spalding (n 1), 15
54 Sheppard (n 3), 174
55 Nybakken and Bertness (n 13), 431

6 How do coral reef ecosystems help humankind?

For many millennia coral reefs and their ecosystems have been supporting human life in physical, economic and nutritional terms. In more recent times, scientific research and the growth of the tourist industry have also developed around these habitats. Each will be looked at in more detail.

6.1 Fisheries and food production

Coral reef ecosystems have provided crucial protein to generations of humans dating back at least 30,000 years.[56] More recently, it has been estimated that fish catch from reefs is 6 million metric tonnes.[57] On top of this, an estimated 9 million metric tonnes of shellfish and other molluscs are taken per year in and around coral reefs.[58] Charles Sheppard and others estimate the annual value of the fishery to be US$5 billion.[59] These figures may be on the conservative side since they do not reflect the additional harvesting of resources through subsistence fishing by local fishers.

The nature of this fishery is quite particular. Most fishing activity around reefs is undertaken by local people, using traditional methods, to support local needs.[60] Catch is often multi-species (e.g. groupers, jacks, snappers, puffer fish), partly because of the diversity of life found in coral reef ecosystems, but also because pressures from large local populations mean that sources of protein must be maximised.[61] That said, occasionally single species can support dedicated industries, as is the case with spiny lobsters and sea cucumbers.[62]

Coral reef ecosystems are not, however, harvested purely as a food source. Catching fish, removing pieces of live coral rock and harvesting other ecosystem inhabitants for the aquarium trade is far more lucrative. In 2000, Spalding recorded that 1kg of live fish caught in one island state was valued at US$500 to the aquarium trade, whilst the same kilo would have been worth only US$6 as food.[63] Properly managed, such trade can be highly lucrative and sustainable.[64] If the revenue produced from trade in other reef products (such as pearls and coral-based jewellery) is factored in,[65] clearly coral reef fisheries are extremely beneficial to humans.

56 Spalding (n 1), 17
57 Austin (n 26), 7
58 Souter and Linden (n 11), 659. *See also* the estimate prepared by Costanza (n 5), 253
59 Sheppard (n 3), 192
60 *See* M Watson and RFG Ormond, 'Effect of an artisanal fishery on the fish and urchin populations of a Kenyan coral reef' (1994) 109 Marine Ecology Progress Series 115
61 Wilkinson (n 8), 22–23
62 Sheppard (n 3), 196–202
63 Spalding (n 1), 50–51
64 *See further* Chapter 8
65 ACJ Vincent, 'Live food and non-food fisheries on coral reefs' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 196–197

6.2 Genetic resources and bioprospecting

Natural ecosystems are a valuable resource to medical and scientific research. Given that knowledge on coral reef ecosystems only began to develop in the latter half of the last century, the full potential of these ecosystems to science and medicine is only now beginning to be recognised. As Spalding notes, many reef inhabitants have had to develop diverse forms of defence within the complexities of the ecosystem against a broad range of predators, and this has driven the development of biochemical compounds in numerous and potentially valuable directions.[66] Of particular interest to the scientific community are possible alternatives to established (and now weaker) antibiotics that can be derived from toxins found in coral reef inhabitants such as puffer fish.[67]

Such bioprospecting is controversial. Whilst a need to encourage research and development exists, a balance is called for to ensure source countries receive a fair return from exploitation of their natural resources. This is especially the case where research and development is conducted by drug companies based in other states.[68] Further, it is difficult to cultivate these useful marine organisms in captivity, so pressures on naturally occurring stocks to supply potentially large demands raise concerns over sustainability.[69]

6.3 Coastal protection and land formation

The iconic view of a tropical coast involves beaches of pale sand, with surf breaking in the middle distance. In fact, such views may well owe a debt to the crucial role that coral reefs play in protecting many islands from the force of waves as well as their role in land formation. Corals thrive in moderate wave action. The barrier that forms as the corals and other calcifying organisms lay down calcium carbonate, shields the land by breaking the power and action of those waves.[70] Further, the nature of calcification by algae, and the breaking down of coral into small particles by reef fish, is the main source of the sand that washes into the calm waters behind a reef, eventually forming beaches.[71]

Even in the wake of storms where break-up of the reef structure can occur, the rubble and sand created are often forced up onto the land. This build-up creates higher ground, which over time becomes the substrata upon which vegetation grows and humans can survive. This process of land formation is the very foundation of many small island states.[72]

66 Spalding (n 1), 53–54
67 *Id.*
68 *See* P Birnie and others, *International Law and the Environment* (3rd edn., OUP, 2009), 801–809
69 Nybakken and Bertness (n 13), 531
70 UNEP/WCMC, *In the Front Line: Shoreline Protection and other Ecosystem Services from Mangroves and Coral Reefs* (UNEP/WCMC, 2006), 14
71 *Id.*, 15
72 Spalding (n 1), 55

6.4 Tourism

According to the World Tourism Organisation, 898 million people travelled to a foreign country in 2007; an increase of around 100 million over two years.[73] This promised an increase in tourism revenues of over US$740 million.[74] Whilst the economic downturn has had an impact upon the numbers travelling in the following two years,[75] tourism remains a significant revenue stream. One area of growth in tourism has come from people wanting to snorkel and dive around reefs.

The number of people diving each year can be difficult to determine with precision. Figures based upon the number of registered divers according to certification agencies such as the British Sub-Aqua Club and the Professional Association of Diving Instructors, merely give an indication of the considerable and growing interest in the sport.[76] In addition, many dives go unrecorded as dive operators offer one-off (pre-certification) 'try dives' so as to introduce people to the sport. What can be observed is that reef-based tourism, as a result of the growth in interest in diving and the increased affordability of international flights, is expanding and extremely lucrative. In a ten-year period from 1985 to 1995, the number of people visiting the Great Barrier Reef in Australia grew from 1.1 million to over 10 million, whilst the value of this tourism to the same area was estimated at US$700 million in 1997.[77] Elsewhere, capacity for tourists in the Sinai Peninsula, Egypt, grew from 1,030 beds in 1988, to over 15,000 by 1998. The Egyptian government has set a ceiling to this capacity at 160,000 beds and this is expected to be reached by 2017.[78] Such expansion is linked to the reefs that fringe the shores of the Red Sea and Gulf of Aqaba, attracting many divers from around the world and in particular from Europe.[79]

Clearly, coral reef ecosystems form a strong basis for tourist developments whether as a destination for divers, or simply for travellers seeking sandy beaches and warm waters.

73 World Tourism Organisation, 'World tourist arrivals: from 800 million to 900 million in two years' (2008) 6(1) World Tourism Barometer 1, 1

74 Figure calculated using data available in World Tourism Organisation, *id.*

75 World Tourism Organisation, 'Testing times for world tourism' (2009) 7(2) World Tourism Barometer 1, 1

76 Spalding estimates that there are 15 million registered recreational divers, although there is no indication whether this includes divers who hold more than one level of qualification, e.g. a Professional Association of Diving Instructors 'Open Water' diver who has taken further training and gained certification as an 'Advanced Open Water' diver; Spalding (n 1), 54

77 *Id.*, 55

78 MP Pearson and AI Shehata, 'Protectorates management for conservation and development in the Arab Republic of Egypt' (1998) 8(2) Parks 29, 31

79 The revenue from scuba diving could be increased, as one study has found a willingness on the part of divers to pay an entrance fee to marine parks, with willingness increasing if such payments are received and managed by NGOs; *see* T Arin and RA Kramer, 'Divers' willingness to pay to visit marine sanctuaries: an exploratory study' (2002) 45 Ocean and Coastal Management 171

7 Human impacts

Human impacts upon coral reef ecosystems are varied. They relate to pollution, sedimentation, fishing, climate change and non-fishing-related physical damage. Understanding the nature of these threats helps to focus conservation strategies to tackle each problem.

7.1 Pollution, sedimentation and nutrification

Increased pollution, sedimentation and nutrification attributable to human activity have four negative consequences for corals, reef building and the ecosystem: they may (a) impair photosynthesis, (b) tip the careful competitive balance within the ecosystem against corals, (c) smother coral polyps and (d) harm the reproductive system of corals.

Reference has already been made to the significant role of photosynthesis by zooxanthellae for satisfying the energy requirements of coral polyps. Because of this, light levels as depth increases limit coral density and reef formation. Further, naturally occurring sediment at freshwater outlets reduces light levels and again contributes to the absence of reefs at such points. These are natural limits on the ability of corals to gain energy from the photosynthetic process. However, anthropogenic increases in sediment and pollution can have a similar effect.

Discharging sewage into marine waters is practised around the world. This increases both the level of nutrients found in the water, and particle suspension when the sewage breaks down.[80] The latter increases sediment levels in the water in terms of density, whilst the former results in algal blooms and increases in phytoplankton in the water.[81] Both inhibit the penetration of light and therefore the potential for photosynthesis.

Increases in nutrients from sewage discharge and agricultural practices in the watershed, can also alter ecosystem community structures. Corals can only maintain a competitive edge over algae when nutrient levels are low.[82] As a result, the introduction of more nutrients by humankind's action tips the balance in favour of fleshy algae. Under such favourable conditions, algae will overgrow and kill the coral, as well as repelling the dispersal and establishment of coral larvae in new areas.[83]

Reproduction, dispersal and recovery of corals are also hampered by increased pollution and sedimentation. Coral larvae prefer to settle on solid substrata in order to become established.[84] An increase in fine silts settling on the sea floor deprives larvae of such conditions and therefore limits the ability of corals to disperse. It has also been suggested that oil pollution can harm the reproductive

80 Nybakken and Bertness (n 13), 521
81 Spalding (n 1), 57
82 Sheppard (n 3), 221
83 Spalding (n 1), 57
84 Sheppard (n 3), 155

systems of corals, affect coral larvae and alter the physical properties of reefs.[85] However these factors may combine, it has been observed that following severe perturbations to corals (such as prolonged exposure to the sun and air following low tide), recovery in polluted environments may never be fully achieved.[86]

Despite the observation above, oil pollution poses a limited threat to corals given their ability to secrete mucus, thereby clearing away oil deposits.[87] Such pollution is commonly the result of vessels discharging ballast water from oil tanks or when such tanks are cleaned, rather than the less frequent (but more widely publicised) oil spills caused by ships running aground or breaking up. Areas that suffer from such pollution include the Gulf of Aden, the Panama Canal and the port of Eilat.

The causes of increased sedimentation, nutrification and pollution are often linked to the growth of human populations.[88] As growing populations need feeding, so agricultural development expands and intensifies, with land being cleared and enriched with fertilisers. Thus more soil and fertiliser enters the catchments of freshwater river systems and ultimately the sea.[89]

Urbanisation to accommodate the growing population compounds the problem. A good illustration of this is provided by events at Kaneohe Bay on the Island of Oahu in Hawaii. James Nybakken and Mark Bertness recount that urbanisation following the outbreak of the Second World War resulted in a tenfold increase in domestic sewage discharges and in increased sedimentation, particularly from storm run-off.[90] As a result, two-thirds of the corals that had once thrived in the bay were destroyed and green algae came to dominate. Fortunately, in 1978 sewage discharges were eliminated, and by 1983 the turbidity of the water had been reduced and corals started to recover.[91]

7.2 *Fishing*

Increasing population levels in coral reef areas and modern fishing techniques place great demands upon coastal fisheries, particularly where access to such resources is practicable for many.[92] Indeed such fisheries supply 10 per cent of the world's

85 NOAA, *Oil Spills in Coral Reefs* (NOAA, 2001), 29. It is worth noting that certain species of warm-water coral are able to remove oil from their outer surfaces through secreting mucus; R Endean, 'Destruction and recovery of coral reef communities' in O Jones and R Endean (eds), *Biology and Geology of Coral Reefs Vol. 3* (Academic Press, 1976), 233–234

86 Loya (n 43), 285. In comparison, the recovery of another local reef, which was not subject to pollution from the local oil facilities at the port of Eilat (the control reef), showed signs of recovery. Yossi Loya concluded that the recovery of reefs unperturbed by human pollution was mainly a function of time.

87 *See* Endean (n 85)

88 K Fabricius, 'Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis' (2005) 50 Marine Pollution Bulletin 125, 125, and more generally on the effects of sedimentation and pollution

89 Roberts (n 21), 248–249

90 Nybakken and Bertness (n 13), 521

91 *Id.*

92 Spalding (n 1), 59

seafood.[93] If the effects of the aquarium, jewellery, medicine and live-fish trades for restaurants are factored in,[94] the need to actively manage harvests of marine life at sustainable levels becomes particularly pressing.

Human pressure upon coral reef ecosystems from fishing relates to two issues. The first is linked to the methods employed by fishermen and principally causes direct physical impacts to corals and the reef. The second is linked to the type and size of harvest that any given reef is subject, and which has repercussions for community structures.[95]

7.2.1 Harm from fishing methods

Methods of catching fish and other marine animals vary, reflecting the diversity of life in coral reef ecosystems. Such 'multi-gear' fisheries range from harvesting by hand, use of spears, fish traps and nets. These methods have, over time, been adapted to increase efficiency. For example, the development of masks and spear guns has improved the efficiency with which spear fishermen can catch fish, with significant consequences for the abundance of target species.[96]

Other methods are less selective but just as damaging. The use of nets on reefs results in breakage of corals, particularly the branching form *Acropora*. Further, muro-ami fishing involves people diving down and dropping weighted lines onto coral reefs in order to scare and drive fish towards a pre-set net. Here, both the nets and weights damage the reef.[97]

Blast fishing is a particular problem in South East Asia and East Africa.[98] Explosives are often home-made from fertilisers and bottles or drums. Such devices are detonated after lighting a fuse and dropping them onto reefs. One estimate claims that a bottle bomb containing 0.5kg of explosive will shatter all the coral reef structure within a 1.15m radius and that a gallon-sized drum filled with explosives will reduce the coral reef to rubble within a 5m radius.[99] The killing zone of fish and invertebrates is far wider.

The impacts of such blast fishing are far more complex than simply reducing coral skeletons to rubble. Diversity on coral reefs is partly the result of the complex topography that offers various habitats for marine species. Destruction of this topography therefore reduces that variety. Further, as with the various netting techniques noted earlier, blast fishing is indiscriminate and leads to many fish being wasted. Fish may also be recovered by other marine animals and birds before they can be harvested by humans, or they may fall into areas where they cannot be recovered.

93 Vincent (n 65), 183
94 *See* Vincent (n 65)
95 For a similar division into direct and indirect impacts *see* Jennings and Polunin (n 7), 44
96 Spalding (n 1), 48. Callum Roberts highlights the serious impact of the spear fishing exploits of Hans Hass in the 1940s and 1950s around Bonaire and Curaçao upon the populations of the largest, oldest and most reproductive fish on the reefs – for example the goliath grouper; Roberts (n 21), 215–217
97 Souter and Linden (n 41), 665; Spalding *id.*
98 Souter and Linden *id.*, 664
99 Jennings and Polunin (n 7), 45

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The demand for live fish from the aquarium trade and from restaurants in Asian countries[100] drives another form of fishing. The use of organic or cyanide-based poisons to stun fish, which can then be harvested live, has grown as a practice ever since its introduction in the 1960s in the Philippines.[101] Whilst the effects of such poisons on corals and human consumers are only just being explored, this practice also encourages unsustainable catch levels since non-target fish die as by-catch, whilst target fish may not survive the effects of the poison when in transit.[102]

Such destructive practices can combine to severely degrade coral reef ecosystems through their direct impact upon the reef structure and the ecosystem as a whole. The elimination of such practices is regarded as a prerequisite to any quotas supporting sustainable fisheries.[103]

7.2.2 Fisheries management and quotas

The projected growth of coastal populations is so great in some island states that it has been estimated that by 2050 there will be a demand for an extra 196,000 km^2 of productive reef to support these people using the current fishing practices.[104] Even with advances in artificial reef construction, this will be difficult to create, which means existing fisheries have to be managed more sustainably. Uncontrolled exploitation of fisheries, however, is currently widespread, leading to a number of undesirable consequences for coral reefs.

Excessive fishing on coral reefs leads to a reduction in the abundance and average size of specimens, ultimately resulting in populations of immature individuals. If such overfishing continues, then reproduction rates fall. The effects of such overfishing, if identified in time, can be reversed following the cessation of fishing activities. However, ecosystems have limits beyond which continued fishing will have irremediable effects. The experiences of Jamaica are often cited by way of illustration.[105]

Studied continuously since the 1950s, Jamaican reefs are probably some of the best recorded in the world and local human impacts some of the best studied over a long period of time.[106] Population pressure in the 1960s led to an increased demand for food, which was in large part satisfied from the abundant life found on fringing reefs.[107] The Jamaican fisheries began to overexploit the resource so that by the

100 Amanda Vincent records that 30,000–35,000 tonnes of such live fish was imported into Hong Kong in the 1990s, accounting for 60 per cent of such demand. These fish were sourced from Australia, Vietnam, Indonesia, Malaysia and the Philippines; Vincent (n 65), 187–188

101 D Bryant, *Reefs at Risk – a Map-Based Indicator of Threats to the World's Coral Reefs* (WRI, 1998), 15. Bryant estimates that more than 1 million kg of cyanide has been squirted onto Philippine reefs since the introduction of cyanide fishing

102 Vincent (n 65), 186

103 Jennings and Polunin (n 7), 45

104 K Newton and others, 'Current and future sustainability of island coral reef fisheries' (2007) 17 Current Biology 655, 657

105 Austin (n 26), 13; Souter and Linden (n 11), 666; Nybakken and Bertness (n 13), 453

106 Nybakken and Bertness *id.*

107 *Id.*

beginning of the 1970s the biomass on Jamaican reefs had been reduced by 80 per cent.[108] Composition of reef species changed (an indicator of overfishing) so that sea urchins became the dominant grazers on algae rather than herbivorous fish. This at least allowed the coral to remain dominant.[109] Nevertheless the change in composition of reef species, caused by the removal of competing herbivorous fish and urchin predators (such as trigger fish) created an over-reliance upon urchins to maintain that coral dominance.[110]

Corals continued to survive whilst the sea urchins kept the competing algae in check. However, a water-born disease that appeared in 1982 spread through the sea urchin population,[111] reducing numbers by 99 per cent.[112] Consequently, algae came to dominate the shallow waters. Coral cover along the Jamaican coastline fell from 52 per cent in 1977, to 3 per cent by 1993, with algal cover increasing by up to 92 per cent at the end of the same period.[113] Overfishing had ultimately caused the loss of the majority of Jamaica's coral reef ecosystems.

Traditional single-species management approaches are difficult to apply to reef-based fisheries. The complex interactions of species demand a more holistic, ecosystem-based approach.[114] Promoting this is one challenge; adopting the appropriate management structure possibly an even greater one. Many different approaches need to be considered, such as limiting the number of fishers through permits, limiting the permitted hours for fishing, designating no-take zones, controlling the size of catch, or a combination of these.[115] Further, Simon Jennings and Nicholas Polunin suggest that whichever approach is adopted, and provided wasteful and destructive fishing practices are eradicated, it should not be forgotten that coral reef fisheries should be managed on the basis of harvesting a diverse range of fish and invertebrates.[116]

Of course, whilst ecosystem-based management approaches are key to the general protection of coral reef fish stocks, some individual species will remain the target of fishing because of their particular value to the market. Queen conch and giant clams are heavily exploited for their meat, with the Philippines exporting 252 tonnes of the latter to Taiwan and Japan in 1990, whilst demand for 'bêche-de-mer' places pressure upon populations of sea cucumber.[117] Further, wrasse and grouper populations in South East Asia have been drastically reduced because of

108 *Id.*

109 W Precht and R Aronson, 'Death and resurrection of Caribbean coral reefs' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 42. For similar links between fishing and sea urchin populations, *see* Watson and Ormond (n 60), 122

110 Precht and Aronson, *id.*

111 The origin of the disease may have been natural or may, it has been suggested, have been introduced through the Panama Canal or in the ballast water of a vessel; Spalding (n 1), 61

112 Nybakken and Bertness (n 13), 453

113 *Id.*

114 Jennings and Polunin (n 7), 44

115 T McClanahan, 'Challenges and accomplishments towards sustainable reef fisheries' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 165

116 Jennings and Polunin (n 7), 48

117 Austin (n 26), 9

the demand for live imports from Asian restaurateurs, causing the search for such fish to spread into previously untouched areas of the Indian Ocean and Western Pacific.[118] For these species it is often the larger specimens that have the greatest reproductive potential but also market value. Recovery of populations is therefore slow where they are targeted.[119] Such species therefore require focused protective measures.

In summary, apex predators in the ecosystem (like groupers) may be singled out for intensive harvesting, whilst those at the lower levels of the system are taken as catch, or killed as by-catch. As a result, fishing attacks coral reef communities from above and below, leading to serious consequences for the life-supporting functions of the ecosystem.

7.3 Non-fishing-related physical damage

Physical damage to reefs caused by humans is also the result of non-fishing activities. Such damage is commonly related to coral mining and tourism.

Smaller island nations, particularly those occupying atolls, have few resources in terms of building materials.[120] In the past, people living in such states have met their needs through utilising broken, fossilised and dead coral reef, as well as using coral rock to produce lime for mortar, plaster and for agricultural purposes.[121] However, demand has increased in recent years leading to the unsustainable mining of coral rock from local reefs.[122] Recovery from such activity is negligible and leads to reduced coastal protection.[123] Whilst such practices may be outlawed in most states, illegal mining is lucrative and the law is difficult to enforce.[124]

Some of the side effects of tourism have already been discussed. The loss of coral reefs through the reclamation of coastal areas for resort development also needs to be highlighted.[125] The engineering involved not only destroys areas of reef directly, but also creates increased sedimentation, whilst the permanent structures can alter current flows upon which reefs previously depended.[126] In addition, indirect loss may arise where reclamation involves the destruction of mangrove ecosystems. Mangroves are particularly important as they help to support nearby coral reef ecosystems through trapping riverine sediments and providing safe waters for juvenile reef fish.[127]

118 Spalding (n 1), 19; *see also* Vincent (n 65), 187
119 Spalding, *id.*
120 Austin (n 26), 17
121 *Id.*
122 Souter and Linden (n 41), 662
123 Austin (n 26), 17
124 *Id.*, 18
125 Jobbins (n 11), 240–212; UNEP/WCMC (n 70), 9–10. Dredging and reclamation of reefs is also associated with housing developments or industrial use; *see* Sheppard (n 3), 225–229
126 Sheppard, *id*
127 P Mumby and A Harborne, 'A seascape-level perspective of coral reef ecosystems' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 78

Further, as this study has indicated, diving has rapidly expanded as a recreational activity for many tourists. The precise effects of such activities are still poorly understood. Certainly, without careful coordination at dive sites, dive boats can cause physical damage where anchors are dropped or boats run aground.[128] In addition, divers may break corals where reefs are used as hand holds or where corals are kicked by fins.[129] Scientists also believe that the disturbance of bottom sediments as divers swim over reefs may stress organisms.[130]

Nevertheless, it is not believed that diving causes coral reef ecosystems long-term harm, particularly relative to the damage caused by fisheries and mining.[131] However, the impacts do cause the reefs to become less aesthetically attractive, causing divers to move to other more pristine reefs.[132] If reefs are to be sustainably managed in order to maximise income from the diving industry, it is important to establish the level of diving activity that will not cause such aesthetic damage.

7.4 Climate change and ocean acidification

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released their latest series of reports on climate change. The latest estimates for increased global average surface temperatures are 1.8–4°C, whilst sea levels are expected to rise 18–59cm.[133] Coral reefs were identified as being particularly vulnerable to increasing acidity of marine waters, increased storm intensity and raised sea temperatures.[134] Indeed, many now consider the negative effects of global climate change and carbon dioxide emissions to be the greatest threat to the future of coral reef ecosystems.[135]

In isolation, sea level change should not adversely affect corals. It is believed that many coral reefs have already reached their upward limit of growth and that such constraints would be broken by increases in the levels of the oceans.[136] Coral reefs are known to grow at rates of 10–100cm per century and therefore the predicted rate of sea level change will not pose problems.[137] However, if the ability for coral reefs to grow is significantly impaired by other human pressures, or as a result of the stresses noted by the IPCC as linked to carbon dioxide and other greenhouse gas emissions, then sea level change may begin to represent more of a challenge to corals.[138]

128 *See* Sheppard (n 3), 232
129 Jobbins (n 11), 239–240
130 D Davies and C Tisdell, 'Recreational scuba-diving and carrying capacity in MPAs' (1995) 26(1) Ocean and Coastal Management 19, 32
131 Jobbins (n 11), 241
132 Davies and Tisdell (n 130), 32
133 IPCC, *Climate Change 2007: Synthesis Report. Summary for Policymakers* (IPCC, 2007), 45
134 IPCC Working Group II Report, *Impacts, Adaptation and Vulnerability* (IPCC, 2007), 91
135 C Wilkinson, 'Executive summary' in *Status of Coral Reefs of the World* (GCRMN, 2002), 7
136 Chadwick-Furman (n 6), 566
137 *Id.*
138 Hoegh-Guldberg (n 27), 859; Sheppard (n 3), 250

The actual impact of increased levels of carbon dioxide upon coral reefs is also beginning to become clearer as scientists expand our understanding of the consequential changes in water chemistry.[139] Research suggests that if carbon dioxide saturation in water increases, so the presence of carbonate compounds (which are the key to calcification) decreases.[140] Further, these projections also indicate that, even though carbonate compounds will be most abundant in tropical waters, concentrations will still have dropped in such latitudes to levels resulting in a significant reduction in calcification rates by 2100.[141] The consequences would be weaker coral skeletons and greater erosion of coral reefs, particularly by wave action and during the fierce storms predicted under climate change models. Further, it is suggested that expansion of warmer sea surface temperatures into higher latitudes does not automatically imply an expansion of coral reefs into these waters: again because of the insufficient levels of saturated carbonate compounds at these latitudes.[142]

Mass coral bleaching has been headline news, particularly so following the event of 1998 in which 16 per cent of the world's corals were killed in a period of nine months.[143] When corals are placed under stress, they tend to expel their zooxanthellae, or simply the pigment in the zooxanthellae, thereby taking on a bleached appearance as their skeletons become visible.[144] This reduces the amount of energy the coral gains from the photosynthetic process and impairs calcification. If the stress that induces the bleaching persists over a prolonged period, this loss of energy supply impairs reproduction, growth and ultimately leads to the death of corals.[145] One of the main causes of stress known to induce bleaching is an increase in water temperature.[146] It is this fact that places coral reefs in further danger from the global climate change phenomenon.

The El Niño-Southern Oscillation (ENSO) has often been linked to bleaching caused by temperature stress as it can cause abnormally high (albeit temporary) sea surface temperatures.[117] The link to global climate change is that, assuming corals

139 *See* Sheppard (n 3), 247–249

140 R Feely and others, 'Impact of anthropogenic CO_2 on the $CaCO_3$ system in the oceans' (2004) 305 Science 362, 365

141 *See* JA Kleypass and others, 'Geochemical consequences of increased atmospheric carbon dioxide on coral reefs' (1999) 284 Science 118

142 Kleypass, *id.*, 119

143 C Wilkinson, *Status of Coral Reefs of the World: 2000* (GCRMN, 2000), 1; Sheppard (n 3), 239–246

144 Hoegh-Guldberg (n 27), 847

145 *Id.*, 849

146 E Williams and L Bunkley-Williams, 'The world-wide coral reef bleaching cycle and related sources of coral mortality' (1990) 335 Atoll Research Bulletin 1, 33

117 As recorded by Kevin Trenberth, 'El Nino' originally applied to the running (around December) of a warm current in a southerly direction along the coastal waters of Peru and Ecuador. Today it is used by scientists to describe the warm phase of a different phenomenon, the El Niño-Southern Oscillation (ENSO), when there is an increase in ocean temperatures in the Pacific Basin and sea level atmospheric pressure in the Western Pacific. The cold phase of ENSO events is called 'La Niña'. The general public, however, tend to use the term 'El Niño' as the term for the whole ENSO event; K Trenberth, 'The Definition of El Niño' (1997) 78(12) Bulletin of the American Metrorological Society 2771, 2771–2772 and 2777

and their zooxanthellae cannot adapt at a pace matching the increases in average sea temperatures linked to climate change, then ENSOs with a weaker warming phase will cause maximum temperatures to be exceeded on a regular basis.[148] Ultimately, due to climate change, the sea surface water temperatures may themselves exceed those maximum temperatures on an annual basis; a point it is predicted will be reached in most reef areas within the next 25 to 60 years.[149]

There has been some debate about the ability of corals to adapt to rising sea temperatures by recruiting different species of zooxanthellae less prone to heat stress.[150] Nevertheless, as Ove Hoegh-Guldberg notes, the recent increased frequency of bleaching events at the same sites suggests that corals have so far been unable to adapt fast enough.[151]

Initial recovery following the last major mass bleaching event in 1998 was mixed. Corals showed 'slow to steady' signs of recovery, although not where reefs were subject to human pressures such as overfishing, high sedimentation levels or nutrient pollution.[152] Thus bleaching of corals as a result of increases in sea surface water temperatures linked to ENSO events, together with the additional damaging consequences of climate change and CO_2 emissions, are clearly of paramount concern to those involved in the conservation of coral reef ecosystems. This is particularly so where climate change effects are entangled with the other anthropogenic stresses that have been described.

8 Responses

Whilst the anthropogenic threats faced by coral reef ecosystems seem numerous and varied, conservation efforts to deal with them can be understood as amounting to two simple pursuits; management and education.

8.1 Education

In relation to the latter, educating stakeholders on the advantages of sustainable practices, at both the community and government level, is often a conservation

148 Hoegh-Guldberg (n 27), 852
149 Sheppard (n 3), 215
150 *Id.*, 121
151 Hoegh-Guldberg (n 27), 856. *See further* CM Eakin and others, 'Global climate change and coral reefs: Rising temperatures, acidification and the need for resilient reefs' in C Wilkinson (ed), *Status of Coral Reefs of the World* (GCRMN, 2008), 31. Recent findings from Australia, however, indicate that the ability of a species of coral to acclimatise may be improved where different types of zooxanthellae are present in the coral polyp. The findings indicate that time may be bought for such coral species where they can alter the proportion of one type of zooxanthellae over another, leading to the dominance of a more heat-tolerant type; *see* R Berkelmans and MJH van Oppen, 'The role of zooxanthellae in the thermal tolerance of corals: A "nugget of hope" for coral reefs in an era of climate change' (2006) Proceedings of the Royal Society B 1
152 Wilkinson (n 143), 7. Some reefs have now made a good recovery, although again not those subject to other human impacts; Wilkinson (n 9), 1

priority.[153] Spalding claims there is widespread agreement that the central message is that immediate economic gains through unsustainable harvesting of coral reef resources, pollution, poor agricultural practices and unplanned development cause short-term harm and more serious impacts in the longer run.[154] In contrast, management based upon sustainable use and planning can bring immediate economic rewards and social benefits.[155]

Of course, dealing with educational issues goes beyond simply informing local communities. Society must also seek to close gaps in its scientific knowledge. It has, for example, been said that whilst man is increasingly coming to understand the extent and causes of coral reef ecosystem degradation, there is little or no data on the consequences for humans of such degradation.[156] Such shortcomings may in turn have implications for the priority afforded to conservation of these ecosystems by states.[157]

8.2 Management

With respect to management, states recognise that global climate change and emissions of greenhouse gases must be managed in accordance with some form of international cooperation. A number of states have therefore subscribed to the legal regime established by the 1992 United Nations Framework Convention on Climate Change and the 1997 Kyoto Protocol. The same can be said with respect to managing international demand for coral reef species and products, through the international community's reliance upon the 1973 Convention on International Trade in Endangered Species. These agreements will be considered towards the end of the book.

Management efforts can also exist at the national level, from developing successful captive breeding programmes in order to supply the aquarium trade,[158] to national fisheries laws prohibiting the use of destructive fishing methods, limiting catch size and establishing fishing seasons.[159] Also of great importance at the national level is the introduction of management planning for development on land in order to control the effects of pollution and sedimentation. One such management tool is the requirement that developments are subject to environmental impact assessment before they begin.[160] However, it is important that the different actors and

153 L Browning and others, 'Education as a tool for coral reef conservation: lessons from marine protected areas' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 119

154 Spalding (n 1), 67

155 *Id.*

156 *See* RS Dimitrov, 'Confronting non-regimes: Science and international coral reef policy' (2002) 11(1) Journal of Environment and Development 53

157 *Id.*

158 Full details on the aquarium trade will be given in Chapter 8

159 Wilkinson notes that dynamite fishing is largely prohibited throughout South-East and East Asia; C Wilkinson, 'Status of coral reefs of the world: summary of threats and remedial action' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 23

160 For a more detailed consideration of environmental impact assessments and the conservation of coral reef ecosystems, *see* J Turner and others, 'Environmental impact assessment for coral reefs: advocating direct protective approaches' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 332

agencies at the national level involved in the programmes such as those discussed above, work together in a manner that reflects the fact that coastal habitats are interlinked amongst themselves (such as mangroves, sea-grass beds and coral reefs) and with freshwater resources and land management. Governments are therefore being encouraged – notably through the work of initiatives such as the UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities – to formulate Integrated Coastal Zone Management plans to coordinate these actors, agencies and policies for the sustainable development of coastal resources.[161] Again the way international law promotes, and seeks to ensure states are taking, such action will be considered in subsequent chapters.[162]

8.3 The importance of enclaves

However, Clive Wilkinson suggests that one of the best ways to manage and protect coral reefs is to establish marine protected areas (MPAs).[163] John Kunich, after paying due respect to the need to control commercial fisheries, dumping at sea, invasive alien species and land-based sources of pollution, concurs more generally that 'a large network of well-chosen and zealously guarded marine protected areas is perhaps the most indispensable ingredient in any effective legal response to the threats to life in the oceans'.[164] Callum Roberts echoes such sentiments, devoting an entire chapter to MPAs as a key measure needed to reinvent fisheries management.[165] He observes that fishery regulations can be removed at will by government officials but that MPAs are more enduring and allow species and habitats (such as those produced by corals) to recover.[166]

MPAs are geographically defined areas of the sea, and (possibly also) shore, which are designated or regulated and then managed to achieve specific conservation objectives.[167] They can achieve a number of important results. For example, they can enhance the resilience and resistance of corals to the negative effects of climate change by reducing or eliminating other anthropogenic threats, whilst their status may force action to reduce pollution impacting on the reserve. Nevertheless, one of the more common objectives of MPAs is the management of

161 Agenda 21 called for states to consider developing ICZM plans; UNCED, A/CONF.151/26 (1992), [17.6]
162 Particular attention will be given to this in Chapter 4
163 Wilkinson (n 9), 34
164 JC Kunich, *Killing Our Oceans* (Praeger, 2006), 122–124
165 Roberts (n 21), Chapter 25.
166 *Id.*, 377
167 For support of this definition *see* IUCN, *Protected Areas: Benefits Beyond Boundaries – WCPA in Action* (IUCN, 2000), 5; G Kelleher and C Recchia, 'Editorial – lessons from marine protected areas around the world' (1998) 8:2 Parks 1, 1. Cyrille de Klemm, however, recognises difficulties in creating mixed terrestrial and marine parks on account of the allocation of functional responsibility between state agencies for land and sea management; C de Klemm, 'Fisheries conservation and management and the conservation of marine biological diversity' in E Hey (ed), *Developments in International Fisheries Law* (Kluwer, 1999), 480

resource utilisation, thereby tackling the negative direct and indirect impacts of fishing and tourist activity. Through such regulation, MPAs might then serve to catalyse the restoration of degraded coral reef ecosystems in the immediate vicinity through coral larvae recruitment from enclaves and re-stocking of fish.[168] For example, by designating the whole or part of an MPA as a no-catch area, instances of stock replenishment inside enclaves and then in bordering fishing areas (as fish populations have spilled outside of park boundaries) have been recorded in the Philippines[169] and Florida.[170]

Managing the impact of tourism upon coral reefs, as well as the relationship between those involved in the tourist industry and fishing, can also be controlled through the creation of an MPA. The number of tourists entering a site can be limited and monitored, as can permitted use and mooring sites.[171] From another perspective, where MPAs are helping to restore coral reef ecosystems or maintain them in an undamaged state, tourists (such as divers) will be more attracted to visiting these reefs. The income that can be generated from such interest, either through park entry fees,[172] or from increasing local business, can then support the management of the park, local economies and/or compensate local fishers who may have forgone fishing in the protected area.[173]

By limiting or excluding human impacts in MPAs, critical habitats can be protected, the diversity of species can be sustained or restored and ecosystem processes maintained. The designation of enclaves is therefore important for the successful conservation of coral reef ecosystems. Consequently, the way in which international law promotes MPA strategies for the conservation of reefs will receive particular attention in this book.

9 Conclusion: the future for coral reefs

Predictions about the outlook for coral reefs have become increasing bleak. This has been driven by the growing realisation that carbon and other greenhouse gas emissions will have profound impacts upon these ecosystems. John Veron has been quoted as saying:

168 CM Roberts and others, 'Redesigning coral reef conservation' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 519

169 By stopping fishing in 15ha of a 50ha reef area, where the remaining 35ha were open to certain types of fishing, fishermen from Sumilon Island increased their catch from 3,633kg in 1976 to 6,948kg in the first ten months of 1979; RV Salm and JR Clark, *Marine and Coastal Protected Areas: A Guide for Planners and Managers* (IUCN, 2000), 30

170 CM Roberts and others, 'Effects of marine reserves on adjacent fisheries' (2001) 294 Science 1920. For a cautionary note as to MPAs as a panacea, *see* T Agardy and others, 'Dangerous targets? Unresolved issues and ideological clashes around marine protected areas' (2003) 13 Aquatic Conservation: Marine and Freshwater Ecosystems 353

171 See the restrictions imposed upon anchoring and fish feeding in the Ras Mohamed National Park, Egypt; G Jobbins, 'Tourism and coral reef-based conservation: can they co-exist?' in I Côté and J Reynolds (eds), *Coral Reef Conservation* (CUP, 2006), 246

172 *See* Arin (n 79)

173 For the negative effects of not reinvesting income generated through MPAs, *see* Jobbins (n 171)

> 'The future is horrific . . . There is no hope of reefs surviving to even mid-century in any form that we now recognise . . . Then there is a domino effect, as reefs fail so will other ecosystems. This is the path of a mass extinction event . . .'[171]

That changes seem inevitable is also reflected in the 2009 outlook report on the Great Barrier Reef where the Great Barrier Reef Marine Park Authority concluded that:

> Despite the introduction of significant protection and management initiatives, the overall outlook for the Great Barrier Reef is poor. Even with the recent initiatives to improve resilience, catastrophic damage to the Great Barrier Reef ecosystem may not be averted. Building the resilience of the Great Barrier Reef ecosystem will give it the best chance of adapting to and recovering from the serious threats ahead, especially from climate change.[175]

The conclusions of last year's 'Coral Reef Crisis Meeting' hosted by the Royal Society highlight the scale of the task and the necessary action if coral reefs are to avoid becoming the first major ecosystem to collapse due to emissions of greenhouse gases.[176] Atmospheric CO_2 levels need to be reduced to well below 350 parts per million[177] whilst:

> Some management interventions will, for a time, increase reef resilience, the most important of which are (a) reducing the harvest of herbivorous fish to sustainable levels . . . (b) maintaining an effective trophic pyramid by protecting sharks and other top predators, (c) managing all aspects of water quality and (d) minimising any other impacts and stressors. Such actions can be supported through the use of large networks of marine protected areas and other direct management interventions such as improved control of watershed-based activities whose effects on water quality are often severe.[178]

171 Quoted in D Adam, 'How global warming sealed the fate of the world's coral reefs', *The Guardian* (London 2 September 2009) <http://www.guardian.co.uk/environment/2009/sep/02/coral-catastrophic-future> accessed 27 January 2010. This position is in large part founded upon a synergy of emissions of 450ppm of carbon dioxide, aragonite reductions and average temperature increases of +2°C (i.e. a synergy produced according to the extent of ambitions publicised at the time of the Copenhagen Climate Negotiations in December 2009); *see* J Veron, 'Is the Great Barrier Reef on death row?', Speech to the Royal Society, 6 July 2009, <http://www.coralreefresearch.org/html/crr_rs.htm> accessed 10 August 2010

175 Great Barrier Reef Marine Park Authority, *Great Barrier Reef Outlook Report 2009* (GBRMPA, 2009), 180

176 'The coral reef crisis: scientific justification for critical CO_2 threshold levels of <350ppm' Output of the technical working group meeting, The Royal Society, London, 6 July 2009, 10 <http://www.coralreefresearch.org/misc/Workshop%20statement%20and%20scientific%20justification.pdf>accessed 30 July 2010

177 *Id.*, 1

178 *Id.*, 11

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Given the gravity of the situation, and the attention drawn almost 20 years ago at the Rio Earth Summit to the need for coral reefs to be protected,[179] this book considers whether international environmental law is contributing towards tackling anthropogenic threats to these ecosystems. By encouraging states to address these threats their impacts will hopefully start to be removed, whilst the resilience of reefs to climate change and ocean acidification will increase. The dominant approach of this study will therefore be to focus upon how various existing multilateral environmental agreements (MEAs) are promoting MPA strategies, other fisheries controls and appropriate management of watersheds so as to reduce land-based sources of pollution. That said, tackling climate change and ocean acidification remains crucial and some reflections on international attempts to legally control greenhouse gas emissions from a coral reef perspective will also be offered.

As will ultimately be revealed, there exist a number of multilateral legal regimes with active programmes for coral reef conservation, and substantive progress has been made in affording some coral reefs protection. Nevertheless, the normative structure is largely fragmented, in parts incomplete, and offers limited opportunities to draw the strands together under an effective all-encompassing governance structure. Deciding where to focus efforts is therefore a pressing issue for those concerned with the future of these ecosystems. The approach of this book will therefore be to take each of these international agreements in turn and to analyse how many of the threats they address and how successfully. A comparison between the treaties can then be offered. Of course, since reefs are one of a number of natural habitats addressed by these MEAs (there being no single dedicated agreement) the story of reef conservation under these treaties is also a story about the treaties themselves, their successes and failures, and the development of international environmental law in a broader setting. Coral reef specific efforts can only be understood within such a wider context and this enlarged narrative must therefore also be included as part of the analysis.

179 Agenda 21, UNCED, A/CONF.151/26 (1992), [17.73] and [17.86]

2 The role of international law

1 Introduction

As this book moves from the previous scientific survey onto legal matters, that transition demands that more general issues be considered as a natural lead-in. For example, when are states apt to cooperate to form a multilateral normative regime? Further, what justifications are there for the intervention of international law in the issue area of coral reef conservation? After due consideration of these questions, the remainder of the chapter establishes the range of enquiries that have so far been undertaken in this field, as well as some further (legal) limits on the scope of this book.

2 Multilateral legal responses

Independent decision-making by states does not always yield the optimal feasible outcome.[1] Such outcomes may be deficient in that states collectively prefer another outcome to that which would inevitably arise through independent decision-making.[2] For instance, there may be common goods in relation to which states have a shared interest in ensuring their optimal provision, but which may become unsustainably utilised by one nation acting independently and driven by self-interest.[3] Therefore, as Robert Keohane observes, 'a major function of international regimes is to facilitate the making of mutually beneficial agreements among governments, so that the structural condition of anarchy does not lead to a complete "war of all against all".'[4]

1 OR Young, *International Cooperation: Building Regimes for Natural Resources and the Environment* (Cornell University Press, 1989), 199

2 OR Young, 'Regime Dynamics: the rise and fall of international regimes' in SD Krasner (ed), *International Regimes* (Cornell University Press, 1983), 120

3 For a classic description of such a problem *see* G Hardin, 'The tragedy of the commons' (1968) 162 (3859) Science 1243. At the human level, unsatisfactory outcomes from the actions of individuals can be avoided through people coming together to form a government and creating authorities to enforce laws designed to avoid those outcomes. However, interactions between nations are not controlled by a world government and superior enforcement body

4 RO Keohane, 'The demand for international regimes' in SD Krasner (ed), *International Regimes* (Cornell University Press, 1983), 148. Debate continues between international relations scholars as

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Zou Keyuan, “China’s U-Shaped Line in the South China Sea Revisited”, *Ocean Development and International Law*, Vol. 43, No. 1 (2012)

Ocean Development & International Law, 43:18–34, 2012

ISSN: 0090-8320 print / 1521-0642 online
DOI: 10.1080/00908320.2012.647483

China's U-Shaped Line in the South China Sea Revisited

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Despite its existence on the Chinese maps for more than six decades, the U-shaped line, as a traditional maritime boundary line of China in the South China Sea, has never received a wide recognition in the world community, much less by the other claimant states in the South China Sea. The U-shaped line is a legal conundrum not only for China but also for the world community, particularly after the map with the U-shaped line, together with China's Notes Verbale with respect to the claims to the outer continental shelves made by Malaysia and Vietnam, were submitted to the UN Commission on the Limits of Continental Shelf in May 2009. This article discusses China's recent practice relating to the U-shaped line as well as the external factors that affect the validity of the line and tries to unravel the legal puzzle posed by the line.

Keywords China, South China Sea, Spratly Islands, UN Convention on the Law of the Sea, U-shaped line

Introduction

The U-shaped line in the South China Sea is the line with nine segments displayed on Chinese maps. Its official Chinese name is "traditional maritime boundary line" (*chuantong haijiang xian*) though it is referred to in different ways, such as the U-shaped line,[1] nine-interrupted-lines,[2] the nine-dashed intermittent line,[3] the line of "national boundary,"[4] the "dotted-line,"[5] the "dashed lines,"[6] the tongue-shaped line,[7] as well as "the Chinese border."[8] Despite the existence of all these varied names, the U-shaped line name is what I use in this article.

More than a decade ago I published a long paper addressing the U-shaped line in the *International Journal of Marine and Coastal Law*.[9] As one of the pioneer papers specifically addressing issues concerning the U-shaped line,[10] it has been widely cited. Numerous other papers have been published.[11] Though there have been academic discussions and debates on the line, the Chinese position on either side of the Taiwan Strait remains ambiguous with there being no official explanation of the line. It is unknown whether what China

Received 3 August 2011; accepted 8 October 2011.

This is a revised and updated version of a paper with the same title presented at the 2011 International Law Association Asia-Pacific Regional Conference "Contemporary International Law Issues in the Asia Pacific: Opportunities and Challenges," Taipei, 29 May 29–1 June 2011.

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claims within the line is its national territory, including the islands, underwater rocks, the seabed, and the water column. In recent years, the discussion and debate on the U-shaped line has intensified, particularly after China attached the map with the line to its diplomatic note protesting the submissions of outer continental shelf by Vietnam and Malaysia to the Commission of the Limits of the Continental Shelf (CLCS) in 2009.[12] In this article, I reexamine the U-shaped line by taking into account recent developments and commentaries.

Brief Background

The South China Sea is categorized as semienclosed sea under the United Nations Convention on the Law of the Sea (the LOS Convention).[13] It is surrounded by six countries—China, Vietnam, the Philippines, Brunei, Malaysia, and Indonesia—and has an area of 648,000 square nautical miles, twice the area of the Sea of Japan.[14] There are hundreds of small insular features in the South China Sea, which are uninhabited islets, shoals, reefs, banks, sands, cays, and rocks in the form of four groups of islands and underwater features: the Pratas Islands (*Dongsha Qundao*), the Paracel Islands (*Xisha Qundao*), the Macclesfield Bank (*Zhongsha Qundao*), and the Spratly Islands (*Nansha Qundao*). The Pratas Islands are under the firm control of Taiwan. No competing claims exist there under the current conception of "One China." For the Macclesfield Bank, the only claimant is China (mainland China and Taiwan).[15] The Paracel Islands are under the control of the People's Republic of China, though contested by the Vietnamese. The dispute over the Spratly Islands is the most complicated since it involves as many as six parties (mainland China, Taiwan, Malaysia, Vietnam, the Philippines, and Brunei), all of whom have made claims over the Spratly Islands, the whole or in part, and their surrounding water areas.

China's claim to the South China Sea is based on the U-shaped line. The line first appeared on the map in December 1914, which was compiled by Hu Jinjie, a Chinese cartographer,[16] but only included the Pratas and the Paracels. In 1935, the Committee of Examining the Water and Land Maps of the Republic of China published the names of 132 islets and reefs of the four South China Sea archipelagos. The publication had an annexed map which marked the James Shoal at the location of about 4° north latitude, 112° east longitude, though there was no demarcation of the line on the map. On 1 December 1947, the Chinese Ministry of Interior renamed the islands in the South China Sea and formally allocated them into the administration of the Chinese Hainan Special Region.[17] Meanwhile, the same ministry prepared a location map of the islands in the South China Sea, which was first released for internal use.[18] In February 1948, the Atlas of Administrative Areas of the Republic of China was officially published, in which the above map was included. This is the first official map with the line for the South China Sea. It has two general characteristics: the southernmost end of the line was set at 4° north latitude, thus including the James Shoal; and an eleven-segment line was drawn instead of the previous continuous line. According to the official explanation, the basis for drawing the line was: "[t]he southernmost limit of the South China Sea territory should be at the James Shoal. This limit was followed by our governmental departments, schools and publishers before the anti-Japanese war, and it was also recorded on file in the Ministry of Interior. Accordingly it should remain unchanged."[19] The map is official and, therefore, different from those previously drawn by individual cartographers. Since 1948, maps officially published in both mainland China and Taiwan are the same regarding the line.

The publication of maps in the People's Republic of China is subject to the approval of the competent government agency—the State Surveying and Mapping Administration. The

Regulations on the Management of Map Compilation adopted in 1995 provide that China's historical boundaries from 1840 up to the founding of the People's Republic of China in 1949 should follow the standard exemplary map, which is jointly prepared by the Foreign Ministry and the competent surveying and mapping department of the State Council.[20] The Regulations on the Management of the Review and Approval of Maps give the authority to the competent surveying and mapping department of the State Council to review and approve maps with national boundaries.[21] Since illustrative maps of China concern state sovereignty and territorial integrity, the preparation of such maps must follow the standard map issued by the State Council, with special attention to the important islands such as Taiwan Island, the islands in the South China Sea, and the Diaoyu Islands.[22] It has been warned that the absence of the *South China Sea limit line* on a map would cause diplomatic difficulties.[23]

While mainland China has remained silent on the line, Taiwan's attitude is more assertive. In 1993 the Taiwanese government adopted South China Sea Policy Guidelines. Taipei indicated that it regarded the entire area within the U-shaped line as its historical waters—"the South China Sea area within the historic water limit is the maritime area under the jurisdiction of the Republic of China, in which the Republic of China possesses all rights and interests."[24] However, recent developments indicate that Taiwan has retreated from its original position. For example, in its draft Territorial Sea Law, the water areas in the South China Sea were regarded as "historic waters" but on the second reading in the Legislative Yuan, this wording was dropped.[25] In this sense, the positions of the two sides across the Taiwan Strait remain ambiguous again. As commented by Hasjim Djalal, the positions of China and Taiwan on the South China Sea are very similar.[26] However, in this article, I examine only the recent practices of mainland China concerning the U-shaped line.

Defending and Enhancing the U-Shaped Line

While there is no official explanation from China regarding the U-shaped line, China has recently reinforced its claims within the line. In addition to fisheries operations carried out by the Chinese fishermen in the South China Sea, China has made numerous moves in support of the line.

Maritime Policing

The China Maritime Surveillance, established in 1998 and subordinated to the State Oceanic Administration, is mandated to carry out the following: (1) to cruise at sea in order to safeguard the national maritime interests; (2) to monitor and maintain surveillance of the marine environment; (3) to investigate, obtain proof and inspect pollution incidents; (4) to be in charge of work relating to marine pollution from oil exploration and exploitation; (5) to be in charge of dumping at sea; (6) to be in charge of the laying of submarine cables and pipelines; and (7) to be in charge of foreign marine scientific research in China's sea areas.[27] In February 2007, the State Council approved a program of regular rights safeguarding law enforcement patrols to be carried out by China Ocean Surveillance in the Yellow Sea and the South China Sea. In 2008, China Maritime Surveillance began its regular law enforcement patrols covering all sea areas within China's jurisdiction from the mouth of Yalu River to James Shoal.[28] It is reported that the *China Haijian 83* followed and kept watch on the USNS *Impeccable* in the South China Sea in March 2009 and the *China Haijian 84*, which is a new and more advanced surveillance vessel, joined the South China Sea Brigade of the

China Maritime Surveillance in May 2011. As of May 2011, the South China Sea Brigade was equipped with 13 vessels and 3 aircraft.[29]

In addition, law enforcement is being conducted by other government departments, including those with respect to fisheries management. The Bureau of Fisheries Management and Fishing Port Superintendence was established in 1978 and 4 years later transferred to the Ministry of Agriculture. Under the bureau, there are four direct fishing divisions—the Yellow, Bohai, East, and South China Seas. In March 2009, China's largest fishing surveillance vessel *Yuzheng 311* was dispatched to the South China Sea. According to the Chinese Foreign Ministry, the Chinese government is paying great attention to the management of fisheries production in the South China Sea and the Chinese vessel was sent there to carry out regular tasks relating to fishery administration.[30] Mischief Reef is used as a base for fisheries administration. On 23 June 2010, the *Yuzheng 311*, together with another fishing administration vessel, forced Indonesia warships to release a detained Chinese fishing vessel in the sea area 57 nautical miles from the Natuna Islands, from which Indonesia claims an exclusive economic zone (EEZ) that China does not recognize.[31] The above water area is within the U-shaped line. The China Ocean Surveillance sent *Haijian 81* and *Haijian 83* to the South China Sea and put a sovereignty tablet on James Shoal in April 2010.[32]

China has intensified its maritime law enforcement patrols in the South China Sea. The South China Sea Brigade of the China Maritime Surveillance increased its patrol journeys from 2 in 2001 to 24 in 2008.[33] According to the *Law Enforcement Bulletin 2008*, China Maritime Surveillance sent 113 vessels/time and 242 aircraft/time, monitoring 285 foreign vessels/time and 43 foreign aircraft/time, including stopping illegal foreign activities in outer continental shelf investigations in 2008[34] while in 2010, the numbers increased to 188 vessels/time, 523 aircraft/time, monitoring 1303 foreign vessels/time, and 214 foreign aircraft/time.[35] In addition, two China Maritime Surveillance branches were created in 2010 for the South China Sea—the 10th Branch stationed in Haikou and the Law Enforcement Branch for the Paracel, Spratly, and Macclesfield Islands.[36]

Article 14 of the EEZ Law

On 26 June 1998, China officially promulgated the Law on the Exclusive Economic Zone and the Continental Shelf in which Article 14 provides that "the provisions of this Law shall not affect the historic rights enjoyed by the People's Republic of China."[37] It is generally agreed that this section is connected to China's claim to the South China Sea within the U-shaped line. However, instead of using the term "historic waters," China wisely chose the more softened term "historic rights." The provision of the EEZ Law on historic rights can be understood as follows: (1) it might be mean that the sea areas which are not part of China's EEZ and/or continental shelf should have the same legal status as the EEZ and/or continental shelf; (2) it might mean that the sea areas which embody China's historic rights include undefined areas beyond the 200-nautical-mile limit; or (3) it might mean that the sea areas that embody China's historic rights which are within the 200-nautical-mile limit can have an alternative management regime different from the EEZ and or continental shelf regime.[38]

While China asserts its historic rights in the South China Sea, it is to be noted that since such "historic rights" are contained in the 1998 Law on the EEZ and Continental Shelf, they may not be treated as equivalent to "historic waters" as generally understood in international law. Having said that, it is also to be noted that in other Chinese legislation the wording such as "other sea areas within China's jurisdiction" has been used in addition to the internal waters, territorial sea, EEZ, and continental shelf. An example is the amended Law on Marine Environmental Protection of 1999.[39] Article 2 provides that "the Law shall apply to internal waters, territorial sea, contiguous zone, exclusive economic zone, continental shelf of the People's Republic of China and *other sea areas under the jurisdiction of the People's Republic of China*" (emphasis added). The original 1982 Law contained the same wording.[40] It is unknown where "other sea areas within China's jurisdiction" are located. One possibility is that it might refer to the sea areas within the U-shaped line that China is unable to claim as part of its territorial sea, EEZ, or continental shelf.

As early as April 1986, Liu Huaqing, the then commander of the Chinese Navy stated that "the sea areas which should be under our jurisdiction are more than three million square kilometres,"[41] which *may* be based on the following calculation: in the Yellow Sea, an equidistance line for delimitation with the Korean Peninsula; in the East China Sea, a delimitation with Japan the middle line of the Okinawa Trough according to the principle of natural prolongation; and, in the South China Sea, the sea areas within the U-shaped line in addition to the EEZ east of Taiwan.[42] According to a Chinese source, the areas in the South China Sea encroached upon by other states are as follows: Vietnam, 1,170,000 square kilometers; the Philippines, 620,000 square kilometers; Malaysia, 170,000 square kilometers; Brunei, 50,000 square kilometers; and Indonesia, 35,000 square kilometers.[43] These estimations are based on the use of the U-shaped line.

Oil Exploration Lease in Vanguard Bank

While the fishery activities do not sufficiently explain the Chinese stance to the line, a lease of an oil exploratory block in the South China Sea to a foreign oil company may have profound significance for the line. In May 1992, Beijing granted a concession to the Crestone Energy Corporation to explore oil in a 7,347 square-nautical-mile area between Vanguard Bank (*Wan'an Tan*) and the Prince of Wales Bank (*Guangya Tan*), 160 nautical miles from Vietnam's coast.[44] Since China had not declared its EEZ at that time, some scholars assumed that the Crestone concession reflected China's view that it was asserting sovereign authority over the waters and resources within its "nine-interrupted-lines" historic claim.[45] The assumption is plausible since the block is situated around a permanently submerged bank that is difficult to claim unless it is claimed as being within the historic waters or within China's EEZ or continental shelf that could be generated from insular features in the Spratly Islands.

When Vietnam protested China's concession, the reason given by the spokesperson from the Chinese Foreign Ministry was that China had "indisputable sovereignty" over the Nansha and Xisha Islands and the contiguous waters and, as a result, that "[t]he exploitation by China's oil company is irreproachable."[46] There was no mention of the U-shaped line or historic waters. On the other hand, China protested the Vietnamese concession to foreign oil companies near Vanguard Bank. On 17 April 1996, a spokesperson from the Chinese Foreign Ministry stated that Vietnam's granting of rights to foreign petroleum companies for oil exploration in the sea area of the Nansha Islands was "illegal and invalid" and "an encroachment on China's sovereignty and its maritime rights and interests."[47] The entire area covered by the Vietnamese contract falls within the Wan'an Tan Bei-21 block licensed by Beijing to Crestone Energy Corporation. In 1996, the contract for the Wan'an Tan Bei-21 block was transferred to another U.S. oil company, Harvest Natural Resources, which continues to hold its interest with the license being extended to 31 May 2013.[48]

With the China Maritime Surveillance intensifying its patrols in the South China Sea, more incidents have happened in and around Vanguard Bank. The recent incident involving the Vietnamese vessel *Binh Minh No. 02* is an example. On 26 May 2011, three Chinese law enforcement vessels tried to stop and finally did sever the seismic survey cable of the *Binh Minh No. 02* operating within Vietnam's claimed EEZ on the Vanguard Bank.[49] It caused a spike in tension between the two countries. There have been other similar incidents between China and Vietnam and between China and the Philippines.

Communication of the U-Shaped Line Map to the United Nations

In May 2009, China sent two diplomatic notes to the UN secretary-general protesting Vietnam's submission and Vietnam-Malaysia's joint submission of their outer continental shelf claims to the CLCS.[50] In these notes, a map of the South China Sea with China's U-shaped line is attached as part of the documents. This is the first time that China had officially used the U-shaped line in defending its claims in the South China Sea. By this move, China called to the attention of the international community that China's territorial and maritime claims were within the U-shaped line. Furthermore, as the U-shaped line map is attached to China's objection to outer continental shelf claims, China intended to express that it would enjoy its rights to the continental shelf within the line.

In response to the Philippines' diplomatic note dated 5 April 2011,[51] China stated in its Note Verbale that "China's sovereignty, related rights and jurisdiction in the South China Sea are supported by abundant historical and legal evidence."[52] China further states that "[s]ince 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."[53] How is China's Nansha Islands clearly defined? It is through the use of the U-shaped line.

The 2011 official communication may reinforce the legal effect of the U-shaped line as it is possible that China has noticed the recent judgments rendered by the International Court of Justice with regard to the legal force of maps in the resolution of territorial and maritime disputes. In this regard, the paragraph contained in the 2002 *Sovereignty over Pulau Ligitan and Pulau Sipadan (Indonesia/Malaysia) Case*, which has appeared in the Court's previous judgments, states that:

> maps merely constitute information which varies in accuracy from case to case; of themselves, and by virtue solely of their existence, they cannot constitute a territorial title, that is, a document endowed by international law with intrinsic legal force for the purpose of establishing territorial rights. Of course, in some cases maps may acquire such legal force, but where this is so the legal force does not arise solely from their intrinsic merits: it is because such maps fall into the category of physical expressions of the will of the State or States concerned. This is the case, for example, when maps are annexed to an official text of which they form an integral part. Except in this clearly defined case, maps are only extrinsic evidence of varying reliability or unreliability which may be used, along with other evidence of a circumstantial kind, to establish or reconstitute the real facts. (footnote deleted)[54]

While it is unknown to what extent the map with the U-shaped line would have legal force in a future settlement of the South China Sea disputes, it is clear that China has attempted to give it as much legal force as possible. The U-shaped line map now unquestionably forms an integral part of China's official documents and, therefore, may "fall into the category of physical expressions of the will of the State," thus producing important legal force.

Raising Questions About the U-Shaped Line

Reduction of Two Segments in the Gulf of Tonkin

The U-shaped map originally had eleven segments. But in the late 1950s, two segments of the line which were located in the Gulf of Tonkin disappeared from the map. Beijing did not give a public explanation about why the two segments were eliminated from the map, but this might be related to the transfer of the sovereignty over the Bai Long Wei Island (Bach Long Vi in Vietnamese) in the Gulf of Tonkin from China to Vietnam.[55] It is said that elimination of the two segments was approved in 1953 by Zhou Enlai, then primary minister of the People's Republic of China.[56] This change to the map may have implications. The disappearance of the two segments in the Gulf of Tonkin indicates that the U-shaped line is flexible with the consequent question that, if China could give up two segments in the Gulf of Tonkin, why could China not give up the other nine remaining segments? Since the cancellation of the two segments was relevant to Vietnam's territorial and maritime interests, it is not surprising that Vietnam is the most vehement opponent to the U-shaped line.

Straight Baselines for the Paracel Islands

In May 1996, China publicized part of its baselines along the mainland coast and encircling the Paracel Islands by the method of straight baselines.[57] China used lines connecting 28 basepoints to encircle the Paracels and the surrounding waters. The waters within the baselines are internal waters and, from the baselines outward, there is a territorial sea of 12 nautical miles. In the same statement, it was declared that China would decide on other baselines in due time, including baselines for the Spratly Islands.

From these baselines, China may claim an EEZ and/or the continental shelf of the Paracel Islands. The publication of the Paracel baselines indicates that China did not consider the U-shaped line to be the maritime boundary line in the South China Sea for historic waters that were equivalent to internal waters or the territorial sea. Otherwise, the Paracel baselines would have been unnecessary.[58] The baselines within the U-shaped line have added uncertainty to the interpretation of the legal status of the U-shaped line.

The 2002 Declaration on Conduct in the South China Sea

In November 2002, China, together with 10 member states of the Association of Southeast Asian Nations (ASEAN), signed the Declaration on the Conduct of Parties in the South China Sea (DOC),[59] which is the first significant regional document specifically applying to the South China Sea. The DOC expressly acknowledges that China and some ASEAN countries have territorial and maritime disputes in the South China Sea and that they pledge to resolve these disputes through peaceful means in accordance with international law, including the LOS Convention. Since the Declaration is applicable to the entire South China Sea, it has an impact on the understanding of the U-shaped line. On the other hand, as a political document, the DOC carries no legal binding force. The existence of the U-shaped line may be one of the reasons why China has been reluctant to sign a legally binding code of conduct with the ASEAN countries.

External Impact of the U-Shaped Line

China has failed to defend or be consistent in defending the waters and islands enclosed by the U-shaped line.

The waters with the U-shaped line have been intruded on through the occupation of islands by other claimants; in fact, most of the islands in the Spratly Islands have been occupied by the countries other than Taiwan or mainland China. In addition to actual occupation, countries adjacent to the South China Sea have enacted laws extending their maritime zones and consolidating their maritime claims in the South China Sea. Table 1

Table 1

Foreign Laws and Proclamations Affecting the U-Shaped Line*

Brunei	(1) Territorial Sea and Fishery Limits Act, January 1982
	(2) Declaration on the Exclusive Economic Zone, 21 July 1993
Malaysia	(1) Continental Shelf Act, 1966, Act No. 57, 28 July 1966, as amended by Act No. 83 of 1972
	(2) Proclamation of the Exclusive Economic Zone, 25 April 1980
	(3) Exclusive Economic Zone Act 1984, Act No. 311
	(4) Baselines of Maritime Zones Act 2006
Philippines	(1) The Petroleum Act of 1949
	(2) Republic Act No. 3046, as amended by Republic Act No. 5446, 17 June 1961
	(3) Presidential Proclamation No. 370, 20 March 1968
	(4) Presidential Decree No. 1599, 11 June 1978 establishing an Exclusive Economic Zone and for Other Purposes
	(5) Constitution of the Republic, 12 July 1979
	(6) Presidential Decree No. 1596, 1979, Declaring Certain Areas Part of the Philippine Territory and Providing for Their Government and Administration (Kalayaan Island Group)
	(7) Republic Act No. 9522: An Act to Amend Certain Provisions of Republic Act No. 3046, as amended by Republic Act No. 5446, 2009
Vietnam	(1) Decree No.4762-CP, 21 December 1933
	(2) Decision No. 420-BNV/HCDP/26, 6 September 1973
	(3) Statement on the Territorial Sea, the Contiguous Zone, the Exclusive Economic Zone, and the Continental Shelf of Vietnam, 12 May 1977
	(4) Resolution adopted by the National Assembly (7th Legislature) of the Socialist Republic of Vietnam, 28 December 1982

*Some relevant Indonesian laws or proclamations regarding the EEZ and/or continental shelf may also affect the U-shaped line. (As stated by Dzurek, the Indonesian continental shelf claim northeast to the Natuna Islands overlaps the southeastern part of the extensive Chinese claim. Daniel J. Dzurek, "Boundary and Resources Disputes in the South China Sea," *Ocean Yearbook* 5 (1985): 277.) According to the Chinese official statement, there is no territorial dispute with Indonesia in the South China Sea, but the delimitation of maritime boundaries between the Spratly Islands and the Indonesian maritime areas remains to be settled.

Source: Mainly adapted from Daniel J. Dzurek, "The Spratly Islands Dispute: Who's on First?" *Maritime Briefing* 2, no. 1 (1996): 59–61, with some updates.

shows some of these national laws that affect the validity of the U-shaped line. The most recent national legislation is from the Philippines—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.[60] It was passed in 2009. China lodged a protest with the United Nations against this law.[61]

Claimants in the South China Sea have reached numerous bilateral agreements, which have included waters within the U-shaped line. Two such agreements are the 1969 Malaysia and Indonesia Agreement on the delimitation of the continental shelf[62] and the 2003 Vietnam and Indonesia Agreement concerning the delimitation of their continental shelf boundary.[63] It is reported that Brunei and Malaysia have recently reached an agreement on oil exploration and exploitation in the South China Sea.[64] It is unknown whether there has been any diplomatic reaction by Beijing to the conclusion of these agreements. There has been no public reaction.

The recent state activities with respect to the outer continental shelf in the South China Sea further affects the integrity of the U-shaped line. As already noted, Vietnam made two submissions to the CLCS—one individual and the other jointly with Malaysia.[65] Brunei submitted Preliminary Information to the Commission for its outer continental shelf in the South China Sea.[66] It is likely that the Philippines will also lodge a submission with the CLCS regarding its outer continental shelf in the South China Sea as it has reserved such a right.[67] China indicated its objection to the Vietnamese-Malaysian submissions, stating that "China has indispensable 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" and requesting the Commission not to consider the submissions by Vietnam or jointly made by Malaysia and Vietnam.[68] Interestingly, there was no official reaction from China regarding Brunei's Preliminary Information. By comparison, China's Preliminary Information with respect to the East China Sea has been challenged by Japan.[69]

Apart from the state practice of the various South China Sea claimants, there exist official and scholarly responses to the U-shaped line from these countries.

Vietnam

According to one Vietnamese official, the U-shaped line is exaggerated and legally groundless.

> There is nothing in the international law of the sea that can justify this kind of claim. ...The fact that other countries have carried on their activities in the Bien Dong Sea (South China Sea), the use of the sea and legislative provisions, have disproved neglecting completely the existence of such a line.[70]

Vietnam has also challenged the provision on historic rights in China's EEZ Law. A Vietnamese scholar asked whether "this article tacitly refers to other interests that China has claimed such as the traditional right of fishing in maritime zones of other countries and the nine broken lines claiming over 80 per cent of area of the East Sea."[71] He further stated that "[a] long time ago, regional countries pursued their normal activities in the East Sea without encountering any Chinese impediment and they have never recognized historical rights of China there."[72] Vietnam officially lodged a protest against China's historic rights in the South China Sea, stating that it will "not recognize any so-called 'historical interests' which are not in consistent with international law and violate the sovereignty, the sovereign rights of Vietnam and Vietnam's legitimate interests in its maritime zones and continental shelf in the eastern Sea as mentioned in article 14" of China's EEZ Law.[73] In response to China's objection to its outer continental shelf claims, Vietnam replied that "China's claim for the nine- dotted line on the map attached to its diplomatic note is null and void as it has no legal, historical and factual ground."[74]

Indonesia

On several occasions, Indonesia has expressed its concern over the publication of Chinese maps showing unclear maritime boundaries between the Natuna and the Spratly Islands.[75] Indonesia was satisfied with China's position that there was no dispute between China and Indonesia regarding the Natuna Islands. In the view of Hasjim Djalal, an Indonesian senior diplomat, the U-shaped line indicates that "the Chinese territorial claims are limited towards the islands and all rights related thereto, and [are] not territorial claims over the South China Sea as a whole."[76] Recently he commented that, since there is no definition of the dashed lines and there are no stated coordinates, the legality and precise location indicated by the lines is not clear.[77] In July 2010, Indonesia sent a diplomatic note to the United Nations stating that the so-called "nine-dotted lines map" as contained in China's 2009 Notes Verbale "clearly lacks international legal basis and is tantamount to upsetting" the LOS Convention.[78]

Malaysia

Malaysia has expressed no official stance regarding the U-shaped line.[79] However, according to B. A. Hamzah, then director-general of the Maritime Institute of Malaysia, the line as a claim over the entire South China Sea should be regarded as "frivolous, unreasonable and illogical" as there is no basis in law or history.[80] He further states that the parties concerned should "drop area claims and focus instead on their claim to islands and non-islands." He dismissed the idea that the water areas within the line are historic waters saying that "[b]y no stretch of imagination can the South China Sea be considered by any nation as its internal waters or historic lake as a basis to assert a claim."

Philippines

In April 2011, the Philippines sent a diplomatic note to the United Nations questioning the validity of the U-shaped line, stating that China's claim to the relevant waters and seabed and subsoil thereof as reflected in the so-called nine-dash line map have no basis in international law, specifically in the LOS Convention.[81]

Other States

The debate concerning the legal nature of the line has expanded to other countries.[82] S. Jayakumar, former senior minister of Singapore, criticized the ambiguity of China's claims based on the U-shaped line on the occasion of a conference on the South China Sea held in Singapore in June 2011. Jayakumar stated that: "China should not continue to leave unaddressed the concerns and questions raised by many over its puzzling and disturbing nine-dotted-lines map."[83] He further warned that:

> [t]his ambiguity has led to concerns not just among claimant States, and it is clearly in China's interests to clarify the extent of its claims and thereby dispel

> any apprehensions over its intentions. Failure to do so could jeopardise the trust essential for any peaceful resolution and undermine all the gains of Chinese diplomacy made in the last two decades.[84]

In response to media queries on the visit of Chinese maritime surveillance vessel *Haixun 31* to Singapore on 20 June 2011, the spokesperson of Singapore's Foreign Ministry commented that: "it is in China's own interests to clarify its claims in the SCS with more precision as the current ambiguity as to their extent has caused serious concerns in the international maritime community."[85]

Following Singapore, the United States also has requested China to explain its claims in the South China Sea. Secretary of State Hilary Clinton, in June 2011, called 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."[86] She further stated that "[c]onsistent with international law, claims to maritime space in the South China Sea should be derived solely from legitimate claims to land features."[87] A retired U.S. naval officer recently called for his country to "join Indonesia and Vietnam in protesting China's expansive U-shaped claim of sovereignty in the South China Sea."[88]

Conclusion

China has not given up maritime claims based on the U-shaped line and recent practice has demonstrated that China is attempting to further consolidate the claim based on the line; in particular by undertaking regular and intensified law enforcement patrols in the South China Sea within the line.

There is no denying that the U-shaped line carries some legal implications for the settlement of territorial and maritime disputes in the South China Sea. China's submission of the U-shaped line map to the United Nations makes it clear that the line is connected to China's claim over continental shelves in the South China Sea. It has been observed that the line is coincidental with the 200-meter isobath in the South China Sea.[89] This was the general definition of the outer limit of the continental shelf provided for in the 1958 Convention on the Continental Shelf.[90] One can argue that the line in the South China Sea was intended to define the continental shelves of the islands within the line. The line along the 200-meter isobath may have been influenced by the 1945 Truman Proclamation.[91]

The U-shaped line was officially proclaimed more than a half-century before the adoption of the LOS Convention and a decade before the adoption of the 1958 Geneva Convention. The historic rights derived from or area delineated by this line cannot be disregarded. Usually the regime of historic rights is favorable for states with a long history, but relatively unfavorable for the newly independent states founded after World War II. This concern was noted when the issue of historic waters was discussed in the UN International Law Commission in the 1950s. García-Amador contended that the concept of historic bays benefited only older countries having a long history and that there were many comparative newcomers to the international community—countries in Latin America, the Middle East and the Far East—which could not claim such historic rights.[92] In comparison with the claims by other countries bordering the South China Sea, China's claim has the longest history. This fact can at least partially explain why other claimants to the islands in the South China Sea are opposed to China's historic claims based on the U-shaped line.

On the other hand, China faces a dilemma regarding the line as it is not yet ready to give a reasonable explanation of the line based on international law. Since there are no express legal provisions in the LOS Convention that can be used as a legal basis to support China's U-shaped line, China is unable to use the LOS Convention to defend its unilateral line in the South China Sea. While the LOS Convention affirms that matters which are not regulated under it should continue to be governed by general international law including customary law, it seems that China faces a dilemma of having no sufficient expertise in international law to explain the U-shaped line. Thus, China has remained silent when it has been asked or challenged by its neighboring countries for an explanation.[93] After communicating the U-shaped line map to the United Nations, China has encountered increased pressure, particularly from the ASEAN countries, for an explanation of the line. Even Singapore, a nonclaimant state in Southeast Asia, has raised concerns about the ambiguous claim made by China in the South China Sea.

China has been trying to apply the LOS Convention to the South China Sea. China has enacted a number of laws in accordance with the LOS Convention, including the 1992 Law on the Territorial Sea and the Contiguous Zone[94] and the 1998 Law on the EEZ and the Continental Shelf.[95] China used straight baselines to define part of its territorial sea along the mainland coast as well as encircling the Paracel Islands.[96] It is predicted that once the EEZ and continental shelf problems are settled for the South China Sea islands, the significance of the U-shaped line will be reduced. In the meantime, the line will be the legal and historical basis for China to defend its territorial and maritime claims in the South China Sea. China has to use the line as a countermeasure against the claims of other states to EEZs and continental shelves in the South China Sea. This has recently been demonstrated in the Chinese objection to the submissions by Vietnam and Vietnam-Malaysia to the CLCS.

As for any dispute resulting from an explanation on the U-shaped line, China can rely on Article 298 of the LOS Convention, which permits states parties to exclude the compulsory procedures provided for in the Convention from applying to the disputes "involving historic bays or titles." China has exercised this right through its declaration of exclusion in 2006.[97] Like many states, China prefers bilateral negotiations to settle territorial and maritime disputes with its neighbors. Through negotiations, China can use its persuasive power to entice its counterparts to reach an agreement. This approach had had some success as evidenced by the conclusion of the Tripartite Agreement on Seismic Activities in the South China Sea among three state-owned oil companies from China, the Philippines, and Vietnam in March 2005.[98] Though the agreement expired in 2008 with no substantial progress, it is perceived that China will continue in its efforts to reach similar agreements for cooperation in the South China Sea.

The U-shaped line is also a dilemma for the ASEAN claimant countries. Given the ambiguity of the basis of the line, except for using words such as "legally groundless" or "null and void," other claimants cannot rely on norms and rules of international law to rebut China's U-shaped line. At least three important research questions arise from the U-shaped line. First, is the LOS Convention the only international law to be relied on to explain the U-shaped line? Second, is there support for the U-shaped line in general international law including customary law? Third, do maritime rights that are set out in the LOS Convention override rights that existed prior to the adoption of the LOS Convention?

Notes

1. See Steven Kuan-Tsyh Yu, "Legal Nature and Status of the U-Shaped Line and the Inside Waters in Our South China Sea" (in Chinese), paper presented at the Conference on the South China Sea, Taipei, 16–18 October 1995, 1– 13.

2. M. J. Valencia, J. M. van Dyke, and N. A. Ludwig, *Sharing the Resources of the South China Sea* (Dordrecht: Martinus Nijhoff, 1997), 24.

3. Ji Guoxing, "China Versus South China Sea Security," *Security Dialogue* 29 (1998): 103.

4. Chi-kin Lo, *China's Policy Towards Territorial Disputes: The Case of the South China Sea Islands* (London: Routledge, 1989), 45.

5. Ian Townsend-Gault, "China Ratifies UNCLOS," 16 May 1996, available at www-ibru.dur.ac.uk/cgi-bin/data.p1 (accessed 14 April 1998).

6. Robert W. Smith, "Maritime Delimitation in the South China Sea: Potentiality and Challenges," *Ocean Development and International* 41 (2010): 224.

7. Daniel J. Dzurek, "The Spratly Islands Dispute: Who's on First?" *IBRU Maritime Briefing* 2 (1996): 11.

8. Hanns J. Buchholz, *Law of the Sea Zones in the Pacific Ocean* (Singapore: Institute of Southeast Asian Studies, 1987), 43.

9. 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," *International Journal of Marine and Coastal Law* 14 (1999): 27–55.

10. Earlier articles include, inter alia, Yann-huei Song and Peter Kien-Hong Yu, "China's Historic Waters in the South China Sea: An Analysis from Taiwan, R.O.C.," *American Asian Review* 12, no. 4 (1994): 83–101.

11. Particular papers of note include Li Jinming and Li Dexia, "The Dotted Line on the Chinese Map of the South China Sea: A Note," *Ocean Development and International Law* 34 (2003): 287–295; and Peter Kien-Hong Yu, "The Chinese (Broken) U-Shaped Line in the South China Sea: Points, Lines, and Zones," *Contemporary Southeast Asia* 25, no. 3 (2003): 405–430.

12. See People's Republic of China, Letter to the U.N. Secretary General, Doc. CML/17/2009, 7 May 2009; and Letter to the U.N. Secretary General, Doc. CML/18/2009, 7 May 2009 in Response to the Malaysia-Vietnam Joint Submission to the Commission on the Limits of the Continental Shelf, Executive Summary, May 2009 and Vietnam Submission to the Commission: North Area, April 2009. All of the above are available at the Web site of the Commission on the Limits of the Continental Shelf (CLCS), www.un.org/los/clcs_new/clcs_home.htm.

13. United Nations Convention on the Law of the Sea, 1833 *U.N.T.S.* 397, Article 122.

14. J. R. V. Prescott, *The Maritime Political Boundaries of the World* (London: Methuen, 1985), 209.

15. A reason that there is no other claimant for the Macclesfield Bank is that it is permanently submerged. Otherwise, Vietnam or the Philippines might also have claimed the feature.

16. The map was named "the Chinese territorial map before the Qianglong-Jiaqing period" (AD 1736–1820) of the Qing Dynasty in Hu Jinjie's compilation, *New Geographical Atlas of the Republic of China*. See Han Zhenhua, ed., *A Compilation of Historical Materials on China's South China Sea Islands* (Beijing: Oriental Press, 1988) (in Chinese), 355.

17. See Ministry of Interior, *An Outline of the Geography of the South China Sea Islands*, National Territory Series, 1947, Fig. 11, 861, as cited in J. K. T. Chao, "South China Sea: Boundary Problems Relating to the Nansha and Hsisha Islands," in *Fishing in Troubled Waters*, eds. R. D. Hill, N. G. Owen, and E. V. Roberts (Hong Kong : Centre for Asian Studies, University of Hong Kong, 1991), 88.

18. The map was named "the Location Map of the South China Sea Islands" (*naihai zhudao weizhi tu*), see Li and Li, supra note 11, at 290.

19. See Han Zhenhua, supra note 16, at 181–184.

20. See Article 6 of the 1995 Regulations on the Management of Map Compilation, available at www.sbsm.gov.cn/article/zcfg/flfg/200709/20070900000664.shtml (accessed 17 May 2011).

21. The Regulations on the Management of the Review and Approval of Maps, available at www.sbsm.gov.cn/article/zcfg/bmgz/200709/20070900000641.shtml (accessed 17 May 2011).

22. See People's Republic of China, "Circular on the Proper Use of Chinese Illustrative Maps," 6 March 2007, available at www.sbsm.gov.cn/article/zcfg/zygfxwj/201101/20110100077693.shtml (accessed 17 May 2011).

23. See People's Republic of China, "Management of Maps," available at www.sbsm.gov.cn/article/zcfg/zcfgjd/200709/20070900000523.shtml (accessed 17 May 2011).

24. The Republic of China, South China Sea Policy Guidelines, are attached as an appendix to Kuan-Ming Sun, "Policy of the Republic of China Towards the South China Sea," *Marine Policy* 19 (1995): 408.

25. Central News Agency (CAN) Taiwan, 30 December 1997.

26. Hasjim Djalal, "The South China Sea: The Long Road Towards Peace and Cooperation," in *Security and International Politics in the South China Sea: Towards a Cooperative Management Regime*, eds. Sam Bateman and Ralf Emmers (London: Routledge, 2009), 177.

27. See Lu Shouben, ed., *The Marine Legal System* (Beijing: Guangming Daily, 1992) (in Chinese), 231–232.

28. See *China Maritime Law Enforcement Bulletin 2008*, available at www.soa.gov.cn/soa/hygb/xzgb/webinfo/2009/03/1271382649196436.htm (accessed 22 May 2011).

29. See "South China Sea Brigade Was Equipped with 13 Vessels by Adding the China Haijian 84," available at www.gov.cn/jrzg/2011-05/08/content_1859750.htm (accessed 20 May 2011).

30. See "Qin Gang: Chinese Vessel Carries Out Regular Tasks of Fishery Administration in the South China Sea," available at military.people.com.cn/GB/1076/117533/8978540.html (accessed 20 May 2011).

31. For details, see "China Fishing Administration Confronts Indonesian Warships and war.news.163.com/10/0728/12/6CM7R3BV00011MTO.html (accessed 20 May 2011).

32. See *China Maritime Law Enforcement Bulletin 2010*, available at www.soa.gov.cn/soa/hygbml/xzgb/ten/webinfo/1304230574153971.htm (accessed 22 May 2011).

33. "Commemorating 10th anniversary of the Founding of the South China Sea Brigade of the China Maritime Surveillance," 21 September 2009, available at www.scsb.gov.cn/html/2/13/article-236.html### (accessed 18 May 2011).

34. *China Maritime Law Enforcement Bulletin 2008*, supra note 28.

35. *China Maritime Law Enforcement Bulletin 2010*, supra note 32.

36. *Ibid*.

37. Law on the Exclusive Economic Zone and the Continental Shelf, 26 June 1998, available at the Web site of the UN Division on Oceans and the Law of the Sea (DOALOS), www.un.org/Depts/los.

38. Zou Keyuan, "Historic Rights in International Law and in China's Practice," *Ocean Development and International Law* 31 (2001): 162.

39. Law on Marine Environmental Protection, 25 December 1999, the text is reprinted in *People's Daily* (in Chinese), 28 December 1999.

40. See Zou Keyuan, "Implementing Marine Environmental Protection Law in China: Progress, Problems and Prospects," *Marine Policy* 33 (1999): 211.

41. As quoted in Ni Jianmin, ed., *Ocean China* (Beijing: China International Broadcasting, 1997) (in Chinese), 368. See also "The Committee of Propaganda Activities for the International Year of Ocean Established," *People's Daily* (in Chinese), 18 February 1998, 3.

42. *Ibid*., at 412.

43. See Chen Shijian, ed., *The Collection of Names and Materials on the South China Sea Islands* (Guangzhou: Guangdong Atlas, 1987) (in Chinese), 381.

44. Vanguard Bank lies 22 nautical miles southwest from Prince Consort Bank (*Xiwei Tan*) at 7°32′N, 109°45′E. The linear crest of this bank is aligned west-east and within the 18.3-meter isobath measures 16 nautical miles long and 3 nautical miles wide. The least recorded depth is 16.5 meters. David Hancox and Victor Prescott, "A Geographical Description of the Spratly Islands and an Account of Hydrographic Surveys Amongst Those Islands," *Maritime Briefing* 1, no. 6 (1995): 16.

45. Valencia, van Dyke, and Ludwig, supra note 2, at 27. Mark J. Valencia, "Spratly Solution Still at Sea," *Pacific Review* 6, no. 2 (1993): 158, wrote: "Although the Crestone concession is clearly on Vietnam's geologic continental shelf and within 350 nm of its coast China argues that the area is within its 'historical line' claim."

46. *Straits Times* (Singapore), 21 May 1992, at 7.

47. Xinhua News Agency, Beijing, 17 April 1996.

48. For details, see "China," available at www.harvestnr.com/operations/china.html (accessed 20 May 2011).

49. For details, see "Chinese Ships Violate Vietnam's Sovereignty, Disrupt Oil Exploration Work," available at www.thanhniennews.com/2010/Pages/20110527182714.aspx (accessed 22 November 2011).

50. PRC, Letter CML/17/2009; and Letter CML/18/2009, supra note 12.

51. The Philippines, Letter to the U.N. Secretary General, Doc. No. 000228, 5 April 2011, available at the CLCS Web site, supra note 12.

52. People's Republic of China, Letter to the U.N. Secretary General, Doc. No. CML/8/2011, 14 April 2011, available at the CLCS Web site, supra note 12.

53. *Ibid.*

54. *Sovereignty Over Pulau Ligitan and Pulau Sipadan, (Indonesia/Malaysia)*, [2002] *I.C.J. Reports* 625, para. 88.

55. See Zou Keyuan, *Law of the Sea in East Asia: Issues and Prospects* (London: Routledge, 2005), 83.

56. Li and Li, supra note 11, at 290.

57. See *People's Daily* (in Chinese), 16 May 1996.

58. Yu, supra note 11, at 415, with regard to the straight baselines and the U-shaped line as "double insurance" for China's interests in the South China Sea.

59. Declaration on the Conduct of Parties in the South China Sea, available at www.aseansec.org/13163.htm (accessed 22 May 2011).

60. The Philippines, 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, and for Other Purposes, approved 10 March 2009, available at the Web site of the Philippine Law and Jurisprudence Database, www.lawphil.net/statutes/repacts/ra2009/ra_9522_2009.htlm.

61. People's Republic of China, Letter to the U.N. Secretary-General, Doc. CML/12/2009, 13 April 2009, available at the DOALOS Web site, supra note 37.

62. Agreement Between Malaysia and Indonesia on the Delimitation of the Continental Shelves of the Two Countries, 27 October 1969, available at the DOALOS Web site, supra note 37.

63. Agreement Between Vietnam and Indonesia Concerning the Delimitation of the Continental Shelf Boundary, 26 June 2003, *Law of the Sea Bulletin*, no. 67 (2008): 39.

64. Malaysia, Ministry of Foreign Affairs, press release, 3 May 2010, available at the Web site of the Ministry of Foreign Affairs.

65. Malaysia-Vietnam Joint Submission and Vietnam Submission: Northern Area, supra note 12.

66. Brunei Darussalam, Preliminary Information Submission to the Commission, May 2009, available at the CLCS Web site, supra note 12.

67. The Philippines, A Partial Submission to the Commission, Executive Summary, May 2009, available at the CLCS Web site, supra note 12.

68. PRC, Letter CML/17/2009; and Letter CML/18/2009, supra note 12.

69. See People's Republic of China, Preliminary Information Submission to the Commission, May 2009; and Letter to the U.N. Secretary-General, Doc. SC/09/246, 23 July 2009, available at the CLCS Web site, supra note 12.

70. Huynh Minh Chinh, "Sovereignty of Vietnam over Hoang Sa (Paracels) and Truong Sa (Spratlys) and Peaceful Settlement of Disputes in the Bien Dong Sea (South China Sea)," in Conference Proceedings, *ASEAN in the 21st Century: Opportunities and Challenges* (Hanoi: Institute of International Relations, March 1996), 98–99.

71. Nguyen Hong Thao, "China's Maritime Moves Raise Neighbors' Hackles," *Vietnam Law and Legal Forum*, July 1998, 21.

72. *Ibid*., at 21–22.

73. Vietnam, "Dispute Regarding the Law on the Exclusive Economic Zone and the Continental Shelf of the People's Republic of China Which Was passed on 26 June 1998," *Law of the Sea Bulletin* no. 38 (1998): 55.

74. See "Viet Nam's Submission on Its Outer Limits of the Continental Shelf, Ministry of Foreign Affairs' Spokesman Mr. Le Dzung Answers Question on 08 May 2009," available at www.mofa.gov.vn/en/tt_baochi/pbnfn/ns090508180346#Z4GcTd019sbm (accessed 23 May 2011).

75. Radio Australia, 16 January 1997.

76. Hasjim Djalal, "Conflicting Territorial and Jurisdictional Claims in the South China Sea," *Indonesian Quarterly* 7, no. 3 (1979): 42.

77. Djalal, supra note 26, at 177.

78. Indonesia, Letter to the U.N. Secretary-General, Doc. 480/POL-703/VII/10, 8 July 2010, available at the CLCS Web site, supra note 12.

79. Even in response to China's objection to its joint submission of the outer continental shelf in the South China Sea, Malaysia stated only that its act conforms to the LOS Convention and the submission is made without prejudice to the question of delimitation in the South China Sea. Malaysia, Letter to the U.N. Secretary-General, Doc. HA24/09, 20 May 2009, available at the CLCS Web site, supra note 12.

80. B. A. Hamzah, "Conflicting Jurisdiction Problems in the Spratlys: Scope for Conflict Resolution," paper presented at the Second Workshop on Managing Potential Conflicts in the South China Sea, Bandung, Indonesia, 15–18 July 1991, 199–200.

81. The Philippines, Letter, supra note 51.

82. Erik Franckx and Marco Benatar, "Dotted Lines in the South China Sea: Fishing for (Legal) Clarity," paper presented at the Second International Workshop on the South China Sea: Cooperation for Regional Security and Development, Hanoi, 11–12 November 2010.

83. S. Jayakumar, "Keynote Address," Conference on Joint Development and the South China Sea, 16 June 2011, Singapore, available at cil.nus.edu.sg/wp/wp-content/uploads/2011/06/CIL_Keynote_Address_16_Jun_11_7.45am-pdf.pdf (accessed 21 June 2011).

84. *Ibid*.

85. Singapore, "MFA Spokesman's Comments in Responses to Media Queries on the Visit of Chinese Maritime Surveillance Vessel Haixun 31 to Singapore," 20 June 2011, available at www.mfa.gov.sg/ (accessed 21 June 2011).

86. Hilary Clinton, "The South China Sea," Press Statement of the Secretary of State, 22 July 2011, available at www.state.gov/secretary/rm/2011/07/168989.htm (accessed 2 August 2011).

87. *Ibid*.

88. Raul Pedrozo, "Beijing's Coastal Real Estate: A History of Chinese Naval Aggression," 15 November 2010, available at www.foreignaffairs.com/articles/67007/raul-pedrozo/beijings-coastal-real-estate (accessed 24 May 2011).

89. Dzurek, supra note 7, at 12, observes that the dashed lines generally follow the 200-meter isobath.

90. Convention on the Continental Shelf, 499 *U.N.T.S.* 311.

91. Fu Kuen-chen, "The Legal Status of the South China Sea and the Feasibility of the Equal Co-operation across the Taiwan Strait"(in Chinese), paper presented at the Conference on the South China Sea, Taipei, 16–18 October 1995, 4.

92. See *Yearbook of the International Law Commission*, vol. 1 (1955), 214.

93. For example, Indonesia sent a diplomatic note to China in 1995, requesting China to explain the U-shaped line. But China replied only that there was no territorial dispute between China and Indonesia in the South China Sea. See Sun Guoxiang, "New Developments in the South China Sea and the Prospects and Challenges for Cross-strait Cooperation," in National Institute for South China Sea Studies (ed.), *Collected Papers from the Cross-Strait Workshop on the South China Sea Issue* (January 2011) (in Chinese), 5.

94. Law on the Territorial Sea and Contiguous Zone, 25 February 1992, available at the DOALOS Web site, supra note 37.

95. Law on the EEZ and the Continental Shelf, supra note 37.

96. People's Republic of China, Declaration on the Baselines of the Territorial Sea, 15 May 1996,; and List of Coordinates for the Baselines, available at the DOALOS Web site, supra note 37.

97. For China's Declaration, 26 August 2006, available at the DOALOS Web site, supra note 37.

98. The three oil companies are China National Offshore Oil Corporation, Philippine National Oil Company, and PetroVietnam. See "Three Nations Sign Pact for Joint Spratlys Survey," *Straits Times* (Singapore), 15 March 2005.

Annex 720

J. Hardy & S. O'Connor, "China Building Airstrip Capable Island on Fiery Cross Reef", *IHS Jane's Defence Weekly* (20 Nov. 2014)

IHS Jane's 360

Country Risk

China building airstrip-capable island on Fiery Cross Reef

James Hardy, London and Sean O'Connor, Indiana - IHS Jane's Defence Weekly

20 November 2014

Airbus Defence and Space imagery dated 14 November 2014 shows Chinese land reclamation operations under way at Fiery Cross Reef in the South China Sea. Multiple operating dredgers provide the ability to generate terrain rapidly. Operating from a harbour area, dredgers deliver sediment via a network of piping. (© CNES 2014, Distribution Airbus DS / Spot Image / IHS)

Key Points

- China is reclaiming land at Fiery Cross Reef in the Spratly Islands, according to satellite imagery
- The reclamation, which started in August, is creating a land mass large enough for a 3,000 m-long airstrip

China is building an island at least 3,000 m long on Fiery Cross Reef that could be the site for its first airstrip in the Spratly Islands in the South China Sea.

Satellite imagery of the island taken on 8 August and 14 November shows that in the past three months Chinese dredgers have created a land mass that is almost the entire length of the reef.

Fiery Cross Reef lies to the west of the main Spratly island archipelago and was previously under water; the only habitable area was a concrete platform built and maintained by China's People's Liberation Army Navy (PLAN).

The new island is more than 3,000 m long and between 200 and 300 m wide: large enough to construct a runway and apron. The dredgers are also creating a harbour to the east of the reef that would appear to be large enough to receive tankers and major surface combatants.

The existing structure on the reef's southwestern edge was home to a PLAN garrison and had a pier, air-defence guns, anti-frogmen defences, communications equipment, and a greenhouse. The concrete structure is currently not attached to the new island, but if previous Chinese land reclamation projects in the Spratlys are any guide, it is only a matter of time before it is joined up.

The Spratly Islands are claimed by Brunei, China, Malaysia, the Philippines, Taiwan, and Vietnam. All but Brunei occupy islands or have built structures on reefs and shoals to assert their claims.

The land reclamation at Fiery Cross is the fourth such project undertaken by China in the Spratly Islands in the last 12-18 months and by far the largest in scope. China has built new islands at Johnson South Reef, Cuateron Reef, and Gaven Reefs, but none are large enough to house an airstrip in their current form.

Ship tracking data from IHS Maritime shows substantial activity at the reef since May 2014. Analysts drew attention to two ships in particular: *Jin Hang Jun 406* , a grab dredger that is fixed on a pontoon, and 3,086-tonne cutter suction dredger *Xin Hai Tun* . Both have been instrumental in dredging and cutting channels into the new harbour basin.

ANALYSIS

IHS Jane's previously reported on China's reclamation project in the Spratlys and noted that until recently Fiery Cross appeared to be acting as a staging post for other island building projects. Given its status as the largest PLAN facility in the Spratlys, this seemed to be an anomaly, something that the 14 November imagery has now corrected.

China has been at a distinct disadvantage compared with other claimants in the Spratly Islands as it is the only claimant not to occupy an island with an airfield. Taiwan has Itu Aba (Taiping) island, the Philippines has Pagasa island, Malaysia has Swallow Reef (a reef on which it reclaimed land and built an airstrip), and Vietnam has Southwest Cay.

The work at Fiery Cross thus brings parity but is likely to cause alarm among the other claimants. China has previously shown it is willing to spend blood and treasure to assert its territorial claims in this region. Given its massive military advantage over the other claimants in terms of quantity and quality of materiel, this facility appears purpose-built to coerce other claimants into relinquishing their claims and possessions, or at least provide China with a much stronger negotiating position if talks over the dispute were ever held.

Related articles:

- Shiptec China 2014: CSSRC showcases plans to build floating docks for Spratly Islands
- China builds another island in South China Sea

(630 words)

Annex 721

Chris P.C. Chung, "Drawing the U-Shaped Line: China's Claim in the South China Sea, 1946-1974", *Modern China* (11 Aug. 2015)

Article

Drawing the U-Shaped Line: China's Claim in the South China Sea, 1946–1974

Modern China
1–35

DOI: 10.1177/0097700415598538
mcx.sagepub.com

Chris P. C. Chung[1]

Abstract

This article examines the genesis, usage, and meaning of the People's Republic of China's and the Republic of China's U-shaped line claim in the South China Sea territorial dispute from 1946 to 1974. The Republic of China (ROC) officially created the line in 1947, which the People's Republic of China (PRC) then adopted in 1949. Although the PRC claims sovereignty over all of the disputed islands and features, it remains silent on what specific waters the line claims. Based on ROC national archival files on the line, which remain virtually unused by scholars on the dispute, this article argues that the line was an "islands attribution" boundary until at least 1974. It claimed only the islands, features, and any adjacent waters consistent with contemporary conceptions of international maritime law. The article concludes with the present-day significance of this history and suggestions for future avenues of scholarship.

Keywords

South China Sea dispute, U-shaped line, nine-dash line, Spratly Islands, Paracel Islands

The South China Sea dispute is among the most pressing issues in Southeast Asia and one of the most complex territorial disputes in the world. Six

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nations—the People's Republic of China (PRC), Vietnam, the Philippines, Malaysia, Brunei, and the Republic of China (ROC, or Taiwan)—vie for control over some or all of the Spratly Islands 南沙群島, Paracel Islands 西沙群島, Pratas Islands 東沙群島, and Macclesfield Bank 中沙群島, which consist of well over a hundred islands, reefs, and banks throughout the South China Sea. These islands and features are miniscule, inhospitable, hazardous to the unwary sailor, and contain negligible economic resources, but they matter in other ways. They stand close to one of the busiest shipping routes in the world, nearby waters teem with seafood, and the seabed holds potentially massive reserves of oil and natural gas.[1]

Political necessity compels disputant governments to firmly maintain their claims to these archipelagos and waters. To do otherwise likely would invite political suicide from a nationalistically inflamed populace and rivals who would seize the opportunity to strike. Hardline stances, provocations such as arrests of foreign fishermen, and even violent conflict all have occurred as a result.

The PRC and ROC have staked the most extensive claims to the region. Both are embodied by a dashed U-shaped boundary line (sometimes called the nine-dash line) that the ROC government originally drew in an official map in 1947 and publicly released the following year, titled the *Location Map of the South China Sea Islands* 南海諸島位置圖 (see Map 1 in the Appendix). The line encompasses most of the South China Sea. The PRC, however, has not officially clarified what the line claims. It asserts ownership over the archipelagos and their "adjacent" and "relevant" waters without specifying their geographical extent and the maritime rights it confers on China, leading to much debate (PRC, 2011: 1). Some scholars, such as Li Jinming and Zhao Lihai, argue that the line is an "islands attribution line," which only delimits a claim to the disputed islands, features, and adjacent waters derived from contemporaneous conceptions of international law (Li, 2011: 60–61; Zhao, 1996: 38).[2] Others, such as Fu Kuenchen, Huang Wei, Wu Shicun, and Gao Zhiguo and Jia Bingbing, assert that it delimits a "historic rights" waters zone. This confers the sole right to economic exploitation, scientific exploration and research, environmental conservation, and the construction of artificial islands and installations over all of the waters contained within the U-shaped line, on the basis of historic Chinese dominance (Fu, 1995: 35–42, 210; Huang, 2011; Wu, 2013: 81–82; Gao and Jia, 2012: 108–10, 123-24). Although Fu uses the term "special historic waters" 特殊的歷史性水域, he advocates the same rights.

The PRC's official ambiguity over the line's meaning plays a significant role in perpetuating the dispute. No meaningful resolution can emerge if it is unclear what the PRC claims in the first place. Uncertainty also prompts

Southeast Asian countries and the media to assume the worst: that the PRC claims sole rights to exploitation and even to passage regulation across most of the South China Sea, as a gigantic historic waters zone (Thanh Nien News, 2013; Calica, 2013).[3] The Philippines' note verbale of April 5, 2011, for instance, denounced the PRC's claim on the grounds that the line delineated the PRC's "relevant waters as well as the seabed and subsoil thereof" (Thang and Nguyen, 2012: 42; Government of the Philippines, 2011a). These countries' adoption of defensive measures such as an arms build-up, alliance making, and encouragement of the United States' involvement in the region alarm the PRC and lead it to believe that foreign powers are conspiring to contain it. Hence, the PRC has escalated its hardline measures.

This article examines the historical origins and meaning of the line in an effort to clear up this vagueness. It does so by analyzing the archival evidence surrounding the formation of the official U-shaped line map from 1946 to 1948 and its usage by the ROC and PRC since then. These archival files, located in Taipei, remain virtually unused by either Chinese or English-language scholarship on the line. Many of the files were declassified in 2008 and 2009. They argue strongly for the islands attribution stance, as does the PRC's early usage of the line.

The three collections of archival files examined constitute most, if not all, of those written during the formation of the U-shaped line: the Military History and Translation Office of the Ministry of National Defense 國防部史政編譯局, the Ministry of the Interior 内政部, and the Ministry of Foreign Affairs 外交部.[4] The Republic of China National Archives Administration, National Development Council 國家發展委員會檔案管理局 holds the first two collections, while the Archives of the Institute of Modern History at the Academia Sinica 中央研究院 holds the third.

Some points about terminology must be mentioned. First, "China" in this article refers to the official representative government of that country in the world at any given point in time: the Qing government during the Qing dynasty (1644 to 1912), the Republic of China during the Republican era (1912 to 1971, when the ROC lost its seat in the United Nations),[5] and the People's Republic of China from 1971 onward. The appellations "PRC" and "ROC" will be used when more specificity is required. Second, this article will only use non-pinyin romanization systems when citing authors or figures whose legal or preferred names are not written in pinyin. It will use traditional Chinese characters, except for names and titles of works originally written in simplified Chinese. Third, all the maps discussed in the article can be found in the Appendix. Fourth, "historic rights waters" is a conceptual term. It refers to maritime zones to which states, as some scholars argue, possess "historic rights." It does not appear in the United Nations Convention of the Law of the Sea (UNCLOS), the dominant piece of international maritime law today (United Nations, 1982). Finally, the term "historic rights" focuses *exclusively* on four themes: economic exploitation, scientific research, the construction of artificial islands and installations, and environmental conservation. All historic rights' scholars agree on their centrality.

At first glance, Fu Kuen-chen and Wu Shicun appear to advocate historic rights that encompass more than these four themes. Fu supports China's "right to control maritime and aerial traffic" within the U-shaped line 航海, 航空交通管制的權利 (Fu, 1995: 210). Likewise, Wu argues for China's right to "designate routes" 航道劃定 within these historic rights waters (Wu, 2013: 81–82). However, both strictly dissociate historic rights waters from maritime zones that confer comprehensive control. Using analogous international legal concepts, they limit regulation to traffic that violates the four historic rights themes.

Fu maintains that historic rights waters are neither internal nor territorial waters, partly because China has never protested against foreign traffic there (Fu, 1995: 34–38). Internal waters stretch landward from a coastal state's baselines.[6] The state possesses all rights to the water column, seabed, and airspace as it would with land territory, such as the exclusion of any foreign traffic. Territorial waters extend 12 nautical miles (nm) seaward from a state's baselines.[7] Foreign vessels and aircraft may traverse them only if their passage is continuous and "innocent," meaning it is "not prejudicial to the peace, good order or security of the coastal state." Otherwise, the state holds significant regulatory powers, such as designating sea lanes for the safety of navigation (United Nations, 1982: Articles 17–22).

Similarly, Wu asserts that China's historic rights are neither

> an entirely exclusive and all-encompassing sovereignty . . . nor [a] purely non-exclusive [one]. . . . The content of [historic] rights should be [made] applicable to the corresponding analogy of the exclusive economic zone [EEZ] and combined according to history. (Wu, 2013: 81–82).

In other words, Wu argues that the content of historic rights is analogous to rights inherent in an exclusive economic zone. Claimants should use history to determine where to apply historic rights.

EEZs are maritime zones that extend up to 200 nm seaward from a coastal state's baselines. EEZ privileges are identical to the four historic rights themes: the sole right to exploit resources, conduct scientific research and exploration, protect and preserve the marine environment, and construct artificial islands and installations (United Nations, 1982: Articles 55–75). Article 58 of UNCLOS limits traffic regulatory powers to these rights. It confers freedom of navigation and overflight in the high seas to all foreign vessels and aircraft that traverse EEZs, provided they "have due regard" for the coastal state's rights and duties there (United Nations, 1982: Articles 58). Wu's analogizing extends this restriction to claimed historic rights waters.

It is possible that Wu ties historic rights traffic regulation to Chinese interpretations of EEZs. One is unconventional: the regulation of foreign military vessels conducting military activities. For instance, on March 8, 2009, five PRC vessels disrupted USNS *Impeccable*'s military surveillance operations and passage within Hainan's EEZ. PRC Foreign Ministry spokesman Ma Zhaoxu denounced the surveillance ship for "conduct[ing] activities in China's special economic zone in the South China Sea without China's permission" (Xinhua News, 2009). Yet, this view is not the focus on the four historic rights themes. It merely shows that Wu's vision of historic rights traffic regulation is tied to a disputed legal interpretation of the *high seas*. Countries that assert EEZ military regulations, such as India, Myanmar, Indonesia, Portugal, and China, commonly hold that military activities are not for "peaceful purposes." Thus, they abuse the freedom of the high seas that Article 58 of UNCLOS confers (Kraska and Pedrozo, 2013: 238–40; Rahman and Tsamenyi, 2013: 324–28; Zou, 2002: 459–68). Wu's analogizing applies this high seas interpretation to claimed historic rights waters.

Sovereignty and Development in the South China Sea Islands after the Second World War

The earliest archival files examined in this article were written in 1946, which marked a continuance of the scramble for the South China Sea islands. Japan's wartime occupation of the archipelagos had only suspended a prior contest in the 1930s between France, Japan, and the ROC (Granados, 2008: 132–40; Samuels, 1982: 55–64). Immediately after the war, the ROC was determined to "reassert" and "protect" its sovereignty over these islands from foreign "infringement." On September 25, 1946, representatives of the Ministry of Foreign Affairs, Ministry of the Interior, Ministry of National Defense, and ROC Navy General Headquarters 海軍總司令部 (NHQ) convened in the Ministry of the Interior to resolve several issues pertaining to the South China Sea islands (MOFA, file series 019.3/0012, files 097 and 098). The minutes listed each issue and the resolution agreed upon. The first topic, the most significant, determined the scope of what the ROC would claim in the South China Sea:

> Resolved matters:
>
> 1. The case of how to delimit the scope of what is to be received [from Japan] for the purpose of reclaiming [lit., "receiving"] each of the islands in the South China Sea.

> Resolution: As according to the scope shown in the Ministry of the Interior's copy of the *Location Sketch Map of the South China Sea Islands* 南海諸島位置略圖. After the Executive Yuan has checked and approved [the scope], it will order the Guangdong provincial government to comply [and carry it out]. (MOFA, file series 019.3/0012, file 097)
>
> 決議事項：1. 接收南海各島應如何劃定接收範圍案。決議：依照內政部擬製之「南海諸島位置略圖」所示範圍呈由。行政院核定令廣東省政府遵照。

The dual use of the verb "to receive" 接收 reflected the ROC's view that the islands were originally theirs. It was "reclaiming" them from Japan, which had recently surrendered.

This passage clearly conveys the ROC government's view of the U-shaped line. It referred solely and directly to the *Location Sketch Map of the South China Sea Islands*—the 1946 U-shaped line map that led to the official version the following year (Map 2 in the Appendix)—when demarcating the area that was to be under Chinese sovereignty.[8] However, all of the area within the U-shaped line was not to be ROC territory. The above passage merely defined the *islands* to be reclaimed: "the scope of what is to be received *for the purpose of* receiving each of the *islands* of the South China Sea" (italics added) ("接收南海各島應如何劃定接收範圍案"). Mention of matters pertaining to the waters around the islands is absent. The remaining six resolutions of the conference concerned other details about the islands, such as the physical expression of Chinese sovereignty or the approval of translations of the names of these islands (MOFA, file series 019.3/0012, files 097 and 098). The U-shaped line, in other words, was created solely to delineate China's sovereignty over the *land* of the islands and other features.

This resolution was adopted in late 1946, when ROC Commanding Officer Lin Zun and Captain Yao Ruyu led several naval expeditions to formally "reclaim" the South China Sea islands from the Japanese. Despite repeated delays in mid-November due to stormy weather, the main islands were secured the following month. ROC troops landed on Woody Island of the Paracels on November 28, 1946, and Itu Aba Island of the Spratlys on December 12, 1946 (MHTO, file series 0035/061.8/3030, files 002/001/0002 and 002/003/0002; MOI, file series 0036/E41502/1, file 0005/007/0001; MHTO, file series 0036/002.2/4022, file 001/001/0005).

These expeditions further constituted the basis for the official U-shaped line of 1947. The "recapture" of these islands led to government discussions about the need for a clear expression and protection of sovereignty over the islands. Situation reports—surveys of the islands describing their geographic coordinates, topography, vegetation, resources, personnel, buildings, histories, and almost always recommendations for future actions—began to call for increased garrisons and construction on the islands. For instance, the *Report on the Reconnaissance of the Paracel Islands in the South China Sea* 南海西沙群島勘察報告書, written by the ROC Air Force General Headquarters 空軍總司令部 and issued on December 25, 1946, recommended that more naval personnel be dispatched to safeguard the islands (MHTO, file series 0035/944/1060, file 001/001/0007). On February 4, 1947, the *Report on the Reconnaissance of the Spratly Islands in the South China Sea* 南海南沙群島勘察報告書 noted that "the Chinese navy has already sent a platoon of soldiers to garrison the islands and set up weather observation and radio stations to prevent foreigners from coveting, invading, and occupying the islands" (MHTO, file series 0035/944/1060, file 001/002/0007). It recommended building a 1,200 meter air strip on Itu Aba Island and envisioned turning the archipelago into a string of "island bases in the South China Sea, akin to American bases in the Pacific Ocean" (MHTO, file series 0035/944/1060, file 001/002/0007).

The ROC government soon held plenary meetings to discuss plans to develop the islands in order to "safeguard" national defense. The Ministry of National Defense sent a report— *File on Increasing Defense and Building Facilities in the Paracel Islands for Ensuring the Protection of Sovereignty* [over the Islands] *and the Strengthening of National Defense* 加強建設西沙群島力保主權而固國防案—of one such meeting to the Executive Yuan on June 14, 1947. It recommended increasing the ROC's military presence in the South China Sea islands by garrisoning troops "wherever possible in the archipelagos"; protecting fishermen who "come from Hainan Island and go to the islands" to fish; "vigorously constructing" lighthouses, weather stations, and radio stations; improving food and water equipment; deciding on the islands' system of governance; investigating several aspects of the islands such as soil quality, weather, marine resources, and governance in order to aid the development of facilities there; and compiling research about the islands to expound Chinese sovereign rights and impress their importance on the Chinese population (MHTO, file series 0035/061.8/3030, files 005/012/0009 to 0011). The ROC supported the garrisoning and development of the South China Sea islands in order to show the world that they were theirs, actions that led to the official promulgation of the U-shaped line.

These files again strongly support the island attribution line. They focus almost exclusively on matters pertaining to the islands' land territories. While the plans for development were never completed because of the Chinese Civil War (1946–1950), the ROC nevertheless strove to assert ownership over the land territories of the archipelagos for the explicit purpose of "reclaiming," demonstrating, and protecting its sovereignty from foreigners

(Granados, 2006a: 173–74). The same cannot be said for the waters around the islands. Neither report made any mention of plans for naval protection over a large special waters zone of any kind. There were only two, and rare, exceptions to the absence of maritime affairs in the archival files. The first was the establishment of naval patrols in order to safeguard supplies to troops stationed on the islands, as distinct from those established to protect a waters zone (MHTO, file series 0035/061.8/3030, file 005/012/0010). These patrols simply were meant to escort supply ships. The second exception was the protection of Chinese fishermen. For instance, as the *File on Increasing Defense and Building Facilities in the Paracel Islands* advocated, the ROC government was to "implement immigration [to the islands] for fishermen who regularly and seasonally travel from Hainan to the Paracel and Spratly archipelagos to fish, and provide greater protection of their fishing permits" (MHTO, file series 0035/061.8/3030, file 005/012/0010). To "provide greater protection of their fishing permits," the ROC navy was to ensure that no one challenged the fishermen's activities.

Although such reports did not specify the exact scope of fishing waters to be guarded by the ROC navy, only "fishermen who went to the Paracel and Spratly Islands from Hainan to catch fish" were to be protected ("對於我國 . . . 來往西南沙群島捕水產之瓊州漁民應加保護獎助." *Qiongzhou* 瓊州 was the old term for Hainan Island). This passage, coupled with the ROC's focus on the islands' land territory, strongly indicates that Chinese fishermen stayed close to the islands and did not routinely venture into the vastness of the South China Sea. This interpretation fits the ROC's contemporary conception of waters zones. At the Hague Codification Conference of 1930, the last international meeting to discuss the standardization of the scope of territorial waters before the creation of the U-shaped line maps, the ROC supported a three nautical mile territorial waters zone and a twelve nautical mile contiguous waters zone beyond it (Koh, 1987: 7–8). The ROC government officially implemented the former zone in 1931, the latter in 1934, and allowed fishing within both despite the conference having never reached a consensus (Chiu, 1975: 38–41; Granados, 2006a: 167). It did not support any other waters zone beyond these two until the concept of the continental shelf zone was first discussed internationally in the UN Geneva Convention of 1958. That the scope of protection of fishermen was not specified in any archival document, especially those focused on increasing the ROC's defense and development of the islands, compromises any argument that the ROC at this time held a historic rights waters view.

It is doubtful that the minutes of the September 1946 conference, the summaries of other meetings convened on the issue, and the situation reports in the ROC archival collections would leave out reference to a special waters zone as massive as the U-shaped line, if one existed. Two express purposes of these documents and meetings were, first, to define the geographical scope of what was to be Chinese, and second, to specify what areas were to be developed and how, with the deliberate aim of asserting and "protecting" Chinese sovereignty. The September 1946 conference, furthermore, eliminates another possibility: that a historic rights waters zone could have emanated from the mainland and not from the South China Sea islands, thus explaining the absence of references to special waters zones in the archival files. As the September 1946 conference summary showed, the ROC purposely created and used the U-shaped line to encompass all matters pertaining to the islands. One cannot dissociate a historic rights waters zone from the islands, since the waters were represented by the line, whose existence hinged on those insular features. Any historic maritime zone as delineated by the U-shaped line must emanate from the South China Sea islands, as must any discussion of the idea. Even authors who support a historic rights claim, such as Fu and Huang, indirectly admit this much, as they unfailingly assert that the line represented and enforced a waters zone *in addition* to showing Chinese sovereignty over the islands (Fu, 1995: 204–10; Huang, 2011).

Similarly, plans to develop marine resources shortly after the genesis of the U-shaped line also focused exclusively on the islands. In March 1950, the Hainan Fisheries Authority submitted a report to the NHQ, titled *The Hainan Fisheries Authority's Pilot Project on the Development of Marine Resources in the Paracel Archipelago* 海南特區水產管理局西沙群島水產開發試驗計劃. It proposed four objectives in expanding the exploitation of resources in the waters around the islands. The first three were to process useful marine fauna; relieve unemployed fishermen by resuming development of marine resources; and "clearly understand" the Paracel and Spratly archipelagos and plan their future development. The fourth "objective" comprised four points, some redundantly listed: increase revenue, cultivate marine resources, improve the islands' infrastructure,[9] and carry forward the Hainan Fisheries Authority's business plans for the islands. It described the funds and equipment required for the proposal, conditions of investment, and plans for radio communication between fishermen and the islands (MHTO, file series 0035/061.8/3030, files 007/013/0011 to 0014). The proposal did not mention protection of Chinese fishermen nor a special waters zone to be enforced by the ROC navy. The first two objectives were silent on the specific area of fishing. In contrast, the third and fourth objectives solely and repeatedly referred to the development of the islands' land territories so as to support fishing nearby. The project merely envisioned an intensification, not an expansion in geographic scope, of the exploitation of marine resources.

Granted, nearly all ROC naval forces stationed on the South China Sea islands had been transferred to Taiwan by June 1949, to defend it against an expected PRC invasion. Yet, a small military presence remained on the islands until May 1950, two months after the Pilot Project was drafted (Granados, 2006a: 160, 162). This decrease cannot account for the absence of well-defined limits of maritime jurisdiction and protection in the plan. On April 12, 1950, the NHQ sent a telegram to the Hainan Fisheries Authority suggesting modifications to the Pilot Project. One proposed that five percent of "profits" go toward the welfare of naval units that provide assistance to the islands as well as "rewards" for garrison troops ("盈利部分提百分之五應改爲海軍協助單位福利金及駐島官兵犒賞費") (MHTO, file series 0035/061.8/3030, files 007/014/0002 to 0003). The source of these "profits," although unspecified, was likely the development of the islands, given the telegram's purpose of providing modifications to the March plan. The ROC evidently remained confident in the future development of the islands and the military's ability to protect them.

ROC diplomatic protests made after the release of the U-shaped line further support the islands attribution argument. The ROC only protested against "infringements" of sovereignty over the islands' *land* territories, not its waters. One example provides a telling distinction between the islands' land and maritime jurisdictions and their importance to the ROC government. On April 13, 1949, ROC ambassador Chen Chih-Ping raised with Felino Neri, the Filipino undersecretary of foreign affairs, the issue of newspaper articles that stated that the Filipino government planned to send Commodore Jose Andrada to inspect Itu Aba Island. One article in particular reported that "some cabinet members suggested that their people be induced to settle there [on Itu Aba] preparatory to making a claim for the annexation of this group to the Philippines, if necessary, as a security measure." Chen requested confirmation of the veracity of these statements and emphasized that "Taiping [i.e., Itu Aba] Island is the territory of the Republic of China." Neri's reply on May 11 reassured Chen that there was no cause for worry: "In the meeting referred to, the Cabinet simply discussed the need for affording greater protection to Filipino fishermen who are reportedly operating in the waters surrounding Itu Aba" (MOFA, file series 019.3/013, files 038 and 039).

Both Chen's and Neri's letters indicated that the islands' land territories were the main concern of the ROC government. Chen worried that the Filipino cabinet had authorized an inspection of Itu Aba Island and discussed the settlement of Filipino fishermen there, thus "infringing" on the ROC's sovereignty. Neri recognized Chen's concern, and through the word "simply" denied the validity of the newspaper reports. Neri, however, clearly thought the presence of Filipino fishermen "operating in the waters surrounding Itu Aba Island"—well within the limit delineated by the U-shaped line—was not an issue. He never mentioned maritime jurisdiction, which presumably he considered a relatively trivial matter.

Chen never replied to Neri's response, which suggests that the Filipino explanation satisfied the ROC. The ROC did not issue any diplomatic protests against the Philippines involving sovereignty issues in the South China Sea region until late May 1956, after a Filipino citizen, Thomas Cloma, informally proclaimed the formation of Kalayaan, or "Freedomland," over some of the Spratly Islands to the Filipino and world press on May 15 (Samuels, 1982: 82).[10] The ROC responded by sending three expeditions to reclaim the Spratly Islands from June 1 to September 24, 1956—ROC garrisons on the islands earlier had been recalled to defend against an anticipated Communist invasion of Taiwan (Samuels, 1982: 84). In short, for the ROC, it was the islands that were the key aspect of the South China Sea archipelagos, not the exclusion of foreign fishermen from the surrounding waters. The ROC did not consider the waters of the U-shaped line as providing special rights.

Like Freedomland, the "Kingdom of Humanity" was also a foreign threat to "Chinese sovereignty" over the islands. Although private American citizen Morton Meads' attempt to establish an independent country over part of the Spratlys was seen as bizarre or comical by most of the international community—Filipino naval and air searches for the kingdom using coordinates provided by Meads proved fruitless—the ROC treated the affair seriously (MOFA, file series 019.3/0003, files 045 to 046). On July 9, 1955, Chow Shu-Kai, ROC chargé d'affaires ad interim in Manila, notified Filipino vice president Carlos Garcia, who also was serving as the Filipino secretary of foreign affairs, that the ROC was

> conducting [an] investigation in the waters around the Spratley Islands [sic] in connection with alleged violation of Chinese territory by the so called "Kingdom of Humanity."
>
> According to information emanating from the "Consul" in Manila of said "Kingdom" [i.e., Meads[11]], the "Kingdom's" territory appears to be so delineated as to include the Spratley Island Group, which constitutes part of the territory of the Republic of China. The Chinese Government has therefore initiated action to conduct [an] investigation in said area with a view of determining whether infringement on Chinese territorial rights has been committed by the said "Kingdom." It would be appreciated if Your Excellency would kindly acquaint pertinent authorities of the Philippine Government with this effect. (MOFA, file series 019.3/0003, file 077)

This statement did not constitute a direct diplomatic protest to Manila, as Meads was acting on his own. Chow was simply informing Garcia of Chinese naval activity in the Spratlys as a result of information on Meads that it received from the Philippines. It may, however, have been an indirect warning, as former Filipino senator Camilo Osías openly believed that the Kingdom existed and the Philippines should establish diplomatic ties with it (MOFA, file series 019.3/0003, file 046). Osías was the only significant politician in his country to take Meads' claim seriously. Chow may have aimed to dissuade the Philippines from annexing the Kingdom by reiterating China's claim to the Spratlys. In any case, the focus again was solely on the islands' *land* territory. While the ROC's investigation was conducted in the waters surrounding the islands, its purposes were to ensure that its sovereignty on the islands was not infringed and to prevent further incursions by foreigners.

Japan's Administration of the South China Sea Islands and Their Postwar Transfer to China

The post–Second World War transfer of sovereignty over the islands from Japan to China presents certain possibilities that could undermine the islands attribution line argument.[12] By March 30, 1939, Japan had militarily occupied the Pratas, Paracel, and Spratly Islands. The next day, it formally proclaimed the creation of the Shinnan Guntō 新南群島 (New South Archipelago), an administrative area covering a portion of the Spratlys and incorporated under Taiwan province (Granados, 2008: 138). ROC archival files on the South China Sea islands include a map of this administration. Its boundaries were solid and encompassed a significant area of water. Its seven corners possessed specific geographic coordinates, contained within the range of 7–12° N and 111–117° E (MOFA, file series 019.3/0012, file 066).[13] Plausibly, the boundary encompassed the Shinnan Guntō's waters, indicating that the zone conferred certain exclusive maritime rights. However, no written document directly verifies this assumption.

Nevertheless, irrespective of the nature of the Shinnan Guntō's boundaries, the postwar transfer of Japan's wartime administration of the islands to China could not have contributed to a historic rights waters zone as delineated by the U-shaped line. If the Shinnan Guntō's boundaries simply denoted an islands attribution line, there would be no waters to hand over to the ROC in the first place when China reacquired Taiwan province after the war. If the Shinnan Guntō's boundaries did denote a waters zone, this was lost in the postwar transfer to China. The Shinnan Guntō factored into the formation of the U-shaped line because of the islands it encompassed, not because it conferred a delineated sea zone. As a telegram order that the Ministry of Foreign Affairs sent to the NHQ on August 5, 1946, indicated, the ROC was simply preparing to take back the islands of the Shinnan Guntō it thought were originally its own. It sought to clarify whether they were the same as those of Tizard Bank, or the Tuansha Islands 團沙群島 (MOFA, file series 019.3/0012, file 014).[14] In December 1946, the ROC dropped the Tuansha appellation and subsumed the area within the Nansha, or Spratly archipelago (MOFA, file series 019.3/0013, file 030).

The report resulting from the telegram listed the islands individually and gave general descriptions of them, with no mention of any waters zone. It concluded that the Tuansha constituted only one part of the Shinnan Guntō, meaning the two were not identical (MOFA, file series 019.3/0012, files 014, 016 to 019). Besides the ROC's sole focus on the islands, these files show that it was not interested in inheriting the Shinnan Guntō administration. Rather, the ROC sought to restore what it thought was the prewar administration of the Tuansha by reclaiming the Shinnan Guntō islands that coincided with the former. These files undercut any argument that the ROC inherited the waters delineated by the boundaries of the Shinnan Guntō.

The ROC's main goal of restoring the prewar Tuansha administration strongly indicates the U-shaped line's islands attribution character in another way. No official Chinese maritime boundaries delineating sovereignty over *waters* existed in the islands region before the Second World War, including the Tuansha administration and the claims of prior dynasties it was based on.[15] Consequently, China had no historic rights waters to inherit after the war. Precursor maps of the U-shaped line existed from the 1910s to 1930s, but the ROC government never officially endorsed them for release. Hu Junjie, a Chinese cartographer, drew the first such map in 1914, which included only the Pratas and Paracel islands. Maps of the region largely continued this pattern until the mid-1930s. In 1935, the ROC Land and Water Maps Inspection Committee 水陸地圖審查委員會 created the *Map of Chinese Islands in the South China Sea* 中國南海各島嶼. It placed the southernmost edge of China's maritime boundary at 4° north latitude, thus incorporating the Spratly Islands and James Shoal. Bai Meichu, another prominent Chinese geographer, drew the last notable map on the eve of the Sino-Japanese War in 1936, the *Map of Chinese Domain in the South China Sea* 海疆南展後之中國全圖. It did not include a boundary line (Zou, 2007: 88–89).

Records from the Qing dynasty indicate that China did not claim or exercise a long-standing dominance of the waters in the center of the South China Sea, as would be needed to substantiate a historic rights waters zone.[16] Mentions of the islands were sparse, brief, and merely demonstrated that China was aware of their existence. An example is Chen Lunjiong's *Records of Sights and Sounds of the Maritime Countries* 海國聞見錄, an official compendium of geographies, locations, and maritime routes to many foreign kingdoms. Completed in 1730, it was the first Qing work to mention the islands:

> [Sailing] by oneself in the Greater Qizhou Sea 七州大洋:[17] The beginning of the sea lies off [of Hainan Island]. The waters here are lively and swing back and forth. There is a ridge of mountains marking the start of the Qizhou Sea 七州洋.[18] Sail with the correct compass bearings and with strong yet smooth winds. Six to seven days are needed for one to cross [the Qizhou Sea], after which one will be able to spot Tiebiluo 呫嗶嘬 [present-day Cham Islands], which lies off the coast of Guangnan 廣南 [Vietnam]. To the east, one will encounter 犯 the Wanli Changsha 萬里長沙 [the Paracels] and Qianli Shitang 千里石塘 [the Spratlys]. To the west are currents that flow into Guangnan Bay [the Gulf of Tonkin]. Without a western wind, one cannot leave this area. (Chen, 1984: 120)

Chen simply described the islands' locations, their use as sea-route landmarks, and the directions needed to sail there. The islands, however, were not intended to be traveled to. Chen noted only that if one strayed east from his described route, these islands would be "encountered." The corresponding Chinese character, 犯 (*fan*), normally denotes "illegality," "trespassing," and "violating," indicating that the Qing regarded the islands as locations to be avoided. All subsequent Qing texts that mentioned the South China Sea islands repeated Chen's focus on description, such as Yan Ruyou's *Essentials of Maritime Defense* 洋防輯要 of 1838 and Wei Yuan's *Illustrated Gazetteer of the Maritime Countries* 海國圖志 of 1847 (Samuels, 1982: 40). There is no mention of dominance over the waters surrounding the islands.

Qing naval defense manuals and travel chronicles, far from considering these archipelagos as areas to be patrolled by the Qing navy, commonly warned sailors to stay away from them. For instance, Lu Kun and Deng Tingzhen's *Compendium on the Maritime Defense of Guangdong* 廣東海防彙覽, completed in 1838, wrote of the "extreme danger" 極險 one would encounter when deviating into the area (Lu and Deng, 2009: 969). Yang Pingnan's *Maritime Records* 海錄, written in 1844, was especially vivid:

> Ships that stray into [the Wanli Changsha 萬里長沙, or Paracels] cannot return due to these floating sands. Many ships are destroyed here. Sailors who encounter this fate have no choice but to lie on wooden planks [i.e., the flotsam of their shipwreck] and spend many days floating toward the sands. . . . To the south of the Qizhou Sea is the Qianli Shitang 千里石塘 [the Spratlys]. Here, there are a great many terrible and furious waves. If ships stray into this area, they will be smashed to pieces. (Yang, 1984: 265–66)

Shallows, storms, and frequently changing winds and currents that can push boats toward the islands and submerged features characterize the area, prompting Yang to remark that ships that stray there cannot escape (United States National Geospatial Intelligence Agency, 2004: 3–14). Sailors had known of these dangers for centuries. As Granados and Samuels note, major trading routes avoided the hazardous center of the South China Sea (Granados, 2006b; Samuels, 1982: 23). The most used route hugged the coastline of southeast China and eastern Vietnam, down south to the coasts of Thailand, Indonesia, and Malaysia. This absence of historic domination over almost all of the South China Sea attenuates any claim to a transfer of sovereignty that could lead to a historic rights waters zone within the U-shaped line.

Physical Characteristics of the U-Shaped Line

Another topic that merits close examination concerns the appearance and physical characteristics of the U-shaped line in its three major manifestations: the 1946 and 1947 versions of the *Location Sketch Map of the South China Sea Islands* and the official 1947 *Location Map of the South China Sea Islands*, which was later publicly released in 1948 (see Maps 1, 2, and 3 in the Appendix). The way the line was drawn supports the conclusion that it was an islands attribution line, not a historic rights waters zone.

Chinese scholars often state that the U-shaped line was an equidistant marker between China and neighboring states. As Li Jinming and Li Dexia note, Wang Xiguang, an ROC official who helped formulate the U-shaped line, stated that "the dotted national boundary line was drawn as the median line between China and adjacent states" (Li and Li, 2003: 290). A line equidistant to the shores of countries claiming the same waters can suggest a maritime boundary. Such a line was one of many basic methods of compromise between competing spheres of maritime sovereignty at the time. Indeed, the distances between the southeasternmost Spratly Islands, the U-shaped line, and Borneo and Palawan Island, are roughly equidistant in the U-shaped line maps. However, this equidistance principle did not feature in most of the U-shaped line, such as between Macclesfield Bank and the Philippines and between the easternmost Spratlys and the southeastern coast of Vietnam (see Maps 1, 2, and 3 in the Appendix). In these cases, the distance from the U-shaped line to the nearest land feature was either much shorter or longer compared to that of the opposite side of the same section of the line. Hence, it is problematic to claim that the U-shaped line was a maritime boundary because of its employment of the equidistance principle.

Virtually all scholars of the South China Sea dispute, moreover, overlook another noteworthy feature. On all three maps of the U-shaped line, an inconspicuous section branches off from the main boundary line and sits between the southern tip of Palawan Island of the Philippines and northern Borneo (see Maps 1, 2, and 3 in the Appendix).[19] This section was attached to and marked identically with the same pattern as the rest of the boundary, using a series of dots, lines, and in the two 1947 maps, incomplete circles. What it denotes thus presumably held true for the rest of the U-shaped line.

This segment of the line clearly did not delineate a maritime boundary. It extended eastward into and past the Philippines' border with northern Borneo, as defined in the Filipino constitution of 1935. According to the government of the Philippines, the nation's boundaries stemmed from the "Philippine Treaty Limits," based on three treaties: the Treaty of Paris between Spain and the United States of December 10, 1898; the Treaty of Washington between Spain and the United States of November 7, 1900, and the "Convention between the United States of America and Great Britain Delimiting the Boundary between the Philippine Archipelago and the State of North Borneo" of January 2, 1930. The last is the most recent and relevant treaty concerning the boundary between North Borneo and the Philippines (Bautista, 2011: 37–39).[20]

Granted, the boundary set by this treaty appeared to have been only an islands attribution line. It established "the line separating the islands belonging to the Philippine Archipelago on the one hand and the islands belonging to the State of North Borneo which is under British protection on the other" (Government of the Philippines, 1930). The treaty did not specify "waters" of any sort. Only in 1961 did the Filipino government officially declare that its territorial waters lay between its straight baselines and the boundaries set by the "Philippine Treaty Limits" (Government of the Philippines, 1961).

Nevertheless, if the boundary set by the 1930 convention had indicated only the islands of the Philippines and Borneo and not their waters, the same conclusion would hold. As Tommy Koh notes, for over a hundred years before the Second World War, Great Britain was a champion of the three nautical mile limit concept for territorial waters (Koh, 1987: 9). It constantly strove to maintain this range unless agreed otherwise in special arrangements with foreign states. Two months after the U.S.–Great Britain Convention of 1930, Britain reiterated this stance in the Hague Codification Conference (Koh, 1987: 7–8). This international conference was the first and last of its kind to address the scope of a nation's waters before the creation of the U-shaped line maps. The segment of the U-shaped line in question, however, did not reflect such long-established maritime borders. According to the distance conversion scale provided by the three U-shaped line maps, the segment of the U-shaped line between British-held Borneo and the Philippines lay roughly 25 km, or 13.5 nm, from the nearest coast of either state, far past the three nautical mile mark (see Maps 1, 2, and 3 in the Appendix). Whether the Philippine Treaty Limits denoted a waters zone in 1946 and 1947 is inconsequential. In either scenario, this segment of the U-shaped line did not conform to *any* maritime boundary or principle previously recognized in the region, whether by the United States, Great Britain, or the Philippines.

In contrast, arguably the ROC drew this segment of the U-shaped line merely to specify where the land of the Philippines ended and that of Borneo began. They possessed islands that were close to each other, particularly the three visible in the U-shaped line maps: Balabac, Banggi, and Balambangan (see Maps 1, 2, and 3 in the Appendix). The U-shaped line correctly marked as Filipino the same islands established by the 1930 convention. This segment of the line, furthermore, does not extend longitudinally past the western half of the width of Palawan Island. Why it was cut short and not enclosed can best be explained by the ROC's main preoccupation with denoting which *islands* were whose via the U-shaped line *from China's viewpoint*. The digression of the line from the main U-shaped body was extended just enough to serve a useful purpose: to avoid confusion in the map. This argument again supports the islands attribution line. Carried over to the rest of the U-shaped line, this underlying intent would explain especially those parts that were equidistant from neighboring lands, such as between the South China Sea islands and Palawan and Borneo, where the two groups lay close to each other and had to be divided for demarcation purposes.

The 1945 Truman Proclamation and Continental Shelf Zones

It would be unconvincing to argue that the archival files did not mention a historic maritime zone around the islands simply because waters zones had not yet been internationally standardized and were seen as a natural extension of the land and hence did not merit mention. Although the Hague Codification Conference of 1930 did not produce an international standardization of territorial waters, countries nevertheless thereafter unilaterally specified maritime borders. On September 28, 1945, for instance, the United States proclaimed the "1945 US Presidential Proclamation No. 2667, Policy of the United States with Respect to the Natural Resources of the Subsoil of the Sea Bed and the Continental Shelf." Also known as the Truman Proclamation of 1945, this document broke precedent in international law by unilaterally declaring an extended fisheries protection and continental shelf zone (Government of the United States of America, 1945). Several other countries followed suit, such as Saudi Arabia and Kuwait in 1949; Chile, Ecuador, and Peru in 1952; Israel in 1953; Iran in 1955; and Venezuela in 1956 (Suarez, 2008: 28–29). This trend led to a convention on continental shelves in the First United Nations Conference on the Law of the Sea, held in Geneva on April 29, 1958 (Suarez, 2008: 29). By no means were countries uninterested in defining the scope of their waters around the time of the creation of the U-shaped line.

The ROC was no exception. It officially announced the extent of its maritime boundaries in 1931 and 1934, before the creation of the U-shaped line. Yet, a historic rights waters zone as massive as the area within the U-shaped boundary would have broken precedent with the ROC's existing borders and the whole world. The line was created at a time when the idea of continental shelves—never mind an even larger historic maritime zone—was still revolutionary in international law. If the concept of a historic maritime zone was what the ROC intended with the U-shaped line, it would not have overlooked the matter out of "insignificance," given the sheer level of detail contained in the situation reports, plans for development, and conference summaries that defined the scope of the line.

Fu's and Gao and Jia's conclusion that the U-shaped line denoted historic rights waters precisely because it was the ROC's own Truman Proclamation is, however, problematic (Fu, 1995: 204; Gao and Jia, 2012: 103, 109).[21] They provide no evidence that the coincidence between the two stemmed from cause and effect. They merely assume this to be the case. The officials who created the U-shaped line, however, did so without considering the Truman Proclamation. The ROC archival files—most importantly those detailing the exact determination of the line—never mentioned the Truman Proclamation, continental shelves, the scope of fishing waters, and scarcely even the United States. Fu as well as Gao and Jia also overlook the logic in the Truman Proclamation and all similar claims by other countries: the claiming of a maritime zone within countries' *continental shelves* (Suarez, 2008: 28–29). Most of the waters that the U-shaped line delineated, especially those surrounding the Spratly Islands, extended far past China's continental shelf. The ROC, furthermore, had not officially declared its support and adherence to the concept of a continental shelf zone when the U-shaped line maps were created. It only advocated a three nautical mile territorial waters zone and a twelve nautical mile contiguous zone (Chiu, 1975: 38). The ROC first officially approved the continental shelf concept nearly a decade after the creation of the U-shaped line, when it helped draft and signed the Geneva Convention in 1958. The ROC government did not ratify it until October 12, 1970 (United Nations, 1964).

Besides the lack of a claim to historic rights waters, nothing indicates that the ROC attempted to enforce such zones throughout the South China Sea. The United States navy by this time reigned supreme in the waters of the South China Sea. ROC naval activity in the region in 1946 and 1947 was largely confined to landing expeditions, supplying garrisons, and protecting a limited fishing zone. The ROC government had more pressing matters to attend to, chief among them the Chinese Civil War. As the tide of the war swung irreversibly in favor of Mao Zedong, and the threat of an invasion in Taiwan loomed in 1949, the South China Sea islands became increasingly trivial to the ROC. By May 1950, the last ROC troops stationed on the islands were recalled to Taiwan (Granados, 2006a: 160, 162). While the ROC sent some troops back to the islands from June to September 1956, only Itu Aba and the Pratas Islands were secured. Naval activity afterward in the South China Sea islands region focused on supplying the garrisons and ensuring that the islands were not infringed upon by others. For instance, on October 1, 1956, a ROC patrol boat and destroyer found Cloma's brother Filemon's ship anchored off North Danger Reef. They demanded he leave and promise never to return to the islands. Filemon refused, and discussions dragged into the next day. After issuing a final warning and confiscating his weapons, the two ROC ships released him and his crew and departed. Filemon discovered that their structures on Northeast and Southwest Cay, the reef's two islands, had been "completely removed" (Hartendorp, 1961: 226–27; Haijun xunyi Nansha haijiang jingguo, 1975: 163–70; Samuels, 1982: 84–85). Developments on the ground during this period confirmed that the ROC's sole concern was the islands' land territory, not a massive waters zone.

There is one last consideration. Jacques deLisle notes that the U-shaped line generally ran along the 200-meter isobaths line, a feature usually associated with continental shelves as set out by the Truman Proclamation and the Geneva Convention of 1958.[22] This "implies that China claimed everything beyond the outer limits of rival states' continental shelves" (deLisle, 2012: 615). While interesting, this logic is flawed. It would mean that the U-shaped line was affected by the Truman Proclamation, for which there is no direct evidence as previously explained. DeLisle also fails to recognize the implication of associating the Truman Proclamation with the line in such a manner. If the ROC had indeed made a historic claim over the waters of the South China Sea in 1946, it willingly diminished what it viewed as a "patriotically sacred" and millennia-old claim for the sake of respecting a year-old principle that was then unprecedented in scope, legally unfounded in international law, and followed by neither the ROC nor any of the Southeast Asian colonies bordering the U-shaped line save the United States in the Philippines. Notwithstanding the inherent contradiction, there simply is no evidence that the ROC government made such a decision.

Enter the PRC

Considering itself to be the sole legitimate representative of China, the PRC adopted the U-shaped line in 1949. Although the line underwent a slight change in 1953—in particular, the removal of the two dashes separating Vietnam and China in the Bay of Tonkin—the same shape remained (Franckx and Benatar, 2012: 91). Like the ROC, the PRC in its early years used the line in a way that supported the islands attribution view. It made no official claim to any waters zone that remotely approached the size of the territory encompassed by the U-shaped line for several decades afterward.

The PRC made its first official claim to the islands in 1951, when Premier Zhou Enlai denounced the joint U.S./U.K. draft for the Treaty of San Francisco: "As a matter of fact, the Paracel Archipelago and Spratly Island, like the entire Nansha [Spratly], Zhongsha [Macclesfield Bank], and Dongsha [Pratas] Archipelagos, have always been Chinese territory" (Zhou, 1990: 41). The PRC simply announced that the South China Sea islands were an inherent part of Chinese territory. It did not mention any special waters zone. Even more telling, its "Declaration on the Territorial Sea" in 1958 announced that:

> The breadth of the territorial sea of the People's Republic of China shall be twelve nautical miles. This provision applies to all territories of the People's Republic of China, including the Chinese mainland and its coastal islands, as well as Taiwan and its surrounding islands, the Penghu Islands, the Pratas Islands, the Paracel Islands, Macclesfield Bank, the Spratly Islands, and all other islands belonging to China, which are separated from the mainland and its coastal islands by the high seas (隔有公海的). (PRC, 1958)
>
> 中华人民共和国的领海宽度为12海里。这项规定适用于中华人民共和国的一切领土，包括中国大陆及其沿海岛屿，和同大陆及其沿海岛屿隔有公海的台湾及其周围各岛、澎湖列岛、东沙群岛、西沙群岛、中沙群岛、南沙群岛以及其他属于中国的岛屿。

This statement explicitly indicated that a belt of high seas separated the Chinese mainland from the South China Sea islands. The PRC did not hold to, nor did it attempt to enforce, a historic rights waters interpretation of the line. Its navy remained largely inactive in the islands region until 1974 (Lo, 1989: 29–29; Samuels, 1982: 67, 87–88).

From that year, however, official PRC claims and protests employed vague terms such as "adjacent" and "relevant" to characterize the waters next to the islands it claimed. The first case was an official PRC statement on January 11, 1974, issued five days before PRC and South Vietnamese forces battled for control of the southern half of the Paracel Islands (the Crescent Group), and in reaction to South Vietnam's official incorporation of the Spratly Islands on September 6, 1973. It stated that "the Nansha [Spratly], Xisha [Paracel], Zhongsha [Macclesfield Bank], and Dongsha [Pratas] archipelagos are all part of Chinese territory. The People's Republic of China has indisputable sovereignty over these islands and islets. The resources of these islands and their *adjacent seas* also belong entirely to China" (Renmin ribao, 1974: 1, italics added). This statement did not clarify the geographic extent or rights of these "adjacent" waters. Thus, it is uncertain whether it can be considered an assertion of a historic rights waters regime.

PRC laws and statements continued this pattern of ambiguity. Article 14 of its EEZ law, implemented on June 26, 1998, stated that "the provisions of this Law shall not affect the *historic rights* enjoyed by the People's Republic of China" (PRC, 1998, italics added). This was the first time the PRC government indicated that it possibly held such rights in the region, but it did not clarify what these entailed and where they applied.

On May 7, 2009, China submitted a note verbale to the UN, responding to Vietnam and Malaysia's joint submission of their claim to an extended continental shelf to the Commission on the Limits of the Continental Shelf. It attached a map of the U-shaped line, the first time the PRC officially presented the line on an international level to illustrate its claim and rebut that of others. However, its only explanation relating to the map was that

> 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[23]). The above position is consistently held by the Chinese Government, and is widely known by the international community.
>
> The continental shelf beyond 200 nautical miles as contained in the Joint Submission by Malaysia and the Socialist Republic of Viet Nam has seriously infringed China's sovereignty, sovereign rights and jurisdiction in the South China Sea. (PRC, 2009)

While terms such as "adjacent waters," "sovereign rights," and "jurisdiction" were used, their scope was not specified. The words "relevant waters" were followed by a reference to the U-shaped line map, without stating whether the "relevant waters" equaled some or all of the waters contained within the line. The confusion was evident in the Filipino note verbale of April 5, 2011, its response to China's note. The Philippines denounced the U-shaped line as illegal, because its scope and the term "relevant waters" were not clarified, while the line overlapped with Filipino claims in the Spratlys (Government of the Philippines, 2011a). China's response to the Filipino note on April 14, 2011, did not address these concerns. It simply reiterated that China had "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" (PRC, 2011).

This official ambiguity has since persisted. On January 22, 2013, in response to the Philippines' efforts to bring the South China Sea dispute before international arbitration, the PRC's ambassador in Manila, Ma Keqing, reiterated Chinese sovereignty "over the islands in the South China Sea and its adjacent waters" (Xinhua News, 2013). On December 12, 2014, PRC foreign ministry spokesman Hong Lei denounced Vietnam for submitting its statement of position to the arbitration panel. He reaffirmed that "China has indisputable sovereignty over the Nansha [Spratly] Islands and their adjacent waters. And it is an indisputable fact that the Xisha [Paracel] Islands are an integral part of China's territory" (PRC, 2014). Neither Ma nor Hong clarified the scope and rights of these "adjacent waters."

Conclusion: The Significance of the History of the U-Shaped Line to the Present Dispute

It is because this vagueness continues today that examining the history of the U-shaped line is important. Not only did the PRC adopt the line used by the ROC to represent its claims in the South China Sea, it used this line in the same way until at least 1974, and possibly beyond: as an islands attribution line. There was continuity between the ROC's and PRC's interpretation of the line. Therefore, the ROC's early usage of the line represents the first step to understanding and clarifying how the PRC interprets it today.

This article points toward an important avenue of future research. A thorough comparison between the origins and early usage of the line and the PRC's position in the South China Sea region since 1974 would reveal changes and continuities on these issues and the reasons for them. Identifying these aspects would help in resolving the disputes over the South China Sea, for instance, by determining *how* to proceed with negotiations. If the PRC continues to adhere predominantly to the islands attribution view, it would be better first to negotiate less sensitive matters pertaining to maritime areas rather than a delineation of the islands, as this would encounter less opposition from China. Initial limited cooperation among claimants would help to reduce provocations and foster confidence building in the region. Examples could include joint projects in marine conservation, emergency response, anti-piracy, and perhaps scientific exploration and research. Such measures could gradually erode mistrust and increase the chances of success in later rounds of negotiations that address more sensitive topics, such as finally settling ownership over the islands.

Determining how far the PRC still adheres to the ROC's early usage of the line will help concerned parties understand the PRC's present claims, and eliminate historical inaccuracies and biases. This would encourage constructive debate and resolution by allowing claimants to sort through worrying aspects of

China's claims that have obstructed progress in the dispute. By the same token, to reveal changes in China's historical arguments that do not adhere to its original claim,[24] have no foundation in international law, or indicate simple expansionism, will assist non-Chinese claimants to decide which areas of the dispute they must be adamant about.

Of special importance, a balanced investigation of the history of the U-shaped line might lead all claimants to understand that listening to other claims does not automatically mean accepting them. This point is often lost in the wrangling over clashing claims. China's assertion of "indisputable sovereignty" in the region, for instance, is far too inflexible. It prevents China from realizing that its historical claim raises genuine concerns, and from addressing them. China's refusal to clarify its historical claims fuels fear among its neighbors, while glaring historical inaccuracies weaken its case and prompt inflexible stances from non-Chinese claimants.

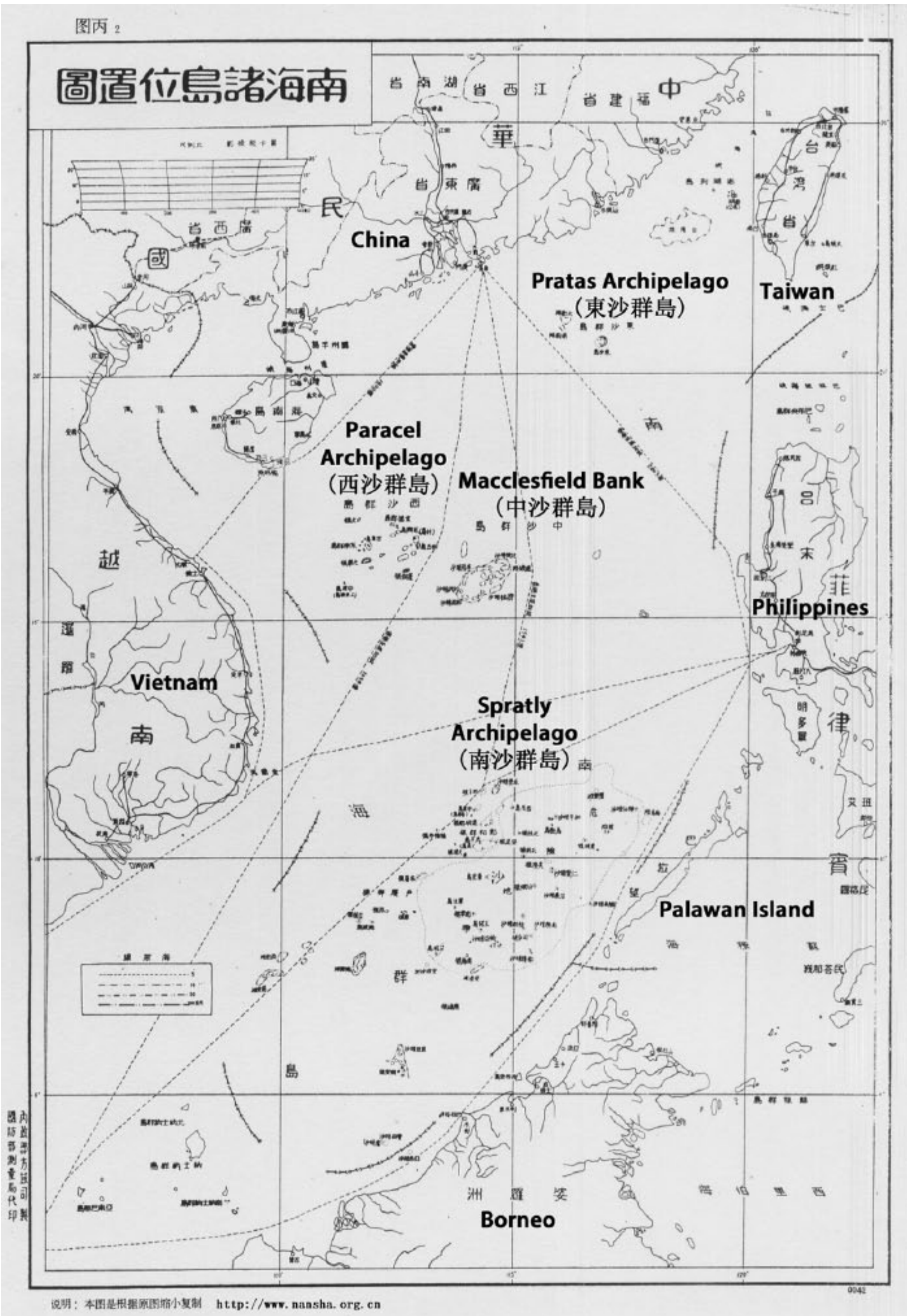
Meanwhile, non-Chinese states' refusal to meaningfully consider China's claims, stemming from a lack of understanding of China's U-shaped line claim, equally discourages peaceful resolution. Thus, the Philippines' unsuccessful Zone of Peace, Freedom, Friendship and Cooperation plan stated in a footnote that the U-shaped line did not merit consideration, even in areas not disputed by the Philippines (Government of the Philippines, 2011b: 2).[25] This approach prevented China from employing the line even as a basis with which to participate in the proposed resolution plan. The Philippines dismissed China's views on history and international law so abruptly that China refused even to discuss the plan. Had the Philippines taken China's claim into consideration, which would not have necessarily meant accepting it, China may have participated and removed ambiguity over the line, thus moving toward resolution. Instead, this incident encouraged China to continue hardline measures in order to "protect" its claims.

Finally, examining the history of the ROC's usage of the line could help guide the ROC government on deciding what stance to adopt on the dispute. Its claims have been as wide-ranging as the PRC's, if not more so. On April 13, 1993, under its "South China Sea Policy Guidelines" 南海政策綱領, the ROC officially stated that "the waters within the South China Sea historic waters boundary (歷史性水域界線) are under the jurisdiction of the Republic of China. Our country possesses all rights and interests in these waters" (Executive Yuan of the Republic of China, 1993). The "historic waters boundary" referred to the U-shaped line created in 1948, as the chairman of the Research, Development, and Evaluation Commission of the Executive Yuan clarified shortly afterward (Sun, 1995: 403). The Policy Guidelines did not articulate what "all rights and interests" entailed. A literal reading of "historic waters" would make nearly the entire South China Sea equivalent to the ROC's internal waters.

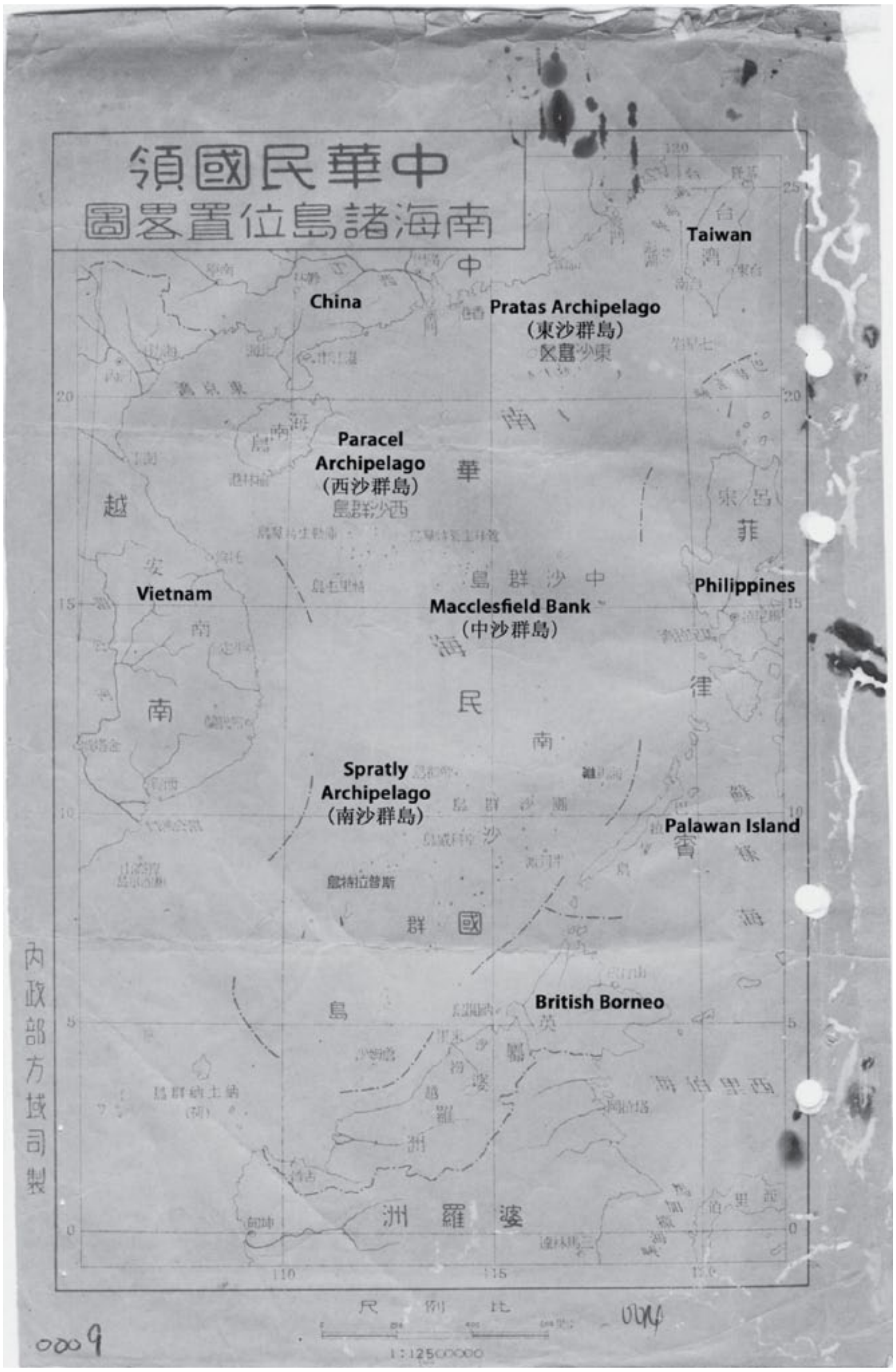
The ROC government terminated the Policy Guidelines on December 15, 2005 (Executive Yuan of the Republic of China, 2005). However, its current official position is unclear. Like the PRC, it claims the islands and their "surrounding waters" 周遭水域 (MOFA, 2011). Recent developments have not clarified this ambiguity. On September 2014, ROC president Ma Ying-jeou delivered a speech at the Academia Historica that adhered to the islands attribution view. According to the *Economist*, he specified that the 1947 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'" ("Joining the Dashes," 2014). Yet, in a letter to the *Economist*'s editor on November 1, ROC representative to the UK Liu Chih-Kung stressed that "President Ma did not 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" (Liu, 2014). It is unclear how far these "surrounding waters" extend, but Liu made it clear that it was *not limited* to twelve nautical miles from the islands. This indicates that the ROC government possibly holds a historic rights or historic waters view. It may also be evidence of confusion or dissension among ROC offficials regarding this stance. There has been no official response to this letter.

The ROC's actions regarding the South China Sea dispute frequently contradict a historic waters or historic rights waters stance. The ROC has never claimed nor attempted to uphold the right to prohibit or regulate foreign maritime and aerial traffic across the South China Sea, notwithstanding the repealed Policy Guidelines (Wang, 2010: 249). The ROC's law on the territorial sea and contiguous zone, Exclusive Economic Zone law, and baselines declaration claim only measurable sea zones, using language derived solely from international law. They do not include such terms as "historic rights" and "adjacent" or "relevant" waters (MOI, 1998a; MOI, 1998b; MOI, 1999). The government continues to focus on garrisoning and developing the islands it has retained since 1955, the Pratas and Itu Aba Island. Almost all development there has focused on land territories. For instance, the ROC opened Itu Aba Island to tourism, built an airstrip to bolster the island's defense in 2007, completed a solar power plant in 2011, and is currently building a port (Lin and Hsiao, 2012: 1–2, 6–7, 13–14; Gold, 2015). The scope of its military patrols is limited to a narrow 10 km (approximately 5.4 nm) belt of exclusionary waters around Itu Aba Island. Given the potentially negative diplomatic consequences of claiming a large historic maritime zone, since archival files support its present focus on the islands, the ROC government might gain from officially declaring an islands attribution stance on the U-shaped line.

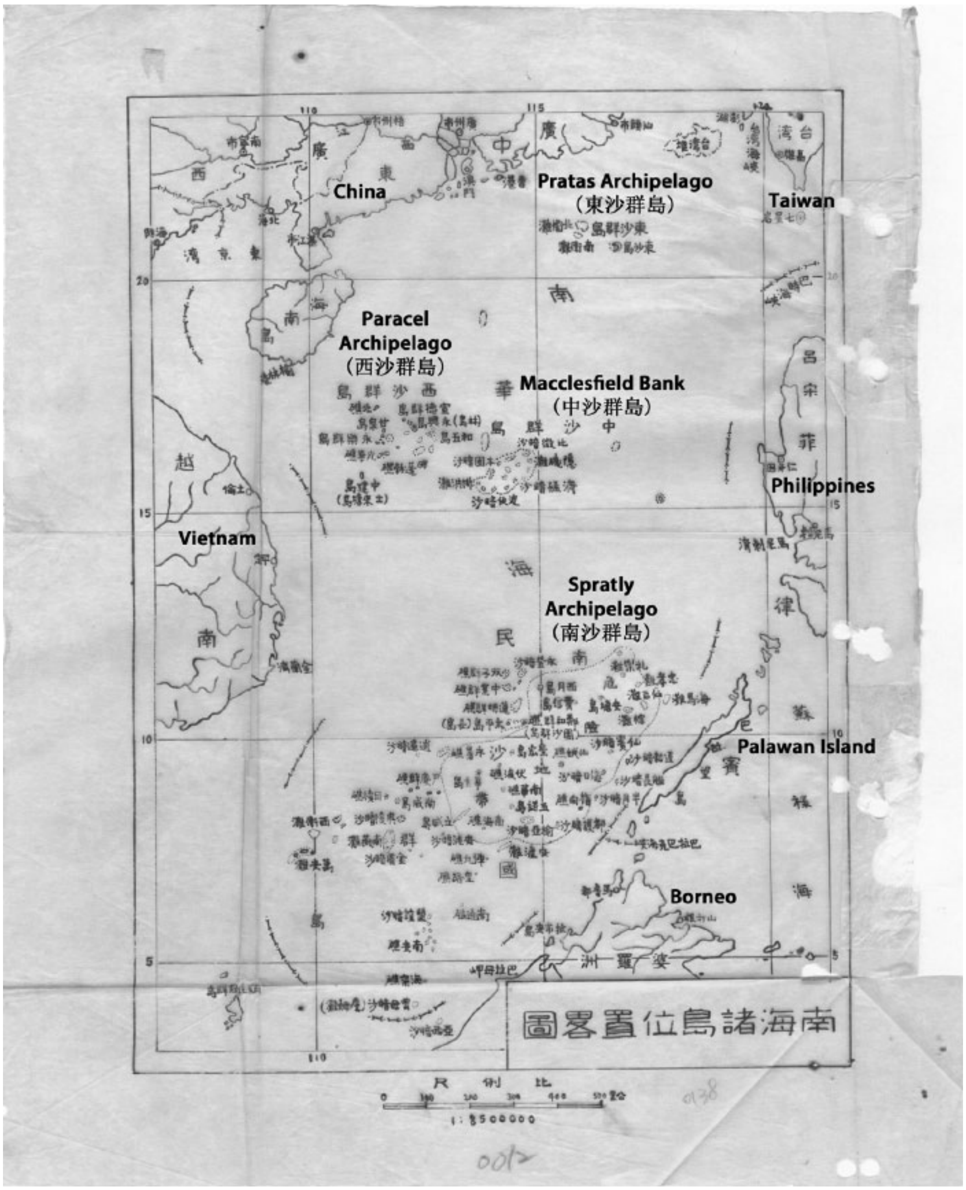
Appendix



Map 1. *The Location Map of the South China Sea* 南海諸島位置圖, 1947 (Government of the Republic of China, 1947). The same map was publicly published in 1948. Reproduced with permission from Nansha.org 南沙群岛在线. The English labels are my own.



Map 2. *The Location Sketch Map of the South China Sea Islands* 南海諸島位置略圖, 1946 (MHTO, file series 0035/061.8/3030, file 001/001/0009). Reproduced with permission from the Republic of China National Archives Administration. This map can also be found in MOFA, file series 019.3/0012, file 103. The English labels are my own.



Map 3. The 1947 version of *The Location Sketch Map of the South China Sea Islands* 南海諸島位置略圖 (MHTO, file series 0035/061.8/3030, file 006/008/0012). Map 1 came from this version. Note the eleven dashes, soon to be standard, as opposed to the eight in the 1946 version. The shape, however, is identical. Reproduced with permission from the Republic of China National Archives Administration. The English labels are my own.

Acknowledgment

I extend my sincere thanks—in alphabetical order by their last names—to Kathryn Bernhardt, John R. Ferris, Richard Gunde, Ma Yu-cheng 馬有成, David Curtis

Wright, Wu Jen-shu 巫仁恕, the peer referees of this article, and the archival staff of the Republic of China National Archives Administration for their invaluable insight and assistance. Two of the three referees have kindly revealed their identities: M. Taylor Fravel and Ulises Granados.

Author's Note

This article is developed from my master's thesis, "'Since Time Immemorial': China's Historical Claim in the South China Sea," completed in 2013 at the University of Calgary. It provides new interpretations of primary source materials, corrects previous mistakes, and covers certain developments since 2013.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Notes

1. Estimates of total proven and probable oil and natural gas reserves in the South China Sea vary considerably due to the territorial dispute, which prevents a thorough survey of the seabed. They range from 11 to 125 billion barrels of oil and 190 to 500 trillion cubic feet of natural gas (United States Energy Information Administration, 2013: 2).
2. By "adjacent waters derived from contemporaneous conceptions of international law," I am referring solely to waters zones created, discussed, and *standardized* by international maritime laws and conferences at any given time. This entails internal waters, territorial waters, contiguous waters, exclusive economic zones, and/or continental shelf zones. For definitions and rights of these maritime zones, see the United Nations Convention of the Law of the Sea (UNCLOS), the dominant international maritime law today (United Nations, 1982). Until finally standardized by UNCLOS in 1982, these zones often varied between different countries and were constantly changed by them. Most of these differences concerned geographical extent. Important differences will be covered in-text.
3. Unlike "historic rights," "historic waters" claim the same privileges found in internal waters on the basis of historic dominance, the most important being the ability to regulate all forms of maritime and aerial traffic (Symmons, 2008: 1–11). Nearly all Chinese scholars today reject or refuse to take this position. Zou Keyuan is especially insistent about this (Zou, 1999: 40–44).
4. On January 27, 2014, the National Institute for South China Sea Studies 中国南海研究院 (NISCSS), the PRC's largest think-tank on the dispute, opened its

South China Sea archives (China Daily USA, 2014). However, the three ROC archival file collections examined still contain most, if not all, of the relevant ROC files written at the time of the creation of the U-shaped line. The NISCSS files focus on and *draw from* ROC-era archival files found in Taiwan, China, and other countries (China Daily USA, 2014). The PRC still lacks data from when the ROC was in control of China. Many ROC academics expressed wariness when NISCSS president Wu Shicun visited the "Exhibition on the Republic of China's Historical Data for the Southern Territories" at the Academia Historica in September 2014. They feared it gave the PRC an opportunity to use ROC files, of which it has few, to bolster its claims (Tzou and Chung, 2014). Granted, the NISCSS archives may contain valuable PRC documents as well as a few files from the ROC era that cannot be found in Taiwan.

5. For the sake of simplicity, the politically complex warlord period from 1916 to 1928 will be subsumed under this category. The actions of the warlord governments have no relevance to the findings and conclusions of this article.
6. Baselines are a series of straight lines that connect the outermost features of a state's coast and islands. There are limitations to the application of baselines. For instance, they "must not depart to any appreciable extent from the general direction of the coast, and the sea areas lying within the lines must be sufficiently closely linked to the land domain" (United Nations, 1982: Article 7). Only archipelagic states may apply straight baselines connecting the outer points of an archipelago (United Nations, 1982: Articles 6, 7, 47).
7. One nautical mile equals 1.852 km (1.15078 miles).
8. The character *lüe* 畧 in the map's title indicates that it was a draft, or "Sketch Map."
9. This infrastructure would serve to facilitate marine resource development. For instance, the report listed the need for wireless radio stations on the islands to enable communications with fishermen (MHTO, file series 0035/061.8/3030, files 007/013/0011 to 0014).
10. Cloma made the formal declaration on July 6 (MOFA, file series 019.3/0005, files 071 to 073).
11. Meads often claimed to be the "consul" of the Kingdom of Humanity (MOFA, file series 019.3/0003, file 045).
12. The assumption here is that Japan formally returned the South China Sea islands to the ROC after the Second World War. The PRC believes it inherited the peace treaty that the ROC signed with Japan in 1952, which supposedly specified the postwar transfer of the islands. These ROC and PRC official views are still debated. This article does not attempt to judge which side is legally correct. Rather, it explains why these interpretations still support the islands attribution stance.
13. The coordinates of the Shinnan Guntō, counterclockwise from the southwesternmost corner, are: 7°N 111°E; 9°N 111°E; 12°N 114°E; 12°N 117°E; 9°N 117°E; 8°N 116°E; and 7°N 114°E.
14. "Check whether the Tuansha [Islands] and Shinnan [Guntō] are two names for the same place. Have we received [i.e., taken] them yet [the islands marked by

the Shinnan Guntō area]?" 查新南與團沙是否同地兩名，我方已否接收？(MOFA, file series 019.3/0012, files 014). Tizard Bank has had several Chinese names. For example, one list of the South China Sea islands in September 1946 translated "Tizard B.R." as 鉄沙群島 (MOFA, file series 019.3/0012, files 089). "Tizard B.R." almost certainly referred to Tizard Bank, the "R" standing for "reef." It was a subheading under which some of its individual parts were listed, and correctly. 鉄沙, pronounced "Tiesha," is a transliteration of Tizard. Today, Tizard Bank is written as 郑和群礁.

15. To the ROC, the Tuansha administration theoretically had its origins in Qing claims. These in turn were supposedly based on over a millennia of uninterrupted historic ownership. This supposed continuity is frequently claimed in ROC archival files (MOFA, file series 019.3/0001, file 011; MHTO, file series 0035/061.8/3030, file 005/012/0010).
16. Chinese mentions of the islands and South China Sea stretch back to at least the tenth century CE, and at most the eleventh century BCE (Samuels, 1982: 10; Shen, 1998: 150). I am, however, evaluating the Qing's historical record for three reasons. First, one needs only to examine the historical record of the last Chinese dynasty before the Republican era to confirm whether this supposedly long and *continuous* history of ownership of the Tuansha did indeed exist. Second, a long history of China's dominance over the South China Sea and its islands would count for nothing if China let the claim fade for several centuries during the Qing dynasty. Finally, most Qing records that mention the islands compile relevant records from past dynasties.
17. Traditionally correlated with part of the South China Sea.
18. That is, if one starts from Hainan Island.
19. The 1946 *Location Sketch Map of the South China Sea* added the term *Yingshu* 英屬 in front of the label for Borneo, which simply denoted that the territory was British.
20. For a map showing the boundaries set by the coordinates provided by the 1930 U.S.–Great Britain Convention, see Bautista, 2011: 37.
21. Zou Keyuan only agrees with the *possibility* of this correlation (Zou, 2012: 28).
22. An isobath line connects points in the seabed that have the same depth; 200 meters in this case.
23. This refers to the U-shaped line map attached at the end of the document.
24. This aspect is important, as the PRC continues to base its claims on the U-shaped line as originally created and used by the ROC.
25. The Zone of Peace, Freedom, Friendship and Cooperation plan envisioned delimiting undisputed areas from disputed ones using ten proposed strategies. Joint cooperation schemes and rights would then be negotiated in disputed areas according to Part IX of UNCLOS and multilateral agreements. The plan would create a Code of Conduct to prevent accidents and misunderstandings. Examples of "joint cooperation" include joint economic development, scientific research, marine conservation, and transnational crime prevention (Government of the Philippines, 2011b: 1–4).

References

BAUTISTA, LOWELL (2011) "Philippine territorial boundaries: internal tensions, colonial baggage, ambivalent conformity." J. of Southeast Asian Studies 16 (Dec.): 35–53.

CALICA, AUREA (2013) "Asean pushes sea code, talks with China." Philippine Star, April 26. www.philstar.com/headlines/2013/04/26/935041/asean-pushes-sea-code-talks-china.

CHEN LUNJIONG 陳倫炯 (1984) 海國聞見錄 (Records of sights and sounds of the maritime countries). 中國南海諸群島文獻彙編 (Collection of documents on the South China Sea Islands), rept. ed., vol. 3. Taipei: Taiwan xuesheng shuju.

China Daily USA (2014) "South China Sea archives open in Hainan." Jan. 28. http://usa.chinadaily.com.cn/china/2014-01/28/content_17261850.htm.

CHIU, HUNGDAH (1975) "China and the question of territorial sea." Maryland J. of Int. Law 1, 1: 29–77.

DELISLE, JACQUES (2012) "Troubled waters: China's claims and the South China Sea." Orbis 56, 4: 608–42.

Executive Yuan of the Republic of China 行政院 (1993) 南海政策綱領 (South China Sea policy guidelines). April 13. www.cga.gov.tw/GipOpen/wSite/public/Attachment/f1259488571867.pdf.

Executive Yuan of the Republic of China (2005) 台內地字第09400162932號函停止適用 (Repeal of ROC Ministry of Interior Department of Land Administration's file #09400162932 [the South China Sea policy guidelines]). Dec. 15. www.land.moi.gov.tw/law/chhtml/lawdetail.asp?Lid=3910.

FRANCKX, ERIK and MARCO BENATAR (2012) "Dots and lines in the South China Sea: insights from the law of map evidence." Asian J. of Int. Law 2 (Jan.): 89–118.

FU KUEN-CHEN 傅崐成 (1995) 南(中國)海法律地位之研究 (Legal status of the South [China] Sea). Taipei: 123 Information Co. Ltd.

GAO ZHIGUO 高之国 and JIA BINGBING 贾兵兵 (2012) "The nine-dash line in the South China Sea: history, status, and implications." Amer. J. of Int. Law 107, 1 (Jan.): 98–124.

GOLD, MICHAEL (2015) "Taiwan turns to Chinese shipper for help with port in disputed waters." Reuters, Feb. 6. www.reuters.com/article/2015/02/06/us-taiwan-china-spratlys-idUSKBN0LA12K20150206.

Government of the Philippines (1930) Convention between the United States of America and Great Britain Delimiting the Boundary between the Philippine Archipelago and the State of North Borneo. Jan. 2. www.gov.ph/1932/12/15/convention-between-the-united-states-of-america-and-great-britain-delimiting-the-boundary-between-the-philippine-archipelago-and-the-state-of-north-borneo-1930/.

Government of the Philippines (1961) Republic Act No. 3046 of 17 June 1961. An Act to Define the Baselines of the Territorial Sea of the Philippines. www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/PHL_1961_Act.pdf.

Government of the Philippines (2011a) Philippines Note Verbale to the United Nations, No. 000228. April 5. www.un.org/Depts/los/clcs_new/submissions_files/vnm37_09/phl_re_chn_2011.pdf.

Government of the Philippines (2011b) Philippine Paper on ASEAN-China Zone of Peace, Freedom, Friendship and Cooperation (ZoPFF/C) in the WPS [West Philippine Sea] (SCS [South China Sea]). Sept. 22. http://nghiencuubiendong.vn/download/doc_download/364-philippine-paper-on-asean-china-zone-of-peace-freedom-friendship-and-cooperation-in-the-south-china-sea.

Government of the Republic of China (1947) Location Map of the South China Sea Islands. In南沙群岛在线 (Nansha.org), 南沙群岛地图–1947. www.nansha.org.cn/maps/3/1947_South_China_Sea_Map.html.

Government of the United States of America (1945) 1945 US Presidential Proclamation No. 2667, Policy of the United States with Respect to the Natural Resources of the Subsoil of the Sea Bed and the Continental Shelf. Sept. 28. http://cil.nus.edu.sg/rp/il/pdf/1945%20US%20Presidential%20Proclamation%20No.%202667-pdf.pdf.

GRANADOS, ULISES (2006a) "Chinese ocean policies towards the South China Sea in a transitional period, 1946–1952." China Rev. 6, 1 (Spring): 153–81.

GRANADOS, ULISES (2006b) "The South China Sea and its coral reefs during the Ming and Qing dynasties: levels of geographical knowledge and political control." East Asian History 32–33 (Dec. 2006–June 2007): 109–28.

GRANADOS, ULISES (2008) "Japanese expansion into the South China Sea: colonization and conflict, 1902–1939." J. of Asian History 42, 2: 117–42.

Haijun xunyi Nansha haijiang jingguo 海軍巡弋南沙海疆經過 [Records of naval patrols along the coastal waters of the Spratly Archipelago] (1975) 中國南海諸群島文獻彙編 (Collection of documents on the South China Sea Islands), rept. ed., vol. 9. Taipei: Taiwan xuesheng shuju.

HARTENDORP, A. V. H. (1961) History of Industry and Trade of the Philippines: The Magsaysay Administration, vol. 2. Manila: Philippines Education Co.

HUANG WEI 黄伟 (2011) "论中国在南海U 形线内'其他海域'的历史性权利" (Discussing the historical rights of "other waters" within the U-shaped line). 中国海洋大学学报 (English title: J. of Ocean Univ. of China) 3: 36–40.

"Joining the Dashes" (2014) The Economist, Oct. 4. www.economist.com/news/asia/21621844-south-china-seas-littoral-states-will-fight-museums-archives-and.

KOH, TOMMY (1987) "The origins of the 1982 Convention on the Law of the Sea." Malaya Law Rev. 29: 1–17.

KRASKA, JAMES and RAUL PEDROZO (2013) International Maritime Security Law. Leiden: Martinus Nijhoff.

LI JINMING 李金明 (2011) "国内外有关南海断续线法律地位的研究述评" (An overview of reviews on the legal status of the U-shaped line in the South China Sea). 南洋问题研究 (English title: Southeast Asian Affairs) 2: 54–80.

LI JINMING and LI DEXIA (2003) "The dotted line on the Chinese map of the South China Sea: a note." Ocean Development & Int. Law 34, 3–4: 287–95.

LIN, CHENG YI and ANNE HSIU-AN HSIAO (2012) "Taiwan's South China Sea policy, 1999–2011." Paper presented at the "Workshop on the South China Sea Dispute: Political and Security Implications for the Region's Future," Jan. 12–13, Academia Sinica, Taipei. Also published under the same title in Center for Asia-Pacific Area Studies of the Research Centre for Humanities and Social Sciences, Academia Sinica, 2012 Workshop on the South China Sea Dispute: Political and Security Implications for the Region's Future. Taipei [Honolulu, HI]: Center for Asia Pacific Area Studies (CAPAS), RCHSS, Academia Sinica, 2012.

LIU CHIH-KUNG (2014) "Taiwan and the South China Sea." The Economist, Nov. 1. www.economist.com/news/letters/21629213-letters-editor.

LO, CHIKIN (1989) China's Policy Towards Territorial Disputes: The Case of the South China Sea Islands. London: Routledge.

LU KUN 盧坤 and DENG TINGZHEN 鄧廷楨 (2009) 廣東海防彙覽 (Compendium on the maritime defense of Guangdong). Wang Hongbin 王宏斌, ed. Shijiazhuang: Hebei renmin chubanshe.

MHTO 國防部史政編譯局 [ROC Military History and Translation Office of the Ministry of Defense]. 國家發展委員會檔案管理局 (ROC National Archives Administration). 西南沙群島勘查報告書 (Reconnaissance reports on the Paracel and Spratly archipelagos), file series 0035/944/1060; 進駐西南沙群島案 (File on the stationing of troops in the Paracel and Spratly archipelagos), file series 0035/061.8/3030; 南沙群島調查概況 (Survey overview of the Spratly archipelago), file series 0036/002.2/4022.

MOFA 外交部檔案 [Archival Files of the ROC Ministry of Foreign Affairs] (1928–1975) 中央研究院近代史研究所檔案館藏 (Archives of the Institute of Modern History, Academia Sinica). 西沙群島問題 (Paracel archipelago issue), file series 019.3/0001; 南沙群島 (Spratly archipelago), file series 019.3/0003, 019.3/0005, 019.3/0012, and 019.3/0013.

MOFA (2011) 中華民國外交部重申南海議題立場 (Republic of China Ministry of Foreign Affairs reaffirms position on the South China Sea issue). Apr. 17. http://www.mofa.gov.tw/News_Content.aspx?n=FAEEE2F9798A98FD&sms=6DC19D8F09484C89&s=112934DBCF739E79.

MOI 內政部 [ROC Ministry of the Interior]. "進駐西南沙群島案" (File on the stationing of troops in the Paracel and Spratly archipelagos). 國家發展委員會檔案管理局 (ROC National Archives Administration). File series 0036/E41502/1.

MOI (1998a) 中華民國領海及鄰接區法 (Law on the territorial sea and the contiguous zone of the Republic of China), Jan. 21. www.land.moi.gov.tw/law/chhtml/mainframe.asp?LCID=212&.

MOI (1998b) 中華民國專屬經濟海域及大陸礁層法 (Law on the exclusive economic zone and the continental shelf of the Republic of China), Jan. 21. http://maritimeinfo.moi.gov.tw/marineweb/aspx/UpLoad/UFile/0000000040///0000000040001.pdf.

MOI (1999) 中華民國第一批領海基線、領海及鄰接區外界線 (Declaration on the first set of the baselines, territorial waters, and contiguous waters of the Republic of China), Feb. 10. Revised Dec. 18, 2009. http://www.land.moi.gov.tw/content/5835-U.pdf.

PRC (1958) 中华人民共和国政府关于领海的声明 (PRC declaration on the territorial sea). Sept. 4. http://big5.gov.cn/gate/big5/www.gov.cn/test/2006-02/28/content_ 213287.htm.

PRC (1998) 中华人民共和国专属经济区和大陆架法 (Law of the People's Republic of China on the exclusive economic zone and the continental shelf). June 26. In Office of the Commissioner of the Ministry of Foreign Affairs of the People's Republic of China in the Hong Kong Special Administrative Region. http://big5.fmprc.gov.cn/gate/big5/www.fmcoprc.gov.hk/chn/tyyflsw/jbflwj/qgxfl/t54834.htm.

PRC (2009) China Note Verbale to the United Nations, CML/17/2009. In United Nations, Oceans and Law of the Sea. May 7. www.un.org/Depts/los/clcs_new/submissions_files/mysvnm33_09/chn_2009re_mys_vnm_e.pdf.

PRC (2011) China Note Verbale No. CML/8/2011. In United Nations, Oceans and Law of the Sea. April 14. http://www.un.org/Depts/los/clcs_new/submissions_files/vnm37_09/chn_2011_re_phl_e.pdf.

PRC (2014) Foreign Ministry Spokesperson Hong Lei's Remarks on Vietnam's Statement on the Chinese Government's Position Paper on Rejecting the Jurisdiction of the Arbitral Tribunal Established at the Request of the Philippines for the South China Sea Arbitration. Dec. 12. www.fmprc.gov.cn/mfa_eng/xwfw_ 665399/s2510_665401/t1218756.shtml.

RAHMAN, CHRIS and MARTIN TSAMENYI (2013) "A strategic perspective on security and naval issues in the South China Sea." Ocean Development & Int. Law 41, 4 (Nov.): 315–33.

Renmin ribao 人民日报 (1974) "我外交部发言人发表声明" (Ministry of Foreign Affairs spokesman issues statement), Jan. 12.

SAMUELS, MARWYN (1982) Contest for the South China Sea. New York: Metheun.

SHEN, JIANMING (1998) "Territorial aspects of the South China Sea island dispute." Pp. 139–218 in Myron Nordquist and John Moore (eds.), Security Flashpoints: Oil, Islands, Sea Access and Military Confrontation. The Hague: Martinus Nijhoff.

SUAREZ, SUZETTE (2008) The Outer Limits of the Continental Shelf: Legal Aspects of Their Establishment. Berlin: Springer.

SUN, KUAN-MING (1995) "Policy of the Republic of China towards the South China Sea." Marine Policy 19, 5 (Sept.): 401–9.

SYMMONS, CLIVE (2008) Historic Waters in the Law of the Sea: A Modern Re-appraisal. Leiden: Martinus Nijhoff.

THANG NGUYEN-DANG and NGUYEN HONG THAO (2012) "China's nine dotted lines in the South China Sea: the 2011 exchange of diplomatic notes between the Philippines and China." Ocean Development & Int. Law 43, 1: 35–56.

Thanh Nien News (2013) "Southeast Asia to reach out to China on sea disputes." April 25. www.thanhniennews.com/index/pages/20130425-southeast-asia-to-reach-out-to-china-on-sea-disputes.aspx.

TZOU JING WEI and JAKE CHUNG (2014) "Chinese official's presence at exhibit arouses concern." Taipei Times, Sept. 5. www.taipeitimes.com/News/taiwan/archives/2014/09/05/2003599057.

United Nations (1964) Convention on the Continental Shelf. June 10. P. 4 in United Nations, Treaty Collection. http://treaties.un.org/doc/Publication/MTDSG/Volume%20II/Chapter%20XXI/XXI-4.en.pdf.

United Nations (1982) United Nations Convention of the Law of the Sea. Dec. 10. www.un.org/depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm.

United States Energy Information Administration (2013) South China Sea. http://www.eia.gov/beta/international/analysis_includes/regions_of_interest/South_China_Sea/south_china_sea.pdf.

United States National Geospatial Intelligence Agency (2004) South China Sea and the Gulf of Thailand. Sailing Directions 9th ed., vol. 162. Annapolis: ProStar.

WANG, KUAN-HSIUNG (2010) "The ROC's maritime claims and practices with special reference to the South China Sea." Ocean Development & International Law 41, 3: 237–52.

WU SHICUN 吴士存 (2013) 南沙争端的起源与发展 (修订版) (The South China Sea dispute: origin and development [revision]). Revised ed. Beijing: Zhongguo jingji chubanshe.

Xinhua News (2009) "Navy lawmaker: violation of China's sovereignty not allowed." Xinhua News, Mar. 10. http://news.xinhuanet.com/english/2009-03/10/content_10985038.htm.

Xinhua News (2013) "Chinese ambassador: China has indisputable sovereignty over South China Sea islands." Xinhua News, Jan. 22. http://news.xinhuanet.com/english/china/2013-01/22/c_132120518.htm.

YANG BINGNAN 楊柄南 (1984) 海錄 (Maritime records) 中國南海諸群島文獻彙編 (Collection of documents on the South China Sea Islands), rept. ed., vol. 3. Taipei: Taiwan xuesheng shuju.

ZHOU ENLAI 周恩来 (1990) 周恩来外交文选 (Selected works of Zhou Enlai on foreign relations), vol. 1. Beijing: Zhongyang wenxian chubanshe.

ZHAO LIHAI 赵理海 (1996) 海洋法问题研究 (A study of the issue of maritime law). Beijing: Beijing daxue chubanshe.

ZOU KEYUAN (1999) "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." International J. of Marine and Coastal Law 14, 1: 27–55.

ZOU KEYUAN (2002) "Disrupting or maintaining the marine legal order in East Asia?" Chinese J. of International Law 1, 2: 449–98.

ZOU KEYUAN (2007) "South China Sea studies in China: achievements, constraints and prospects." Singapore Year Book of Int. Law 11: 85–98.

ZOU KEYUAN (2012) "China's U-shaped line in the South China Sea revisited." Ocean Development & Int. Law 43: 18–34.

Author Biography

Chris Chung is a PhD student in history at the University of Toronto. He focuses on the history of the South and East China Sea islands disputes. He generally studies how late imperial and modern Chinese notions of history, territory, and international law have intersected to inform national identity.

Annex 722

Christina Larson, "China's island building is destroying reefs", *Science*, Vol. 349, No. 6255 (25 Sept. 2015)

ENVIRONMENT

China's island building is destroying reefs

Land creation and dredging in the South China Sea come at the expense of corals and fisheries

By **Christina Larson**, *in Beijing*

The geopolitical maneuvering in the South China Sea (SCS) is taking a heavy toll on the marine environment, scientists believe.

The Spratly, or Nansha, Islands, a cluster of coral reefs and atolls, has become the focus of a territorial dispute between China and its neighbors. To the dismay of other countries bordering the SCS—Vietnam, Malaysia, the Philippines, and Brunei—China claims most of the sea, and it is bolstering its claims with a massive landfilling effort to transform some of the atolls into full-fledged islands. The scale and speed of the effort emerged earlier this month, when the Center for Strategic and International Studies (CSIS) in Washington, D.C., released high-resolution satellite photos showing that over the past 2 to 3 years, China has created 13 square kilometers of island area—about a quarter the size of Manhattan.

That is not just a challenge to its neighbors, which also claim some parts of the sea. By piling sand, gravel, and dead coral onto reef flats to create new land and dredging shipping channels nearby, China has destroyed large areas of biodiverse reef that served as nurseries for fisheries throughout much of the SCS. "This is the most rapid permanent loss of coral reef in human history," says John McManus, a marine biologist at the University of Miami in Florida. "It's a terrible, terrible thing to do this."

The waters around the Spratly archipelago are home to "some of the most beautiful and biodiverse coral in the world," McManus adds. Roughly equidistant between Vietnam and the Philippines, they are "like an oasis in the desert," says Ed Gomez, a marine biologist at the University of the Philippines, Manila.

The reefs are economically important, too, as McManus realized roughly 2 decades ago when he faced a puzzle. Overfishing had depleted fish stocks in the SCS; some fish species had apparently disappeared entirely from the coastal regions his team studied. Then, after several years, unexpectedly, the fish all reappeared. By analyzing ocean currents, McManus discovered that larvae from coral reefs in the Spratlys and the nearby Scarborough reefs were likely replenishing the sea. The reefs "serve as nursing grounds for a lot of species," Gomez says. "They are important sources of larvae for of all kinds of marine life."

Now, China "has deployed one of the world's largest dredging fleets," says Andrew Erickson, an associate professor at the U.S. Naval War College's China Maritime Studies Institute in Newport, Rhode Island. The area of newly built land—where buildings, concrete plants, and three airstrips have been built or are under construction, according to CSIS—is more than 10 times the total area that other SCS nations cumulatively have built up, Erickson notes. "Whether in scale or sophistication, there are simply no grounds for comparison."

Perhaps the most extensive ecological damage comes from dredging. In creating shipping lanes near the islands, the Chinese cut through reefs. As the lanes will most likely be dredged frequently to remain navigable, "that's near permanent damage," McManus says. And at Fiery Cross Reef in the Spratlys, they've dug a huge harbor, Gomez says. "We don't know how much area has been destroyed underwater by deep dredging," he says. But digging a deep harbor, he notes, destroys corals, seaweeds, and seagrasses. "No productive ecosystem can survive."

The dredging takes a toll on nearby ecosystems as well. "Plumes of sediment that flow from the construction work will have an impact on whatever life relies on photosynthesis to survive," says Youna Lyons, a marine scientist and expert in marine law at the National University of Singapore. "If you don't have sunlight, nothing can grow. This impacts all the bottom of the food chain, including coral and algae."

The island building was expected to be on the agenda last week when Chinese President Xi Jinping visited Washington, D.C., given the U.S. government's concern about a military buildup in the SCS as well as its interest in ensuring freedom of navigation through one of the world's busiest shipping channels. Yet convincing China to reverse course will not be simple. "The Nansha Islands have been China's territory since ancient times," Xi told *The Wall Street Journal*. "China's development and maintenance of facilities on some of our garrisoned islands and reefs in the Nansha Islands does not impact on or target any other country."

Scientists have little hope that environmental concerns will make a difference. "China keeps saying it cares about the environment," Lyons notes, but it has not published an environmental impact assessment for any of its island building activities in the SCS.

In spite of Xi's reassurance, other countries will feel the consequences. "For centuries, many of the countries surrounding the SCS have been dependent on fishery resources from these chains of reefs and islands," Gomez says. Now, he says, key reefs are "forever gone" beneath the landfill and concrete. ■

Terraforming at sea

To secure its claim on the Spratly Islands, China has developed reefs like Fiery Cross, where satellite images reveal new features including a 3000-meter runway and a port.

IMAGES: CSIS ASIA MARITIME TRANSPARENCY INITIATIVE/DIGITALGLOBE

Published by AAAS

Annex 723

International Union for Conservation of Nature and Natural Resources, S. Wells, "Tridacna derasa", *IUCN Red List of Threatened Species*, *available at* http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22136A9362077.en (accessed 1 Nov. 2015)

The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2008: T22136A9362077

Tridacna derasa, Southern Giant Clam

Assessment by: Wells, S.

View on www.iucnredlist.org

Citation: Wells, S. 1996. *Tridacna derasa. The IUCN Red List of Threatened Species 1996*: e.T22136A9362077. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22136A9362077.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Bivalvia	Veneroida	Tridacnidae

Taxon Name: *Tridacna derasa* (Röding, 1798)

Common Name(s):

- English: Southern Giant Clam

Assessment Information

Red List Category & Criteria: Vulnerable A2cd ver 2.3

Year Published: 1996

Date Assessed: August 1, 1996

Annotations: Needs Updating

Previously Published Red List Assessments

1994 – Vulnerable (V)

1990 – Vulnerable (V)

1988 – Vulnerable (V)

1986 – Vulnerable (V)

1983 – Vulnerable (V)

Geographic Range

Country Occurrence:

Native: Australia; Fiji; Indonesia; New Caledonia; Palau; Papua New Guinea; Philippines; Solomon Islands; Tonga

Possibly extinct: Guam; Northern Mariana Islands

Introduced: American Samoa (American Samoa); Cook Islands; Marshall Islands; Micronesia, Federated States of

Habitat and Ecology

Systems: Marine

Credits

Assessor(s): Wells, S.

Annex 724

International Union for Conservation of Nature and Natural Resources, S. Wells, “Tridacna gigas”, *IUCN Red List of Threatened Species*, *available at* http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22137A9362283.en (accessed 1 Nov. 2015)

The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2008: T22137A9362283

Tridacna gigas, Giant Clam

Assessment by: Wells, S.

View on www.iucnredlist.org

Citation: Wells, S. 1996. *Tridacna gigas. The IUCN Red List of Threatened Species 1996*: e.T22137A9362283. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22137A9362283.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Bivalvia	Veneroida	Tridacnidae

Taxon Name: *Tridacna gigas* (Linnaeus, 1758)

Common Name(s):

- English: Giant Clam
- French: Bénitier Géant

Assessment Information

Red List Category & Criteria: Vulnerable A2cd ver 2.3

Year Published: 1996

Date Assessed: August 1, 1996

Annotations: Needs Updating

Previously Published Red List Assessments

1994 – Vulnerable (V)

1990 – Vulnerable (V)

1988 – Vulnerable (V)

1986 – Vulnerable (V)

1983 – Vulnerable (V)

Geographic Range

Country Occurrence:

Native: Australia; Indonesia; Japan; Kiribati; Malaysia; Marshall Islands; Micronesia, Federated States of ; Myanmar; Palau; Papua New Guinea; Philippines; Solomon Islands; Thailand; Tuvalu

Possibly extinct: Fiji; New Caledonia; Northern Mariana Islands; Taiwan, Province of China; Vanuatu

Introduced: United States

http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22137A9362283.en

Habitat and Ecology

Systems: Marine

Credits

Assessor(s): Wells, S.

http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22137A9362283.en

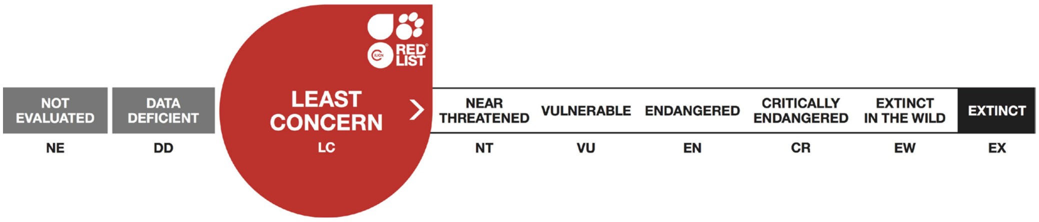
Annex 725

International Union for Conservation of Nature and Natural Resources, S. Wells, “Tridacna maxima”, *IUCN Red List of Threatened Species*, *available at* http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22138A9362499.en (accessed 1 Nov. 2015)

The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2008: T22140A9362870

Tridacna squamosa, Fluted Giant Clam

Assessment by: Wells, S.



View on www.iucnredlist.org

Citation: Wells, S. 1996. *Tridacna squamosa. The IUCN Red List of Threatened Species 1996*: e.T22140A9362870. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22140A9362870.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Bivalvia	Veneroida	Tridacnidae

Taxon Name: *Tridacna squamosa* Lamarck, 1819

Common Name(s):

- English: Fluted Clam, Fluted Giant Clam, Scaly Clam

Assessment Information

Red List Category & Criteria: Lower Risk/conservation dependent ver 2.3

Year Published: 1996

Date Assessed: August 1, 1996

Annotations: Needs Updating

Previously Published Red List Assessments

1994 – Indeterminate (I)

1990 – Indeterminate (I)

1988 – Indeterminate (I)

1986 – Indeterminate (I)

1983 – Indeterminate (I)

Geographic Range

Country Occurrence:

Native: American Samoa (American Samoa); Australia; British Indian Ocean Territory; Egypt; Fiji; French Polynesia; India (Andaman Is., Laccadive Is., Nicobar Is.); Indonesia; Kenya; Kiribati; Madagascar; Malaysia; Maldives; Marshall Islands; Mauritius; Micronesia, Federated States of ; Mozambique; Myanmar; New Caledonia; Palau; Papua New Guinea; Philippines; Samoa; Saudi Arabia; Seychelles; Singapore; Solomon Islands; South Africa; Sri Lanka; Thailand; Tokelau; Tonga; Tuvalu; Vanuatu; Viet Nam

Possibly extinct: Japan; Northern Mariana Islands

Introduced: United States (Hawaiian Is.)

Habitat and Ecology

Systems: Marine

Credits

Assessor(s): Wells, S.

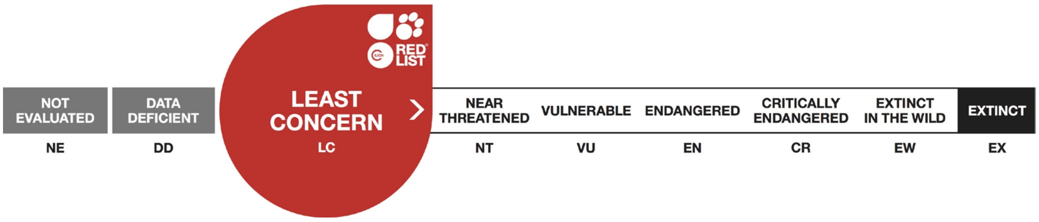
Annex 726

International Union for Conservation of Nature and Natural Resources, S. Wells, "Tridacna squamosa", *IUCN Red List of Threatened Species*, *available at* http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22140A9362870.en (accessed 1 Nov. 2015)

The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2008: T22140A9362870

Tridacna squamosa, Fluted Giant Clam

Assessment by: Wells, S.



View on www.iucnredlist.org

Citation: Wells, S. 1996. *Tridacna squamosa. The IUCN Red List of Threatened Species 1996*: e.T22140A9362870. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T22140A9362870.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Bivalvia	Veneroida	Tridacnidae

Taxon Name: *Tridacna squamosa* Lamarck, 1819

Common Name(s):

- English: Fluted Clam, Fluted Giant Clam, Scaly Clam

Assessment Information

Red List Category & Criteria: Lower Risk/conservation dependent ver 2.3

Year Published: 1996

Date Assessed: August 1, 1996

Annotations: Needs Updating

Previously Published Red List Assessments

1994 – Indeterminate (I)

1990 – Indeterminate (I)

1988 – Indeterminate (I)

1986 – Indeterminate (I)

1983 – Indeterminate (I)

Geographic Range

Country Occurrence:

Native: American Samoa (American Samoa); Australia; British Indian Ocean Territory; Egypt; Fiji; French Polynesia; India (Andaman Is., Laccadive Is., Nicobar Is.); Indonesia; Kenya; Kiribati; Madagascar; Malaysia; Maldives; Marshall Islands; Mauritius; Micronesia, Federated States of ; Mozambique; Myanmar; New Caledonia; Palau; Papua New Guinea; Philippines; Samoa; Saudi Arabia; Seychelles; Singapore; Solomon Islands; South Africa; Sri Lanka; Thailand; Tokelau; Tonga; Tuvalu; Vanuatu; Viet Nam

Possibly extinct: Japan; Northern Mariana Islands

Introduced: United States (Hawaiian Is.)

Habitat and Ecology

Systems: Marine

Credits

Assessor(s): Wells, S.

Annex 727

World Wildlife Fund, "Islands of Socorro, Clarion, San Benedicto, and Roc Partida in the Pacific Ocean off the coast of Mexico", *available at* http://www.worldwildlife.org/ecoregions/nt0216 (accessed 11 Nov. 2015)

World Wildlife Fund - WWF - Worldwildilife.org

Islands of Socorro, Clarion, San Benedicto, and Roc Partida in the Pacific Ocean off the coast of Mexico

This group of volcanic islands off the Pacific coastside of Mexico contains an amazing amount of endemic species due to its isolation from the mainland. All the terrestrial vertebrates are endemic to the islands, excluding introduced species, and fourteen out of sixteen avifauna are endemic. Considered an Endemic Bird Area, the fauna of these islands is currently threatened by introduced species such as feral cats and exotic birds. Domestic sheep are allowed to roam freely, and have contributed to the destruction of large amount of natural vegetation.

Scientific Code
(NT0216)
Ecoregion Category
Neotropical
Size
100 square miles
Status
Critical/Endangered
Habitats

Description
Location and General Description
Volcanic activity from the Pleistocene gave rise to the four Revillagigedo Islands: Socorro, Clarión, San Benedicto, and Roca Partida. Socorro Island is the largest of the four; it first formed as a series of small explosions from the Evermann volcano, at 1,150 m. above sea level. Socorro and Clarion share an abrupt topography of deep canyons and valleys. Rocky or sandy beaches can be found on all islands. In Clarion, the highest elevations are at 350 m above sea level. The climate is tropical subhumid with summer rains throughout the archipelago. Socorro Island also has a tropical semi-dry climate zone (between 0-400 m above sea level) and a subtropical subhumid climate zone (between 400-1150 m above sea level) with occasional summer rains. In general, the four islands are dry, with a mean annual precipitation of 600 mm/year. Soils are of volcanic origin; Clarion's soil is older and deeper than Socorro's. Both islands share an abundance of igneous rocks, mostly of basalt and cineritic cones. The four islands are covered by dry forest and share climatic and ecological characteristics that are responsible for the different vegetation associations found at the islands. The coastline is dominated by mangle botoncillo (Conocarpus erecta), and Hibiscus pernambucensis, and herbaceous elements are abundant. At elevations between 0-250 m., growing on basalt spills, the scrub Croton masonii is the dominant species. On top of the Croton scrub, a secondary type of vegetal community has developed due to extensive erosion. Here Ficus cotinifolia, Psidium spp, and Guettarda insularis dominate the forest. Herbaceous elements are also abundant. The most dominant vegetation association in the islands is composed of Dodonea viscosa herbs, pygmy Guettarda insularis, Prunus serotina and the endemic cactus Opuntia sp., where the fern, Pteridium caudatum is very abundant. On elevations of 250-500 m. in Socorro, a dense forest of amate (Ficus cotinifolia) is the dominant vegetation; higher in the mountains (>500 m) other species substitute Ficus cotinifolia, including Bumelia socorrensis, Ilex socorrensis, and Psidium socorrense. Climbers and epiphytes are more abundant in these forests. Above 700 m, Meliosma nesites, Oreopanax xalapense, and Prunus capuli dominate the landscape; humidity levels in this area are higher than in any other part of the island, and therefore lichens and ferns (e.g. Adiantopsis radiata, Polypodium alfredii, and Asplenium formosum) grow abundantly. A prairie association of Centaurium pacificum, Hypericum eastwoodianum and Heterotoma cordifolia, among many others, covers the Evermann volcano, at 1,100 m above sea level.

Biodiversity Features
The isolation of the Revillagigedo Islands in the Pacific Ocean has favored the radiation of many species making the islands a place of unparalleled endemism. Of 117 species of native plants, 31.6% are endemic on Socorro island, 26% on Clarión, and 45% on San Benedicto (Challenger 1998). All of the terrestrial vertebrates are endemic to the islands, as well as 14 out of 16 terrestrial birds (Brattstrom 1990). The Revillagigedo Islands are

considered as a priority area for conservation by IUCN (1980), and as an Endemic Bird Area (EBA) by ICBP (1992). Forest associations house the highest number of endemic bird species in the islands (León de la Luz et al. 1994). The islands constitute one of the most important nesting, breeding, and foraging sites for four sea turtle species that are in need of special protection: leatherback turtle (Dermochelys coriacea), olive ridley turtle (Lepidochelys olivacea), hawksbill turtle (Eretmochelys imbricata) and the green turtle (Chelonia mydas). Its isolation from the continent makes Revillagigedo Islands one of the few ecosystems that have unique species of flora and fauna worldwide (Jiménez et al. 1994).

Distinctive species on these islands include the following endemic and restricted range species: Socorro Island tree lizard (Urosaurus auriculatus), a brown recluse spider (Loxosceles reclusa), Socorro dove (Zenaida graysoni), Socorro parakeet (Arahuga brevipes), Socorro wren (Thryomanes sissonii), and Socorro Mockingbird (Mimodes graysoni) (Stattersfield et al. 1998).

Current Status
A great portion of the original vegetation of the Revillagigedo Islands has been destroyed over the last 50 years. Domestic sheep were introduced to the island in the 1960’s and 70’s, contributing to the loss of at least 1% of the native vegetation (Castellanos & Rodríguez-Estrella 1992). Feral cats have also contributed to the reduction of native bird populations (Ortega et al. 1992); as a consequence of this and other pressures, the Socorro dove became extinct in the wild between 1958-1978 (Jehl & Parkes 1982, CONABIO-INE 1995).

Types and Severity of Threats
Main threats to the islands include destruction and perturbation of native vegetation, soil erosion caused by introduced ungulates, and the introduction of exotic birds and mammals. Naval officers and their families, who are responsible for the gradual destruction of the vegetation, inhabit the islands. They maintain the populations of introduced sheep, but do not keep adequate control of them. Since most of the flora and fauna is endemic to the islands and the ecological relationships among members of the biota are complex, the gradual loss of some elements from the ecosystem could lead directly to extinction. The islands have received federal protection since 1994, yet an adequate management program is needed: sheep populations should be caged and appropriate control of their grazing habits should be monitored to prevent loss of vegetation. Elimination of the feral cat population is also recommended, as is the creation of a biological station for monitoring the islands’ status.

Justification of Ecoregion Delineation
This island ecoregion is justified from its distance from shore and subsequent endemic species (Stattersfield et al 1998). We consulted Rzedowski (1978) for classification, and linework and delineation’s encompass all of the islands in the Islas de Revillagigedo group.

References
Brattstrom, B.H. 1990. Biogeography of the Islas Revillagigedo, México. Journal of Biogeography. 17:177-190.

Castellanos, A., and R. Rodriguez-Estrella. 1992. La situación del zenzontle de Socorro (Mimodes graysoni). Ciencia y Desarrollo Vol 64. No.104:64 -75.

Challenger, A. 1998. Utilización y conservación de los ecosistemas terrestres de México. Pasado, presente y futuro. México: Conabio, IBUNAM y Agrupación Sierra Madre.

CONABIO and INE. 1995. Reservas de la Biósfera y otras áreas naturales protegidas de México. México: SEMARNAP.

ICBP. 1992. Putting biodiversity on the map: Priority areas for global conservation. Cambridge, U.K.: ICBP.

IUCN. 1980. Estrategia mundial para la conservación. Morges, Switzerland: IUCN-PNUMA-WWF.

Jehl, J. R., and K. C. Parkes. 1982. The status of the avifauna of the Revillagigedo Islands, Mexico. Wilson Bull. 94:1-19.

Jiménez, M. L., A. Tejas-Romero, and R. Aguilar. 1994. Los artrópodos terrestres. Pages 153-184 in A. Ortega-Rubio, and A. Castellanos-Vera, editors, La Isla Socorro, Reserva de la Biósfera Archipielago de Revillagigedo, México. México: Centro de Investigaciones Biológicas del Noroeste México..

León de la Luz, J. L., A. Breceda, R. Coria, and J. Cancino. 1994. Asociaciones vegetales. Pages 115-142 in A. Ortega-Rubio, and A. Castellanos-Vera, editors, La Isla Socorro, Reserva de la Biósfera Archipielago de Revillagigedo, México: Centro de Investigaciones Biológicas del Noroeste, México.

Ortega, A., A. Castellanos, G. Arnaud, Y. Maya, R. Rodríguez, J. León, J. Cancino, C. Jiménez, J. Llinas, S. Alvarez, P. Galina, A. Breceda, E. Troyo, F. Salinas, S. Díaz, R. Servín, H. Romero, A. Rodríguez, and R. Coria. 1992. Recursos naturales de la isla Socorro, Revillagigedo, México. CIENCIA 45:175-184.

Rzedowski, J. 1978. Vegetación de Mexico. Editorial Limusa. Mexico, D.F., Mexico.

Stattersfield, A.J., M.J. Crosby, A.J. Long and D.C. Wege. 1998. Endemic bird areas of the World: Priorities for biodiversity conservation. Birdlife Conservation. Series No. 7., Birdlife International, Cambridge, UK.

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Annex 728

World Wildlife Fund, “Islands off the coast of eastern Brazil”, *available at* http://www.worldwildlife.org/ecoregions/nt0172 (accessed 11 Nov. 2015)

World Wildlife Fund - WWF - Worldwildilife.org

Islands off the coast of eastern Brazil

The Trindade and Martin Vaz Archipelago is the most eastward point of Brazilian territory, and is a result of volcanic activity deep below the Atlantic Ocean. The islands are the site of Brazil's largest rookery of green sea turtles and are home to large populations of seabirds. Though there is currently no permanent human population on the archipelago, past attempts at colonization, as well as military occupations and research expeditions, introduced destructive animal species that have caused Trindade, the main island, to become severely degraded.

Scientific Code
(NT0172)
Ecoregion Category
Neotropical
Size
50 square miles
Status
Critical/Endangered
Habitats

Description
Location and General Description
Trindade (20º 50' S and 29º 30' W) is 1,140 km from the mainland, and the Martin Vaz islets (20º 50' S and 28º 85' W) are visible from Trindade, 42 km to the east. Trindade is a small island, 8 km long and 2 km wide with an entire area of 13.5 km², and three points on the island reach an altitude of about 600 m above sea level. Entirely volcanic in origin, Trindade has a steep and rugged terrain. The island is composed of volcanic and subvolcanic rocks formed between the end of the Pliocene and the Holocene periods, and it marks the only place in the Brazilian territory where part of a volcanic cone is still recognizable (Almeida 2000). Other characteristics of the island are several other cones, slope aprons, algal reefs (of Lithothamnium sp.), narrow beaches, and small areas of dunes and of fluvial deposits along the coast (Almeida 2000). The small Martin Vaz Islands also have a steep and rocky terrain that is covered in grasses and small shrubs, with no tree species.

The archipelago has a tropical oceanic climate, with an annual mean temperature of 25°C, March being the warmest month of the year and June the coolest (Almeida 1961). Between April and October, the archipelago is subject to cold air masses from the South Pole. Daily rain showers, locally called pirajá, generally last for just five minutes (Moreira et al. 1995).

A forest dominated by Colubrina glandulosa var. reitzii covered 85% of Trindade until the mid 1700's, when settled by 130 families from the Azores (Alves 1998). These Portuguese colonists brought along herds of goats, sheep and pigs, which rapidly degraded the soil layer, leaving erosive gullies of up to 6 meters deep. At some point during this period or after, the island's trees were almost entirely eliminated. Possible explanations for this die-off involve volcanic gas, overgrazing by the introduced goats, a decrease in rainfall, or most likely, fire set by humans. Continued overgrazing prevented regrowth of the trees. Local flora is now marked by areas of Cyathea coelandii, an endemic tree fern that reaches 6 m in height (Moreira et al. 1995). Otherwise, vegetation is short and shrubby, consisting of herbs, grasses, and Ciperaceae, though the native Colubrina glandulosa var. reitzii does still occur on Trindade (Almeida 2000). A new Piperaceae species, Peperomia beckeri, was described from Trindade in 1998 (Alves and Guimaraes 1998). Other endemic plants are Cyperus atlanticus, Bulbostylis nesiotis, Achyrocline disjuncta and Plantago trinitatis (Alves 1998).

Biodiversity Features
Trindade is the most important nesting ground for green sea turtle (Chelonia mydas) in all of Brazil, supporting some 1,800 nests per year on 3 km of sandy beach (Moreira et al. 1995). Chelonia mydas is the only turtle species to nest on the island, and peak nesting season is January-March. The hatchling's predators include crabs (Geocarcinus lagostoma, Grapsus grapsus) and fishes (Mycteroperca sp., Epinephlus sp., Caranx lugubrix, Hynnis cubensis, Sphyrraena barracuda) (Moreira et al. 1995). The native crab, G. lagostoma, is abundant on Trindade and can be observed throughout the island, from the beaches to the island's highest point, "Pico do Desejado" (620 m) (Moreira et al. 1995). A new species of fasciolariid gastropod (Leucozonia ponderosa), was described in 1998 and is endemic to Trindade Island (Vermeij 1998).

Likely the most impressive fauna of the Trindade-Martin Vaz Archipelago are the islands' large populations of seabirds. The Trindade petral (Pterodroma a. arminjoniana) is found only here within the Atlantic region and otherwise occurs only in the Indian Ocean on Mauritius. It breeds on Trindade and on the islet of Pedro Segundo within the Martin Vaz islets. This archipelago is the only place in the Atlantic where great frigatebird (Fregata minor) and lesser frigatebird (F. ariel) occur, although normally found in the Indo-Pacific. Although the frigatebird spends most of its life at sea, it is rarely seen swimming. Its feathers are not waterproof and its feet so small that they have trouble rising from the water. Instead of catching their own fish, frigatebirds often steal a catch from other seabirds. Red-footed booby (Sula sula), once very common, has seen a decrease in its populations. Similarly, white tern (Gygis alba) has diminished populations. Other birds include brown noddy (Anous stolidus), phoenix petrel (Pterodroma alba arminjoniana), and sooty tern (Sterna fuscata).

Current Status
The Trindade-Martin Vaz Archipelago has no permanent settlement, though Trindade is visited by researchers and periodically occupied by teams from the Brazilian Navy. In 1957, the Brazilian Navy established the Oceanographic Station of the Trindade Island (POIT), and since that time expeditions are made frequently to undertake meteorological observations and also to attempt to reforest the island (Almeida 2000). Brazil's national Marine Turtle Protection and Research Program (TAMAR-IBAMA Project) has also conducted work on the island since 1982 with support from the Navy (Moreira et al. 1995).

Types and Severity of Threats
Though the archipelago is practically, if not officially, protected from tourism, due to the long distance from the mainland, rugged terrain, and lack of tourist facilities, past human interference has lead to dramatic losses of biodiversity on Trindade Island. The island is subject to goats, sheep, pigs, feral cats, and mice. Facing no natural enemies, the introduced animals have flourished, causing severe destruction to the island's vegetation and soils (Almeida 2000). Present soil conditions no longer permit reintroduction of several tree species once found on Trindade (Alves 1998). Further, many endemic plant and animal species are presently considered extinct. Despite extensive searches, at least 21 plant and 15 animal species previously registered on Trindade have not been found again since 1965 (Alves 1998). The current population of Trindade petrels is estimated to be approximately 5,000 birds. These and almost all other forms of native wildlife are under serious threat from habitat destruction.

Conservation initiatives on Trindade involve the removal of introduced animals, the preservation of remaining native flora and fauna, particularly endemic species, and the reforestation of soil-favorable areas. POIT has undertaken these tasks, and it is expected that Trindade may eventually recover a portion of its original vegetation, referred to as "exuberant" in ancient descriptions (Almeida 2000).

Justification of Ecoregion Delineation
The Trindade-Martin Vaz archipelago, located about 1,150 km from the nearest mainland, has been isolated enough to see significant speciation of its flora and fauna. Several species of plant are restricted to this island group, and the assemblage of resident avifauna is dissimilar to other Atlantic islands.

References
Almeida, F. F. M. 2000. The Island of Trindade. Geological and Paleontological Sites of Brazil - 092. Retrieved (2001) from: <http://www.unb.br/ig/sigep/sitio092/sitio092english.htm>.

Almeida, Fernando Flávio Marques de. 1961. Geologia e petrologia da ilha da Trindade. Divisão de geologia e Mineralogia. Monografia 18.

Alves, R. J. V. 1998. Ilha da Trindade e Arquipélago Martin Vaz - Um Ensaio Geobotânico.http://acd.ufrj.br/~mndb/trimanpo.html>.

Alves, R. J. V. and Guimaraes, E. F. 1998. Piperaceae from Trinidad. Bradea 8:97-100.

Moreira, L., C. Baptistotte, J. Scalfone, J. C. Thomé, and A. P. L. S. de Almeida. 1995. Occurrence of Chelonia mydas on the Island of Trindade, Brazil. Marine Turtle Newsletter 70:2.

Vermeij, G. J. a. S. M. A. 1998. Leucozonia ponderosa, a new fasciolariid gastropod from Brazil. Nautilus 112:117-119.

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Annex 729

"Bird Island", *Encyclopædia Britannica Online*, *available at* http://www.britannica.com/place/Bird-Island-islet-Caribbean-Sea (accessed 11 Nov. 2015)

Bird Island

Islet, Caribbean Sea

Written by: The Editors of Encyclopædia Britannica | 1

READ VIEW HISTORY EDIT FEEDBACK

Alternative titles: *Aves Island; Isla Aves; Islote Aves*

Bird Island, also called **Aves Island**, Spanish **Isla Aves**, or **Islote Aves**, coral-covered sandbank only 15 feet (4.5 metres) high at low tide, located in the Caribbean Sea about 350 miles (560 km) north of Venezuela and 70 miles (110 km) west of Dominica. (The island is not a part of the group of Venezuelan islands of similar name, Islas de Aves, comprising Aves de Barlovento and Aves de Sotavento, located 145 miles [230 km] north of Caracas, just east of Bonaire.) The uninhabited islet was valued in the past for its abundant guano (used as fertilizer) and was claimed or occupied by a number of powers (Spain, Venezuela, the United States, the Netherlands, Great Britain, and Dominica) after the arrival of Europeans in the West Indies.

The islet acquired political significance in the 1970s because of its strategic importance for the control of the Caribbean basin and became the subject of a tense dispute between Venezuela and Dominica. Dominica's claim is based on geographical criteria, since the island rises from a long submarine sandbank, the Aves Ridge, which apparently connects it with Dominica. Venezuela's claim stems from having maintained an armed force there and exercised acts of sovereignty by virtue of which it was awarded to Venezuela in 1865. The controversy continued into the 21st century as Venezuela in 2001 made several moves to reaffirm its ownership of the islet, including announcing plans to expand the country's small military base there. Such actions drew protests from other Caribbean states, who opposed the extension of Venezuela's exclusive economic zone.

Annex 730

Hong Nong, "Interpreting the U-Shape Line in the South China Sea", *China-US Focus Digest* (15 May 2012)

CHINA US Focus
ENGAGE. STIMULATE. IMPACT.

Hong Nong

May 15, 2012

Interpreting the U-shape Line in the South China Sea

Keywords : Huangyan Island, South China Sea, Territorial Dispute

It has been almost one month since the standoff started on April 10, 2012 between the Philippines and China at the waters around at Huangyan Island (Scarborough Shoal). This standoff raises a new round of debate on the dispute between China and other claimant states on both the sovereignty and maritime jurisdiction. This article only addresses the impact of China's U-shape line on the competing maritime claims in the dispute South China Sea.

Background

The prevailing basis for China's historic claims to the SCS （South China Sea） is the U-shaped line (also called nine-dotted line, or nine-dash line) officially drawn on the Chinese map in 1947 by the then–Chinese Nationalist Government, which was originally an "eleven-dotted-line" . After the Communist Party of China took over mainland China and formed the People's Republic of China in 1949, the line was adopted and revised to nine as endorsed by Zhou Enlai. The line, which has been called a "traditional maritime boundary line", encloses the main island features of the SCS: the Pratas Islands, the Paracel Islands, the Macclesfield Bank, and the Spratly Islands. No country, including Southeast Asian countries or their past rulers, protested or challenged the validity of the 9-dash line from 1947 to 1970s.

Legal Status of the U-shape Line

There are four schools of thoughts among China's academies on the interpretation of this line, namely the line of boundary, the line of historic waters, the line of historic rights and the line of ownership of the features. "Line of Boundary" theory simply indicates that the U-shape line defines the limit or extent of China's territory. The basis of this theory is comparatively weak in international law, and has been criticized even by some Chinese scholars.

The Taiwan authorities gave the status of historic water to the water areas within the U-shaped line in 1993 when it issued the SCS Policy Guidelines, which stated that "the SCS area within the historic water limit is the maritime area under the jurisdiction of the Republic of China, in which the Republic of China possesses all rights and interests.” This can be regarded as Taiwan’s official position on the concept of historic waters, though this claim has not acquired unanimous support among Taiwanese scholars.

We have to realize that the formulation of the concept of historic waters requires an adjustment of the generally accepted law of the sea regimes. Because of the peculiar circumstances of some maritime areas which fall within the national jurisdiction of coastal states, these areas are allowed to be part of the jurisdictional waters as an exception to the general rule. As early as 1984 the question was asked whether the doctrine of historic bays and historic waters had become obsolete with the development of new, alternative concepts of national maritime expansion such as the EEZ and the continental shelf. Judged by recent State practice, the answer to this question is no. Rather, there is a trend toward the application and assertion of historic claims whether to bays, waters or rights in spite of the establishment of new legal concepts such as the EEZ and continental shelf in the law of the sea. Such a trend may eventually help to codify the rules of historic rights and/or historic waters in general international law.

There also exists the separable term of ‘historic rights’ — normally in high seas areas, but without any connotations as to sovereignty in the locale, such as historic fishing rights. The 2006 Barbados/Trinidad and Tobago Arbitration case entails the argument of historic rights of fishing. The term ‘historic rights’ is broader than that of ‘historic waters’. In its widest sense, it implies that a State claiming to exercise certain jurisdictional rights in what usually basically satisfy the same, or at least similar, supposed requirements for establishing ‘historic waters’ claims per se, particularly those of continuous and long usage with the acquiescence of relevant other States. For example, in the Tunisian pleadings in Tunisia/Libya, it was, in effect, argued that historic rights were claimable on a similar basis to that relation to historic waters, namely that they were established by exercise of peaceable and continued sovereignty, with prolonged toleration on the part of other States.

Currently, the theory of “sovereignty + UNCLOS + historic rights” prevails among the Chinese scholars. According to this theory, China enjoys sovereignty over all the features within this line, and enjoys sovereign right and jurisdiction, defined by the UNCLOS, for instance, EEZ and continental shelf when the certain features fulfill the legal definition of Island Regime under Article 121 of UNCLOS. In addition to that, China enjoys certain historic rights within this line, such as fishing rights, navigation rights and priority rights of resource development.

Historic concepts and maritime delimitation

The presence of historic concepts may affect the drawing of a maritime boundary. The delimitation of the territorial sea specifically requires an adjustment of the median line where it is necessary to take account of "historic title or other special circumstances". The relevance of claimed historic rights to maritime delimitation of the expanded maritime zones such as EEZ and the continental shelf remains somewhat unclear in the light of case law, though State practice in recent times suggests that historic rights, even if considered irrelevant to delimitation issues, may still be independently taken into account by special agreement as to access.

Since there are no definitive rules in international law which govern the status of maritime historic rights, China's claim is not a violation of international law. Similarly, since there are no such rules, it is doubtful whether China's claim could be established in international law. What is more problematic is China's implementation of what it has claimed in the SCS or elsewhere where China may assert historic rights and interests. As the ICJ once stated, general international law does not provide for a single 'regime' of historic waters or historic bays, but only for a particular regime for each of several specific, generally recognized cases of historic waters or historic bays. From this point of view, China's claim can be regarded as one of these particular cases, which may stand up in international law as doctrine evolved over time.

Historic concepts vs. new maritime regimes in the SCS

China's historical claim in the SCS based on the 'U-shaped line' overlaps with the claims to EEZ and continental shelf areas of Vietnam, Indonesia, Malaysia, Brunei and the Philippines. The perceived excessive claims put forward by other SCS countries, such as the Philippines and Malaysia, who have claimed some islands in the SCS based upon the 200 nautical mile EEZ rights of UNCLOS, may have encouraged China to insist that its SCS claim is based upon the U-shaped line. In China's view, a claim derived from historic rights may seem more forceful and valid in law than claims simply based upon the EEZ concept. A balance is needed between historic claims and modern claims under the UNCLOS.

Historic concepts related dispute settlement under UNCLOS

Compulsory dispute settlement under Section 2 in Part XV of UNCLOS is available for States for disputes relating to the delimitation of the territorial sea, EEZ, continental shelf, and to historic title unless States have opted to exclude these disputes by virtue of Article 298 (1) (a). Declarations permitted under Article 298 relate first, to maritime delimitation disputes in relation to the territorial sea, EEZ or continental shelf of States with opposite or adjacent coasts, as well as disputes involving historic bays or title. Chin made a declaration in 2006 under Article 298 (1) (a) of UNCLOS.

Concluding remark

China has not given up maritime claims based on the U-shaped line and recent practice has demonstrated that China is attempting to further consolidate the claim based on the line; in particular by undertaking regular and intensified law enforcement patrols in the South China Sea within the line. The U-shaped Line map issued by China is a strong evidence for China; however, China needs to address its formal position and clarification of this map, in order to avoid the misunderstanding on China's position on the South China Sea dispute.

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Keywords : Huangyan Island, South China Sea, Territorial Dispute

Annex 731

Paul Fontaine, "Kolbeinsey Is Shrinking", *Reykjavik Grapevine* (29 Aug. 2013)

The REYKJAVÍK GRAPEVINE

Kolbeinsey Is Shrinking

Words by
Paul Fontaine
@pauldfontaine

Published August 29, 2013

Iceland's northernmost island continues to shrink, and could disappear in less than a decade. Morgunblaðið reports that the Icelandic Coast Guard, which regularly checks on the Arctic island, found that the island is eroding at an accelerated rate. The Coast Guard did not speculate on when the tiny island would disappear completely.

As it is today, the island barely measures 90 square meters and has no vegetation. While a helicopter pad was built on the island in 1989, erosion claimed half the pad in 2006, and landings are no longer made there.

It was last estimated that the island will disappear altogether by 2020. When that happens, Grímsey will then assume the title of Iceland's Northernmost Point.

Annex 732

"Manila Says China Reclaimaing Land in Disputed Sea", *New York Times* (14 May 2014)

Annex 732

The New York Times

ASIA PACIFIC

Manila Says China Reclaiming Land in Disputed Sea

By THE ASSOCIATED PRESS MAY 14, 2014, 4:42 A.M. E.D.T.

MANILA, Philippines — The Philippines has protested China's reclamation of land in a disputed reef in the South China Sea that can be used to build an airstrip or an offshore military base in the increasingly volatile region, the country's top diplomat and other officials said.

Foreign Secretary Albert del Rosario told The Associated Press on Wednesday that the Philippines lodged the protest against China last month after surveillance aircraft confirmed and took pictures of the reclamation and dredging being done by Chinese vessels at the Johnson Reef in the Spratly Islands, which Manila says violates a regional nonaggression pact.

Del Rosario said it was not clear what China would build on the reef, which Manila claims as part of its western province of Palawan, but that one possibility was an airstrip. A senior government official, who spoke on condition of anonymity because he was not authorized to talk about the issue, said China could also build an offshore military and resupply and refueling hub.

"We're not exactly sure what are their intentions there," Del Rosario said.

In Beijing, Chinese Foreign Ministry spokeswoman Hua Chunying said the reef was part of China's territory. "It falls within China's sovereignty rights to engage in construction on the relevant reef," she said at a news conference. "I wonder what special motives there are behind such concerns by the Philippines."

The discovery of the reclamation, and the possibility of China building an airstrip in the reef, called Chigua by China and Mabini by the Philippines, would likely raise alarm among rival claimant countries because it would bolster Beijing's naval and air force mobility in a South China Sea region far from the Chinese mainland.

Johnson Reef, located in a vast, bean-shaped submerged coral outcrop, is also claimed by Vietnam, which maintains several nearby military installations. Chinese and Vietnamese forces fought a deadly naval battle in the contested region in 1988.

The Philippine senior government official said China's reclamation was first detected by air force planes six months ago. Philippine aircraft searching for a missing Malaysian jetliner in March also spotted the continuing reclamation on the submerged Johnson Reef by at least one Chinese dredging ship backed by smaller vessels, the official said.

The Philippine government estimates that the reclamation has turned the submerged reef and a sand bar into a 30-hectare (74-acre) land mass that transformed the underwater outcrop into an islet, a senior diplomat told the AP on condition of anonymity because of a lack of authority to discuss the issue.

It's the latest of several territorial spats between the Asian neighbors that have ratcheted tensions in the potentially oil- and gas-rich region, which also straddles one of the world's busiest sea lanes. Vietnam and China have separately been engaged in a dangerous standoff off the Paracel Island after Beijing deployed a mobile oil rig backed by dozens of security vessels.

Del Rosario said the Philippines raised the reclamation issue, along with the deployment of Chinese coast guard ships at the Second Thomas Shoal and "harassments of our fishermen," during a summit of the Association of Southeast Asian Nations last weekend in Myanmar. Four members of the 10-nation bloc — Brunei, Malaysia, the Philippines and Vietnam — are locked in territorial disputes in the Spratlys with China and Taiwan.

ASEAN issued a statement expressing concern over recent territorial spats in the South China Sea after the summit, which was attended by

Southeast Asian heads of state.

During the summit, Philippine officials also reported the intrusion by a suspected Chinese research ship last month near the Philippine Galoc oil field off Palawan province, del Rosario said.

China and ASEAN member states signed a nonbinding 2002 declaration urging rival claimant countries to settle their disputes peacefully, refrain from occupying new islands or reefs and launching construction efforts that could raise tensions.

But accusations of repeated violations of the pact have sparked international calls for a legally binding "code of conduct" that could prevent a major armed conflict in the South China Sea.

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Associated Press writers Oliver Teves in Manila and Christopher Bodeen in Beijing contributed to this report.

Annex 733

Keith Bradsher, “Philippines Challenges China Over Disputed Atoll”, *New York Times* (14 May 2014)

The New York Times | http://nyti.ms/1k1mQC2

ASIA PACIFIC

Philippines Challenges China Over Disputed Atoll

By **KEITH BRADSHER** MAY 14, 2014

HONG KONG — The Philippines said on Wednesday that it had protested signs of land reclamation by China aimed at expanding a disputed coral atoll near the southern Philippines, the latest in a series of disputes pitting China against its neighbors in the South China Sea.

The Philippines Department of Foreign Affairs said in a statement that it had lodged a protest with China on April 4, nearly five weeks ago, regarding the Chinese activity, but Beijing had rejected the protest. The Philippines also raised the issue at the Association of Southeast Asian Nations summit meeting over the weekend in Myanmar, and has included the dispute in a legal case against China filed with a United Nations tribunal, demanding arbitration of territorial disagreements.

The land reclamation dispute involves Johnson South Reef, a tiny coral atoll also known as Mabini or Yongshu. It is part of the Spratly Islands and is near southern Vietnam, Palawan Island of the Philippines and the north coast of Borneo. It is nearly 700 miles southeast of the southern end of China's Hainan Island.

Charles Jose, a spokesman for the Department of Foreign Affairs, said there was no sign yet that China was undertaking construction on the atoll, which has a single small structure on it, but added that the Philippines was nonetheless concerned.

“They are still in the process of reclaiming the land, but judging by the size of it, they could be planning to build an airstrip,” Mr. Jose said.

Johnson South Reef is a potato-shaped atoll about two miles long that until now has barely stuck up above sea level. An airstrip on it would give Chinese planes convenient proximity to the oil fields and gas fields of Brunei and Malaysia on the north coast of Borneo, as well as Ho Chi Minh City.

The Chinese Ministry of Foreign Affairs was silent about Johnson South Reef at its daily briefing in Beijing on Wednesday. The official Xinhua News Agency had no immediate report on the Philippines’ announcement, which is sometimes an indication that a development is being studied closely in Beijing.

But the Philippines has an unsteady record in monitoring Chinese activity off its shores. The Philippines accused China last fall of beginning construction at Scarborough Shoal, 440 miles northeast of Johnson South Reef, only to withdraw the accusation a month later and declare that new concrete blocks apparently seen at the shoal were not actually new and might even be a natural formation.

The dispute over Johnson South Reef coincided with anti-Chinese rioting in southern Vietnam, after a state-owned Chinese oil company set up a $1 billion oil drilling rig off the coast of southern Vietnam and near another disputed coral atoll, Triton Island. China is also upset after the Philippines police seized 11 Chinese fishermen a week ago and accused them of illegally poaching hundreds of rare, legally protected sea turtles off the west coast of the Philippines.

Two of the fishermen were found to be minors and released while the rest are being prosecuted and could face long jail sentences unless a diplomatic deal is reached.

China says that Johnson South Reef, Triton Island and much of the rest of the South China Sea nearly to the shores of Borneo, including where the fishermen were detained near the Philippines coast, represent an ancient fishing area for southern Chinese communities and belong to China.

A Xinhua commentary on Wednesday carried a strong warning for the Philippines and Vietnam. “All parties should also be reminded that ignorance of China’s resolve to defend its sovereign land will induce consequences too severe for certain countries to bear,” it said.

The Chinese military seized Johnson South Reef in 1988, killing dozens of Vietnamese military personnel who were there at the time. During an earlier confrontation with Vietnam in 1974, Chinese forces seized the Paracel Islands, about 450 miles north of South Johnson Reef and near where the drilling rig has now been erected.

Peter Dutton, the director of the China Maritime Studies Institute at the United States Naval War College in Newport, R.I., said that China’s historical behavior in the South China Sea suggests that its recent actions should not be taken lightly. “The Chinese, in a previous policy era, have been willing to use military force,” he said.

Floyd Whaley contributed reporting from Manila.

Annex 734

"Philippines Releases Photos of Chinese Reclamation", *Daily Mail* (15 May 2014)

Philippines releases photos of Chinese reclamation

By ASSOCIATED PRESS

PUBLISHED: 12:51 EST, 15 May 2014 | **UPDATED:** 12:51 EST, 15 May 2014

MANILA, Philippines (AP) — The Philippine government on Thursday released military surveillance photos of Chinese land reclamation on a reef claimed by Manila in the South China Sea that it said showed Beijing violated a regional agreement not to escalate territorial disputes.

Foreign Affairs Department spokesman Charles Jose said the pictures show Chinese aggressiveness in asserting its claims over the entire South China Sea.

The aerial photographs were accompanied by a caption stating that they were obtained from "Philippine intelligence sources." The caption said the "extensive reclamation" by China on the Johnson South Reef, called Mabini by Manila and Chigua by Beijing, was "destabilizing."

In this photo taken Feb. 25, 2014 by surveillance planes and released Thursday, May 15, 2014, by the Philippine Department of Foreign Affairs, a Chinese vessel, top center, is used to expand structures and land on the Johnson Reef, called Mabini by the Philippines and Chigua by China, at the Spratly Islands at South China Sea, Philippines. The Philippines has protested China's reclamation of land in the disputed reef in the South China Sea that can be used to build an airstrip or an offshore military base in the increasingly volatile region, the country's top diplomat and other officials said Wednesday, May 14, 2014. The white arrow was added by the source. (AP Photo/Philippine Department of Foreign Affairs)

The Chinese Embassy in Manila had no immediate comment, but a Foreign Ministry spokesman in Beijing has said that the area is part of China's territory, and that any Chinese activities at the reef should be of no concern to Manila.

The United States said it was aware of the reports that China is reclaiming land on a disputed reef in the South China Sea. State Department spokeswoman Marie Harf urged self-restraint in activities that could escalate or complicate disputes.

"Major upgrades or the militarization of disputed land features in the South China Sea by any claimant has the potential to raise tensions," she said.

Jose noted that a 2002 nonbinding agreement between China and the 10-member Association of Southeast Asian Nations calls for restraint in conducting activities in the region that would "complicate or escalate disputes" and to not inhabit uninhabited areas

"We want to show people that (China's) actions are part of its aggressive behavior to assert its claim in violation of the DOC," or Declaration on the Conduct of Parties in the South China Sea, which was signed by China, Philippines and nine other ASEAN members, Jose said.

Philippine President Benigno Aquino III said a stronger accord and international arbitration would offer more lasting solutions to the territorial conflicts. A proposed legally binding "code of conduct" between China and Southeast Asian countries is seen as a mechanism to prevent a major armed conflict in the disputed waters. Manila sought international arbitration against Beijing in January 2013 after Chinese government ships took control of a shoal claimed by the Philippines off its main island of Luzon.

Philippine Foreign Secretary Albert del Rosario said Wednesday that it was not clear what China would build on the reclaimed land, but that an airstrip was a possibility.

A senior government official, speaking on condition of anonymity because he was not authorized to talk about the issue, said it could also be used as a military base and a resupply and refueling hub. The official said the reclamation was first detected by air force planes six months ago.

Defense Secretary Voltaire Gazmin said the Philippine military has been monitoring Chinese activities at the reef for several months. "For whatever purpose (the reclamation was done) we still do not know, but we are almost sure that there will be a base," he told reporters Thursday.

An airstrip or a military base on the reef would boost the mobility of Beijing's naval and air forces in the South China Sea region, far from the Chinese mainland.

The pictures showed "before-and-after" images — from an untouched reef in 2012, followed by another showing a concrete building jutting out of the water, and the reclaimed land two years later. Philippine aircraft helping search for the missing Malaysian Airlines plane in March reported reclamation work was continuing, Jose said.

Del Rosario said Manila lodged a protest against China last month, but that Beijing has ignored it.

Chinese Foreign Ministry spokeswoman Hua Chunying said in Beijing on Wednesday that the reef was part of China's territory and any construction there is covered by its "sovereignty rights."

The Philippine government estimates that the Chinese have reclaimed a land mass of at least 30 hectares (74 acres) from the reef, which Manila says is part of its western Palawan province. What has emerged from the coral outcrop appears like a vast tree-less island of white sand in the middle of turquoise blue waters.

One of the released pictures shows a long pipe connected to a large dredging vessel on the northwestern edge of the reef. A concrete building, likely to be China's outpost on the reef, stands on the southern edge of the emerging islet. A ship is anchored close by.

The reef, part of the Spratly Islands chain, is also claimed by Vietnam, which fought a deadly naval battle against China in the area in 1988.

Associated Press writers Jim Gomez in Manila, Christopher Bodeen in Beijing and Matthew Pennington in Washington contributed to this report.

In this photo taken Feb. 28, 2013 by a surveillance plane, and released Thursday, May 15, 2014, by the Philippine Department of Foreign Affairs, Chinese-made structures stands on the Johnson Reef, called Mabini by the Philippines and Chigua by China, in the Spratly Islands in South China Sea. The Philippines has protested China's reclamation of land in the disputed reef in the South China Sea that can be used to build an airstrip or an offshore military base in the increasingly volatile region, the country's top diplomat and other officials said said Wednesday, May 14, 2014. The white arrow was added by the source. (AP Photo/Philippine Department of Foreign Affairs)

In this photo taken March 13, 2012 by surveillance planes and released Thursday, May 15, 2014, by the Philippine Department of Foreign Affairs, the Johnson Reef, locally called Mabini Reef, called Mabini by the Philippines and Chigua by China, is seen at the Spratly Islands at South China Sea. The Philippines has protested China's reclamation of land in the disputed reef in the South China Sea that can be used to build an airstrip or an offshore military base in the increasingly volatile region, the country's top diplomat and other officials said. The white arrow, top right, was added by the source. (AP Photo/Philippine Department of Foreign Affairs)

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Annex 735

Manuel Mogato, "Philippines' Aquino says China violates informal code on sea", *Reuters* (19 May 2014)

REUTERS

World | Mon May 19, 2014 5:08am EDT

Related: WORLD, CHINA

Philippines' Aquino says China violates informal code on sea

MANILA | BY MANUEL MOGATO

President Benigno Aquino of the Philippines arrives at Naypyitaw international airport to attend the 24th ASEAN Summit May 10, 2014.
REUTERS/SOE ZEYA TUN

Philippine President Benigno Aquino accused China on Monday of violating a 12-year-old informal code of conduct in the South China Sea with land reclamation work in a disputed shoal.

China has stepped up activity to assert its claim to most of the energy-rich South China Sea.

But Brunei, Malaysia, the Philippines, Vietnam and Taiwan also have claims over parts of the sea through which about $5 trillion of ship-borne goods pass every year.

China's activity has in particular raised alarm in the Philippines and in Vietnam, where a dispute over an offshore drilling rig sparked deadly anti-Chinese riots last week.

China and the 10-member Association of South East Asian Nations (ASEAN) signed an agreement in 2002 to refrain from occupying uninhabited reefs and shoals in the sea, and from building new structures that would complicate disputes.

"In our view, what they are doing there now is in violation of what we had agreed in the Declaration of Conduct of Parties in the South China Sea," Aquino told reporters.

"The problem is this code is not binding, not enforceable, so we need to come up with a formal code of conduct to resolve the dispute and prevent any potential conflict."

Last week, the Philippine foreign ministry released surveillance photographs of China's reclamation work in Johnson South Reef in the disputed Spratly Islands. China appears to be building an airstrip, its first in the Spratlys.

Peter Paul Galvez, a Philippine Defense Department spokesman, said the military noticed the reclamation work early this year. A Chinese airstrip in the area could pose a serious threat to security and stability in the region, he said.

China has rejected the Philippine protest over its work on the reef saying it is its territory so China has the right to develop it.

Elsewhere in the South China Sea, Vietnamese and Chinese vessels are squaring off in disputed waters where China wants to place the oil rig.

China and ASEAN, which includes the Philippines and Vietnam, have been negotiating a formal code of conduct but some ASEAN states are getting impatient with the slow pace of progress.

Aquino said Vietnam and the Philippines were pushing for the code of conduct to be concluded quickly.

(Editing by Robert Birsel)

Annex 736

Edward Wong, "Analysts Say China May Try to Use Manmade Islands to Bolster Bid for Economic Development", *New York Times* (19 June 2014)

The New York Times

Analysts Say China May Try to Use Manmade Islands to Bolster Bid for Economic Development

By Edward Wong June 19, 2014 9:09 am

China has been moving sand onto some reefs and rocks in the Spratly archipelago of the South China Sea to create islands that can support buildings, equipment and human habitation. The construction is stirring anxiety in the Philippines and Vietnam, which compete with China over territorial claims in the Spratly Islands, and raising alarms in the United States, which sees China's actions in the South China Sea as destabilizing.

Analysts say China could try to assert that these new islands entitle the country to an exclusive economic zone that extends 200 miles from the islands' shoreline. Such a zone is defined in the United Nations Convention on the Law of the Sea, to which China is a signatory.

But China might have a tough time convincing an international tribunal that its new islands can generate an exclusive economic zone. A clause under Article 60 of the convention says: "Artificial islands, installations 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."

The language sounds definitive, though China could argue that its new islands are not entirely artificial, since there were reefs and rocks at the sites before the sand dredging and land reclamation began.

In Article 121, the United Nations convention gives this definition for an island: "An island is a naturally formed area of land, surrounded by water, which is above water at high tide."

Lawrence Juda, a professor of maritime affairs at the University of Rhode Island in Kingston, said in an email, "Artificial islands, thus, do not qualify as 'islands' with the consequent legal rights of those that are naturally formed."

If China were to use these new creations to try to claim an exclusive economic zone, "I do not think that this claim would be legitimate or recognized," Mr. Juda said. "Moreover, such a claim would be unacceptable, not only to the Philippines, but also to important maritime states such as the United States. Acceptance of a Chinese claim to an E.E.Z. around an artificial island would set a terrible precedent and open a potential Pandora's box to extensive national claims to ocean areas, spawning a wide variety of legal and political problems."

Perhaps not surprisingly, China has been pushing back against an attempt by Japan, another territorial rival, to claim a continental shelf and exclusive economic zone around a tiny atoll in another body of water. The atoll, called Okinotorishima, sits in the Philippine Sea, east of the Philippines and Taiwan and west of Guam. Only two knobs are visible at high tide. As of 2012, Japan had spent $600 million to surround the atoll with a wall of concrete, according to a report by Foreign Policy. Fishery officials planted extra coral in the area to reinforce the appearance of an island.

Chinese officials have argued that Okinotorishima does not qualify as an island as defined by the United Nations convention and so cannot have a continental shelf or generate an exclusive economic zone. In April 2012, a United Nations commission made a partial ruling on the matter that left fundamental questions unanswered. A post on the blog of Herbert Smith Freehills, a global commercial law firm, said whether Okinotorishima officially qualifies as an island was "a distinction of considerable significance for international law of the sea purposes, as it may determine Japanese sovereignty claims over the surrounding continental shelf and its potentially vast natural resources."

This March, Asahi Shimbun, a Japanese newspaper, reported that Japan was spending $780 million to build a port at the site. The newspaper reported: "Although the transport ministry's stated goal is to extract seabed resources in the surrounding areas, observers say the harbor construction may be intended as a warning to China, which is looking for opportunities to weaken Japan's control over the exclusive economic zone around the tropical islets."

Correction: June 19, 2014
Because of an editing error, an earlier version of this post misidentified the article of the United Nations Convention on the Law of the Sea that defines an island. It is Article 121, not 21.

Annex 737

Shi Yang, “Excellent Tool for Land Reclamation in Nansha”, *BBSBIAN* (13 Sept. 2014)

Shi Yang: Excellent Tool for Land Reclamation in Nansha
09-13-2014 | BBSBIAN

Various countries have paid close attention to China's large-scale land reclamation construction on several islands and reefs in South China Sea. The BBC even sent reporters to the front line to film these island and reef construction sites claimed to be "for air force bases." In the photographs shown by the media, a several hundred meter-long artificial island had already been formed on the reef base, and many machines were engaged in construction.

Chigua Jiao [Johnson South Reef] – Chigua Dao [Johnson South Island] (image provided by South China Sea Research Forum)

Nansha has always been well known for its small reef bases and difficulties for personnel in residence. In 1988, when the People's Liberation Army began to be permanently stationed in Nansha, stilted houses constructed from bamboo poles, bamboo mats, and plastic sheeting were known as "foxholes on the sea" because of their poor residential conditions. The concrete reef forts were slightly bigger, but other than the vegetable plots, there was only a small area for exercise; it was even too small for helicopters to land. It is impossible to create a few islands out of South China Sea during a short period of time without some brilliant tools.

Shi Yang: Excellent Tool for Land Reclamation in Nansha

First generation stilted house

Second generation stilted house

Third generation stilted house (fort). The right side were the remnants of the second generation stilted house.
Provided by Nansha Guard Squad.

Speaking of land reclamation in Nansha, most people would first think of sending out cargo boats from the mainland loaded with sand, rocks, or prefabricated concrete blocks to pile them around the beaches of Nansha. However, reclaiming land in the South China Sea, far from the mainland, would require millions of tons of sand and earth. Moreover, since the cost of land sand is far higher than sea sand, and cargo ferries with high tonnage in waters without docks would require loading and unloading using small boats, even though the technical requirements of this type of land reclamation would be low, the cost would be extremely high and it would be extremely inefficient, making this method inappropriate for large-scale land reclamation. Because of these restrictions, Vietnam could only use these methods when reclaiming land on reefs and islands it illegally occupied in Nansha.

Shi Yang: Excellent Tool for Land Reclamation in Nansha

Vietnam’s expansion of Sin Cowe Island in Nansha

Vietnam’s island construction on West Reef in Nansha

Many reef bases in Nansha have large shallow beaches that contain massive quantities of sea sand. The most efficient and economic method of land reclamation is to extract the sand for local use. Because there is so much sand, it cannot be shoveled on a small scale, but a more efficient operational method must be used—dredge pumping.

Dredge pumping generally refers to using dredgers to dig mud, then pumping the mixture of mud in the mud hopper through pipes onto land near the sea, removing water in the mud to reach a certain height, making the mud usable. To accelerate land reclamation in the South China Sea region, China mobilized many work boats and machines to participate in construction, even to the extent that the navy has retrofitted several landing vessels to ensure the quality of life of the construction team. In this squad, it is the “Tianjing,” Asia’s largest self-propelled cutter suction dredger, that has a decisive effect on land reclamation work.

Shi Yang: Excellent Tool for Land Reclamation in Nansha

Front of “Tianjing”

Side view of “Tianjing”

The “Tianjing” was jointly designed by Shanghai Jiao Tong University and German company VOSTA LMG, and built by China Merchants Heavy Industry (Shenzhen) Ltd. Construction began in April 28, 2008 and was completed in 21 months. The vessel is 127 meters long and 23 meters wide. It is currently the largest self-propelled cutter suction dredger in Asia, equipped with many pieces of the most advanced dredging equipment in the world; its installed power and dredging ability are number one in Asia and number three in the world. At the same time, since the vessel has unlimited sailing ability and loading and transport functions, it can be mobile on the high seas, and is suitable for large-scale dredging operations under any circumstance on the sea.

When executing dredge pumping work, the vessel can move the mixture of sand and seawater at a rate of 4500 cubic meters per hour as far as 6000 meters away. The amount of dredged and pumped sand can reach more than one hundred thousand cubic meters per day. At the same time, the vessel is equipped with the most powerful digging system in Asia with cutting power of 4000 KW, so the cutter would not be damaged by coral reefs on the reef base and interfere with the work.

Shi Yang: Excellent Tool for Land Reclamation in Nansha

The cutter at the head of "Tianjing"

Since the "cutter" at the head of "Tianjing" is such a powerful construction machine, China's "violent land reclamation" has become extremely efficient. Unlike Vietnam's method of first constructing dams to drain out the seawater before pouring domestic sand and earth, "Tianjing" directly fills the shallow beaches with sea sand, with no damming facilities and taking no note of minor losses through drifts.

According to information aggregated from vessel automatic identification systems, between September 2013 and June 2014, "Tianjing" has traveled back and forth among Huayang Jiao [Cuarteron Reef], Yongshu Jiao [Fiery Cross Reef], Chigua Jiao [Johnson South Reef], Dongmen Jiao [Hughes Reef], and Nanxun Jiao [Gaven Reefs]. Work was done in turns to elevate efficiency, for a total of 193 days. During this period, from December 2013 to now was a peak operational period of "Tianjing" in Nansha. It traveled among the five reef bases and worked for a total of 174 days. Based on 4500 cubic meters of pumped sand per hour, "Tianjing" dredged and pumped over ten million cubic meters of sand and water at the five islands in Nansha; this is approximately equal to the amount of concrete used in three Hoover Dams.

Tianjing's worksite at Chigua Jiao

Shi Yang: Excellent Tool for Land Reclamation in Nansha

After reclamation, heavy machinery such as trucks, diggers, and forklifts have arrived on Chigua Jiao

Four cement towers have been erected on Chigua Jiao; a fishing boat parked nearby can be seen

At the same time, China has continuously engaged in another major land reclamation project in Xisha. This February, "Tianqi" dredger and a 20-cubic-meter grab dredger were photographed while dredging at the harbor for Yongxing Dao [Woody Island]. "Tianqi" is the largest non-self-propelled cutter suction dredger in Asia, constructed by Qianjin Shipbuilding Factory in Qingdao in April 2008. Its stated production capacity was 4500 cubic meters/hour and can expel sand as far as 6300 meters away; the pumping ability is actually stronger than the "Tianjing." The vessel is wave-resistant, and can dig clay, compacted sand, gravel, and rocks. It is perfect for land reclamation at Yongxing Dao, which requires a great deal of sand but not frequent movement.

Shi Yang: Excellent Tool for Land Reclamation in Nansha

Photograph published by the Vietnamese media, showing “Tianqi” and the 2000-ton dredger at work

“Tianqi” dredger undertaking dredging work in Xisha

As for why land reclamation work only attracted media attention recently, on one hand, because the dredge-and-pump stage in land reclamation in Nansha is largely complete, a great number of construction personnel and machinery have arrived on the island for construction, and the scale and purposes of the artificial islands have elicited vigilance or even anxiety from surrounding countries of certain types that covet resources in Nansha. On the other hand, the months-long “Haiyang Shiyou 981 oil platform standoff” since this May has attracted attention from various parties.

Shi Yang: Excellent Tool for Land Reclamation in Nansha

In less than one year, from stilted houses to islands (images provided by South China Sea Research Forum; the top set shows the fort, the bottom set are recent photographs after land reclamation)

On the issue of developing the islands and reefs, China has always maintained the greatest degree of restraint. However, Vietnam and the Philippines have continuously violated the *Declaration on the Conduct of Parties in the South China Sea* of 2002, and have devoted significant effort to permanent structures and constantly constrain China. At present, the main reefs and islands under Chinese control have been constructed into large artificial islands that are several hundred meters long. The surface area and scale of land reclamation has outpaced that by surrounding nations altogether. In this land reclamation race involving both national will and ability, China has become the leader despite its late start; without a doubt, the key has been the advanced technologies and outstanding products from its industrial sector.

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This article only represents the author's personal views.

Source: Observer Web

Responsible editor: Chen Xuanfu

施洋：南沙填海利器

2014-09-13 | BBSBIAN | 转藏(1)

中国在南海多个岛礁进行的大规模填海工程，引发多国关注。英国广播公司甚至派遣记者亲临一线，拍摄这些据称“要建成空军基地”的岛礁工地。在媒体展示的照片中，礁盘上已经形成了边长数百米的人工岛屿，并有不少工程机械正在施工。

赤瓜礁—赤瓜岛（南海研究论坛供图）

南沙向来以礁盘狭小、难于驻守著称，1988年解放军开始常驻南沙时，竹竿、篾席和塑料布搭起的高脚屋因为居住环境恶劣被戏称为“海上猫耳洞”；混凝土的礁堡面积稍大，但除去菜地之外，空地也只有一小块操场，甚至无法起降直升机。要短时间内在南海变出几个岛来，没有两把刷子是不行的。

第一代高脚屋。

第二代高脚屋。

第三代高脚屋(礁堡)。右侧是第二代高脚屋遗迹。

南沙守备部队提供

说起在南沙填海，一般人首先想到的是从大陆派出货船，运载沙土石料或混凝土预制块填在南海浅滩周围的景象。不过，在远离大陆的南海填海造陆，所需要的沙土量以百万吨计，加上陆沙价格远远高于海沙，无码头水域大吨位货轮需要小船卸载等因素，使这种填海方法虽然技术门槛低，但成本极高、效率极差，对于大规模填海来说并不适用。越南由于条件所限，在南沙非法占据的岛礁上填海时，只能经常使用这样的手法。

越南扩建南沙景宏岛

越南在南沙西礁填海造岛

南沙礁盘周围大多有面积广大的浅滩，里面最多的就是大量海沙，填海最有效率也是最经济的方法就是将这些沙子利用起来，就地开采使用。如此多的海沙当然不能用抓斗或者铲子蚂蚁搬家，而依赖于一种更有效率的作业方式——吹填。

吹填一般是指用挖泥船挖泥后，通过管线把泥舱中的泥水混合物，排放到近海陆地，将近海淤泥填垫，排除淤泥中的水分，达到一定标高，使之具有可利用价值。为了加快在南海区域的填海速度，中国出动了大量工程船只和机械参与施工，其规模甚至大到海军专门改造了数艘登陆舰作为“施工队”的生活保障船。而在这支船队中，对填海工程起着决定性作用的，便是亚洲第一大自航绞吸挖泥船“天鲸”号。

“天鲸”号正面

“天鲸”号侧视

“天鲸”号由上海交通大学、德国VOSTA LMG公司联合设计，招商重工（深圳）有限公司建造，2008年4月28日开工，历时21个月建成。该船长127米，宽23米，是目前亚洲最大的自航绞吸挖泥船，配备多种当前国际最先进的疏浚设备，装机功率、疏浚能力均居亚洲第一、世界第三。该船同时具有无限航区的航行能力和装驳功能，可以在远海灵活机动，适用于各种海况的大型疏浚工程。

在执行吹填作业时，该船能以每小时4500立方米的速度将海沙、海水的混合物排放到最远6000米外，每天吹填的海沙达十多万立方米。与此同时，该船装备亚洲最强大的挖掘系统，绞刀功率达到4000千瓦，使其不会被礁盘上的珊瑚礁损坏而影响工作。

“天鲸”号船首的绞刀

有了如此强劲的工程器械，中国在南沙的“暴力填海”体现出了极高的效率：与越南先修筑围堰，排空海水后再将国内运来的沙土倒入不同，“天鲸”号直接将海沙向浅滩吹填，没有任何的围堰设施，也不计较细小的漂散损失。

根据从船舶自动识别系统处综合来的信息，从2013年9月至2014年6月间，“天鲸”号多次往返于南沙华阳礁、永暑礁、赤瓜礁、东门礁和南薰礁之间，通过轮流作业提高效率，累计天数达193天。其中，2013年12月至今是“天鲸”号在南沙作业的高峰时段，他往来于五个礁盘之间，累计工作174天，按照每小时吹填海沙4500立方米计算，“天鲸”号在南沙五个岛礁吹填了超过1000万立方米的沙土和海水，大约相当于3个美国胡佛水坝消耗的混凝土。

天鲸号在赤瓜礁作业现场

吹填后的赤瓜礁上已经进驻了卡车、挖掘机和铲车等重型机械

赤瓜礁上已经竖立起四座水泥塔，近处可见一艘渔船停泊

与此同时，中国在西沙也在持续进行着规模不小的填海工程。今年2月，“天麒”号挖泥船与一艘20立方米抓斗式挖泥船被拍摄到正在永兴岛港口进行疏浚。“天麒”号是亚洲最大的非自航式绞吸挖泥船，2008年4月在青岛前进船厂建造，公称生产量4500立方米/小时，排距6300米，其吹填能力甚至比“天鲸”号更强。该船抗风浪能力强，可挖掘粘土、密实砂土、碎石土和强风化岩，对于需要大量海沙却不需要频繁机动的永兴岛填海工程正是恰如其分。

越南媒体公布的照片，图中可见“天麒”号和2000吨挖泥船正在作业

正在西沙进行疏浚作业的“天麒”号挖泥船

至于填海工程为何直到近日才成为媒体焦点，一方面是因为目前南沙填海工作的吹

填阶段已经基本结束，大量工程人员和机械上岛施工，人工岛屿的规模和用途都引起了觊觎南沙资源的某型周边国家的警觉甚至不安；另一方面，则是今年5月以来围绕“南海981”号钻井平台持续数月的海上对峙与冲突吸引了各方的注意力。

从高脚屋到岛屿，就在不到一年间（南海研究论坛供图，上组为礁堡，下组为填海后近照）

中国在建设岛礁的问题上，一直保持了最大克制。但越南、菲律宾等却不断违反2002年《南海各方行为宣言》，大搞永久性设施，不断逼迫中国。目前，中国控制的几个南沙主要岛礁均已经建起了边长数百米的大型人工岛，其填海面积和规模远超周边国家近年来填海的总和。在这场国家意志与能力并存的填海竞赛中，中国一出手就得以后来居上，工业部门的先进技术和优秀产品无疑是关键。

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本文仅代表作者个人观点。

来源：观察者网

责任编辑:陈轩甫

Annex 738

J. Hardy & S. O'Connor, "China Builds Another Island in South China Sea", *IHS Jane's Defence Weekly* (30 Sept. 2014)

IHS Jane's 360

Country Risk

China builds another island in South China Sea

James Hardy, London and Sean O'Connor, Indiana - IHS Jane's Defence Weekly

30 September 2014

IHS Jane's has obtained satellite imagery that further illustrates the extent of China's building of new islands in the Spratly Islands.

The latest image shows a new island on Gaven Reefs, known in the Philippines as the Burgos Reef, in Vietnam as Dá Ga Ven and Dá Lc and in China as Nanxun Jiao and Xinan Jiao.

China previously built a concrete platform that sat above the reef on its western side. This structure was fortified and housed anti-air and naval gun systems, along with communications equipment.

However, Airbus Defence and Space satellite imagery dated 31 March and 7 August 2014 shows that between these two dates a channel was cut out of the centre of Gaven Reefs and the resultant rubble deposited to create a rectangular island that is about 300 m by 250 m. Along with a spit that leads to the channel, about 114,000 m^2 of new land has been created.

As with Johnson South and Cuateron reefs - other sites of recent Chinese reclamation in the Spratlys - workers have enclosed the island with a concrete sea wall.

The dredging and reclamation were most likely carried out by *Tian Jing Hao* , a 6,017-tonne, 127 m-long cutter suction dredger that is believed to be the largest of its type in the Asia-Pacific region. *IHS Jane's* previously reported that *Tian Jing Hao* was present at Gaven Reefs from 24 May to 15 June 2014.

Based on the 7 August image, construction of the island at Gaven Reefs has not progressed as far as that at Johnson South or Cuateron reefs. For example, there are no piers or roll-on/roll-off (ro-ro) docks or foundations for buildings at Gaven Reefs, although there are barracks, ISO containers and construction materials.

The seawalls at Cuateron, Gaven and Johnson South reefs all suggest that plans to build airstrips at any of the sites are secondary to establishing the islands' structure before typhoon season in late summer to autumn. In previous land reclamation activities in the South China Sea, such as in the Paracel islands, China has been content to expand each feature's footprint gradually.

COMMENT

Beijing continues to defend its right to create the islands although its logic is sometimes impenetrable. Responding to reporters' questions at a regular press briefing on 9 September, Chinese Foreign Ministry spokesperson Hua Chunying said: "We have answered this question many times before, and I suppose you must be fully aware of China's position. China asserts indisputable sovereignty over the Nansha [Spratly] Islands and the adjacent waters, and China's activities on relevant islands and reefs of the Nansha Islands fall entirely within China's sovereignty and are totally justifiable."

When asked what the purpose of the recent construction was, Hua said it was "mainly for the purpose of improving the working and living conditions of people stationed on these islands".

When a reporter noted that "given the fact that China is building new islands, there is no way that construction on them is for improving the living conditions of inhabitants on them", Hua replied: "I have already answered your question."

Related articles:

- VIDEO: Castles made of sand: Chinese land reclamation in the South China Sea
- China advances with Johnson South Reef construction
- China expands runway, harbour at Woody Island

(541 words)

Annex 739

Bree Feng, "China's Naval Chief Visited Disputed Islands in the South China Sea, Taiwan Says", *New York Times* (16 Oct. 2014)

The New York Times

China's Naval Chief Visited Disputed Islands in the South China Sea, Taiwan Says

By **Bree Feng** October 16, 2014 5:28 am

In the latest turn in the continuing territorial disputes in the South China Sea, Taiwan's top intelligence official has said that the Chinese naval chief surveyed islands in the strategic waterway where China has been carrying out land reclamation work despite protests from other countries in the region, Hong Kong and Taiwanese news media reported on Thursday.

Speaking at a meeting in Taipei on Wednesday of the Foreign and Defense Committee of the Legislative Yuan, Lee Hsiang-chou, the director general of Taiwan's National Security Bureau, said that Adm. Wu Shengli, the commander of the Chinese People's Liberation Army Navy, conducted a survey of five islands in the disputed Spratly archipelago last month. Calling the trip "unprecedented," Mr. Lee said that Admiral Wu had made the weeklong trip on a military ship in order to inspect the land reclamation work that China has been conducting on the islands in recent months, according to Takungpao, a Hong Kong newspaper.

Takungpao, as well as the Taiwan-based United Daily News, also reported Mr. Lee as saying that President Xi Jinping of China had personally approved the reclamation work, which alarmed Southeast Asian nations that also claim sovereignty over the Spratly Island group when it was revealed earlier this year. Using a dredging vessel, China has been slowly turning several reefs into islands. Other claimants fear that Beijing wants to build military facilities on these land features, including an air base, in order to strengthen its claims.

The media reports did not identify all the South China Sea islands Mr. Lee was referring to, but, citing government reports, The Philippine Star reported last summer that China was carrying out reclamation activities on five reefs of the Spratly Islands that the Philippines also claims.

Mr. Lee's comments, which were also reported on the website of the Chinese state-run newspaper Global Times but whose substance has not been formally confirmed by Beijing, are likely to set off new concerns about China's territorial aspirations in the South China Sea.

At a regional security conference in May, Defense Secretary Chuck Hagel of the United States leveled a rare, pointed criticism at China for what he called "destabilizing, unilateral actions" in asserting its territorial claims in the South China Sea, including "land reclamation activities at multiple locations."

But it now appears that China has shrugged off these critiques and is intent on consolidating its territorial claims in the potentially resource-rich waters, through which around half of the world's freight cargo passes.

China claims a large swath of the South China Sea, represented by a nine-dash line drawn from a Nationalist Chinese map in 1947. At its southernmost point, Beijing's claim extends hundreds of miles from the Chinese mainland, nearly reaching the coastline of several Southeast Asian countries. The Philippines, Vietnam, Brunei and Malaysia each claim parts of the sea, and the claims of Taiwan, to which the Nationalist forces retreated after their defeat in the Chinese civil war in 1949, echo those of Beijing.

Mr. Lee's comments came as Taipei is seeking to fortify its own claims in the sea with new military facilities. Reuters reported on Thursday that

Taiwan is considering bolstering its military presence in the South China Sea by stationing ships permanently near disputed islands. The self-governing island, over which Beijing also claims sovereignty, is constructing a $100 million dollar port on Taiping Island in the Spratlys, where it already maintains an airstrip. Set to be completed next year, the port will allow the Taipei-controlled island to host 3,000-ton military and coast guard vessels.

At the meeting on Wednesday, Mr. Lee also said that Admiral Wu had overseen Chinese troop drills at Yongshu Island in the Spratly archipelago. Internationally known as Fiery Cross Reef, the site is about 740 nautical miles south of the Chinese mainland and serves as the administrative and military headquarters of China's Spratly Island claims. It is home to about 100 troops.

Despite the criticism, it seems that China has continued to assert its claims through what some analysts have dubbed a "salami-slicing" approach, even as it calls for talks on joint development of the seas and says navigational safety will not be threatened. Earlier this year, the Chinese government said it would offer financial subsidies to fishermen who live in the Spratly and Paracel islands of the South China Sea.

Last spring, protests broke out in several cities in Vietnam after China deployed a deep-water oil-drilling platform near an island grouping off Vietnam's coast that is controlled by China but claimed by Vietnam.

Annex 740

"Chinese Land Reclamation at 7 South China Sea Islands, Taiwan is Concerned That This Will Adversely Impact the Defense Work at Itu Aba Island", *360doc.com* (21 Oct. 2014)

Chinese land reclamation at 7 South China Sea Islands has expanded from 1,000 square meters to 180,000 square meters. Taiwan is concerned that this will adversely impact the defense work at Itu Aba Island.

Archived by: Du Mingyuan

Chinese Land Reclamation at 7 South China Sea Islands, Taiwan is Concerned That This Will Adversely Impact the Defense Work at Itu Aba Island

[…]

Itu Aba Island, under the control of the Taiwanese government, has begun harbor construction; the image is a projection of the completed construction. Source of image: *China Times News* of Taiwan.

[General report from www.huanqiu.com] Taiwan's *China Times* reports that starting from this year, Mainland China has begun to conduct large-scale land reclamation at several reefs and islands in the South China Sea, surrounding Itu Aba Island. Taiwan's "national security" authorities are paying close attention. According to earlier reports, Taiwan's "Director-General of the National Security Bureau" Lee Hsiang-chou admitted at Taiwan's "Legislative Yuan" that he was "very worried." He stated that at present, of the Mainland Chinese land reclamation operations at the 7 islands in the South China Sea, 5 were approved by the supreme leaders, with the goal of "fortification of small islands" and "creation of bases from large islands."

Lee Hsiang-chou stated that, as an example, "Huayang Reef" was only 1,000 square meters last March, but by July of this year it was 140,000 square meters, and 180,000 square meters at the end of September.

Lee Hsiang-chou said that in late September, the naval commander of the People's Liberation Army unprecedentedly took one week to inspect the land reclamation work conducted at these islands, even inspecting simulation of combined army, navy and air force military operations at Fiery Cross Reef. This was used to demonstrate that China has had comprehensive strategic plans for the South China Sea.

According to reports, Kuomintang "legislator" Lin Yu-fang, who has long been concerned with the situation in the South China Sea, stated that Johnson South Reef, Hughes Reef, Gaven Reef, and Cuarteron Reef have formed a "surrounding formation" for Itu Aba Island. Some foreign officials also believe that after completion of Cuarteron Reef, Johnson South Reef and Gaven Reef, China will announce the establishment of the "South China Sea Air Defense Identification Zone."

Lin Yu-fang stated that Johnson South Reef, Hughes Reef, and Gaven Reef have not only "surrounded" Itu Aba Island, but also become "closer and closer" in terms of their distance to Itu Aba Island. Johnson South Reef is 70 kilometers to the south of Itu Aba Island, Hughes Reef is 57 kilometers to the southeast, and Gaven Reef is only 30 kilometers to the southwest of Itu Aba Island. Regardless of whether the ultimate aims of Chinese land reclamation are large radar stations, docks, or airstrips, it would result in a "severe impact" on the defensive work at Itu Aba Island.

Chinese naval officers stationed at Fiery Cross Reef cheering in front of the sovereignty monument.

[Report from Huanqiu.com reporter Li Botao] In summary of reports from the Taiwanese media, since this June China has actively conducted land reclamation work at Fiery Cross Island of the Nansha Islands. Fiery Cross "reef" has not only become Fiery Cross "island," with its latest surface area increasing from 0.081 square kilometers to almost 1 square kilometer (0.96 square kilometers). From a reef that was submerged at high tide, it has surpassed Itu Aba Island, with 0.5 square kilometers [exposed at high tide] and is under the de facto control of the Taiwanese government. It has become "the biggest island among Nansha Islands," and the fifth largest island in the South China Sea, only after Woody Island, Pratas Island, Lincoln Island, and Triton Island.

Taiwanese media stated by reference to Guancha.cn that in the last year, China has engaged in large-scale land reclamation to expand several islands and reefs in the South China Sea, including Johnson South Reef, Cuarteron Reef, Gaven Reef, and their nearby sea regions. Large groups of construction workers have appeared and they have rapidly advanced construction progress. Among these, "Fiery Cross Reef" of Sansha, Hainan Province, is strategically important in terms of geographical location, with a greater reef platform, it has no enemy-occupied bases within a 70 kilometer radius, thus it has become an important island for land reclamation construction in this round.

According to reports, Fiery Cross Island is centrally located among South China Sea islands, at the midway point between Union Banks and Reef and London Reefs, approximately 740 nautical miles from China, 560 nautical miles from Yulin Port of Hainan Island; thus, its geographical location is very important. In 1988, China decided to construct a manned marine observation station at Fiery Cross Reef, and afterwards constructed a helipad, a 4000-ton harbor, a two-story building, and a 500 square meter vegetable shack; this can hold 200 naval soldiers of the People's Liberation Army. There are currently no civilians residing on Fiery Cross Reef.

According to Chinese military experts, the ultimate surface area of Fiery Cross Island, serving as the Chinese administrative and military command center in the Nansha Islands, will be 2 square kilometers. A large military airstrip will be constructed, then after land reclamation at Johnson South Reef and other islands is complete, the "South China Sea Air Defense Identification Zone" can be established. Afterward, the People's Liberation Army will deploy "HQ-9" air defense missiles and "YJ-62" anti-ship missiles there, expanding defense fighter aircraft, rapid landing crafts and yachts to strengthen responses against countries such as Vietnam and the Philippines.

According to reports, originally, among Nansha Islands, only four islands including Itu Aba Island, Spratly Island, and Thitu Island could allow for take-off and landing by large military aircraft. In 1988, after Chinese and Vietnamese engagement in naval warfare at Johnson South Reef in the Nansha Islands, the Vietnamese and Philippine militaries both strengthened the maintenance and construction at key islands under their occupation. If a situation arises in the South China Sea, and the People's Liberation Army engages in military operations there, fighter jets departing from Hainan would have to fly nearly 1000 kilometers before they arrive.

Chinese military expert Song Zhongping provided his analysis. Fiery Cross Island is about 110 kilometers from Spratly Island, 550 kilometers from Malaysia, and 550 kilometers from the Philippines. This distance is the current range for warfare of all its mainstream fighter jets. The air force base constructed at Fiery Cross Island in the future would give China substantive control over the air space in South China Sea; if J-11 can take off from Johnson South Reef, the entire South China Sea can become the scope for military operations. This is the reason that China is actively constructing a military airstrip at Johnson South Reef. If the landing spots on the other reefs can be connected, it would create a naval and air force military base that would be difficult to counter.

大陆南海7岛填海造陆由1000平方米已达18万平方米。 台担心严重冲击太平岛防务

大陆南海7岛填海造陆 台担心严重冲击太平岛防务

2014-10-21 09:56:00 环球网 分享 639 参与

台当局控制的太平岛码头兴建工程已启动，图为完工后示意图。 图片来源：台湾《中时电子报》

【环球网综合报道】台湾《中国时报》报道称，中国大陆从今年开始，在南海多个岛礁进行大规模填海造陆，对太平岛形成“包围之势”，台“国安”单位相当重视。据早前报道，**台“国安局长”李翔宙曾在台“立法院”坦言“非常担心”，称大陆目前在南海7个岛礁所进行的填海造陆作业，有5个是由最高领导人核定的，目标是“小岛堡垒化”和“大岛阵地化”。**

李翔宙表示，以“华阳礁”为例，去年3月还只有1000平方米，到今年7月已经有14万平方米，到9月底已达18万平方米。

李翔宙说，解放军海军司令在9月下旬，史无前例地用一星期时间，逐岛视察这些岛礁的填海造陆工程，还在永暑礁视察三军联合作战想定的操演，借此宣示中国大陆在南海已经有全盘的战略规划。

报道称，长期关心南海局势的国民党“立委”林郁方指出，包括赤瓜礁、东门礁、南熏礁和华阳礁，对太平岛已呈现“包围态势”。有外国官员还认为，在华阳礁、赤瓜礁和南熏礁完工后，大陆就会宣布设立“南海防空识别区”。

林郁方表示，赤瓜礁、东门礁和南熏礁不仅已经对太平岛形成“包围”，与太平岛的距离更是“一个比一个近”，赤瓜礁在太平岛南方70公里、东门礁在东南方57公里，南熏礁更是在太平岛西南方只有30公里。不论中国大陆最后填海的目的是大型雷达站、码头或跑道，对太平岛的防务势将造成“严重的冲击”。

驻守在永暑礁的大陆海军官兵在主权碑前欢呼。

【环球网综合报道 记者李柏涛】综合台媒媒体报道，大陆自今年6月起，积极进行南沙群岛永暑岛填海造陆工程，永暑“礁”不但变身永暑“岛”，其最新面积从0.081平方公里已逼近1平方公里(0.96平方公里)，从一个会随潮水淹没的礁石，一举超过台当局实际控制、面积0.5平方公里的太平岛，成为“南沙第一大岛”，也是南海诸岛第5大岛，仅次于永兴岛、东沙岛、东岛、中建岛。

台媒引述观察者网的报道称，最近一年来大陆大规模填海扩建南海多个岛礁，包括赤瓜礁、华阳礁、南熏礁及其附近海域，均出现大批工程人员，施工进展极迅速。其中隶属海南省三沙市的“永暑礁”由于地理位置险要，且有较大礁盘，周边70公里半径也没有密切靠近的敌占据点，因此成为本轮填海工程的重点建设岛屿。

据悉，**永暑岛位于南沙群岛中部，九章群礁和尹庆群礁的中点，距大陆约740海里，据海南岛榆林港560海里，地理位置重要。**1988年大陆决定在永暑礁建一座有人驻守的海洋观测站，随后搭建一个直升机平台、一个4000吨级码头、一座2层楼房和一个500平方米蔬菜棚，约可容纳200名解放军海军驻守，目前无平民居住。

据大陆军事专家透露，作为大陆在南沙的行政与军事指挥中心的永暑岛最后面积将达2平方公里，并将兴建大型军用机场，待赤瓜礁等造陆工程完成后，就可划设“南海防空识别区”。解放军之后将在此部署“红旗-9”型防空导弹和“鹰击-62”反舰导弹，并且扩大驻防战机、快速登陆艇和快艇部队，加强应对 越南 、 菲律宾 等国。

报道称，原本在南沙群岛中，仅有太平岛、南威岛、中业岛等4个岛屿，可供大型军机起降。1988年中越在南沙赤瓜礁发生海战后，越军、菲军皆加强对占领核心岛礁的维修和建设。一旦南海有事，解放军在南海作战，战机从海南起飞，需要近1000公里才能飞到。

大陆军事专家宋忠平分析，永暑岛距离南威岛约110公里、距离 马来西亚 约550公里，距离菲律宾约550公里，此距离是大陆目前所有主力战机全程火力打击范围，永暑岛未来建成的空军基地将能使大陆实质控制南海空域;歼11如果从赤瓜礁起飞，也可以将整个南海纳入作战范围。所以大陆目前积极在赤瓜礁兴建军用机场。如果和其他礁石上泊地结合起来，那将构成一个难以对付的海空军基地。

Annex 741

"China's Reclamation in Disputed Reefs Now Massive", *New York Times* (21 Jan. 2015)

The New York Times http://nyti.ms/1xVK4MI

ASIA PACIFIC

Manila: China's Reclamation in Disputed Reefs Now Massive

By THE ASSOCIATED PRESS JAN. 21, 2015, 6:50 A.M. E.S.T.

MANILA, Philippines — China's land reclamation in contested reefs in the South China Sea has become "massive," and is continuing despite protests from other countries, a Philippine official said Wednesday, citing surveillance photographs.

Philippine Foreign Undersecretary Evan Garcia and the top U.S. diplomat for East Asia, Daniel Russel, said after annual security talks that their governments have separately urged Beijing to stop activities that could worsen tensions and violate a 2002 accord designed to prevent armed conflicts over disputed islands and reefs.

"It is massive, just look at the photographs. These are not small adjustments. These are huge activities that are obviously designed to change the status quo," Garcia said in a joint news conference with Russel.

"Let me add also that the massive reclamation of China in the South China Sea is a clear violation of what we have agreed upon" in the 2002 accord, Garcia said. "It is not helpful in terms of finding a way forward and it is not an example of what anybody would understand as self-restraint."

The photographs Garcia referred to were not immediately distributed to the media.

The Chinese Embassy in Manila had no immediate comment, but Beijing's foreign ministry has said that the area where the reclamation is reportedly underway is part of China's territory, and that any Chinese activities there should be of no concern to Manila.

In May last year, the Philippine government released military surveillance photos of Chinese land reclamation in Johnson South Reef, called Mabini in the Philippines and Chigua in China, in the disputed Spratly chain of islands, reefs and atolls.

Military chief of staff Gen. Gregorio Pio Catapang told reporters two weeks ago that China's reclamation work in at least three reefs appeared to be "50 percent complete," including one with an elongated portion that is 1 to 2 kilometers (1/2 mile to 1.2 mile) long and could be turned into an airstrip.

Catapang told The Associated Press on Wednesday that the latest surveillance photos of China's reclamation work were obtained by the military in October and new photographs would be pursued.

The Philippines, Vietnam and Malaysia have protested the reclamation on Johnson South Reef and other reefs. The reclaimed areas could be used by Beijing as a military base and a resupply and refueling hub, according to military officials.

Brunei and Taiwan also claim parts of the sprawling sea that China claims virtually in its entirety.

China's reclamation work and other related activities are "an ongoing concern" for the U.S. and other nations, which rely "on freedom of navigation and sea lanes and the principle of unimpeded, lawful commerce" in the South China Sea, Russel said. The South China Sea has some of the world's busiest commercial sea lanes.

"But behavior that raises tensions, behavior that raises questions about China's intention and behavior that would appear to be inconsistent with the principles that I've enumerated work counter to those goals," he said.

Russel and Garcia said their governments support a peaceful resolution of the disputes based on international law.

Annex 742

"Great News on Chinese Island Construction in South China Sea: Construction has begun on Mischief Reef", *Global Military Web* (22 Jan. 2015)

[…]

Great News on Chinese Island Construction in South China Sea: Construction has begun on Mischief Reef

Time: 2015-01-22 14:43 Source: Global Military Web Clicks: Loading ___ times

According to the latest news, a Ninghai Tuo Tugboat 4002 dragged the Tianbin 6 non-self-propelled cutter suction dredger with 3500 m^3/h production capacity into Subi Reef; a Ninghai Tuo Tugboat 5001 dragged a Tiankai non-self-propelled cutter suction dredger with 4000 m^3/h production capacity into Mischief Reef.

Recently, there has been more good news on the Chinese construction of artificial islands in the South China Sea. Since the "Tianbin 6" has joined, Chinese island construction in South China Sea has improved by leaps and bounds!

According to the latest news, a Ninghai Tuo Tugboat 4002 dragged the Tianbin 6 non-self-propelled cutter suction dredger with 3500 m^3/h production capacity into Subi Reef; a Ninghai Tuo Tugboat 5001 dragged a Tiankai non-self-propelled cutter suction dredger with 4000m^3/h production capacity into Mischief Reef.

This shows that construction will also begin at Mischief Reef. This is another encouraging piece of news for China! We are the movers of nature, and our goal is to move the roof of the world to the South China Sea.

Tianbin 6

Nature is showing us its wondrous works again. It seems that we can create more spots to first ensure long-term full coverage of the South China Sea by the China Coast Guard and the fishery administration, then continuously add military deployment, and ultimately develop key reefs and islands into military bases.

[…]

Mischief Reef in South China Sea

The island of utmost importance in the South China Sea is Fiery Cross Island. Next, I will show you the secret of military deployment at Woody Island and Fiery Cross Island!

Woody Island in Xisha Islands originally had a surface area of 2.13 square kilometers. After this expansion, it should be above 3 square kilometers. After Fiery Cross Reef of the Spratly Islands is expanded into Fiery Cross Island, it will also be around 3 square kilometers. What can we do with these brother islands of 3 square kilometers that are 800 kilometers apart?

From what I can imagination, each island can be equipped with eight J-10 aircrafts or Su-27 fighter aircrafts, more than four Y 8/9 special aircrafts, and several helicopters, with their daily tasks being air defense, anti-submarine, reconnaissance, patrolling, and transport. In emergency situations, the equipment can be augmented on a temporary basis.

[…]

中国南海填岛传大好消息：美济礁动工了

时间:2015-01-22 14:43来源:环球军事网 点击:加载中 次
据最新消息：宁海拖4002拖船拉着生产能力3500m3/h的天滨6号非自航绞吸式挖泥船进入渚碧礁;宁海拖5001拉着生产能力4000m3/h天凯号非自航绞吸式挖泥船进入美济礁。

近日，中国南海填岛又有好消息传来，自从“天滨6号”的加入，中国在南海的填岛造陆可谓是如虎添翼!

据最新消息：宁海拖4002拖船拉着生产能力3500m3/h的天滨6号非自航绞吸式挖泥船进入渚碧礁;宁海拖5001拉着生产能力4000m3/h天凯号非自航绞吸式挖泥船进入美济礁。

这就说明美济岛也要开始动工了，这对中国来说又是一个振奋人心的消息!我们是大自然的搬运工,我们的目标是把世界屋脊搬到南海。

天滨6号

大自然又要为我们展示它的鬼斧神工了。看来是先多点开花，先确保海警渔政南海海域全覆盖并长期存在，之后再不断增加军事部署，最终将重点岛礁发展成军事基地。

南海美济礁

而南海的重中之重就是永署岛，下面笔者就来为你揭秘永兴岛和永署岛军事部署!

西沙永兴岛原面积2.13平方公里，本次扩建后应该在3平方公里以上;南沙永署礁本次扩建成永署岛后，面积也在3平方公里左右;这两个相距约800公里的3平方公里的兄弟小岛，可以干什么呢?

按照笔者的想象，每个岛上可常驻8架歼10或苏27系列歼击机，4架以上的运8/9特种飞机，若干直升机，日常任务是执行防空、反潜、侦察巡逻、运输等，非常时期可视需要短期增加配备。

Annex 743

David S. Cloud, "China's man-made islands in disputed waters raise worries", *Los Angeles Times* (28 Jan. 2015)

World / Asia

China's man-made islands in disputed waters raise worries

By **David S. Cloud · Contact Reporter**

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Chinese dredging has created a new island nearly 2 miles long and several hundred yards wide

JANUARY 28, 2015, 4:00 AM | REPORTING FROM WASHINGTON

China is rapidly building five man-made islands from tiny reefs and shoals in the South China Sea, U.S. officials say, sparking concern that Beijing is growing more assertive in the disputed waters even as the United States boosts its own forces in the western Pacific.

Dredging around Fiery Cross Reef, a former outcropping in the Spratly Islands, over the last year has created a new island nearly 2 miles long and several hundred yards wide.

U.S. officials say it is large enough for China to build its first airstrip in the remote archipelago, one long enough for most of its combat and support aircraft. Satellite photos also reveal a small port under construction.

U.S. officials worry that the buildup indicates a Chinese push to establish de facto control over the resource-rich waters and islets also claimed by the Philippines, Malaysia, Taiwan, Brunei and Vietnam.

Article continues below ↓

Except for Brunei, those nations all maintain small airstrips or symbolic military outposts in the Spratlys, but the Chinese military dwarfs others in the region and could undermine the tense status quo. Confrontations have broken out over fishing, oil and gas drilling and military maneuvers in recent years.

Article continues below ↓

India is the latest country to express alarm about Beijing's growing military clout, partly because the Chinese navy has sent nuclear submarines into the Indian Ocean, rattling New

Delhi's defense community.

During a three-day visit to New Delhi that ended Tuesday, President Obama signed a joint statement with Indian Prime Minister Narendra Modi calling for "safeguarding maritime security and ensuring freedom of navigation and overflight throughout the region, especially in the South China Sea." They urged all parties "to avoid the threat or use of force."

White House aides portrayed Obama's trip as a way to emphasize his attempt to focus more military and other resources on Asia and the western Pacific, a pivot intended in part to offset China's influence. The Pentagon has sent more warships and troops to the region and has forged closer military ties with several of China's neighbors.

A military-grade airstrip and dredged harbor on Fiery Cross Reef, which lies on the western edge of the Spratly archipelago, clearly would expand China's ability to operate in an area considered a potential tinderbox. Land reclamation is also underway at Johnson South Reef, Johnson North Reef, Cuarteron Reef and Gaven Reef.

"China appears to be expanding and upgrading military and civilian infrastructure — including radars, satellite communication equipment, antiaircraft and naval guns, helipads and docks — on some of the man-made islands," according to a report last month by the U.S.-China Economic and Security Review Commission, which was set up by Congress.

Beijing insists the reclamation projects are an internal matter taking place on Chinese territory, and recently said it needs a base in the South China Sea to support radar and intelligence gathering. It has rebuffed regional demands to submit to international arbitration to resolve the maritime and territorial disputes.

The White House has refused to take sides in the territorial disputes, calling for a halt in all provocative activities. But the Obama administration faces growing pressure from allies to push back any Chinese effort to establish a permanent offshore military presence in the contested area.

Pentagon officials and the State Department repeated those demands in the last week, urging China to halt the island-building projects.

"We call on China to clarify their reclamation intentions" and "to cease these large-scale reclamation activities, recognize how they are increasing regional tensions, and pursue diplomatic alternatives," said Lt. Col. Jeffrey Pool, a Pentagon spokesman.

"They're reclaiming land in shoals and rocks in sensitive areas whose sovereignty is contested," Assistant Secretary of State Daniel R. Russel said at a Jan. 21 news conference in Manila. "We think there is a powerful case to be made for the maximum exercise of restraint."

Evan P. Garcia, a senior Philippine diplomat, told reporters the island-building "is not helpful in terms of finding a way forward.... It's so frustrating."

In late 2013, China's Defense Ministry sparked deep unease when it warned that it would take "defensive emergency measures" against foreign aircraft that did not give notification before entering an air-defense identification zone that Beijing had declared off its coast.

In response, the Pentagon sent a pair of unarmed B-52s over the East China Sea to challenge the Chinese claim. The crisis was defused when China backed down and signaled it would not endanger the lives of pilots and passengers.

Pentagon officials were furious in August when a Chinese fighter jet did a barrel roll over a U.S. Navy P-8 Poseidon surveillance aircraft over the South China Sea, and the White House called the incident a deliberate provocation. In 2001, a Chinese fighter jet collided with a Navy EP-3 surveillance plane, forcing it to make an emergency landing on nearby Hainan island.

At the same time, the Chinese military still faces severe limitations. Most of its fighter aircraft lack the range to patrol over the Spratly Islands, which lie more than 600 miles from China's nearest air base and more than 400 miles from a Chinese airstrip in the Paracel Islands at the northern end of the sea, according to the report by the congressional commission.

Its navy similarly has a limited ability to operate in open waters for long periods because it lacks offshore bases for refueling and resupply, according to U.S. officials who requested anonymity because of the sensitivity of discussing China's military. China launched its first aircraft carrier in 2012, but the ship is not expected to be capable of flight operations until 2016, at the earliest.

A senior Chinese military official said in November that Chinese leaders decided to expand a military presence in the South China Sea after participating in the multinational search for Malaysia Airlines Flight 370, which disappeared March 8 while flying from Kuala Lumpur to Beijing with 239 people aboard.

The pilots made their last voice contact over the South China Sea, although the search soon expanded to the vast reaches of the southern Indian Ocean. Debris from the missing jet still has not been found.

"There is a need for a base to support our radar system and intelligence-gathering activities," Jin Zhirui of the Chinese air force headquarters told reporters at the Xiangshan Forum, a Beijing national security conference, according to news reports.

The search "made us realize we lacked sufficient air force capabilities in the South China Sea," Jin said. "There is a need for a base of operations in the South China Sea for state security and to protect national interests."

China is unlikely to build a major military base in an area regularly hit by typhoons, said Jeffrey Engstrom, an Asia security expert at Rand Corp., a Santa Monica-based think tank. But, he said, the "man-made islands would be useful for establishing presence and limited power projection in the South China Sea."

Times staff writer Julie Makinen in Beijing contributed to this report.

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Annex 744

Manuel Mogato, "Manila says China starts dredging at another reef in disputed waters", *Reuters* (5 Feb. 2015)

REUTERS

World | Thu Feb 5, 2015 6:40am EST

Related: WORLD, CHINA

Manila says China starts dredging at another reef in disputed waters

MANILA | BY MANUEL MOGATO

China has started dredging around the disputed Mischief Reef in the South China Sea, a Philippine navy commander said on Thursday, signalling Beijing may be preparing to expand its facilities in the area.

Last year, Chinese President Xi Jinping tried to set Southeast Asian minds at ease over the country’s regional ambitions, but Beijing's reclamation work in the Spratlys underscores its drive to push claims in the South China Sea and reassert its rights.

China has already undertaken reclamation work on six other reefs it occupies in the Spratlys, expanding land mass five-fold, aerial surveillance photos show. Images seen by Reuters last year appeared to show an airstrip and sea ports.

China has claims on almost the entire South China Sea, which is believed to have rich deposits of oil and gas. Brunei, Malaysia, the Philippines, Vietnam and Taiwan also have claims on the sea where about $5 trillion of ship-borne trade pass every year.

Rear Admiral Alexander Lopez, commander of the Philippine military's western command, told reporters on Thursday a Chinese dredging ship was spotted at Mischief Reef, about 135 km southeast of the island of Palawan.

"We don't know what they plan to do in Mischief," he said. "They have long been doing that, only that it was Fiery Cross that got a lot of attention because that was on a bigger scale."

IHS Jane's said in November images it had obtained showed the Chinese-built island on the Fiery Cross Reef to be at least 3,000 metres (1.9 miles) long and 200-300 metres (660-980 ft) wide.

Lopez did not say when China started the dredging work or give any details on the extent of reclamation at Mischief Reef, saying only the work had been "substantial".

Surveillance photos that were taken of Mischief Reef last October showed no reclamation work in the area.

The photos, seen by Reuters, showed two structures, including a three-storey building sitting on an atoll, equipped with wind turbines and solar panels.

China occupied Mischief Reef in 1995, building makeshift huts, which Beijing claimed provided shelter for fishermen during the monsoon season. But, China later built a garrison in the area, deploying frigates and coast guard ships.

In 2002, Southeast Asian states agreed with China to sign an informal code of conduct in the South China Sea to stop claimant states from occupying and constructing garrisons in the disputed Spratlys.

Last year, the Philippines and Vietnam protested China's reclamation work as a violation of the informal code.

North of Mischief Reef, China on Thursday defended the actions of a coast guard vessel in the Scarborough Shoal after the Philippines accused it of ramming three fishing boats.

"China's coast guard sent a dinghy to drive them away and slightly bumped one of the fishing vessels," Chinese Foreign Ministry spokesman Hong Lei said at a daily news briefing in Beijing.

"We ask that the Philippines strengthen education and indoctrination of its fishermen to prevent such incidents from happening again."

A Philippine military spokesman, Colonel Restituto Padilla, described China's action as "alarming" saying the local fishermen were trying to seek shelter due to bad weather.

(Additional reporting by Aubrey Belford in Bangkok and Sui-Lee Wee in Beijing; Editing by Nick Macfie and Jeremy Laurence)

Annex 745

Manuel Mogato, "Manila urges Beijing to halt reclamation work on Mischief Reef", *Reuters* (6 Feb. 2015)

REUTERS

Industries | Fri Feb 6, 2015 7:31am EST

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Manila urges Beijing to halt reclamation work on Mischief Reef

MANILA

The Philippines strongly urged China to stop reclamation work on a disputed submerged reef within its exclusive economic zone in the South China Sea, the foreign ministry said on Friday.

A Philippine navy commander said on Thursday that China had started dredging around the disputed Mischief Reef, signalling Beijing may be preparing to expand its facilities in the area.

"We strongly urge China to desist from its reclamation activities at Panganiban Reef," the foreign ministry said in a statement, referring to Mischief reef by its Philippine name.

"Under the U.N. Convention on the Law of the Sea, the Philippines has exclusive right to authorise construction of artificial islands, installations or other structures in the vicinity of Panganiban Reef."

China claims the entire South China Sea, believed to be rich in oil and gas deposits. Brunei, Malaysia, the Philippines, Taiwan and Vietnam also have claims on the sea where about $5 trillion of ship-borne trade annually.

Beijing has already undertaken reclamation work on six other reefs it occupies in the Spratlys, expanding land mass five-fold, aerial surveillance photos show. Images seen by Reuters last year appeared to show an airstrip and sea ports.

"China's reclamation activities constitute a flagrant violation of these rights and increase tensions in the region," Charles Jose, a foreign ministry spokesman. He said the activities were a violation of an informal code between China and Southeast Asian states.

China occupied Mischief Reef in 1995, building makeshift huts, which Beijing claimed provided shelter for fishermen during the monsoon season. But, China later built a garrison in the area, deploying frigates and coast guard ships. (Reporting by Manuel Mogato; Editing by Jeremy Laurence)

Annex 746

Redempto D. Anda, "China's mischief: Expansion, reclamation", *Inquirer* (7 Feb. 2015)

China's mischief: Expansion, reclamation

Inquirer Southern Luzon

By: Redempto D. Anda, February 7th, 2015 03:25 AM

Map showing the disputed areas in the West Philippine Sea (south China Sea), including the Spratlys Islands and Scarborough Shoal. AFP

PUERTO PRINCESA CITY, Philippines—China has deployed a dredging ship at the disputed Panganiban Reef (Mischief Reef) and is doing "substantial" reclamation in the partially submerged area, signaling Beijing may be preparing to expand its facilities there, according to the military command that is directly in charge of securing the country's maritime interests in the West Philippine Sea.

China has been earnestly conducting dredging activities at Panganiban Reef —a Philippine-claimed area in the Spratly group of islands, which Beijing occupied in the mid-1990s —similar to earlier reported land reclamation work in other areas of the Spratlys, said Rear Admiral Alexander Lopez, chief of the Western Command (Wescom) of the Armed Forces of the Philippines.

"We don't know what they plan to do in Mischief. It is already a garrison to begin with and far from being just a fisherman's shelter, which was what (China) claimed when they first occupied it," Lopez said.

Aerial photos

Lopez did not say when China started the dredging work or give any details on the extent of reclamation at Panganiban Reef, saying only the work had been "substantial."

He said the Navy has taken aerial photographs of the reclamation activities at Panganiban Reef but that his command was not authorized to release those photos.

But Lopez said the physical change in Panganiban Reef since the dredging "has been substantial."

He said Panganiban Reef has been functioning as a base for Chinese frigates that have been patrolling the area.

Note verbale

Panganiban Reef, one of the rocky islets in the Spratlys archipelago that is being claimed by the Philippines as it lies just 135 kilometers southeast of Palawan and within the country's exclusive economic zone (EEZ) and its continental shelf, was taken over by the Chinese in 1995 over the protests of the Philippines even as Beijing claimed that they only intended to build shelters for Chinese fishermen that visit the area.

The Department of Foreign Affairs (DFA) on Friday said it has already lodged a protest with China concerning the land reclamation activities at Panganiban. It said the protest was included in the note verbale that it handed last Wednesday to Chinese Embassy representatives which also expressed the Philippines' strong objection to the stepped-up Chinese building activities at Kagitingan Reef (Fiery Cross Reef), also part of the Spratlys, accusing China of planning to build an airstrip on top of land dredged from around the area, in violation of previous international agreements.

“China’s reclamation activities constitute a flagrant violation of [the Philippines’ exclusive right to authorize construction of artificial islands, installations or other structures in the vicinity of Panganiban Reef under the United Nations Convention on the Law of the Sea] and increase tensions in the region,” the DFA said.

China has claims on almost the entire South China Sea, which is believed to have rich deposits of oil and gas. Brunei, Malaysia, the Philippines, Vietnam and Taiwan all have sovereignty claims on the sea and its mostly uninhabited islands that is a marginal part of the Pacific Ocean where about $5 trillion of ship-borne trade pass every year.

6 other reefs

Last year, Chinese President Xi Jinping tried to set Southeast Asian minds at ease over the country’s regional ambitions, but Beijing’s reclamation work in the Spratlys underscores its drive to push claims in the South China Sea and reassert its rights.

China has already undertaken reclamation work on six other reefs it occupies in the Spratlys, expanding land mass five-fold, aerial surveillance photos show. Images seen by Reuters last year appeared to show an airstrip and sea ports.

Surveillance

IHS Jane’s said in November images it had obtained showed the Chinese-built island on the Kagitingan Reef to be at least 3,000-meters long and 200- to 300-meters wide.

Surveillance photos that were taken of Panganiban Reef last October showed no reclamation work in the area.

The photos, seen by Reuters, showed two structures, including a three-story building sitting on an atoll, equipped with wind turbines and solar panels.

In 2002, Southeast Asian states agreed with China to sign an informal code of conduct in the South China Sea to stop claimant states from occupying and constructing garrisons in the disputed Spratlys.

Last year, the Philippines and Vietnam protested China’s reclamation work as a violation of the informal code.

PH fishing boats rammed

Just last Thursday, the Philippines accused China of ramming Filipino fishing boats off the disputed (Panatag Shoal) Scarborough Shoal, north of Panganiban Reef, and demanded that Beijing respect its sovereignty over the potential flash-point territory.

The DFA said it had sent two notes of protest over the Jan. 29 incident off Panatag Shoal, as well as the removal of critically endangered giant clams by Chinese fishermen in the area a week earlier.

China's foreign ministry immediately fired off a stern rebuke and defended the actions of its coast guard vessel, claiming that the Filipino fishing vessels were "illegally lingering" in the waters surrounding Panatag Shoal, prompting its coast guard to send a dinghy "to drive them away and slightly bumped one of the fishing vessels."

A Philippine military spokesperson, Col. Restituto Padilla, described China's action as "alarming" saying the local fishermen were trying to seek shelter due to bad weather.

Creeping invasion

China has controlled Panatag Shoal, a rich fishing ground in the South China Sea (referred to as the West Philippine Sea by the Philippines) 220 kilometers west of Luzon, since 2012 following a tense standoff between the Philippine Navy and Chinese maritime patrol vessels.

The Philippines has alleged that China's actions in the South China Sea were part of a creeping invasion and has asked a United Nations arbitration panel to rule on its maritime disputes with Beijing which has refused to participate in the proceedings.

China occupied Panganiban Reef in 1995, building makeshift huts, which Beijing claimed provided shelter for fishermen during the monsoon season. But it later built a garrison in the area, deploying frigates and coast guard ships.

"China intends to seize as much of the South China Sea as possible," said Michael Tkacik, a security specialist with the Texas-based Stephen F. Austin State University, in a security forum in Manila on Wednesday.

Sparring over islands, shoals and outcrops might drag China into conflict with another superpower, the United States, a longtime military ally of the Philippines, he warned. ***With reports from AFP and Christine Avendaño***

RELATED STORIES

DFA tells China: Stop harassing Filipino fishermen

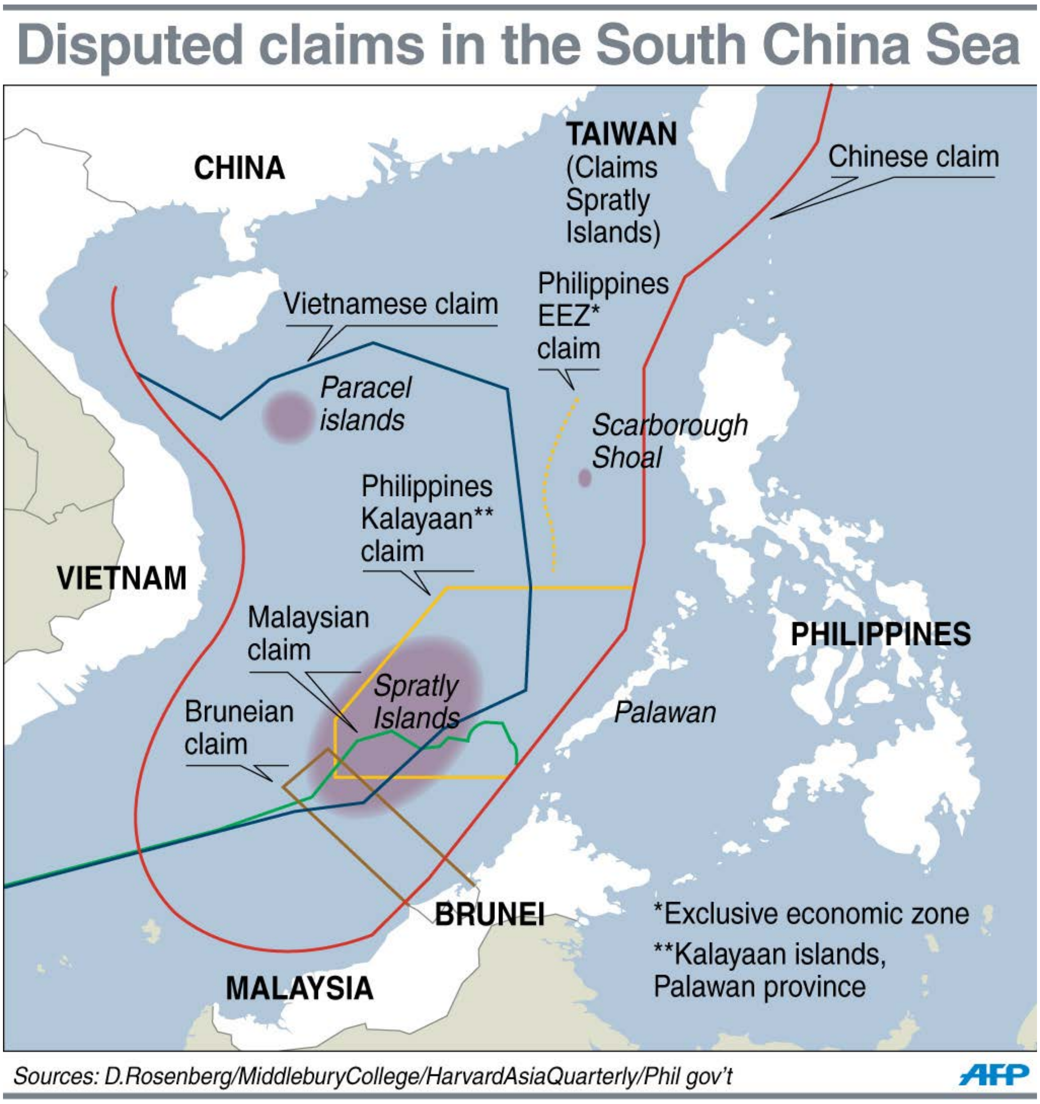
Annex 747

"Philippines Protests China Land Reclamation at Another Reef", *Inquirer* (10 Feb. 2015)

Philippines protests China land reclamation at another reef

Associated Press

February 10th, 2015 07:27 PM



Graphic on contested claims in the South China Sea.

MANILA, Philippines— The Philippines has protested Chinese land reclamation at a disputed reef in the South China Sea, saying it violates Manila's exclusive economic zone.

Foreign Affairs Department spokesman Charles Jose said Tuesday a diplomatic protest was handed to a Chinese Embassy representative on Feb. 4 urging Beijing to stop the land reclamation at Panganiban Reef, also called Mischief Reef.

China occupied the reef in 1995, and later expanded stilt structures into a concrete building several stories high. The Philippines protested both moves at the time.

Jose said it appears China is constructing an artificial island at the reef.

China claims virtually the entire South China Sea, resource-rich waters where the Philippines and other neighboring nations also have claims.

Vietnam, Malaysia and the Philippines have separately protested Chinese land reclamation at a number of reefs in the Spratly Islands, fearing they could be used for air, naval or logistic bases to bolster China's territorial claims far from its mainland.

Two other diplomatic protests made on Feb. 4 were earlier announced. They involved the alleged ramming of three Philippine fishing boats by a Chinese coast guard ship at Scarborough Shoal and the reported collection of endangered giant clams by Chinese fishermen which also destroyed coral outcrops at the shoal.

Annex 748

J. Page & J.E. Barnes, "China Expands Island Construction in Disputed South China Sea", *Wall Street Journal* (18 Feb. 2015)

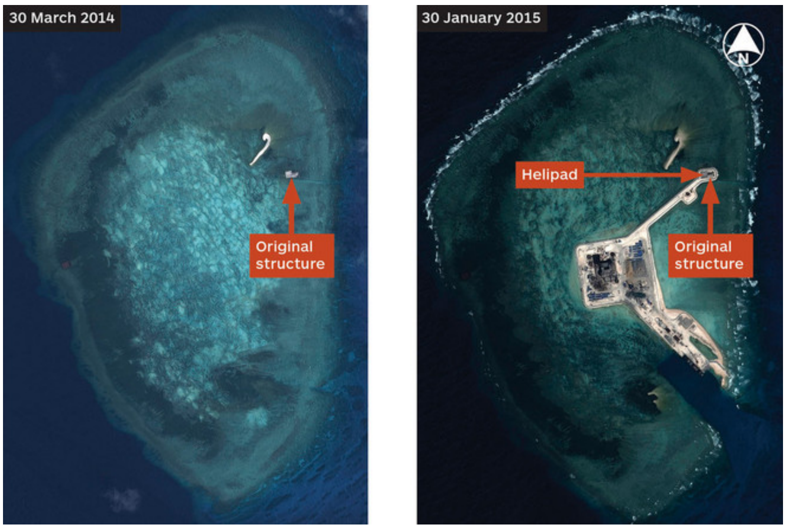
THE WALL STREET JOURNAL.

http://www.wsj.com/articles/china-expands-island-construction-in-disputed-south-china-sea-1424290852

WORLD

China Expands Island Construction in Disputed South China Sea

Construction of artificial islands shows Beijing isn't backing off its territorial ambitions



1 of 13

By **JEREMY PAGE** in Beijing and **JULIAN E. BARNES** in Washington
Updated Feb. 18, 2015 7:33 p.m. ET

BEIJING—Newly released satellite images show a dramatic expansion in China's construction of artificial islands on disputed South China Sea reefs, intensifying concerns about Beijing's territorial ambitions.

The images provide the first visual evidence that China has built an artificial island covering 75,000 square yards—about 14 football fields—and including two piers, a cement plant and a helipad, at a land formation called Hughes Reef, according to experts who have studied the pictures. The reef, which is above water only at low tide, lies about 210 miles from the Philippines and 660 miles from China.

The pictures, taken by a commercial satellite division of Airbus Group and released by IHS Jane's, a defense intelligence provider, also show that China has made significant progress in building similar infrastructure in two other places, Johnson South Reef and Gaven Reefs, where Beijing's territorial claims overlap with those of its neighbors.

'We can see that this is a methodical, well-planned campaign to create a chain of air- and sea-capable fortresses across the center of the Spratly Islands chain.'

—James Hardy, Asia Pacific Editor of IHS Jane's Defence Weekly

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China appears to be building a network of island fortresses to help enforce control of most of the South China Sea—one of the world's busiest shipping routes—and potentially of the airspace above, according to experts who have studied the images.

The pace and scale of its South China Sea buildup shows that Beijing, despite having recently reined in its rhetoric and avoided confrontations at sea and in the air, hasn't tempered its ambitions to project power in the region.

"The Chinese have built up a head of steam on the land reclamation in the South China Sea over the course of 2014; if anything, it looks to be accelerating," said a senior U.S. official, who described the extent of China's reclamation work as "unprecedented."

Historical images from Google Earth and others reveal that work at all four reefs began after President Xi Jinping took power in 2012. Construction at two of the sites began in the past year, despite protests from neighboring countries, warming military ties with Washington, and a new Chinese drive to improve relations in its periphery.

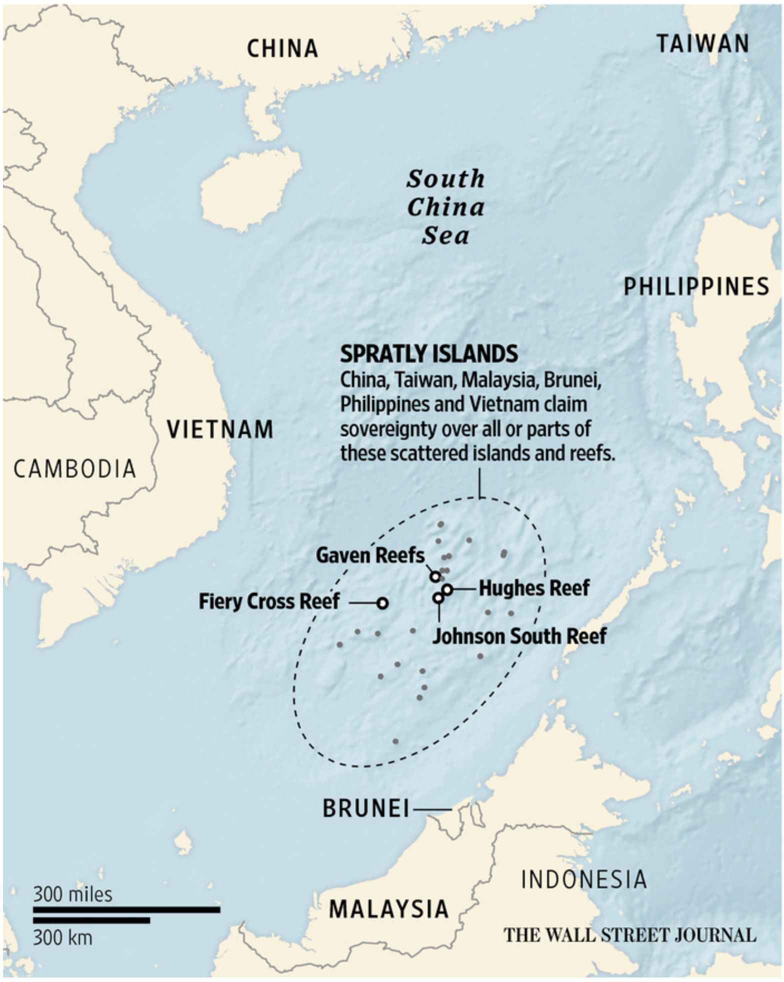
U.S. officials say they have repeatedly asked China to stop the work, to no avail. Daniel Russel, Assistant Secretary of State for East Asian and Pacific Affairs, conveyed U.S. concerns about the issue on a visit to Beijing this month, according to people familiar with the matter.

In an interview, Mr. Russel declined to discuss the specifics of his talks in Beijing, but said that the U.S. hoped China would stop the reclamation work.

"It is destabilizing and is at odds with the commitments the Chinese made" to members of the Association of Southeast Asian Nations, or Asean, he said.

'The sheer acreage of China's reclamation work over the past two to three years dwarfs anything and everything other claimants have done by many times over.'

—Daniel Russel, Assistant Secretary of State for East Asian and Pacific Affairs



China signed a nonbinding agreement with Asean committing to avoid provocative activities in the South China Sea, such as inhabiting previously deserted islands and reefs.

"The sheer acreage of China's reclamation work over the past two to three years dwarfs anything and everything other claimants have done by many times over," Mr. Russel said.

China's foreign ministry declined to comment on the satellite images, but referred to earlier statements that Beijing has sovereignty in the areas where the construction is taking place and that the work is designed to improve the lives of personnel working there.

The reefs in the latest images are part of the Spratly Islands, a cluster of islets, rocks and reefs lying within the so-called nine-dash line by which Beijing delineates its claim to almost all of the South China Sea.

China's claims overlap with those of Malaysia, Vietnam, Brunei, Taiwan and the Philippines—a U.S. treaty ally—and many of them have been bolstering defense ties with the U.S. in recent years in response to what they see as Beijing's enhanced efforts to assert its claims.

Other claimants, notably Vietnam, have built infrastructure on islands and reefs they control, but on a much smaller scale, according to U.S. officials and regional experts.

The Philippine government has been especially vocal in protesting Chinese construction in contested areas, most recently lodging a formal complaint this month over reclamation it says China is conducting at another site in the Spratlys called Mischief Reef. Philippine officials declined to comment on the new images, and Vietnamese authorities weren't immediately available to comment.

Many experts and U.S. officials say the Chinese infrastructure is explicitly military in nature, whereas some of its other recent efforts to assert territorial claims have been carried out by its coast guard and fisheries administration.

"Where it used to have a few small concrete platforms, it now has full islands with helipads, airstrips, harbors and facilities to support large numbers of troops," said James Hardy, Asia Pacific Editor of IHS Jane's Defence Weekly, a publication specializing in military affairs.

Such infrastructure, he said, allows China to enforce the nine-dash line more forcefully. He said China was reclaiming land in at least one other reef in the area, but satellite imagery wasn't publicly available.

"We can see that this is a methodical, well-planned campaign to create a chain of air and sea capable fortresses across the center of the Spratly Islands chain," he said.

Some U.S. and regional officials have suggested that China could use the new infrastructure to help enforce an Air Defense Identification Zone similar to the one it established in late 2013 over much of the East China Sea, where its territorial claims overlap with Japan's. China has said it would establish more air-defense zones but doesn't have imminent plans to establish one over the South China Sea.

Images published by Jane's in November show Chinese work in a fourth disputed area, Fiery Cross Reef, which experts including military analysts and academics say is extensive enough to eventually include an airstrip.

Chinese aircraft can patrol the East China Sea with relative ease from bases in eastern China, but can't operate effectively over the Spratlys and other far-flung parts of the South China Sea without refueling and ground support.

The facilities at Fiery Cross Reef could be suitable for that eventually, according to some experts. One possibility is that China would use an airstrip there as a backup for future operations by its first aircraft carrier, which it launched in 2011 and has sent on training operations in the South China Sea.

In the near term, the infrastructure will likely be used more to enhance radar coverage of the area, support a small presence of military personnel, and provide logistics support for ships patrolling the farther reaches of the South China Sea, according to several experts.

The facilities will likely be used to “enforce China’s territorial and jurisdictional claims, and bring pressure to bear on warships and coast guard vessels from the other claimants,” said Ian Storey, an expert on the South China Sea at the Institute of Southeast Asian Studies in Singapore.

“It shows that despite recent accommodating rhetoric from Beijing that it seeks to cool tensions in the South China Sea, its policy to assert dominance within the so-called nine-dash line remains fundamentally unchanged.”

He and other experts, as well as U.S. officials, said that China’s activities wouldn’t bolster its legal claims in the South China Sea under the U.N. Convention on the Law of the Sea, as only naturally-formed land features allow a country to claim maritime rights in surrounding waters.

A U.N. tribunal is currently hearing a case brought by the Philippines against China over its claims in the South China Sea. However, China is widely expected to ignore the tribunal’s verdict and the U.S. and its allies and partners have few options to prevent Beijing from continuing with its reclamation and construction work.

“The U.S. and its allies and partners can only make declaratory protests that China should halt its activities and exercise self-restraint. China will ignore these protests,” said Carlyle Thayer, an expert on the South China Sea at the Australian Defence Force Academy. “The use of U.S. naval warships would be an escalation and carry risks.”

Write to Jeremy Page at jeremy.page@wsj.com and Julian E. Barnes at julian.barnes@wsj.com

Annex 749

"China 'aggressively' expanding into South China Sea says US", *The Guardian* (26 Feb. 2015)

theguardian

China 'aggressively' expanding into South China Sea says US

Director of National Intelligence James Clapper tells US senators there is a worrying trend of conflict between China's neighbours over expansion

Associated Press

Thursday 26 February 2015 21.37 EST

China is expanding its outposts in the South China Sea to include stationing for ships and potential airfields as part of its "aggressive" effort to exert sovereignty, the US intelligence chief said Thursday.

Director of National Intelligence James Clapper was speaking at a Senate Armed Services Committee hearing on worldwide threats. His comments underscore US concern over land reclamation activities that could fuel tensions between China and its neighbours over disputed islands and reefs.

"Although China is looking for stable ties with the United States it's more willing to accept bilateral and regional tensions in pursuit of its interests, particularly on maritime sovereignty issues," Clapper said.

He described China's claims traced by a so-called nine-dash line a rough boundary covering more than 80 percent of the South China Sea as "exorbitant."

The US is not a claimant of territory in the South China Sea but does claim a national interest in the peaceful resolution of the disputes in a region crucial for world trade.

China says its territorial claims have a historical basis and objects to what it consider US meddling.

Sen John McCain, the committee's Republican chairman, displayed commercial satellite imagery showing expansion of the Chinese-occupied Gaven Reef in the Spratly Islands in the past year.

He said China's expansion could allow it to employ weaponry, including anti-air and other capabilities.

Clapper said China was still in a construction phase so it was unclear what weaponry or forces it might deploy there.

He said such Chinese activities in the past year-and-a-half, combined with oil drilling near disputed islands that caused conflict with Vietnam, was a "worrying trend."

The Centre for Strategic and International Studies last week said Vietnam, Malaysia and

Taiwan have over the years modified existing land masses in the South China Sea, and the Philippines is planning to upgrade an airport and pier on an island it occupies.

But among the claimants, China is unusual in how it has been “dramatically changing the size and structure of physical land features,” the think tank said.

China has had a troop and supply garrison at Gaven Reef since 2003, but it began significant construction there last year, building a new artificial island, more than 18 acres in size. The main building on the new island appears to have an anti-aircraft tower, the center said.

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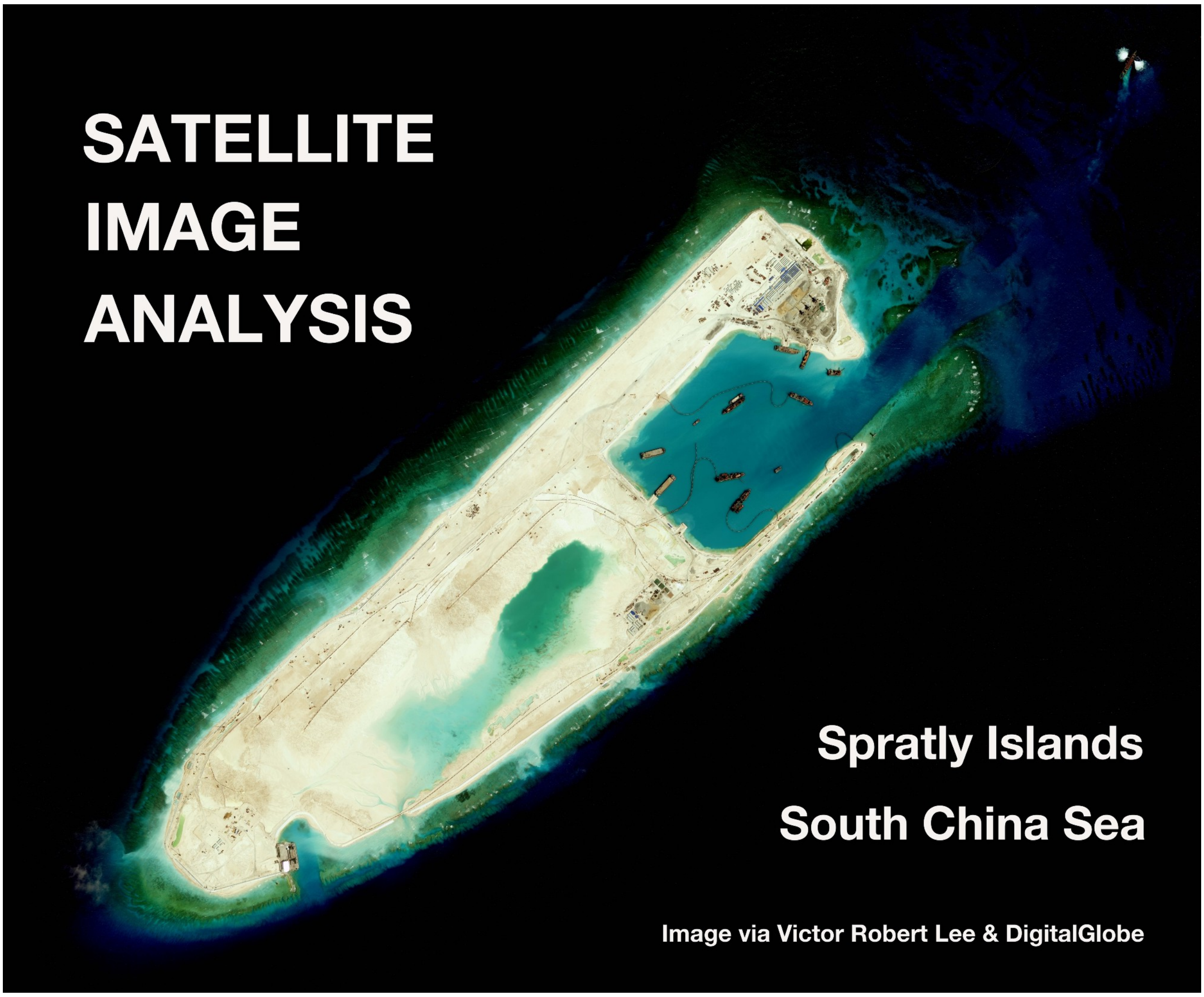
Annex 750

Victor R. Lee, "China's New Military Installations in the Disputed Spratly Islands: Satellite Image Update", *Medium* (16 Mar. 2015)



Fiery Cross Reef, Spratly Islands, 14 February 2015.

China's New Military Installations in the Disputed Spratly Islands: Satellite Image Update

Recent high-resolution images show new areas of reclamation on Mischief and Subi Reefs, and intensive construction on Fiery Cross as well as several other reefs.

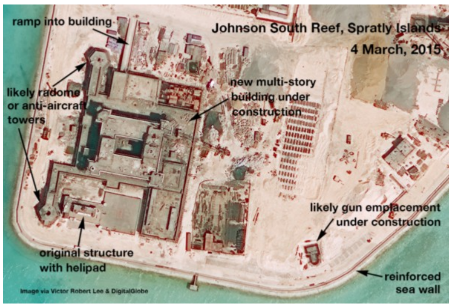
By Victor Robert Lee

16 March 2015

China is rapidly transforming numerous reefs of the Spratly island group into military installations, part of a strategy to solidify its hold on the South China Sea despite competing territorial claims by Vietnam, the Philippines, Malaysia, Taiwan and Brunei. The bases will likely serve to constrain the activities of competing militaries in the region, and appear more than adequate to support air traffic monitoring and enforcement in the event China were to declare an Air Defense Identification Zone over the South China Sea.

U.S. Library of Congress.

— **Fiery Cross Reef**, more than 1,000 kilometers from China's coastline, is close to becoming a combined naval/air base far larger than any other in the Spratly Islands, with a harbor that can accommodate China's largest naval vessels and an airstrip long enough (~3,300 meters) for most combat and support aircraft in the People's Liberation Army, Navy and Air Force. In addition to enabling force projection within the nearby seas, Fiery Cross will significantly reduce the time required for PLA/N aircraft and ships to reach the Malacca Straits in the event of a blockade of this major trade artery.



Larger image below.

— New structures being built at **Johnson South Reef** include likely radar towers, gun emplacements and a large multi-story building with a footprint larger than 530 square meters (Vietnamese press photos from December 2014 show it to be more than ten stories high). There is no sign of airstrip construction, contrary to other recent reports.

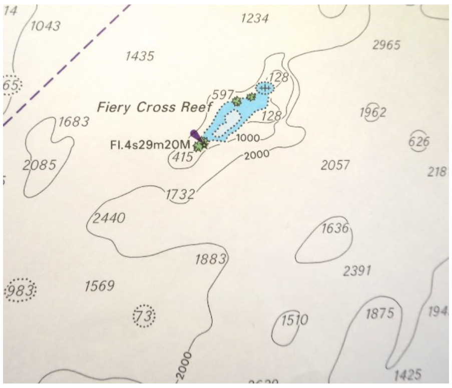
— A cutter suction dredger is creating new landfill on the southern rim of **Mischief Reef**, and another landfill, heretofore unreported, is underway on the western rim of Mischief Reef.

— Ongoing construction at **Hughes**, **Gaven** and **Cuarteron Reefs** includes large, multi-story buildings, radar towers, and likely gun emplacements; reinforced sea walls and ship docks are complete or nearly complete. The buildings under construction at Hughes and Gaven Reefs are nearly identical, and are similar to that on Johnson South Reef.

— New landfill is underway at two locations on southwest **Subi Reef**, with four cutter suction dredgers in operation and more than a dozen additional construction-related vessels nearby.

— The northern tip of **Eldad Reef** shows probable nascent landfill and likely suction dredger tracks on the nearby seabed, but no vessels are seen in the current image.

Additional observations:

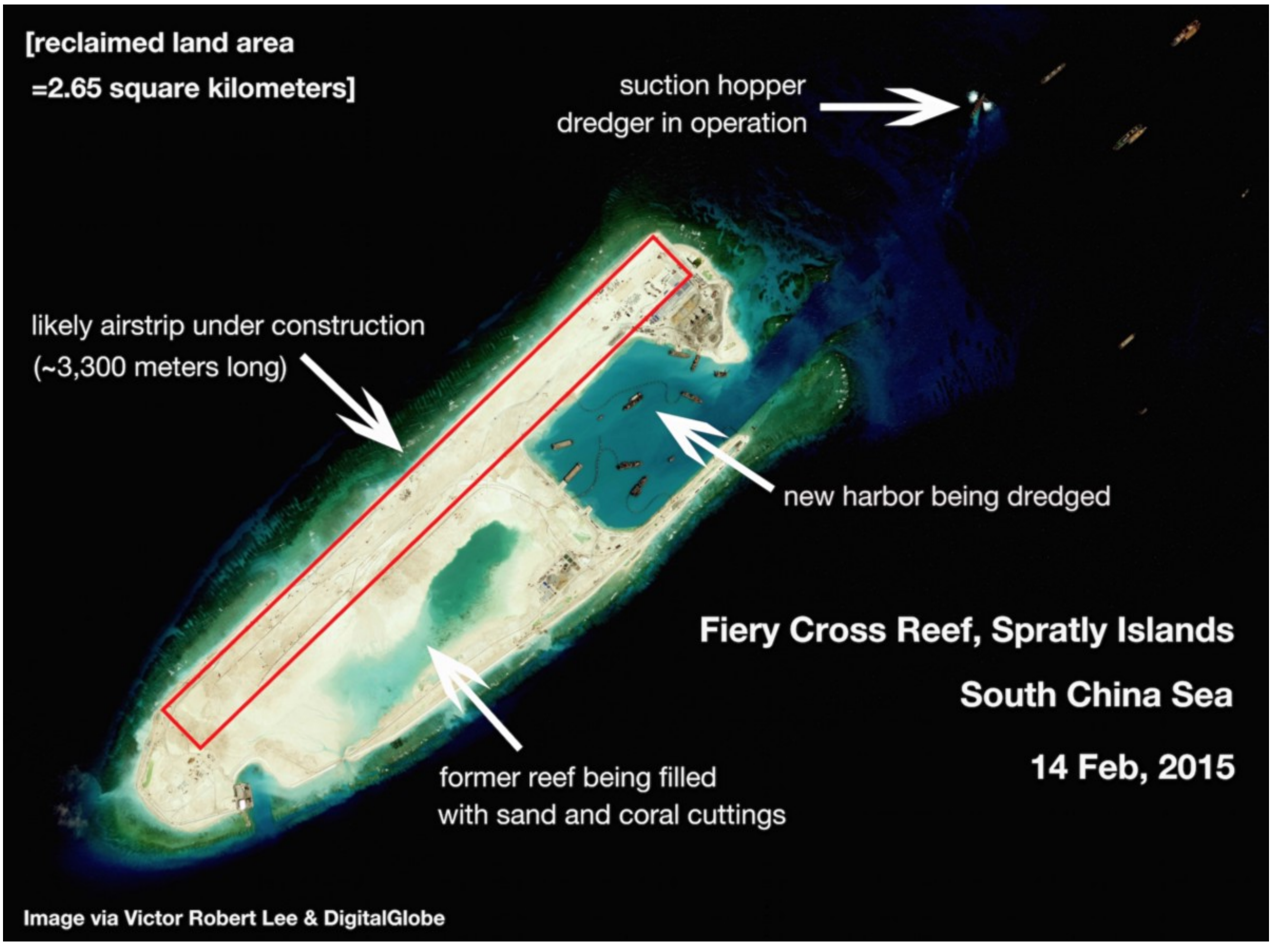


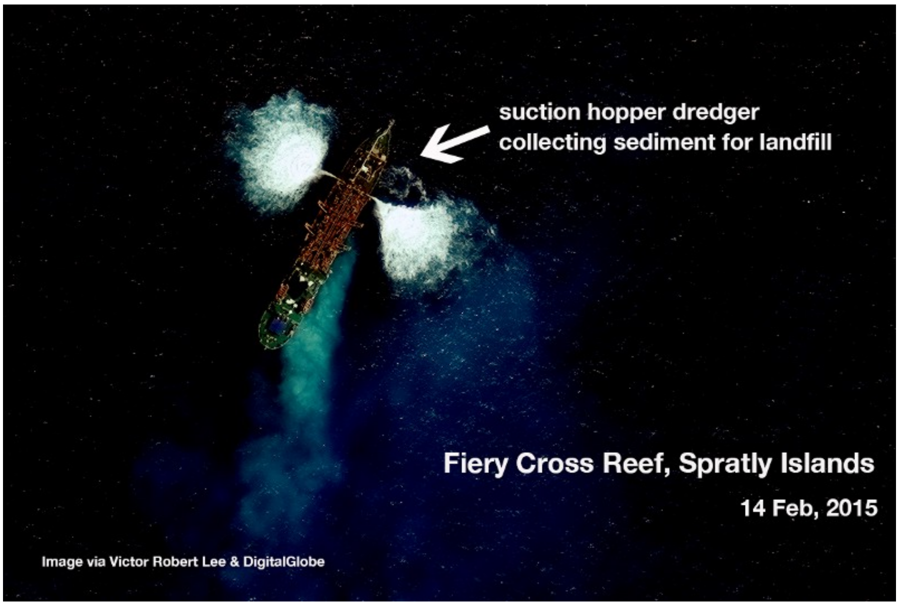
Depths shown in meters. U.K. Hydrographic Office.

— The newly built harbor at Fiery Cross Reef (now an island) affords quick access to deep waters (2,000 meters depth within a few kilometers from shore), better suited to submarine basing than the shallow waters surrounding the PLAN south fleet's harbor at Hainan Island.

— The deep waters near all of the eight reefs analyzed here are also viable channels for the submarines of other navies (U.S., Vietnamese, Singaporean, Japanese, for example); the PLAN can be expected to use its newly built-out bases to deploy fixed ocean-floor acoustic arrays as well as to support other forms of air, maritime and anti-submarine surveillance.

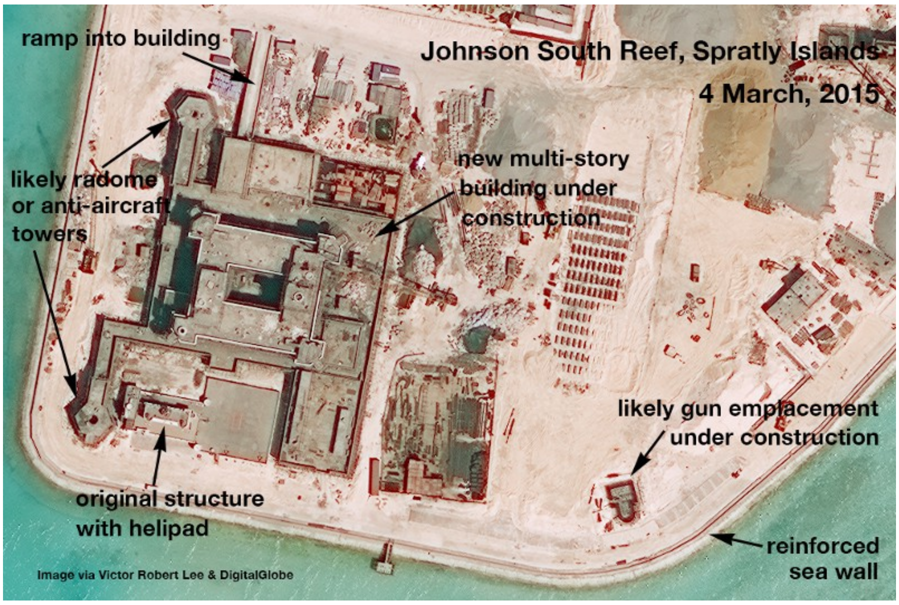
Fiery Cross Reef

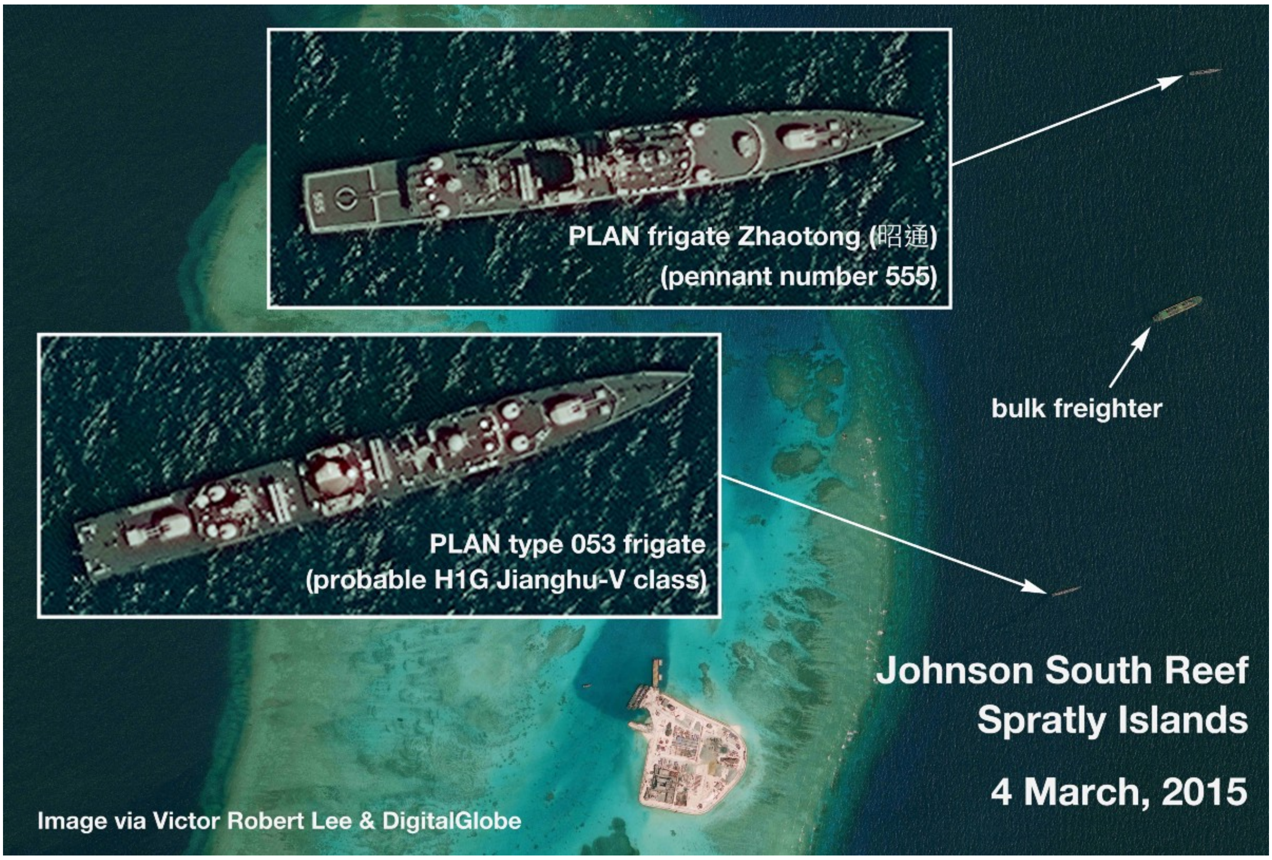

[reclaimed land area
=2.65 square kilometers]
suction hopper
dredger in operation
likely airstrip under construction
(~3,300 meters long)
new harbor being dredged
Fiery Cross Reef, Spratly Islands
South China Sea
14 Feb, 2015
former reef being filled
with sand and coral cuttings
Image via Victor Robert Lee & DigitalGlobe



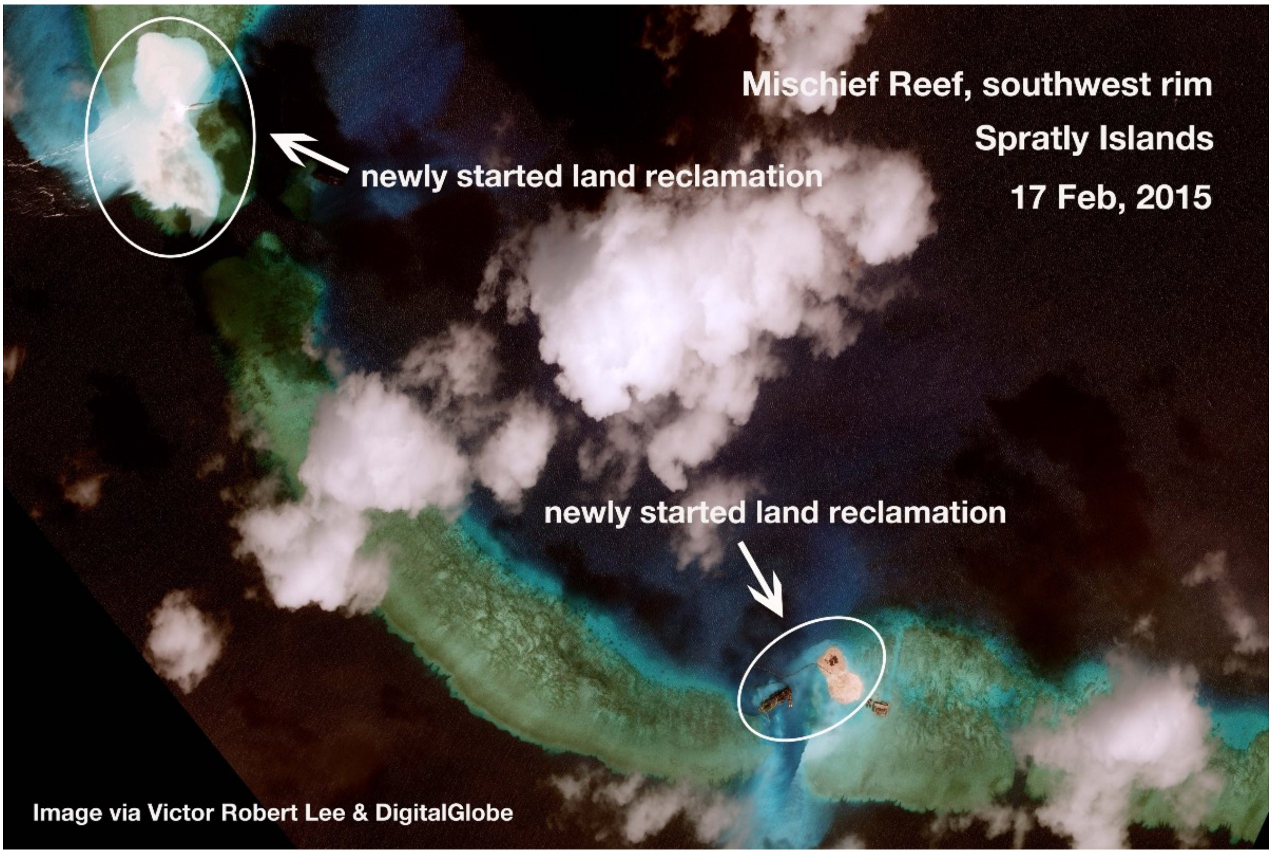
Johnson South Reef


Johnson South Reef, Spratly Islands
4 March, 2015
Image via Victor Robert Lee & DigitalGlobe

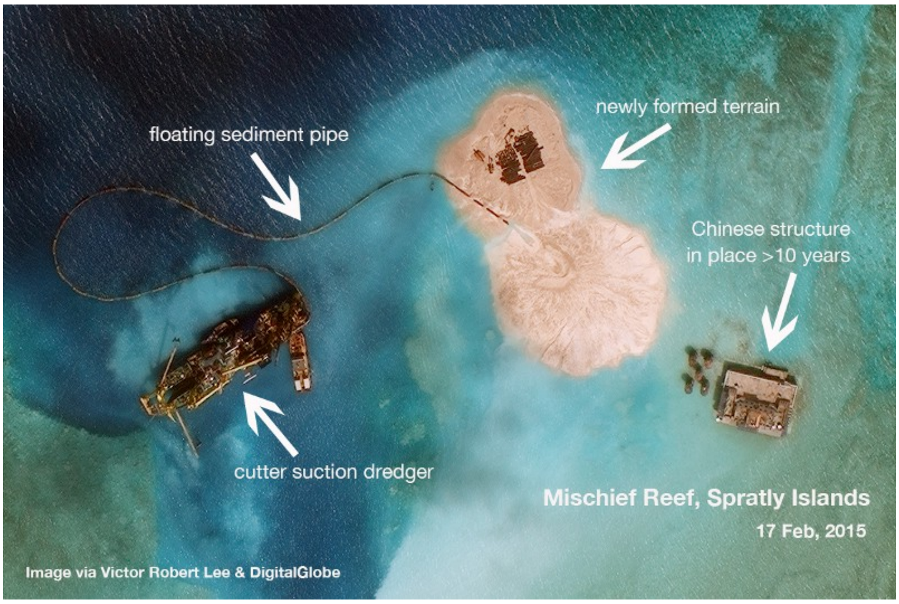

ramp into building
Johnson South Reef, Spratly Islands
4 March, 2015
likely radome
or anti-aircraft
towers
new multi-story
building under
construction
likely gun emplacement
under construction
original structure
with helipad
reinforced
sea wall
Image via Victor Robert Lee & DigitalGlobe

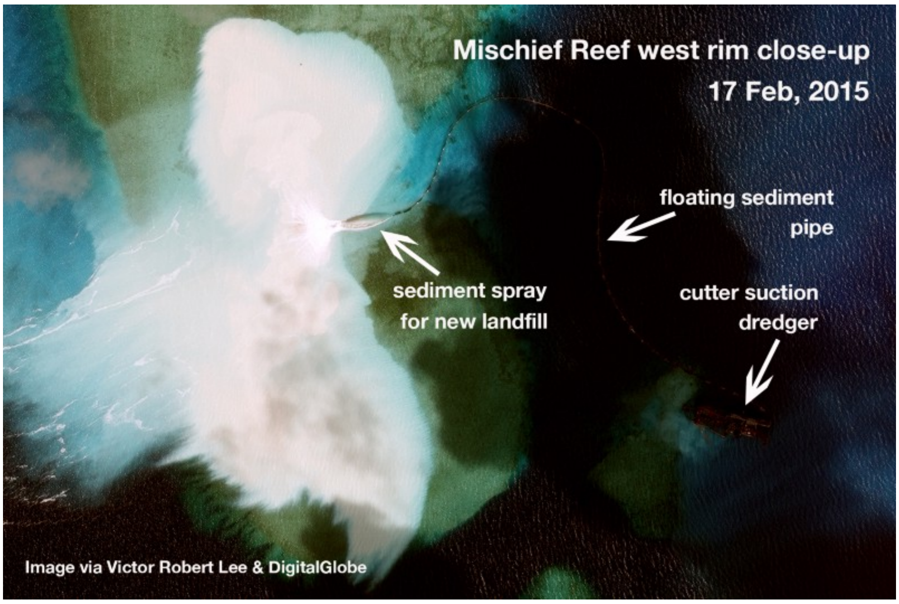


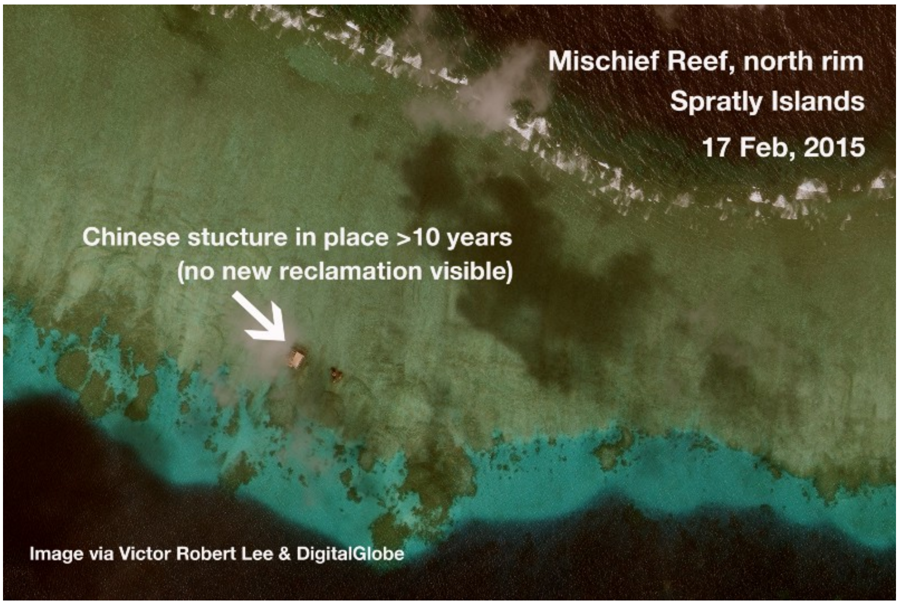
Mischief Reef


Mischief Reef, southwest rim
Spratly Islands
17 Feb, 2015
newly started land reclamation
newly started land reclamation
Image via Victor Robert Lee & DigitalGlobe


Southern Rim, Mischief Reef, Spratly Islands
17 Feb, 2015


newly formed terrain
floating sediment pipe
Chinese structure in place >10 years
cutter suction dredger
Mischief Reef, Spratly Islands
17 Feb, 2015
Image via Victor Robert Lee & DigitalGlobe


Mischief Reef west rim close-up
17 Feb, 2015
floating sediment pipe
sediment spray for new landfill
cutter suction dredger
Image via Victor Robert Lee & DigitalGlobe

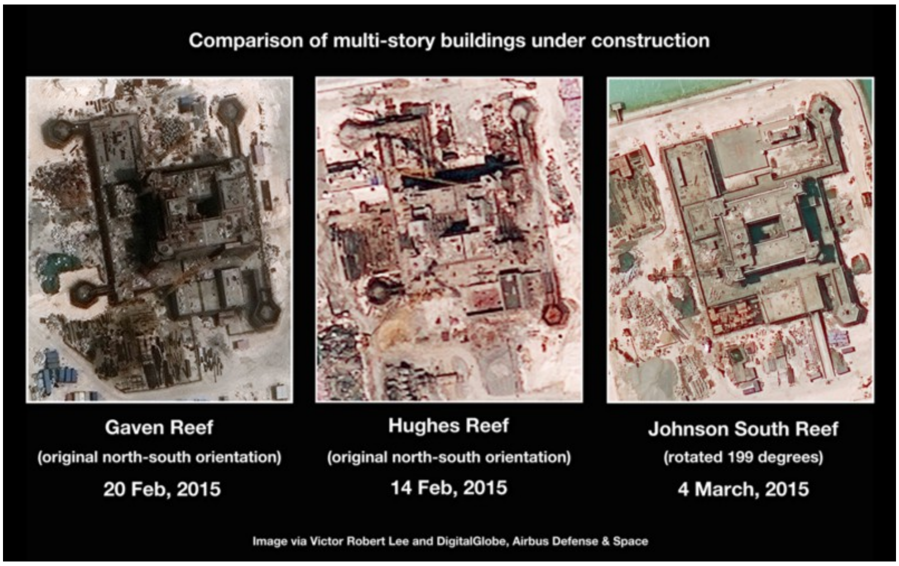

Mischief Reef, north rim
Spratly Islands
17 Feb, 2015
Chinese stucture in place >10 years
(no new reclamation visible)
Image via Victor Robert Lee & DigitalGlobe

Hughes Reef


Hughes Reef, Spratly islands
14 Feb, 2015
Image via Victor Robert Lee and Airbus Defense & Space

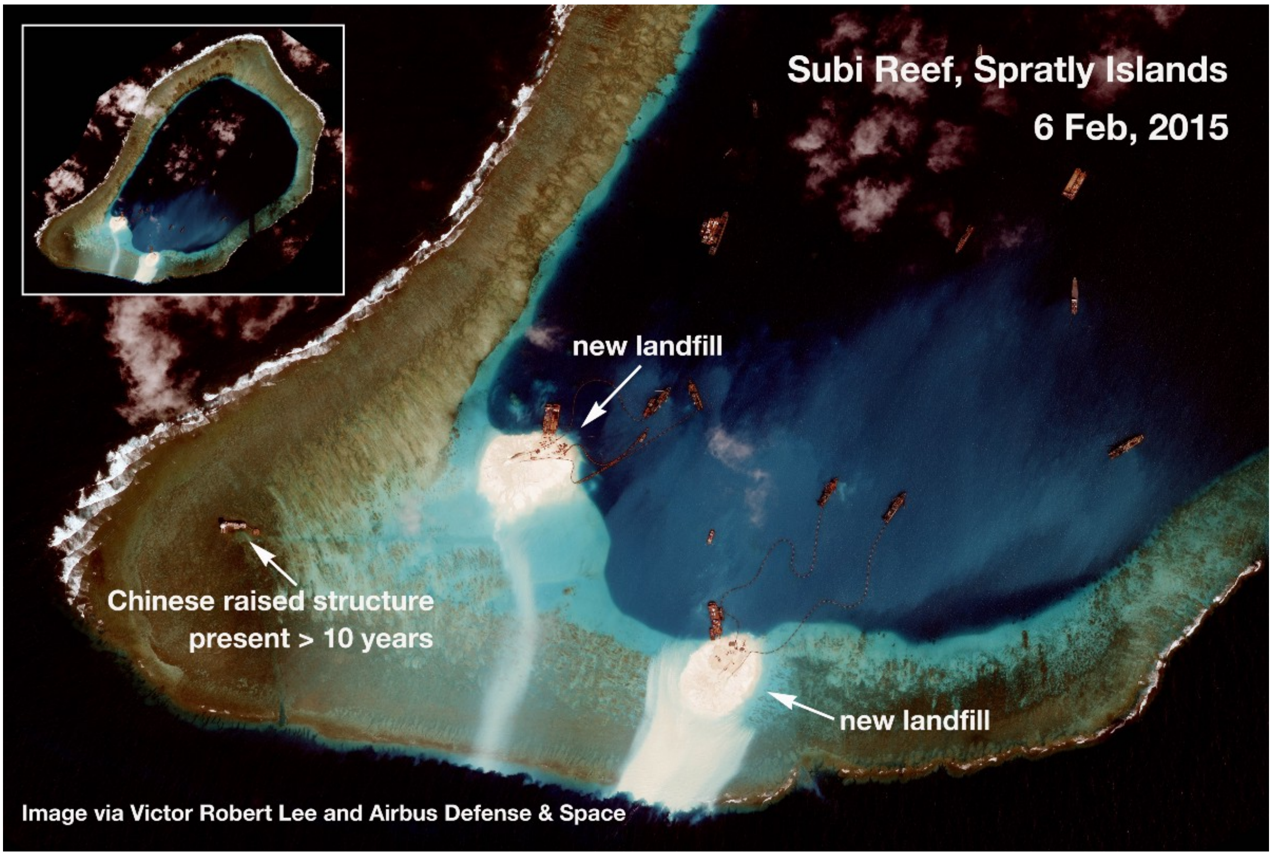
Gaven Reef

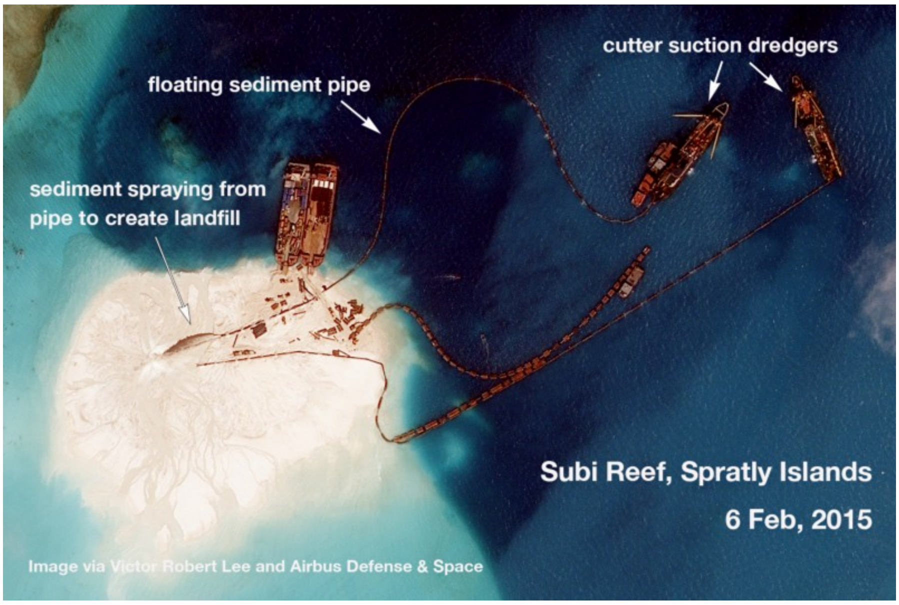
Gaven, Hughes, Johnson South Reefs: Similar Large, Multi-story Buildings

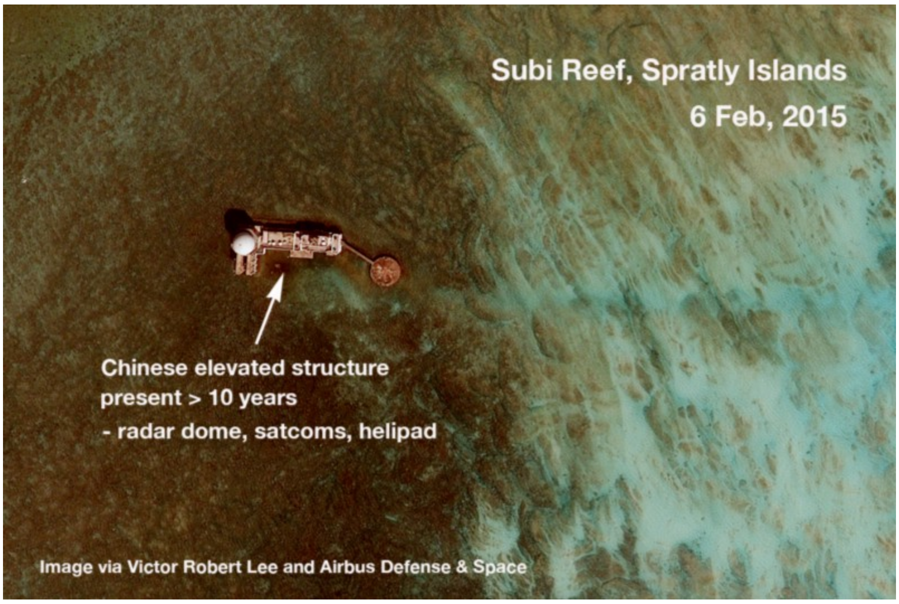


Cuarteron Reef

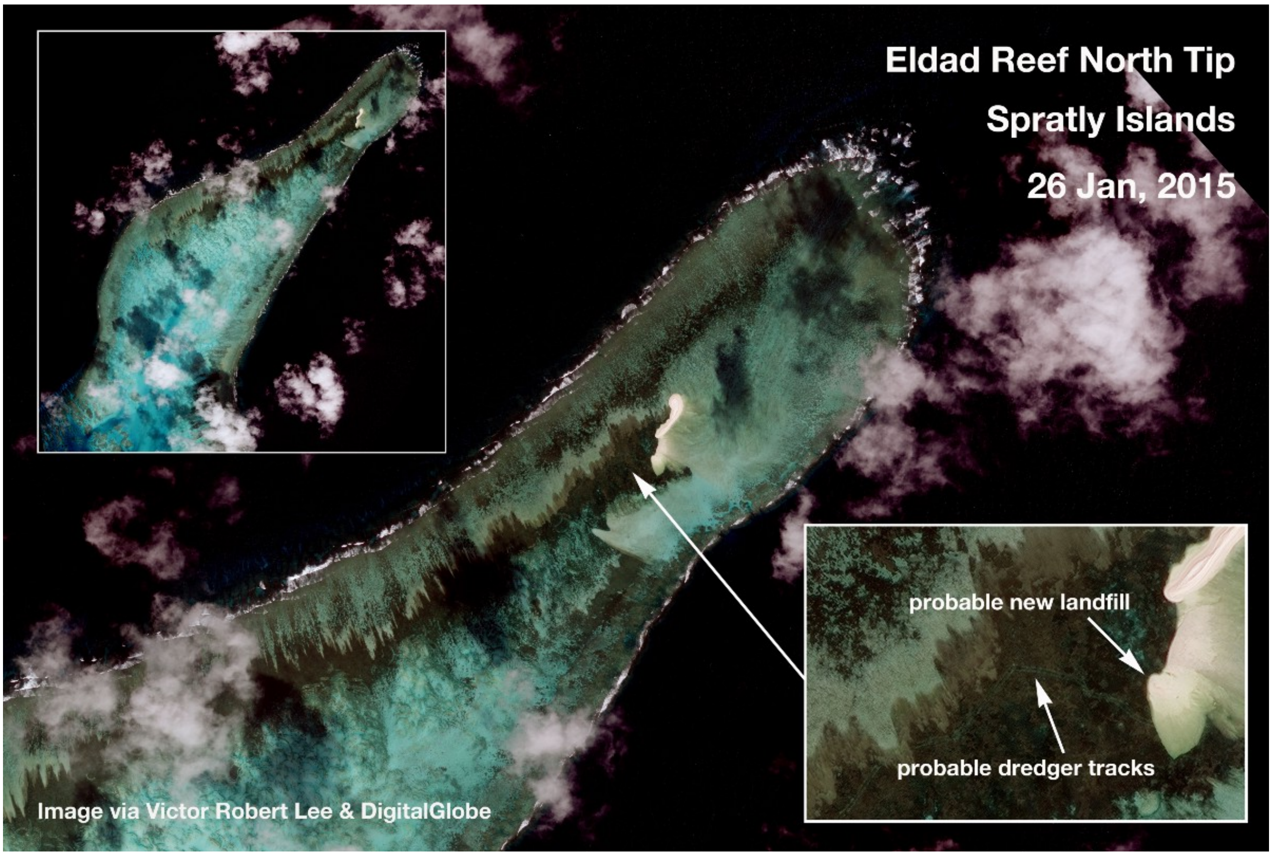
Subi Reef


Subi Reef, Spratly Islands
6 Feb, 2015
new landfill
Chinese raised structure
present > 10 years
new landfill
Image via Victor Robert Lee and Airbus Defense & Space


cutter suction dredgers
floating sediment pipe
sediment spraying from
pipe to create landfill
Subi Reef, Spratly Islands
6 Feb, 2015
Image via Victor Robert Lee and Airbus Defense & Space


Subi Reef, Spratly Islands
6 Feb, 2015
Chinese elevated structure
present > 10 years
- radar dome, satcoms, helipad
Image via Victor Robert Lee and Airbus Defense & Space

Eldad Reef



. . .

China is not alone in beefing up military facilities in the Spratly Islands; Vietnam has recently reclaimed land at Sin Cowe Island, and Taiwan is carrying out a US$110 million port expansion and airstrip reinforcement at its Itu Aba (Taiping) Island, a mere 22 kilometers from the new Chinese base at Gaven Reef. However, these measures by Vietnam and Taiwan are dwarfed by the scale, quantity, and capabilities present in China's militarization of the Spratlys.

The strategic importance of China's Spratly Islands expansion was made evident in September of 2014, when Wu Shengli, commander of the PLA Navy, personally made an inspection of each of the newly filled-in reefs, according to Lee Hsiang-Chou, the head of Taiwan's National Security Bureau. In a presentation to Taiwanese legislators, Lee also stated that China's President Xi Jinping had personally authorized five of Beijing's new military sites in the Spratlys.

. . .

Victor Robert Lee reports from the Asia-Pacific region and is the author of the espionage novel *Performance Anomalies*. His non-fiction articles on the South China Sea, the East China Sea, China, Indonesia, and other Asian territories can be found in *The Diplomat* and elsewhere.

Annex 751

Simon Denyer, "U.S. Navy alarmed at Beijing's 'Great Wall of Sand' in South China Sea", *Washington Post* (1 Apr. 2015)

The Washington Post

World

U.S. Navy alarmed at Beijing's 'Great Wall of sand' in South China Sea

By Simon Denyer April 1

BEIJING — China is building a "Great Wall of sand" through an unparalleled program of land reclamation in the South China Sea, raising concerns about the possibility of military confrontation in the disputed waters, according to the commander of the U.S. Pacific Fleet.

In one of the strongest and highest-level criticisms of the reclamation project to date, Adm. Harry B. Harris Jr. told a naval conference in Australia late Tuesday that competing territorial claims by several nations in the South China Sea continue to stoke "regional tensions and the potential for miscalculation."

"But what's really drawing a lot of concern in the here and now is the unprecedented land reclamation currently being conducted by China," he added.

Satellite images show rapid construction on various coral reefs and rocks controlled by China within the disputed Spratly Islands, including harbors, piers, helipads, buildings and potentially at least one airstrip, experts say. Last month, State Department spokeswoman Jen Psaki expressed concerns that the program was an attempt to "militarize outposts on disputed land features."

Harris said that China has created 1.5 square miles of artificial landmass in recent months.

"China is building artificial land by pumping sand onto live coral reefs — some of them submerged — and paving them over with concrete," he said. In a region known for its beautiful natural islands, he said, "China is creating a Great Wall of sand with dredges and bulldozers over the course of months."

China claims almost all of the South China Sea as its territorial waters, but its claims overlap with those of Vietnam, the Philippines, Taiwan, Malaysia and Brunei.

Last month, Chinese Foreign Minister Wang Yi said that the country was merely carrying out "necessary construction on its own islands and reefs" and that it would continue to uphold freedom of navigation in the busy shipping waters of the South China Sea, as well as resolve disputes through "direct dialogue" and consultation.

"The construction does not target or affect anyone," he said at a news conference. "We do not accept criticism from others when we are merely building facilities in our own yard. We have every right to do things that are lawful and justified."

State news agency Xinhua was more forthright in rejecting U.S. criticisms last month, accusing Washington of displaying a "perverted sense of insecurity" and a "pirate-style mindset."

While China's attention was focused elsewhere in previous decades, the other major claimants to the Spratly Islands occupied various islands and rocks throughout the archipelago, building ports, piers, bases and airstrips there. China now appears to be rushing to underline its own claims.

"This history matters a great deal, because what Washington and its friends and allies may see as punctuated, lightning-speed construction is likely viewed in China as a perfectly legitimate game of catch-up," Mira Rapp-Hooper, director of the Asia Maritime Transparency Initiative and a fellow at the Center for Strategic and International Studies (CSIS), wrote in a recent report.

"What sets China's activities apart, however, is that Beijing has been dramatically changing the size and structure of existing physical land features, while other claimants have built upon or modified existing land masses," she wrote in a related report.

The only major claimant without an airstrip in the archipelago, China appears to be turning the hitherto largely submerged Fiery Cross Reef into the largest island in the Spratly Islands, experts said.

Yanmei Xie, senior China analyst with the International Crisis Group in Beijing, said the island reclamation project was a deliberate strategic decision.

"Although China's exact intention is unclear so far, they are likely mainly designed to extend China's power projection, by expanding, for example, its surveillance, early warning and air interception capabilities further out into the sea," she said. "With these added capabilities, China could have a de facto 'air defense identification zone' in the South China Sea, even though it may not rush to declare one out of concern for the political and diplomatic fallout."

China provoked strong U.S. criticism when it unilaterally declared an air defense identification zone over disputed waters in the East China Sea in 2013, and Secretary of State John F. Kerry was among those who warned Beijing not to do the same for the South China Sea.

Harris said that the pace of China's construction of artificial islands "raises serious questions about Chinese intentions."

He added, "How China proceeds will be a key indicator of whether the region is heading toward confrontation or cooperation."

Foreign-policy experts said China's activities would not reinforce its legal claims to the islands under the U.N. Convention on the Law of the Sea because only natural land features are relevant to maritime rights. But it could help China enforce de facto control of some of the disputed waters.

Chris Johnson, a senior CSIS adviser, said that China had carried out more reclamation work on the islands in the past five months than other claimants had done in the past five years. “They want to be able to operate with impunity in these waters, and they want the rest of us to accept it,” he said.

“So what does the game plan ultimately entail? Is it to be able to move around in these areas and operate, and by doing so, in a de facto manner, emphasize their claims? Or do they have intent, over time, to kick rival claimants off?” he asked. “I don’t think there’s a sense of that, but I do think their behavior suggests they are moving in one direction, and they expect the other claimants to respect their growing power.”

Liu Liu contributed to this report.

Read more:

U.S. flies two warplanes over East China Sea, ignoring new Chinese air defense zone

China withdraws oil rig from waters disputed with Vietnam, but warns it could return

China’s rise and Asian tensions send U.S. relations into downward spiral

Today’s coverage from Post correspondents around the world

Simon Denyer is The Post’s bureau chief in China. He served previously as bureau chief in India and as a Reuters bureau chief in Washington, India and Pakistan.

Annex 752

D.E. Sanger and R. Gladstone, “Piling Sand in a Disputed Sea, China Literally Gains Ground”, *New York Times* (8 Apr. 2015)

The New York Times | http://nyti.ms/1FiVbbQ

ASIA PACIFIC

Piling Sand in a Disputed Sea, China Literally Gains Ground

By **DAVID E. SANGER and RICK GLADSTONE** APRIL 8, 2015

WASHINGTON — The clusters of Chinese vessels busily dredge white sand and pump it onto partly submerged coral, aptly named Mischief Reef, transforming it into an island.

Over a matter of weeks, satellite photographs show the island growing bigger, its few shacks on stilts replaced by buildings. What appears to be an amphibious warship, capable of holding 500 to 800 troops, patrols the reef's southern opening.

China has long asserted ownership of the archipelago in the South China Sea known as the Spratly Islands, also claimed by at least three other countries, including the Philippines, an American ally. But the series of detailed photographs of Mischief Reef shows the remarkable speed, scale and ambition of China's effort to literally gain ground in the dispute.

The photographs show that since January, China has been dredging enormous amounts of sand from around the reef and using it to build up land mass — what military analysts at the Pentagon are calling "facts on the water" — hundreds of miles from the Chinese mainland.

The Chinese have clearly concluded that it is unlikely that anyone will challenge them in an area believed rich in oil and gas and, perhaps more important, strategically vital. Last week Adm. Harry Harris, the commander of the United States Pacific Fleet, accused China of undertaking an enormous and unprecedented artificial land creation operation.

"China is creating a great wall of sand with dredges and bulldozers," Admiral Harris said in a speech in Canberra, Australia.

Defense Secretary Ashton B. Carter, on his first trip to Asia, put the American concerns in more diplomatic language, but the message was the same. In an interview to coincide with his visit, published Wednesday in The Yomiuri Shimbun, one of Japan's largest dailies, Mr. Carter said China's actions "seriously increase tensions and reduce prospects for diplomatic solutions" in territory claimed by the Philippines and Vietnam, and indirectly by Taiwan.

He urged Beijing to "limit its activities and exercise restraint to improve regional trust." That is the same diplomatic message the Obama administration has been giving to China since Hillary Rodham Clinton, then the secretary of state, and her Chinese counterpart faced off over the issue at an Asian summit meeting in 2010.

While other countries in Southeast Asia, like Malaysia and Vietnam, have used similar techniques to extend or enlarge territory, none have China's dredging and construction power.

The new satellite photographs were taken by DigitalGlobe, a commercial satellite imagery provider, and analyzed by the Center for Strategic and International Studies, a Washington research group. They certainly confirm the worries expressed by both Mr. Carter and Admiral Harris.

"China's building activities at Mischief Reef are the latest evidence that Beijing's land reclamation is widespread and systematic," said Mira Rapp-Hooper, director of the center's Asia Maritime Transparency Initiative, a website devoted to monitoring activity on the disputed territory.

The transformation of Mischief Reef, which the Chinese call Meiji Reef, she said, is within territory claimed by the Philippines and is one of seven small outposts the Chinese have sought to establish in the South China Sea. “These will allow Beijing to conduct regular, sustained patrols of the airspace and water, and to attempt to press its far-flung maritime claims as many as 1,000 miles from its shores,” she said.

Although these outposts are too vulnerable for China to use in wartime, she said, “they could certainly allow it to exert significant pressure on other South China Sea claimants, such as the Philippines and Vietnam.”

The issue poses a problem for the Obama administration, not simply because the Philippines is a treaty ally. China is working so quickly that its assertion of sovereignty could become a fait accompli before anything can be done to stop it.

The United States has long insisted that the territorial disputes be resolved peacefully, and that no claimant should interfere with international navigation or take steps that impede a diplomatic resolution of the issue. But to the Chinese — already flexing muscle in other territorial disputes and with the creation of an Asian infrastructure bank to challenge the Western-created World Bank — this is not a matter for negotiation.

When Mrs. Clinton raised the issue in Hanoi five years ago at the Asian Regional Forum, her Chinese counterpart, Yang Jiechi, responded with a 25-minute speech, exclaiming: “China is a big country. Bigger than any other countries here.” It seemed to be a reminder that its military could make sure no one would dare challenge its building spree on disputed territory — and so far, no one has, other than with diplomatic protests.

Since then, China has made no secret of its territorial designs on the Spratlys, creating at least three new islands that could serve as bases for Chinese surveillance and as resupply stations for navy vessels, according to IHS Jane’s.

Satellite imagery of the Spratlys publicized by IHS Jane’s in November showed how the Chinese had created an island about 9,850 feet long and 985 feet wide on Fiery Cross Reef, about 200 miles west of Mischief Reef, with a harbor capable of docking warships. IHS Jane's said the new island could support a runway for military aircraft.

The United States is about to conduct a joint military exercise with the Philippines, part of an emerging Obama administration strategy to keep American ships traversing the area regularly, a way of pushing back on Chinese claims of exclusive rights. The administration did the same when China declared an air defense zone in the region more than a year ago.

The Chinese have said they consider most of the South China Sea to be rightfully theirs — a claim others make as well. China and Japan have a separate territorial dispute over islands that Japan calls the Senkaku and China calls the Diaoyutai. Those tensions have eased slightly in recent times.

Last year, China and Vietnam became entangled in an angry exchange after China towed a $1 billion oil drilling rig to an area 150 miles off Vietnam's coast. On Tuesday China's official Xinhua news agency reported that the leaders of both countries wanted to soothe their differences and "control their disputes to ensure that the bilateral relationship will develop in a right track."

David E. Sanger reported from Washington, and Rick Gladstone from New York. Helene Cooper contributed reporting from Tokyo.

A version of this article appears in print on April 9, 2015, on page A1 of the New York edition with the headline: Piling Sand in a Disputed Sea, China Literally Gains Ground.

Annex 753

Dean Yates, “New images show China’s reclamation on Mischief Reef in South China Sea”, *Reuters* (9 Apr. 2015)

REUTERS

Industries | Thu Apr 9, 2015 2:10am EDT

Related: ENERGY

CORRECTED-New images show China's reclamation on Mischief Reef in South China Sea

(Makes clear Manila says reef is in its exclusive economic zone, corrects reef's distance from Philippines)

(Reuters) - Newly published satellite images show that China is quickly reclaiming land around a submerged reef within an area the Philippines regards as its exclusive economic zone, with several dredgers in operation and seawalls built.

The work on Mischief Reef is China's most recent reclamation in the disputed Spratly archipelago of the South China Sea. Reclamation is well advanced on six other reefs in the Spratlys, Reuters reported in February, activities that have alarmed other claimants and drawn criticism from Washington.

A March 16 image published by the Washington-based Center for Strategic and International Studies (CSIS) shows what it said were a chain of small artificial land formations as well as new structures, fortified seawalls and construction equipment along Mischief Reef.

Several dredgers are also present while the entrance to the reef had been expanded, the CSIS Asia Maritime Transparency Initiative said on its website. amti.csis.org/

An image from Feb. 1 showed a Chinese amphibious transport naval vessel about several hundred metres from the reef's entrance. CSIS said such a ship was capable of holding up to 800 troops and as many as 20 amphibious armoured vehicles.

Surveillance photos taken of Mischief Reef in October and seen by Reuters showed no reclamation work.

In an interview with Japan's Yomiuri newspaper published on Wednesday, U.S. Secretary of Defense Ash Carter expressed concern about China's reclamation in the Spratlys.

"We are especially concerned at the prospect of militarisation of these outposts," said Carter, who is in Tokyo on his first visit to Asia as defense chief.

Beijing rejects criticism of its activities around the reefs, saying the work falls "within the scope of China's sovereignty".

While the new islands will not overturn U.S. military superiority in the region, Chinese workers are building ports and fuel storage depots as well as possibly two airstrips that experts have said would allow Beijing to project power deep into the maritime heart of Southeast Asia.

The Philippines first said in February that Chinese dredgers had started work at Mischief Reef, 216 km (135 miles) west of the Philippine island of Palawan.

China claims the entire South China Sea. Brunei, Malaysia, the Philippines, Taiwan and

Vietnam also have claims on a waterway where $5 trillion in ship-borne trade passes annually.

China occupied Mischief Reef in 1995. The October photos showed two structures, including a three-storey building sitting on an atoll equipped with wind turbines and solar panels. (Reporting by Dean Yates; Editing by Robert Birsel)

Annex 754

"Chinese Mischief at Mischief Reef", *New York Times* (11 Apr. 2015)

The New York Times | http://nyti.ms/1z6boKa

SundayReview | EDITORIAL

Chinese Mischief at Mischief Reef

By THE EDITORIAL BOARD APRIL 11, 2015

In recent years, China has laid claim to the South China Sea with increasing fierceness, challenging the counterclaims of neighboring states and confronting their fishing boats on the open water. But new satellite photos have provided the most dramatic evidence yet of just how aggressively China is acting to establish a sphere of influence in the South China Sea and reduce the possibility of a diplomatic resolution of the territorial disputes there.

The photographs, which are available on the web, were taken by DigitalGlobe, a commercial satellite imagery provider, and analyzed by the Center for Strategic and International Studies. They show that since January China has moved with alarming speed to dredge huge quantities of sand from around Mischief Reef in the Spratly Islands and use it to create a more substantial land mass. A few existing shacks were replaced by buildings, and what appears to be an amphibious warship has been seen patrolling nearby.

It is one of seven small outposts the Chinese have established in the South China Sea. Another involves Fiery Cross Reef, about 200 miles away, where the Chinese created an island about 9,850 feet long and 985 feet wide, with a harbor capable of docking warships, according to IHS Jane's, which released satellite imagery of that project in November.

China is not alone in having an interest in what is essentially a collection of rocks, reefs and specks of land in a vast ocean. The South China Sea is believed to be rich in oil and gas; it is also a strategic waterway for billions of dollars in annual trade. Many countries have overlapping claims to the Spratlys, including the Philippines, Vietnam and Malaysia, and have made similar moves to extend territory, so in some ways China is just catching up.

Experts say the island construction does not enhance China's legal claim to that area of ocean, but that speck of land gives China a presence that it could use to assert more territorial control. In recent years, China has expanded its navy and increased its patrols in the South China Sea.

Last month, Adm. Harry Harris, commander of the Pacific Fleet, said the "unprecedented land reclamation" had raised "serious questions about Chinese intentions," and on Thursday, President Obama faulted China for using its "sheer size and muscle" to push around its smaller neighbors. It is natural for China, as a rising power, to want a larger role in Asia, but its attitude toward its neighbors and its refusal to engage in talks over the disputed areas is alarming.

The result is that most Asian countries have sought to build closer relations with the United States, which remains the dominant naval power in the region. No one, including the United States, is expected to push China off the disputed areas, but sea-based confrontations must be avoided. One possible approach is through joint development of oil and gas, as well as a legally binding code of conduct to govern navigation and prevent territorial grabs. The other claimant nations should also support the arbitration case brought by the Philippines against China under the United Nations Convention on the Law of the Sea treaty.

A decade ago, American officials were hoping China would be a constructive "stakeholder" in upholding the post-Cold War system that guaranteed the free flow of navigation and trade in oceans in that part of the world. Increasingly, it seems America must play a vigilant role to discourage China's attempts to exert its power over weaker Asian states.

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A version of this editorial appears in print on April 12, 2015, on page SR10 of the New York edition with the headline: Chinese Mischief at Mischief Reef.

Annex 755

Floyd Whaley, "China's Island-Building Is Ruining Coral Reefs, Philippines Says", *New York Times* (13 Apr. 2015)

The New York Times | http://nyti.ms/1FBPNvg

ASIA PACIFIC

China's Island-Building Is Ruining Coral Reefs, Philippines Says

By FLOYD WHALEY APRIL 13, 2015

MANILA — China's island-building activities have destroyed about 300 acres of coral reefs and are causing "irreversible and widespread damage to the biodiversity and ecological balance" of the South China Sea, a spokesman for the Philippine Department of Foreign Affairs said on Monday.

"China has pursued these activities unilaterally, disregarding people in the surrounding states who have depended on the sea for their livelihood for generations," the spokesman, Charles Jose, said during a news briefing in Manila.

He said China's neighbors in the South China Sea could lose up to $100 million a year because of the loss of the coral reefs, which are breeding grounds for high-value fish harvested by countries surrounding the sea.

China has been undertaking land reclamation projects on the sand spits, islets and submerged reefs of the Spratly Islands in the South China Sea, according to satellite images released in the last year. United States and Philippine officials have said the newly constructed islands could serve as military outposts in the area, parts of which are also claimed by the Philippines, Vietnam and other governments.

A Chinese Foreign Ministry spokeswoman said last week that the construction was focused on building maritime aids for China, its neighbors and international vessels in the South China Sea. The islands will host "typhoon shelters, navigation aids, search-and-rescue centers, marine meteorological forecasting stations, fishing services and civil administration offices," she said.

United States military officials have used strong language in the past month to protest China's island-building activities, noting that the construction work is decreasing the chances of a diplomatic resolution to the territorial disputes in the South China Sea.

Last week, the Philippines and the United States announced that their annual joint military exercises would be the largest conducted in 15 years and would include war games in coastal areas facing the South China Sea. The exercises, which are to begin next Monday, include more than 11,000 soldiers and sailors from both countries. That is twice the number of troops involved in last year's exercises, officials said.

The joint operations will be conducted throughout the country, including on the west coast of Luzon Island and in the western coastal areas of the province of Palawan, both of which face the South China Sea. Some of the military drills will be held at the former United States naval base in San Miguel in the province of Zambales, which is less than 150 miles from Scarborough Shoal, a Chinese-controlled reef that is also claimed by the Philippines.

Philippine military officials said last week that the expansion of the war games was not intended to send a message to China. A Philippine military spokesman, Lt. Col. Harold Cabunoc, said the activities, called Balikatan, were part of regular annual exercises and would be focused primarily on disaster response.

"The higher strength of Balikatan 2015 for this year only reflects the Philippines' and the United States' growing commitment to enhance our capability to conduct joint military and nonmilitary activities," he said.

The Philippines filed a case in March last year with an international tribunal based in the Netherlands seeking to clarify the conflicting claims in the South China Sea. The Philippine foreign secretary, Albert del Rosario, has said a decision from the tribunal could come by the first quarter of 2016. China has declined to participate in the proceedings, saying the areas in question are sovereign territory not under the jurisdiction of an international tribunal.

A version of this article appears in print on April 14, 2015, on page A8 of the New York edition with the headline: Philippines Issues a Protest Over China's Island-Building.

Annex 756

Jane Perlez, "China Building Aircraft Runway in Disputed Spratly Islands", *New York Times* (16 Apr. 2015)

The New York Times | http://nyti.ms/1IO29Xv

ASIA PACIFIC

China Building Aircraft Runway in Disputed Spratly Islands

By JANE PERLEZ APRIL 16, 2015

BEIJING — China is building a concrete runway on an island in the South China Sea's contested waters that will be capable of handling military aircraft when finished, satellite images released Thursday show.

The first section of the runway appears like a piece of gray ribbon on an image taken last month of Fiery Cross Reef, part of the Spratly Islands, an archipelago claimed by at least three other countries. Adjacent to the runway, work is underway on an apron for taxiing and parking planes.

The runway, which is expected to be about 10,000 feet long — enough to accommodate fighter jets and surveillance aircraft — is a game changer in the competition between the United States and China in the South China Sea, said Peter Dutton, professor of strategic studies at the Naval War College in Rhode Island.

"This is a major strategic event," Mr. Dutton said. "In order to have sea control, you need to have air control."

Analysts had speculated that China planned to build an airstrip on Fiery Cross Reef, but the satellite image from March 23, provided by Airbus and released Thursday by Jane's Defense Weekly, is the first hard evidence that it is doing so.

In time, Mr. Dutton said, China is likely to install radar and missiles that could intimidate countries like the Philippines, an American ally, and Vietnam, which also have claims to the Spratlys, as they resupply modest military garrisons in the area.

More broadly, he said, China's ability to use Fiery Cross Reef as a landing strip for fighter and surveillance aircraft will vastly expand its zone of competition with the United States in the South China Sea.

Over the past decade and a half, a series of tense encounters between American and Chinese forces on the sea and in the air, starting with a near collision in 2001 between an American EP-3 spy plane and a Chinese fighter, have occurred in the sea's northern waters, near China. The new installations in the Spratlys, about 1,000 miles beyond China's southernmost point on Hainan Island, will create a much wider arena for potential close calls, Mr. Dutton said.

"This will expand the area in which there are likely to be tensions between the United States and China," he said.

The construction on Fiery Cross Reef is part of a larger Chinese reclamation project involving scores of dredgers on at least five islands in the South China Sea. China is converting tiny reefs, once barely visible above water, into islands big enough to handle military hardware, personnel and recreation facilities for workers.

Satellite images of the reclamation efforts have been released in steady doses over the last few months, as smaller countries with claims to islands in the area have voiced concern about China's accelerated construction, and as the United States has stepped up its criticism.

During his recent first trip to Asia as the American defense secretary, Ashton B. Carter said in Japan that the reclamation efforts were seriously aggravating tensions between Beijing and Washington and hurting prospects for diplomatic solutions.

After Mr. Carter spoke, the Center for Strategic and International Studies, a Washington research group, released images of Mischief Reef, also in the Spratly archipelago, that showed large-scale dredging of sand and coral to create land mass on what had been a partly submerged reef.

The construction on Fiery Cross Reef, hundreds of miles west of Mischief Reef, appears to have taken place in the last several weeks. An Airbus image from Feb. 6, also released Thursday by Jane's Defense Weekly, shows empty sand where the runway is now being built.

"We absolutely think it is for military aircraft, but of course an airstrip is an airstrip — anything can land on it if it's long enough," said James

Hardy, Asia-Pacific editor for Jane's Defense Weekly. "Three thousand meters is big enough for pretty much any aircraft." He noted that the superjumbo Airbus A380's runway requirement is 2,950 meters, or just under 10,000 feet.

Other runways used by the Chinese military have ranged from around 8,850 feet to more than 13,100, Mr. Hardy said. By comparison, he said, the runway the United States Air Force maintains at Diego Garcia, an island in the Indian Ocean that is much bigger and more developed than Fiery Cross Reef, is 11,800 feet.

"The main question is, what else would land there?" he said. "Unless they are planning to turn these into resorts — which seems unlikely, not least given the statement from the Foreign Ministry last week — then military aircraft are the only things that would need to land there."

China's Foreign Ministry said in a statement last week that the reclamation efforts were intended to serve civilian purposes, such as providing a base for search-and-rescue operations, but also for "satisfying the need of necessary military defense." Though the statement placed more emphasis on the nonmilitary goals, it was a rare acknowledgment of Chinese military intentions in the South China Sea.

Mr. Hardy said China's military appeared to have chosen Fiery Cross Reef as a command-and-control center for its Spratly Islands operations.

China claims more than 80 percent of the South China Sea, arguing that a "nine-dash line" that it drew around the waterway in the late 1940s conforms to its rights there. No other country recognizes the validity of the nine-dash line, and many fear that China's reclamation activities are part of a drive to create an inevitability about Chinese ownership.

In another example of the Pentagon's growing criticism of China's efforts, a senior Navy commander, Rear Adm. Christopher J. Paul, said last month in Australia that there were countries "who attempt to constrict movement through international waters, who create land areas where there were none; who create exclusion zones where there should be shared use."

In response, he said, the Navy is creating "hunter-killer surface action groups" of ships. He suggested that Australia, one of America's top allies, would be invited to contribute to the new efforts in offensive naval warfare.

A version of this article appears in print on April 17, 2015, on page A8 of the New York edition with

the headline: China Building Runway on Contested Island.