ARBITRATION UNDER ANNEX VII OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

PEOPLE'S REPUBLIC OF BANGLADESH

v.

REPUBLIC OF INDIA

COUNTER-MEMORIAL OF THE REPUBLIC OF INDIA

VOLUME II – ANNEXES

31 JULY 2012

LIST OF ANNEXES

Annex IN-11 *Note Verbale* from the High Commission of Bangladesh to the Ministry of External Affairs of India, 13 December 1974.

Annex IN-12 Press Release of 2 April 1975 on the talks held between the Foreign Ministers of India and Bangladesh at New Delhi from 29 March to 2 April 1975.

Annex IN-13 India's Territorial Waters, Continental Shelf, Exclusive Economic Zone and Other Maritime Zones Act, No. 80, 28 May 1976.

Annex IN-14 Joint press statement issued on the conclusion of Indo-Bangladesh talks on delimitation of maritime boundary, 24 March 1978 reproduced in A. S. Bhasin (ed.), *India - Bangladesh Relations: Documents 1971-2002*, Vol. IV, 2003, p. 1919.

Annex IN-15 Report on the Indo-Bangladesh Talks on Maritime Boundary, 5 December 1980 reproduced in A. S. Bhasin (ed.), *India - Bangladesh Relations: Documents 1971-2002*, Vol. IV, 2003, pp. 1930-1931.

Annex IN-16 Letter from the representative of Bangladesh to the President of the Conference, Doc. A/CONF.62/L.140, 28 April 1982.

Annex IN-17 Letter from the representative of India to the President of the Conference, Doc. A/CONF.62/L.148, 30 April 1982.

Annex IN-18 Letter from the representative of Burma to the President of the Conference, Doc. A/CONF.62/L.149, 30 April 1982.

Annex IN-19 Summary Records of the 191st Plenary Meeting of the Third United Nations Conference of the Law of the Sea, Doc. A/CONF.62/SR.191, 9 December 1982.

Annex IN-20 A. H. A. Soons, "The Effects of a Rising Sea Level on Maritime Limits and Boundaries", *Netherlands International Law Review*, Vol. 37, 1990, pp. 207-232.

Annex IN-21 D. A. V. Stow, K. Amano, P. S. Balson, G. W. Brass, J. Corrigan, C. V. Raman, J. J. Tiercelin, M. Townsend and N. P. Wijayananda, "Sediment Facies and Processes on the Distal Bengal Fan, Leg 116", in J. R. Cochran, D. A. V. Stow *et al.* (eds.), *Proceedings of the Ocean Drilling Program, Scientific Results*, Vol. 116, 1990, pp. 377-396.

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Annex IN-24 P. Saenger and N. A. Siddiqi, "Land from the Sea: The Mangrove Afforestation Program of Bangladesh", *Ocean and Coastal Management*, Vol. 20, 1993, pp. 23-39.

Annex IN-25 Relevant Abstracts of the Scientific and Technical Guidelines of the Commission on the Limits of the Continental Shelf, Doc. CLCS/11, adopted at its fifth session on 13 May 1999.

Annex IN-26 N. P. C. Reddy and K. Mohano Rao, "Heavy Sediment Influx during Early Holocene: Inference from Clay Mineral Studies in a Core from the Western Bay of Bengal", *Current Science*, Vol. 81, 2001, pp. 1361-1364.

Annex IN-27 S. J. Sangode, N. Suresh and T. N. Bagati, "Godavari Source in the Bengal Fan Sediments: Results from Magnetic Susceptibility Dispersal Pattern", *Current Science*, Vol. 80, 2001, pp. 660-664.

Annex IN-28 F. Blasco and M. Aizpuru, "Mangroves along the Coastal Stretch along the Bay of Bengal: Present Status", *Indian Journal of Marine Sciences*, Vol. 31, 2002, pp. 9-20.

Annex IN-29 A. A. Allen, "Volte-Face in the Punjab", *Nature*, Vol. 438, 2005, pp. 925-926.

Annex IN-30 P. D. Clift and J. Blustajn, "Reorganization of the Western Himalayan River System After Five Million Years Ago", *Nature*, Vol. 438, 2005, pp. 1001-1003.

Annex IN-31 G. Prasetya, "The Role of Coastal Forests and Trees in Protecting against Coastal Erosion", in S. Braatz, S. Fortuna, J. Broadhead and R. Leslie (eds.), *Coastal Protection in the Aftermath of the Indian Ocean Tsunami: What Role for Forests and Trees?, Proceedings of the Regional Technical Workshop, KhaoLak, Thailand, 28–31 August 2006*, FAO, 2007, pp. 103-130.

Annex IN-32 Energy and Mineral Resources Division of the Ministry of Power, Energy and Mineral Resources of the Government of The People's Republic of Bangladesh and Bangladesh Oil, Gas And Mineral Corporation (Petrobangla), Notice Inviting Bids for Exploration of Oil and Natural Gas under Bangladesh Offshore Bidding Round 2008 (with map), February 2008.

Annex IN-33 Y. Tanaka, "Reflections on Maritime Delimitation in the *Nicaragua /Honduras* Case", *Zeitschrift für ausländisches öffentliches Recht und Völkerrecht*, Vol. 68, 2009, pp. 903-937.

Annex IN-34 *Note Verbale* from the Ministry of Foreign Affairs of Bangladesh to the High Commission of India, Notification under Article 287 and Annex VII, Article 1 of UNCLOS, 8 October 2009.

Annex IN-35 *Note Verbale* from the Permanent Mission of Bangladesh to the Secretary-General of the United Nations, 29 October 2009.

Annex IN-36 *Note Verbale* from the Ministry of External Affairs of India to the High Commission of Bangladesh, 6 November 2009.

Annex IN-37 R. Bastia, S. Das and M. Radhakrishna, "Pre- and Post-Collisional Depositional History in the Upper and Middle Bengal Fan and Evaluation of Deepwater Reservoir Potential along the Northeast Continental Margin of India", *Marine and Petroleum Geology*, Vol. 27, 2010, pp. 2051-2061.

Annex IN-38 M. M. Rahman and S. K. Biswas, "Feasible Solution of Protection and Adaptation Strategy for Coastal Zone of Bangladesh", *Pakistan Journal of Meteorology*, Vol. 8, 2011, pp. 9-19.

Annex IN-39 List of Agreements concluded by India with neighbouring countries.

Annex IN-1

Government of Bengal, Notification No. 964 Jur., 24 January 1925.

REGISTERED No. C207. **No. 5 of 1925.**

The Calcutta Gazette

THURSDAY, JANUARY 29, 1925.

CONTENTS.

PART I.

Orders and Notifications by the Governor of Bengal, the Government of Bengal, the High Court, Government Treasury, etc.

ORDERS BY HIS EXCELLENCY THE GOVERNOR OF BENGAL.

No. 1318A.—The 22nd January 1925.—Whereas a vacancy has occurred in the Indian Tea Association constituency of the Bengal Legislative Council by reason of the resignation of Mr. A. D. Gordon, His Excellency the Governor is pleased, in pursuance of sub-rule (*1*) of rule 26 of the Bengal Electoral Rules, to call upon the Indian Tea Association constituency to elect a person for the purpose of filling the vacancy before the 25th February 1925.

L. BIRLEY,

Chief Secretary to the Government of Bengal.

Annex IN-1

Police-station.		Number and date of notification defining jurisdiction.
Janjira	...	No. 10535P., dated the 9th November 1914, No. 3618P.J., dated the 17th October 1919, No. 3620P.J., dated the 17th October 1919, No. 1901Pl., dated the 18th May 1922, No. 3364Pl., dated the 14th September 1922, No. 2622Pl., dated the 25th October 1924, No. 1568Pl., dated the 8th May 1924, and Nos. 104Pl. and 106Pl., dated the 16th January 1925.
Palong	...	No. 1151J., dated the 14th April 1913, No. 15611P., dated the 11th December 1917, No. 1725P.J., dated the 14th May 1918, and No. 3618P.J., dated the 17th October 1919.
Gosairhat	...	No. 109, dated the 27th August 1874, No. 4:4J.D., dated the 26th April 1905, and Nos. 1725P.J., and 1726P.J., dated the 14th May 1918.
Bhedarganj	...	No. 109, dated the 27th August 1874, No. 494J.D., dated the 26th April 1905, No. 15611P., dated the 11th December 1917, Nos. 1725P.J. and 1726P.J., dated the 14th May 1918, and No. 1725P.J., dated the 20th May 1919.
Lonesingh	...	No. 15611P., dated the 11th December 1917, and No. 2352P.J., dated the 13th August 1918.

Khulna. 24-Parganas.

No. 964Jur.—The 24th January 1925.—In exercise of the power conferred by the Bengal Districts Act, 1864 (Bengal Act IV of 1864), and in modification of all previous notifications relating to the boundary between the districts of Khulna and the 24-Parganas, the Governor in Council is pleased to declare that the following shall be the boundary between the said two districts :—

From the south-west corner of village Chanduria, J. L. No. 1, the western boundary of district Khulna passes along the south-western boundary of Chandanpur, J. L No. 2, western and southern boundaries of Sultanpur, J. L. No. 3, southern boundary of Hijaldi, J. L. No. 4 (all the above villages are in police-station Kalaroa), then along the midstream of the main channel for the time being of the river Sonai up to the south-west corner of Keragachhi, J. L. No. 14, then the boundary passes along the south-western boundary of Keragachhi, J L. No. 14, in police-station Kalaroa up to the north-western corner of village Talaigachha, J. L. No. 1, in police-station Satkhira, then along the western boundary of Talaigachha, J. L. No. 1, north-western boundary of Satani Kushkhali, J. L. No. 8, northern and western boundaries of Kushkhali, J. L. No. 9, and north-western boundary of Chhaygharia, J. L. No. 11, western and southern boundaries of Kaliani, J. L. No. 12, south-western boundary of Chhaygharia, J. L. No. 11, western and southern boundaries of Baikari, J. L. No. 13, south-western boundary of Dantbhangarbil, J. L. No. 21, western boundary of Mahadebnagar, J. L. No. 24, and Mahmudpur, J. L. No. 35, northern and western boundaries of Lakshmidari, J. L. No. 26, western boundary of Bhomra, J. L. No. 27, and Padma Sakra, J. L. No. 28, and north-western boundary of Radhanagar J. L. No. 29 (all the above villages are in police-station Satkhira) till it meets the midstream of the main channel of the river Ichhamati, then along the midstream of the main channel for the time being of the rivers Ichhamati and Kalindi, Raimangal and Haribhanga till it meets the Bay.

W. S. HOPKYNS,
Secretary to the Government of Bengal (offg.).

JAILS.

Dacca.

No. 780 Jails.—The 20th January 1925.—Captain B. G. Mallya, I.M.S., officiating Superintendent, Dacca Central Jail, is allowed leave on average pay for twelve days, under article 100 of the Fundamental Rules, in extension of the leave granted to him under the orders of the 22nd October 1924.

W. S. HOPKYNS,
Secretary to the Government of Bengal (offg.).

Orders by the Conservator of Forests, Bengal.

Sundarbans.

No. 1For.—The 15th January 1925.—On return from leave granted to him in Bengal Government, Revenue Department, notifications Nos. 5361For., dated the 11th June 1924, and 578 T.R., dated the 1st October 1924, Babu Priya Nath Sarkar, Extra Assistant Conservator of Forests, is posted to the Sundarbans Division as an attached officer with headquarter at Khulna.

E. O. SHEBBEARE,
Conservator of Forests, Bengal (offg.).

Annex IN-2

Bengal Boundary Commission Report (Radcliffe Award) to His Excellency the Governor General of India, including Annexure A and B, 12 August 1947.

REGISTERED No. L. 818

The Gazette of India

EXTRAORDINARY

PUBLISHED BY AUTHORITY

NEW DELHI, SUNDAY, AUGUST 17, 1947

GOVERNMENT OF INDIA

LEGISLATIVE DEPARTMENT

(Reforms)

NOTIFICATION

New Delhi, the 17th August 1947

No. F. 68/47-R.—The Reports of the Bengal Boundary Commission and of the Punjab Boundary Commission are published for general information.

REPORT OF THE BENGAL BOUNDARY COMMISSION p.1059
" " " Punjab " " p.1065

To

HIS EXCELLENCY THE GOVERNOR-GENERAL.

1. I have the honour to present the decision and award of the Bengal Boundary Commission, which, by virtue of section 3 of the Indian Independence Act, 1947, is represented by my decision as Chairman of that Commission. This award relates to the division of the Province of Bengal, and the Commission's award in respect of the District of Sylhet and areas adjoining thereto will be recorded in a separate report.

2. The Bengal Boundary Commission was constituted by the announcement of the Governor-General, dated the 30th of June, 1947, Reference No. D50/7/47R. The members of the Commission thereby appointed were

Mr. Justice Bijan Kumar Mukherjea,

Mr. Justice C. C. Biswas,

Mr. Justice Abu Saleh Mohamed Akram, and

Mr. Justice S. A. Rahman.

I was subsequently appointed Chairman of this Commission.

3. The terms of reference of the Commission, as set out in the announcement, were as follows :—

"The Boundary Commission is instructed to demarcate the boundaries of the two parts of Bengal on the basis of ascertaining the contiguous areas of Muslims and non-Muslims. In doing so, it will also take into account other factors."

We were desired to arrive at a decision as soon as possible before the 15th of August.

4. After preliminary meetings, the Commission invited the submission of memoranda and representations by interested parties. A very large number of memoranda and representations was received.

5. The public sittings of the Commission took place at Calcutta, and extended from Wednesday the 16th of July 1947, to Thursday the 24th of July 1947, inclusive, with the exception of Sunday, the 20th of July. Arguments were presented to the Commission by numerous parties on both sides, but the main cases were presented by counsel on behalf of the Indian National Congress, the Bengal Provincial Hindu Mahasabha and the New Bengal Association on the one hand, and on behalf of the Muslim League on the other. In view of the fact that I was acting also as Chairman of the Punjab Boundary Commission, whose proceedings were taking place simultaneously with the proceedings of the Bengal Boundary Commission, I did not attend the public sittings in person, but made arrangements to study daily the record of the proceedings and all material submitted for our consideration.

6. After the close of the public sittings, the remainder of the time of the Commission was devoted to clarification and discussion of the issues involved. Our discussions took place at Calcutta.

7. The question of drawing a satisfactory boundary line under our terms of reference between East and West Bengal was one to which the parties concerned propounded the most diverse solutions. The province offers few, if any, satisfactory natural boundaries, and its development has been on lines that do not well accord with a division by contiguous majority areas of Muslim and non-Muslim majorities.

8. In my view, the demarcation of a boundary line between East and West Bengal depended on the answers to be given to certain basic questions which may be stated as follows :—

(1) To which State was the City of Calcutta to be assigned, or was it possible to adopt any method of dividing the City between the two States?

(2) If the City of Calcutta must be assigned as a whole to one or other of the States, what were its indispensable claims to the control of territory, such as all or part of the Nadia River system or the Kulti rivers, upon which the life of Calcutta as a city and port depended?

(3) Could the attractions of the Ganges-Padma-Madhumati river line displace the strong claims of the heavy concentration of Muslim majorities in the districts of Jessore and Nadia without doing too great a violence to the principle of our terms of reference?

(4) Could the district of Khulna usefully be held by a State different from that which held the district of Jessore?

(5) Was it right to assign to Eastern Bengal the considerable block of non-Muslim majorities in the districts of Malda and Dinajpur?

(6) Which State's claim ought to prevail in respect of the Districts of Darjeeling and Jalpaiguri, in which the Muslim population amounted to 2.42 per cent. of the whole in the case of Darjeeling, and to 23.08 per cent. of the whole in the case of Jalpaiguri, but which constituted an area not in any natural sense contiguous to another non-Muslim area of Bengal?

(7) To which State should the Chittagong Hill Tracts be assigned, an area in which the Muslim population was only 3 per cent. of the whole,

but which it was difficult to assign to a State different from that which controlled the district of Chittagong itself?

9. After much discussion, my colleagues found that they were unable to arrive at an agreed view on any of these major issues. There were of course considerable areas of the Province in the south-west and north-east and east, which provoked no controversy on either side: but, in the absence of any reconciliation on all main questions affecting the drawing of the boundary itself, my colleagues assented to the view at the close of our discussions that I had no alternative but to proceed to give my own decision.

10. This I now proceed to do: but I should like at the same time to express my gratitude to my colleagues for their indispensable assistance in clarifying and discussing the difficult questions involved. The demarcation of the boundary line is described in detail in the schedule which forms Annexure A to this award, and in the map* attached thereto, Annexure B. The map is annexed for purposes of illustration, and if there should be any divergence between the boundary as described in Annexure A and as delineated on the map in Annexure B, the description in Annexure A is to prevail.

11. I have done what I can in drawing the line to eliminate any avoidable cutting of railway communications and of river systems, which are of importance to the life of the province: but it is quite impossible to draw a boundary under our terms of reference without causing some interruption of this sort, and I can only express the hope that arrangements can be made and maintained between the two States that will minimize the consequences of this interruption as far as possible.

CYRIL RADCLIFFE.

NEW DELHI,
The 12th August, 1947.

THE SCHEDULE

See Annexures A and B.

ANNEXURE A

1. A line shall be drawn along the boundary between the Thana of Phansidewa in the District of Darjeeling and the Thana Tetulia in the District of Jalpaiguri from the point where that boundary meets the Province of Bihar and then along the boundary between the Thanas of Tetulia and Rajganj; the Thanas of Pachagar and Rajganj, and the Thanas of Pachagar and Jalpaiguri, and shall then continue along the northern corner of the Thana Debiganj to the boundary of the State of Cooch-Behar. The District of Darjeeling and so much of the District of Jalpaiguri as lies north of this line shall belong to West Bengal, but the Thana of Patgram and any other portion of Jalpaiguri District which lies to the east or south shall belong to East Bengal.

2. A line shall then be drawn from the point where the boundary between the Thanas of Haripur and Raiganj in the District of Dinajpur meets the border of the Province of Bihar to the point where the boundary between the Districts of 24 Farganas and Khulna meets the Bay of Bengal. This line shall follow the course indicated in the following paragraphs. So much of the Province of Bengal as lies to the west of it shall belong to West Bengal. Subject to what has been provided in paragraph 1 above with

*Not published.

regard to the Districts of Darjeeling and Jalpaiguri, the remainder of the Province of Bengal shall belong to East Bengal.

3. The line shall run along the boundary between the following Thanas:

Haripur and Raiganj; Haripur and Hemtabad; Ranisankail and Hemtabad; Pirganj and Hemtabad; Pirganj and Kaliganj; Bochaganj and Kaliganj; Biral and Kaliganj; Biral and Kushmundi; Biral and Gangarampur; Dinajpur and Gangarampur; Dinajpur and Kumarganj; Chirirbandar and Kumarganj; Phulbari and Kumarganj; Phulbari and Balurghat. It shall terminate at the point where the boundary between Phulbari and Balurghat meets the north-south line of the Bengal-Assam Railway in the eastern corner of the Thana of Balurghat. The line shall turn down the western edge of the railway lands belonging to that railway and follow that edge until it meets the boundary between the Thanas of Balurghat and Panchbibi.

4. From that point the line shall run along the boundary between the following Thanas:

Balurghat and Panchbibi; Balurghat and Joypurhat; Balurghat and Dhamairhat; Tapan and Dhamairhat, Tapan and Patnitala; Tapan and Porsha; Bamangola and Porsha; Habibpur and Porsha; Habibpur and Gomastapur; Habibpur and Bholahat; Malda and Bholahat; English Bazar and Bholahat; English Bazar and Shibganj; Kaliachak and Shibganj; to the point where the boundary between the two last mentioned thanas meets the boundary between the districts of Malda and Murshidabad on the river Ganges.

5. The line shall then turn south-east down the River Ganges along the boundary between the Districts of Malda and Murshidabad; Rajshahi and Murshidabad; Rajshahi and Nadia; to the point in the north-western corner of the District of Nadia where the channel of the River Mathabanga takes off from the River Ganges. The district boundaries, and not the actual course of the River Ganges, shall constitute the boundary between East and West Bengal.

6. From the point on the River Ganges where the channel of the River Mathabanga takes off, the line shall run along that channel to the northern most point where it meets the boundary between the Thanas of Daulatpur and Karimpur. The middle line of the main channel shall constitute the actual boundary.

7. From this point the boundary between East and West Bengal shall run along the boundaries between the Thanas of Daulatpur and Karimpur; Gangani and Karimpur; Meherpur and Karimpur; Meherpur and Tehatta; Meherpur and Chapra; Damurhuda and Chapra; Damurhuda and Krishnaganj; Chuadanga and Krishnaganj; Jibannagar and Krishnaganj; Jibannagar and Hanskhali; Maheshpur and Hanskhali; Maheshpur and Ranaghat; Maheshpur and Bongaon; Jhikargacha and Bongaon; Sarsa and Bongaon; Sarsa and Gaighata; Gaighata and Kalaroa; to the point where the boundary between those thanas meets the boundary between the districts of Khulna and 24 Parganas.

8. The line shall then run southwards along the boundary between the Districts of Khulna and 24 Parganas, to the point where that boundary meets the Bay of Bengal.

REPORT OF THE BENGAL BOUNDARY COMMISSION (SYLHET DISTRICT)

To

HIS EXCELLENCY THE GOVERNOR GENERAL.

1. I have the honour to present the report of the Bengal Boundary Commission relating to Sylhet District and the adjoining districts of Assam. By virtue of Section 3 of the Indian Independence Act, 1947, the decisions contained in this report become the decision and award of the Commission.

2. The Bengal Boundary Commission was constituted as stated in my report dated the 12th of August 1947 with regard to the division of the Province of Bengal into East and West Bengal. Our terms of reference were as follows :—

> "The Boundary Commission is instructed to demarcate the boundaries of the two parts of Bengal on the basis of ascertaining the contiguous majority areas of Muslims and non-Muslims. In doing so, it will also take into account other factors.
>
> In the event of the referendum in the District of Sylhet resulting in favour of amalgamation with Eastern Bengal, the Boundary Commission will also demarcate the Muslim majority areas of Sylhet District and the contiguous Muslim majority areas of the adjoining districts of Assam."

3. After the conclusion of the proceedings relating to Bengal, the Commission invited the submission of memoranda and representations by parties interested in the Sylhet question. A number of such memoranda and representations was received.

4. The Commission held open sittings at Calcutta on the 4th, 5th and 6th days of August 1947, for the purpose of hearing arguments. The main arguments were conducted on the one side by counsel on behalf of the Government of East Bengal and the Provincial and District Muslim Leagues ; and on the other side, by counsel on behalf of the Government of the Province of Assam and the Assam Provincial Congress Committee and the Assam Provincial Hindu Mahasabha. I was not present in person at the open sittings as I was at the time engaged in the proceedings of the Punjab Boundary Commission which were taking place simultaneously, but I was supplied with the daily record of the Sylhet proceedings and with all material submitted for the Commission's consideration. At the close of the open sittings, the members of the Commission entered into discussions with me as to the issues involved and the decisions to be come to. These discussions took place at New Delhi.

5. There was an initial difference of opinion as to the scope of the reference entrusted to the Commission. Two of my colleagues took the view that the Commission had been given authority to detach from Assam and to attach to East Bengal any Muslim majority areas of any part of Assam that could be described as contiguous to East Bengal, since they construed the words "the adjoining districts of Assam" as meaning any districts of Assam that adjoined East Bengal. The other two of my colleagues took the view that the Commission's power of detaching areas from Assam and transferring them to East Bengal was limited to the District of Sylhet and contiguous Muslim majority areas (if any) of other districts of Assam that adjoined Sylhet. The difference of opinion was referred to me for my casting vote, and I took the view that the more limited construction of our

terms of reference was the correct one and that the "adjoining districts of Assam" did not extend to other districts of Assam than those that adjoined Sylhet. The Commission accordingly proceeded with its work on this basis.

6. It was argued before the Commission on behalf of the Government of East Bengal that on the true construction of our terms of reference and section 3 of the Indian Independence Act, 1947, the whole of the District of Sylhet at least must be transferred to East Bengal and the Commission had no option but to act upon this assumption. All my colleagues agreed in rejecting this argument, and I concur in their view.

7. We found some difficulty in making up our minds whether, under our terms of reference, we were to approach the Sylhet question in the same way as the question of partitioning Bengal, since there were some differences in the language employed. But all my colleagues came to the conclusion that we were intended to divide the Sylhet and adjoining districts of Assam between East Bengal and the Province of Assam on the basis of contiguous majority areas of Muslims and non-Muslims, but taking into account other factors I am glad to adopt this view.

8. The members of the Commission were however unable to arrive at an agreed view as to how the boundary lines should be drawn, and after discussion of their differences, they invited me to give my decision. This I now proceed to do.

9. In my view, the question is limited to the districts of Sylhet and Cachar, since of the other districts of Assam that can be said to adjoin Sylhet neither the Garo Hills nor the Khasi and Jaintia Hills nor the Lushai Hills have anything approaching a Muslim majority of population in respect of which a claim could be made.

10. Out of 35 thanas in Sylhet, 8 have non-Muslim majorities; but of these eight, two—Sulla and Ajmiriganj (which is in any event divided almost evenly between Muslims and non-Muslims), are entirely surrounded by preponderatingly Muslim areas, and must therefore go with them to East Bengal. The other six thanas comprising a population of over 530,000 people stretch in a continuous line along part of the southern border of Sylhet District. They are divided between two sub-divisions, of which one, South Sylhet, comprising a population of over 515,000 people, has in fact a non-Muslim majority of some 40,000; while the other, Karimganj, with a population of over 568,000 people, has a Muslim majority that is a little larger.

11. With regard to the District of Cachar, one thana, Hailakandi, has a Muslim majority and is contiguous to the Muslim thanas of Badarpur and Karimganj in the District of Sylhet. This thana forms, with the thana of Katlichara immediately to its south, the sub-division of Hailakandi, and in the Sub-division as a whole Muslims enjoy a very small majority being 51 per cent. of the total population. I think that the dependence of Katlichara on Hailakandi for normal communications makes it important that the area should be under one jurisdiction, and that the Muslims would have at any rate a strong presumptive claim for the transfer of the Sub-division of Hailakandi, comprising a population of 166,536. from the Province of Assam to the Province of East Bengal.

12. But a study of the map shows, in my judgment, that a division on these lines would present problems of administration that might gravely affect the future welfare and happiness of the whole District. Not only would the six non-Muslim thanas of Sylhet be completely divorced from

the rest of Assam if the Muslim claim to Hailakandi were recognised, but they form a strip running east and west whereas the natural division of the land is north and south and they effect an awkward severance of the railway line through Sylhet, so that, for instance, the junction for the town of Sylhet itself, the capital of the district, would lie in Assam, not in East Bengal.

13. In those circumstances I think that some exchange of territories must be effected if a workable division is to result. Some of the non-Muslim thanas must go to East Bengal and some Muslim territory and Hailakandi must be retained by Assam. Accordingly I decide and award as follows :—

A line shall be drawn from the point where the boundary between the Thanas of Patharkandi, and Kulaura meets the frontier of Tripura State and shall run north along the boundary between those Thanas, then along the boundary between the Thanas of Patharkandi and Barlekha, then along the boundary between the Thanas of Karimganj and Barlekha, and then along the boundary between the Thanas of Karimganj and Beani Bazar to the point where that boundary meets the River Kusiyara. The line shall then turn to the east taking the River Kusiyara as the boundary and run to the point where that river meets the boundary between the Districts of Sylhet and Cachar. The centre line of the main stream or channel shall constitute the boundary. So much of the District of Sylhet as lies to the west and north of this line shall be detached from the Province of Assam and transferred to the Province of East Bengal. No other part of the Province of Assam shall be transferred.

14. For purposes of illustration a map* marked A is attached on which the line is delineated. In the event of any divergence between the line as delineated on the map and as described in paragraph 13, the written description is to prevail.

NEW DELHI,

CYRIL RADCLIFFE.

The 13th August 1947.

REPORT OF THE PUNJAB BOUNDARY COMMISSION

To

HIS EXCELLENCY THE GOVERNOR-GENERAL

1. I have the honour to present the decision and award of the Punjab Boundary Commission which, by virtue of section 4 of the Indian Independence Act, 1947, is represented by my decision as Chairman of that Commission.

2. The Punjab Boundary Commission was constituted by the announcement of the Governor-General dated the 30th of June 1947, Reference No. D50/7/47R. The members of the Commission thereby appointed were—

Mr. Justice Din Muhammad,

Mr. Justice Muhammad Munir,

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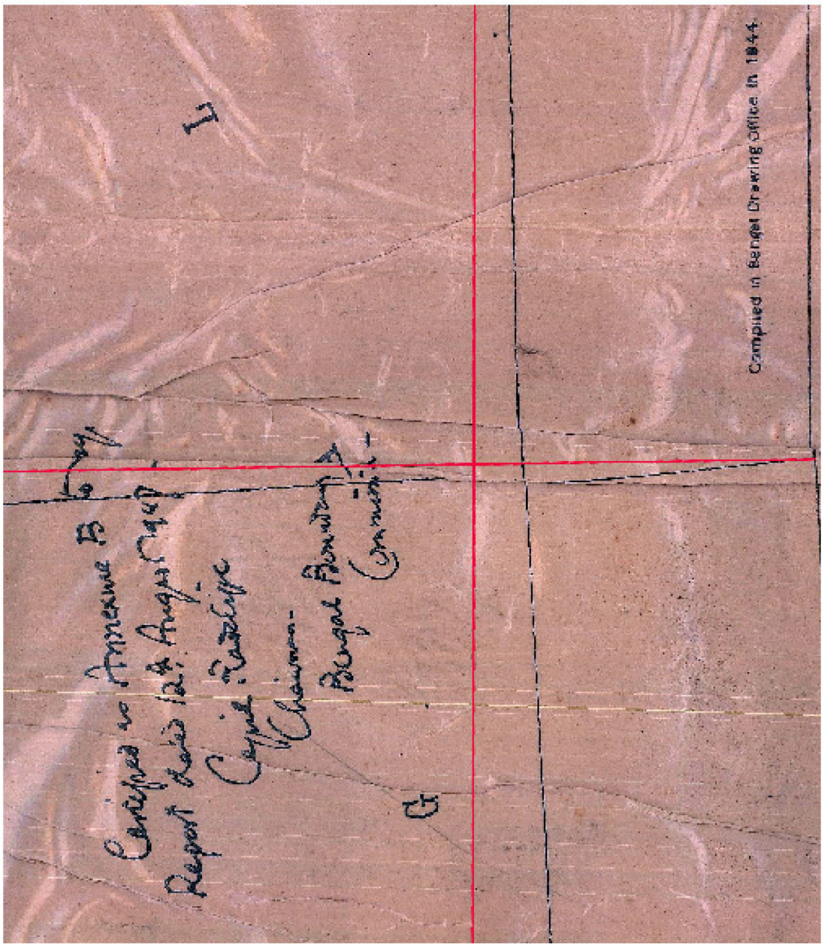
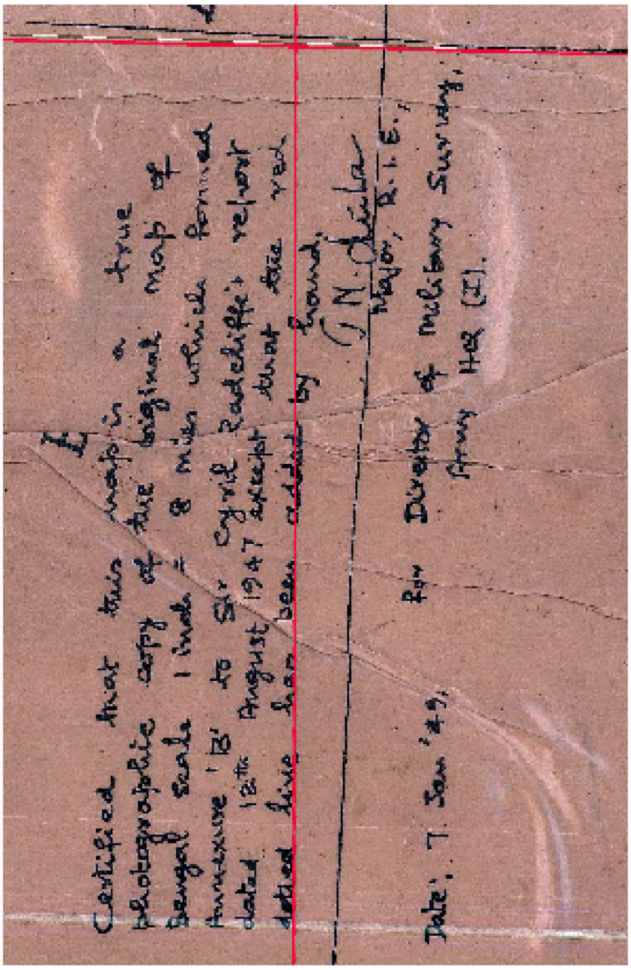
* Not published.

Annexure B to the Report of the Bengal Boundary Commission
13 August 1947


SHEET No. 2
2


Annexed to Annexure B to my
Report dated 12th August 1947
Cyril Radcliffe
Chairman
Bengal Boundary
Commission
H
G
Compiled in Bengal Drawing Office in 1944


MAP OF
BENGAL
Scale 1 Inch = 8 Miles
REFERENCES
Province Boundary
District Boundary
Sub Division Boundary
Police Station Do.
District Head Quarters
Railway with Station
Metalled Road
Unmetalled Road


E
Certified that this map is a true
photographic copy of the original map of
Bengal scale 1 inch = 8 miles which formed
Annexure 'B' to Sir Cyril Radcliffe's report
dated 12th August 1947 except that the red
dotted line has been added by hand.
Major, R.E.,
For Director of Military Survey,
Army HQ (I).
Date: 7 Jan '49.

Annex IN-3

International Law Commission, Report of the Committee of Experts on Technical Questions Concerning the Territorial Sea, The Hague, 14 to 16 April 1953, reproduced in English in N. Nandan and S. Rosenne (eds.), *United Nations Convention on the Law of the Sea, 1982: A Commentary*, Vol. II, pp. 59-63 (the original French text of the report is reproduced in the *Yearbook of the International Law Commission*, Vol. II, 1953, pp. 77-79).

Center for Oceans Law and Policy
University of Virginia School of Law

UNITED NATIONS CONVENTION ON THE LAW OF THE SEA 1982

A COMMENTARY

Volume II

Articles 1 to 85
Annexes I and II
Final Act, Annex II

Satya N. Nandan and Shabtai Rosenne
Volume Editors
Neal R. Grandy
Assistant Editor

Martinus Nijhoff Publishers
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APPENDIX

Report of the Committee of Experts on technical questions concerning the territorial sea

At the invitation of Professor François, special rapporteur for the regime of the territorial sea of the International Law Commission, the following technical experts, sitting in their personal capacity, met at the Peace Palace, The Hague, from 14 to 16 April 1953, in order to examine certain questions of a technical nature raised during the discussions of the Commission:

Professor L.E.G. ASPLUND (Geographic Survey Department, Stockholm);
Mr. S. Whittemore BOGGS (Special Adviser on Geography, Department of State, Washington D.C.);
Mr. P.R.V. COUILLAULT (Ingénieur en Chef du Service central hydrographique, Paris);
Commander R. H. KENNEDY, O.B.E., R.N. (Retd.) (Hydrographic Department Admiralty, London) accompanied by Mr. R.C. SHAWYER (Administrative Officer, Admiralty, London);
Vice-Admiral A.S. PINKE (Retd.) (Royal Netherlands Navy, The Hague).

This Committee of Experts met under the chairmanship of the special rapporteur and its report was drafted by Mr. C.W. van Santen, assistant juridical counsel of the Netherlands Ministry of Foreign Affairs.

A questionnaire drawn up by the special rapporteur was submitted to the experts. The questions, and the answers of the experts, are given below. It should be emphasized that these replies are given from the technical point of view, bearing in mind in particular the practical difficulties of the navigator.

I

Assuming the territorial sea to be measured from the low-water line, what line might then preferably be taken as such?

----

1. Except as otherwise provided for, the base-line for measuring the territorial sea should be the low-water line along the coast as marked on the largest-scale chart available, officially recognized by the coastal State. If no detailed charts of the area have been drawn, which show the low-water line, the shore-line (high-water line) should be used.

2. The Committee did not consider that there was any danger that omission of the provisions made by the 1930 Conference as regards special indications in this matter, might tempt governments unreasonably to extend their low-water lines on their charts.

3. The Committee added a proviso, however, that rocks (and similar elevations) awash at the datum of the chart ("*au niveau qu'on a choisi pour la carte*") should not be taken into consideration.

4. Drying rocks and shoals that are exposed between the datum of the chart and high water, if within the territorial sea, may be taken as individual points of departure for measuring the territorial sea, thereby causing a bulge in the outer limit of the latter.

5. As regards coral reefs, the edge of the reef as marked on the above-mentioned charts, should be accepted as the low-water line for measuring the territorial sea.

II

Accepting the low-water line system as the general rule for measuring the territorial sea, while in bays a straight line across the bay should circumscribe the "inland waters", what technical observations can be made as to

A. the definition of a bay as opposed to a mere curvature in the coastline?

B. any relation between the maximum length (B miles) of the above-mentioned straight line and the width of the territorial sea?

C. the points between which the said straight line should be drawn?

D. the direction of or the points between which this line should be drawn in case different lines of B miles are conceivable?

----

ad A. 1. A bay is a bay in the juridical sense, if its area is as large as, or larger than that of the semi-circle drawn on the entrance of that bay. Historical bays are excepted; they should be indicated as such on the maps.

2. If a bay has more than one entrance–as indicated sub B–this semi-circle should be drawn on a line as long as the sum-total of the length of the different entrances.

3. Islands within a bay should be included as if they were part of the water area of the bay.

ad B. 1. The closing line across a (juridical) bay should not exceed 10 miles in width, this being twice the range of vision to the horizon in clear weather, from the eye of a mariner at a height of 5 metres (which is the internationally accepted height for hydrographical purposes). In cases of considerable tidal differences the low-water lines should be taken as the shore-lines between which the width of the bay should be computed.

2. If the entrance of a (juridical) bay is split up into a number of smaller openings by various islands, closing lines across these openings may be drawn provided that none of these lines exceeds five miles in length–except one which may extend up to a maximum of 10 miles.

ad C. 1. In case the entrance of the bay does not exceed 10 miles in width, the line *inter fauces terrarum* should constitute the delimitation between inland-waters and the territorial sea.

2. In case the entrance of the bay exceeds 10 miles, a closing line of this length should be drawn within the bay. When different lines of this length can be drawn, that line should be chosen which encloses the maximum water area within the bay.

ad D. D has become redundant by the answer to [the] foregoing questions.

III

If the low-water line may be replaced by a straight base-line, as indicated by the International Court of Justice in the Anglo-Norwegian Fisheries Case, what technical questions may arise as to

A. the points between which these lines should be drawn?

B. the maximum length of these lines?

C. the islands, rocks and shallow waters within T miles before the coast (T standing for the width of the territorial sea)?

----

1. The Committee considered that the maximum permissible length for a "straight base-line" should first be fixed. The Committee chose 10 miles, this being–like already mentioned sub 2 B–twice the range of vision.

2. Such "straight base-lines" might be drawn–if specifically justified by international law–between headlands on the coastline or between such headlands and islands less than 5 miles from the coast or between such islands, provided such headlands and/or islands are not further than 10 miles apart.

3. The Committee considered that between three or more islands at a distance of less than 5 miles from each other, "straight base-lines" might be drawn. In that case, these islands constitute a *group*. Waters lying within the outer base-lines around a group should be considered as inland waters.

4. The Committee recognizes as a special case a group of islands in which one, but only one, of the said connecting lines exceeds 5 miles though not 10 miles in length. This case may be called a "fictitious bay".

5. A "fictitious bay" may also be formed by a string of islands taken together with a portion of the mainland coastline as provided for under 2 B.

6. The Committee agreed that "straight base-lines" should not be drawn to and from drying rocks and shoals. Their part in measuring the territorial sea has been stated sub I.

IV

If the base-line should, as a rule, not depart to any appreciable extent from the general direction of the coast, how should this technically be accomplished?

----

1. The Committee agreed that it is impracticable to establish any "general direction of the coast" in many instances, and observed that any effort to do so involves questions as to the scale of the chart used for the purpose, and the somewhat arbitrary decision as to how much coast shall be utilized in attempting to determine any "general direction" whatever.

2. With this qualification in mind the Committee answered the above question by fixing the maximum length or any such "straight base-lines" at 10 miles.

3. In exceptional cases, especially justified by international law, the drawing of longer lines may be permitted in regard to a particular coast. No point, however, on such lines should be farther than 5 miles from the coast.

4. The Committee, speaking from the technical and navigational points of view, agreed that in principle the drawing of "straight base-lines"–otherwise than provided for in sub II for the closing line of a bay–should be avoided as this results in an unwarranted extension of inland-waters and undesirably throws the outer limit of the territorial sea further seaward.

5. Where such straight lines are justified, it should be the responsibility of the coastal State to give adequate publicity to them.

6. The Committee rejected the idea of establishing any relationship between the length of "straight base-lines" and the width of the territorial sea.

V

How should the outer limit of the territorial sea be drawn, when the width of the territorial sea is T miles?

The outer limit of the territorial sea is the line, every point of which is at a distance of T miles from the nearest point of the base-line. It constitutes a continuous series of intersecting arcs of circles drawn with a radius of T miles from all points on the base-line. The limit of the territorial sea is formed by the most seaward arcs (this method had been used prior to 1930, but the terms which were sometimes used to convey the same connotation, namely "envelopes of arcs of circles" appear to have been not infrequently misunderstood).

VI

How should the international boundary be drawn between two countries, the coasts of which are opposite each other at a distance of less than 2 T miles? To what extent have islands and shallow waters to be accounted for?

An international boundary between countries the coasts of which are opposite each other at a distance of less than 2 T miles should as a general rule be the median line, every point of which is equidistant from the base-lines of the States concerned. Unless otherwise agreed between the adjacent

States, all islands should be taken into consideration in drawing the median line. Likewise, drying rocks and shoals within T miles of only one State should be taken into account, but similar elevations of undetermined sovereignty, that are within T miles of both States, should be disregarded in laying down the median line. There may, however, be special reasons, such as navigation and fishing rights, which may divert the boundary from the median line. The line should be laid down on charts of the largest scale available, especially if any part of the body of water is narrow and relatively tortuous.

VII

How should the (lateral) boundary line be drawn through the adjoining territorial sea of two adjacent States? Should this be done

A. by continuing the land frontier?

B. by a perpendicular line on the coast at the intersection of the land frontier and the coastline?

C. by a line drawn vertically on the general direction of the coastline?

D. by a median line? If so, how should this line be drawn? To what extent should islands, shallow waters and navigation channels be accounted for?

----

1. After thoroughly discussing different methods the Committee decided that the (lateral) boundary through the territorial sea–if not already fixed otherwise–should be drawn according to the principle of equidistance from the respective coastlines.

2. In a number of cases this may not lead to an equitable solution, which should be then arrived at by negotiation.

REMARK REGARDING THE ANSWERS TO VI AND VII:

The Committee considered it important to find a formula for drawing the international boundaries in the territorial waters of States, which could also be used for the delimitation of the respective continental shelves of two States bordering the same continental shelf.

GENERAL REMARK:

The Committee desired to stress that the delimitation of the outer limits of any "contiguous zone" should be measured from the same base-line as the territorial sea.

Annex IN-4

United Nations General Assembly, Resolution 3067(XXVIII), Reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction and use of their resources in the interests of mankind, and convening of the Third United Nations Conference on the Law of the Sea, 16 November 1973.

RESOLUTIONS ADOPTED ON THE REPORTS OF THE FIRST COMMITTEE

CONTENTS

3067 (XXVIII). Reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction and use of their resources in the interests of mankind, and convening of the Third United Nations Conference on the Law of the Sea[1]

The General Assembly,

Recalling its resolutions 2467 (XXIII) of 21 December 1968, 2750 (XXV) of 17 December 1970, 2881 (XXVI) of 21 December 1971 and 3029 (XXVII) of 18 December 1972,

Having considered the report of the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction on the work of its sessions in 1973,[2]

Recalling in particular paragraph 2 of resolution 2750 C (XXV),

Considering that the Committee has accomplished, as far as possible, within the limits of its mandate, the

[1] See also "Other decisions", p. 24.

[2] *Official Records of the General Assembly, Twenty-eighth Session, Supplement No. 21* (A/9021 and Corr.1 and 3).

work which the General Assembly entrusted to it for the preparation of the Third United Nations Conference on the Law of the Sea, and that it is necessary to proceed to the immediate inauguration of the Conference in 1973 and the convening of a substantive session in 1974, in order to carry out the negotiations and other work required to complete the drafting and adoption of articles for a comprehensive convention on the law of the sea,

Recalling further its resolutions 2480 (XXIII) of 21 December 1968, 2539 (XXIV) of 11 December 1969, 2736 (XXV) of 17 December 1970 and 3009 (XXVII) of 18 December 1972 concerning the composition of the Secretariat, as well as the general dispositions on the same matter recommended by the Fifth Committee and adopted by the General Assembly at its twenty-sixth and twenty-seventh sessions,

1. *Expresses its appreciation* to the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction on the work it has done in preparing for the Third United Nations Conference on the Law of the Sea;

2. *Confirms* its decision in paragraph 3 of resolution 3029 A (XXVII) and decides to convene the first session of the Third United Nations Conference on the Law of the Sea in New York from 3 to 14 December 1973 inclusive for the purpose of dealing with matters relating to the organization of the Conference, including the election of officers, the adoption of the agenda and the rules of procedure of the Conference, the establishment of subsidiary organs and the allocation of work to these organs and any other purpose within the scope of paragraph 3 below;

3. *Decides* that the mandate of the Conference shall be to adopt a convention dealing with all matters relating to the law of the sea, taking into account the subject-matter listed in paragraph 2 of General Assembly resolution 2750 C (XXV) and the list of subjects and issues relating to the law of the sea formally approved on 18 August 1972 by the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction[3] and bearing in mind that the problems of ocean space are closely interrelated and need to be considered as a whole;

4. *Decides* to convene the second session of the Conference, for the purpose of dealing with the substantive work of the Conference, for a period of ten weeks from 20 June to 29 August 1974 at Caracas and, if necessary, to convene not later than 1975 any subsequent session or sessions as may be decided upon by the Conference and approved by the General Assembly, bearing in mind that the Government of Austria has offered Vienna as the site for the Conference in 1975;

5. *Invites* the Conference to make such arrangements as it may deem necessary to facilitate its work;

6. *Refers* to the Conference the reports of the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction on its work and all other relevant documentation of the General Assembly and the Committee;

7. *Decides*, having regard to the desirability of achieving universality of participation in the Conference, to request the Secretary-General to invite, in full compliance with General Assembly resolution 2758 (XXVI) of 25 October 1971, States Members of the United Nations or members of specialized agencies or the International Atomic Energy Agency and States parties to the Statute of the International Court of Justice as well as the following States to participate in the Conference: Republic of Guinea-Bissau and Democratic Republic of Viet-Nam;

8. *Requests* the Secretary-General:

(*a*) To invite to the Conference intergovernmental and non-governmental organizations in accordance with paragraphs 8 and 9 of resolution 3029 A (XXVII);

(*b*) To invite the United Nations Council for Namibia to participate in the Conference;

(*c*) To provide summary records in accordance with paragraph 10 of resolution 3029 A (XXVII);

9. *Decides* that the Secretary-General of the United Nations shall be the Secretary-General of the Conference and authorizes him to appoint a special representative to act on his behalf and to make such arrangements—including recruitment of necessary staff, taking into account the principle of equitable geographical representation—and to provide such facilities as may be necessary for the efficient and continuous servicing of the Conference, utilizing to the fullest extent possible the resources at his disposal;

10. *Requests* the Secretary-General to prepare appropriate draft rules of procedure for the Conference, taking into account the views expressed in the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction and in the General Assembly, and to circulate the draft rules of procedure in time for consideration and approval at the organizational session of the Conference;

11. *Invites* States participating in the Conference to submit their proposals, including draft articles, on the substantive subject-matter of the Conference to the Secretary-General by 1 February 1974 and requests the Secretary-General to circulate the replies received by him before the second session with a view to expediting the work of the Conference;

12. *Decides* that the provisions of paragraph 11 above shall not preclude any State participating in the Conference from submitting proposals, including draft articles, at any stage of the Conference, in accordance with the procedure adopted by the Conference, provided that States which have already submitted any proposals and draft articles need not resubmit them;

13. *Dissolves* the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction as from the inauguration of the Conference.

2169th plenary meeting
16 November 1973

3075 (XXVIII). Economic and social consequences of the armaments race and its extremely harmful effects on world peace and security

The General Assembly,

Having considered the item entitled "Economic and social consequences of the armaments race and its extremely harmful effects on world peace and security",

[3] *Ibid., Twenty-seventh Session, Supplement No. 21* (A/8721 and Corr.1), para. 23.

Annex IN-5

Bangladesh Territorial Waters and Maritime Zones Act, No. XXVI, 14 February 1974.

Territorial Waters and Maritime Zones Act 1974, Act No. XXVI of 1974

An act to provide for the declaration of the territorial waters and maritime zones.

Whereas clause (2) of Article 143 of the Constitution provides that Parliament may, from time to time, by law provide for the determination of the territorial waters and the continental shelf of Bangladesh;

And whereas it is necessary to provide for the declaration of the territorial waters, continental shelf and other maritime zones and for matter ancillary thereto;

It is hereby enacted as follows:

Short title

l. This Act may be called the Territorial Waters and Maritime Zones Act, l974.

Definitions

2. In this Act, unless there is anything repugnant to the subject or context:

(a) "conservation zone" means a conservation zone established under section 6;

(b) "contiguous zone" means the zone of the high seas declared by section 4 to be the contiguous zone of Bangladesh;

(c) "continental shelf" means the continental shelf of Bangladesh referred to in section 7;

(d) "economic zone" means the zone of the high seas declared under section 5 to be the economic zone of Bangladesh;

(e) "territorial waters" means the limits of sea declared under section 3 to be the territorial waters of Bangladesh.

Territorial waters

3. (1) The Government may, by notification in the official Gazette, declare the limits of the sea beyond the land territory and internal waters of Bangladesh which shall be the territorial waters of Bangladesh specifying in the notification the baseline:

(a) from which such limits shall be measured; and

(b) the waters on the landward side of which shall form part of the internal waters of Bangladesh.

(2) Where a single island, rock or a composite group thereof constituting the part of the territory of Bangladesh is situated seawards from the main coast or baseline, territorial waters shall extend to the limits declared by notification under sub-section (1) measured from the low waterline along the coast of such island, rock or composite group.

(3) The Sovereignty of the Republic extends to the territorial waters as well as to the air space over and the

bed and subsoil of, such waters.

(4) No foreign ship shall, unless it enjoys the right of the innocent passage, pass through the territorial waters.

(5) Foreign ship having the right of innocent passage through the territorial waters shall, while exercising such right, observe the laws and rules in force in Bangladesh.

(6) The Government may, by notification in the official Gazette, suspend, in the specified areas of the territorial waters, the innocent passage of any ship if it is of opinion that such suspension is necessary for the security of the Republic.

(7) No foreign warship shall pass through the territorial waters except with the previous permission of the Government.

(8) The Government may take such steps as may be necessary:

(a) to prevent the passage through the territorial waters of any foreign ship having no right of innocent passage;

(b) to prevent and punish the contravention of any law or rule in force in Bangladesh by any foreign ship exercising the right of innocent passage;

(c) to prevent the passage of any foreign warship without previous permission of Government; and

(d) to prevent and punish any activity which is prejudicial to the security or interest of the Republic.

Explanation - In this section "warship" includes any surface or sub-surface vessel or craft which is or may be used for the purpose of naval warfare.

Contiguous zone

4. (1) The zone of the high seas contiguous to the territorial waters and extending seawards to a line six nautical miles measured from the outer limits of the territorial waters is hereby declared to be the contiguous zone of Bangladesh.

(2) The Government may exercise such powers and take such measures in or in respect of the contiguous zone as it may consider necessary to prevent and punish the contravention of, and attempt to contravene, any law or regulation in force in Bangladesh relating to:

(a) the security of the Republic;
(b) the immigration and sanitation; and
(c) customs and other fiscal matters.

Economic zone

5. (1) The Government may, by notification in the official Gazette, declare any zone of the high seas adjacent to the territorial waters to be the economic zone of Bangladesh specifying therein the limits of such zone.

(2) All natural resources within the economic zone, both living and non-living, on or under the seabed and sub-soil or on the water surface or within the water column shall vest exclusively in the Republic.

(3) Nothing in sub-section (2) shall be deemed to affect fishing within the economic zone by a citizen of

Bangladesh who uses for the purpose vessels which are are not mechanically propelled.

Conservation zone

6. The Government may, with a view to the maintenance of the productivity of the living resources of the sea, by notification in the official Gazette, establish conservation zones in such areas of the sea adjacent to the territorial waters as may be specified in the notification and may take such conservation measures in any zone so established as it may deem appropriate for the purpose including measures to protect the living resources of the sea from indiscriminate exploitation, depletion or destruction.

Continental shelf

7. (1) The continental shelf of Bangladesh comprises:

(a) the seabed and subsoil of the submarine areas adjacent to the coast of Bangladesh but beyond the limits of the territorial waters up to the outer limits of the continental margin bordering on the ocean basin or abyssal floor; and

(b) the seabed and subsoil of the analogous submarine areas adjacent to the coasts of any island, rock or any composite group thereof constituting part of the territory of Bangladesh.

(2) Subject to sub-section (1), the Government may, by notification in the official Gazette, specify the limits thereof.

(3) No person shall, except under and in accordance with the terms of, a licence or permission granted by Government explore or exploit any resources of the continental shelf or carry out any search or excavation or conduct any research within the limits of the continental shelf:

Provided that no such licence or permission shall be necessary for fishing by a citizen of Bangladesh who uses for the purpose vessels which are not mechanically propelled.

Explanation: Resources of the continental shelf include mineral and other non-living resources together with living organisms belonging to sedentary species, that is to say, organisms which at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil.

(4) The Government may construct, maintain or operate within the continental shelf installations and other devices necessary for the exploration and exploitation of its resources.

Control of pollution

8. The Government may, with a view to preventing and controlling marine pollution and preserving the quality and ecological balance in the marine environment in the high seas adjacent to the territorial waters, take such measures as it may deem appropriate for the purpose.

Power to make rules

9. (1) The Government may makes rules for carrying out the purposes of this Act.

(2) In particular and without prejudice to the generality of the foregoing power, such rules may provide -

(a) for the regulation of the conduct of any person in or upon the territorial waters, contiguous zone, economic zone, conservation zone and continental shelf;

(b) for measures to protect, use and exploit the resources of the economic zone;

(c) for conservation measures to protect the living resources of the sea;

(d) for measures regulating the exploration and exploitation of resources within the continental shelf;

(e) for measures designed to prevent and control of marine pollution of the high seas.

(3) In making any rule under this section the Government may provide that a contravention of the rule shall be punishable with imprisonment which may extend to one year or with fine which may extend to five thousand takas.

Annex IN-6

Notification No. LT-1-3-74 of the Ministry of Foreign Affairs of Bangladesh, 13 April 1974.

Notification No. LT - I/3/74 of the Ministry of Foreign Affairs, Dacca, of 13 April 1974

No. LT-I/3/74. In exercise of the powers conferred by sub-section (1) of section 3 of the Territorial Waters and Maritime Zones Act, 1974 (Act No. XXVI of 1974), and in supersession of any previous declaration on the subject, the Government is pleased to declare that the limits of the sea specified in paragraph 2 beyond the land territory and internal waters of Bangladesh shall be the territorial waters of Bangladesh.

2. The limits of the sea referred to in paragraph 1 shall be twelve nautical miles measured seaward and the baselines set out in paragraph 3 so that each point of the outer limit of the sea to the nearest point inward on the baselines is twelve nautical miles.

3. The baselines from which territorial waters shall be measured seaward are the straight lines linking successively the baseline points set out below:

Baseline Point	Geographical Co-ordinates Baseline Point	
	Latitude	Longitude
No. 1	21° 12'00" N.	89° 06'45" E.
No. 2	21° 15'00" N.	89° 16'00" E.
No. 3	21° 29'00" N.	89° 36'00" E.
No. 4	21° 21'00" N.	89° 55'00" E.
No. 5	21° 11'00" N.	90° 33'00" E.
No. 6	21° 07'30" N.	91° 06'00" E.
No. 7	21° 10'00" N.	91° 56'00" E.
No. 8	20° 21'45" N.	92° 17'30" E.

...

No. LT-I/3/74 - In exercise of the powers conferred by sub-section (1) of section 5 of the Territorial Waters and Maritime Zones Act, 1974 (Act No. XXVI of 1974), the Government is pleased to declare that the Zone of the high seas extending to 200 nautical miles measured from the baselines shall be the economic zone of Bangladesh.

Annex IN-7

Summary Records of the 27th Plenary Meeting of the Third United Nations Conference on the Law of the Sea, Doc. A/CONF.62/ SR.27, 3 July 1974.

Third United Nations Conference on the Law of the Sea

1973-1982
Concluded at Montego Bay, Jamaica on 10 December 1982

Document:-
A/CONF.62/ SR.27

Summary Records of Plenary Meetings
27th plenary meeting

Extract from the *Official Records of the Third United Nations Conference on the Law of the Sea, Volume I (Summary Records of Plenary Meetings of the First and Second Sessions, and of Meetings of the General Committee, Second Session)*

94. In order to end the continually increasing imbalance between developed and developing countries, the Organization of African Unity believed that it was indispensable to recognize that all coastal States had the right to establish, beyond their territorial sea, an exclusive economic zone, whose breadth should not exceed 200 nautical miles, in which they would exercise permanent sovereignty over all the biological and mineral riches without unduly prejudicing other legitimate uses of the sea. However, by virtue of regional solidarity, the land-locked countries and the other disadvantaged countries had the right to participate on an equal footing in the exploitation of the living resources of neighbouring economic zones.

95. It was also necessary to protect the living resources from pollution and from the dangers connected with intensive fishing on the high seas of migratory and anadromous species by establishing regional institutions and an international authority entrusted with enforcing the principles of fisheries management.

96. Furthermore, the African countries believed that it was urgent to accelerate the transfer of technology with respect to ocean science, particularly by the training of personnel in the developing countries. Fruitful co-operation would then be possible.

97. Finally, given the importance of the international zone of the sea-bed, which the General Assembly had defined as "the common heritage of mankind", it was essential that no persons, natural or juridical, should undertake any exploitation before the international régime had been established. The Organization of African Unity believed that a treaty should be concluded regulating that zone, elaborating an international régime for the exploitation of biological and mineral riches of ocean space and instituting a body entrusted with applying that régime. That body should undertake the equitable distribution of benefits, minimize the disastrous repercussions which could arise from fluctuations in the prices of raw materials resulting from the exploitation of the zone, and distribute equitably among all developing countries all the revenues from such exploitation. It should also ensure the protection of the marine environment.

98. He believed that the principle of universality, which constituted the very essence of the United Nations, was flouted by the fact that representatives of racist and colonialist Powers which had plundered millions of human beings were participating in the Conference. The Conference should not forget the lesson of history and decide the lot of entire peoples without giving them the possibility of having their say.

99. The Organization of African Unity proposed a policy of peace and human brotherhood and hoped that the fruitful co-operation of all men for the progress and well-being of all would replace confrontation and imperialist exploitation.

Mr. Amerasinghe (Sri Lanka) resumed the Chair.

100. Mr. LE VAN LOI (Republic of Viet-Nam), speaking in exercise of the right of reply, pointed out that the Hoang Sa and Truong Sa Archipelagos had always been an integral part of Viet-Nam's national heritage. In January 1974, the forces of Peking had landed and occupied the Hoang Sa Archipelago after three days of air and naval battle. The Peking régime had thus given a new dimension to its expansionist and imperialist policy at the expense of developing countries bordering China. Tibet, the countries south of China's borders, and the northern part of Viet-Nam had one after another fallen under its sway. With the conquest of the Hoang Sa Archipelago, the Peking régime had entered a new stage: its objective was now to establish a new empire, embodying all the ocean space of the western Pacific and the seas of South-East Asia. The Truong Sa Archipelago, which it was also aiming at, was 600 miles from the Chinese coast. Furthermore, with the assistance of Hanoi it had used local rebel elements as a cover for its armed aggression against the independent countries in the region and for the purpose of interfering in those countries' internal affairs. In Viet-Nam they used for that purpose the so-called Provisional Revolutionary Government of South Viet-Nam, which did not represent any part of the people of South Viet-Nam. No threat from Peking would set back the Viet-Namese people, who were resolved to defend and recover their heritage.

101. His delegation reserved the right to return to that question if it considered it necessary.

102. Mr. SOTH (Khmer Republic), speaking in exercise of the right of reply, said that one delegation had questioned the delegation and Government of the Khmer Republic and its political régime. Those insulting allegations were entirely baseless and constituted a flagrant interference in the internal affairs of the Khmer Republic. His delegation reserved the right to return to that question if it thought it necessary.

103. The PRESIDENT, without questioning the right of any country to exercise its right of reply, observed that the Conference on the Law of the Sea did not have the competence to solve the problems which had been raised.

104. Mr. KIM (Democratic People's Republic of Korea), speaking in exercise of the right of reply, said that the allegations by the representative of South Korea were intended only to conceal an inadmissible attitude with respect to the fishing grounds of the continental shelf. His own delegation had confined itself to the facts.

105. Referring to the unjust claims of the Saigon Government, he pointed out that the archipelagos in question were historically an integral part of Chinese territory.

106. Mr. RAMPHUL (Mauritius) paid a tribute to the memory of General Perón noting in particular his courageous policy with respect to oppressed peoples, such as the people of Guinea-Bissau, and to national liberation movements. He expressed his most sincere condolences to the family of the deceased and to the Argentine people.

The meeting rose at 6.40 p.m.

27th meeting

Wednesday, 3 July 1974, at 10.55 a.m.

President: Mr. H. S. AMERASINGHE (Sri Lanka).

In the absence of the President, Mr. Al-Saud Al-Sabah (Kuwait), Vice-President, took the chair.

Statement by the President

1. The PRESIDENT read out the text of a letter he had received from the head of the Argentine dèlegation thanking the Conference for its expression of sympathy on the occasion of the death of General Perón, President of Argentina.

General statements (*continued*)

2. Mr. GOKHALE (India) said that, since the issues to be discussed by the Conference would affect the interests of all States and the world community as a whole, all national libera-

tion movements should be invited to attend the Conference. Those movements would soon be establishing legitimate Governments in their countries, and they should be present during the consideration of questions relating to the law of the sea that affected their interests.

3. The lengthy preparations for the Conference had made the world as a whole realize that a fair and durable legal framework for the use of the sea and the sea-bed and their resources was essential. Agreement on such a framework would be possible if a balance was maintained between legitimate national interests and the interests of the world community as a whole.

4. His Government approached the issues facing the Conference from the viewpoint of its national interests and also from the viewpoint of the international community. Although India, with a coastline of over 4,000 miles, had long been aware of the potential of the continental shelf and margin for the production of petroleum and natural gas, it had begun drilling successfully in the sea west of Bombay only in 1974. India, a developing country, was developing rapidly economically and, since its national oil production represented only one third of its total consumption, the exploration and exploitation of the resources of the continental margin were matters of national importance to India. His Government had devoted increasing attention to the exploitation of the fishery resources of the sea adjacent to the coast and would be interested in establishing exclusive jurisdiction of coastal States over an economic and fishery zone. Indian shipping and trade interests needed freedom of navigation in order to ensure economic development, while at the same time the shores and marine resources needed protection against pollution. India had over 1,280 islands, including two archipelagos, and would therefore be interested in evolving a suitable régime for archipelagos and islands.

5. Commenting on specific issues, he said that the outer limit of the territorial sea should be 12 nautical miles measured from the appropriate baseline along the coast. An 18-mile contiguous zone adjacent to the territorial sea could also be established to protect the customs, fiscal and health interests of coastal States. Coastal States should be entitled to establish an economic zone of up to 200 miles from the coast in which they would enjoy sovereign rights and exclusive jurisdiction over the resources of the sea, the sea-bed and its subsoil. In that connexion he recalled that his delegation had sponsored a comprehensive proposal for fisheries (A/9021 and Corr.1 and 3, vol. III, sect. 27), and he suggested that the outer limit of the fishery zone, which had been left blank in the proposal, should be set at 200 nautical miles since that limit had received general support from developing countries in Asia, Africa and Latin America and also from some important developed States. Coastal States should have jurisdiction in the economic zone to apply measures to preserve the quality of the marine environment and to prevent and control marine pollution. They should also have the exclusive right to regulate the conduct of scientific research within the zone by foreign vessels.

6. In connexion with the question of the outer limit of the national sea-bed and continental shelf, he recalled that his delegation had suggested a uniform limit of 200 miles. Since, however, no other country with a continental shelf and margin extending beyond 200 miles had supported that suggestion, and since existing international law recognized the jurisdiction of coastal States over their entire continental shelf, his Government had reviewed its position. It now supported the view that the national sea-bed of a State should extend to the outer edge of the continental margin. Jurisdiction over the 200-mile economic zone of the national sea-bed should not prejudice the position of coastal States with a shelf extending beyond 200 miles. His Government would, however, be willing to elaborate proposals under which the benefits derived from the exploitation of the resources of the national sea-bed beyond 200 nautical miles from the coast could be shared with the proposed International Sea-Bed Authority; a formula for such sharing might be devised by the Conference.

7. The definition of basic principles governing the international sea-bed area and its resources would not present much difficulty as the general principles had already been unanimously approved by the General Assembly in resolution 2749 (XXV). He shared the majority view that the proposed International Sea-Bed Authority should, in the initial period, be a simple organization consisting of an assembly representing all member States, a smaller council which would supervise the work of the Authority under the over-all control of the assembly, a corporation conducting the exploitation of the sea-bed resources, and a secretariat recruited on the basis of geographical representation. No single State or group of States should have a preferential position in any decision-making organ of the Authority, and the basis of representation should be geographical, not functional or political. The Authority should have comprehensive powers, and it should be entitled to decide whether to exploit the resources of the international sea-bed area directly, or by entering into contracts with competent international or other corporations, or by any other means, without sacrificing its effective supervision and control over the entire operation. The resources of the sea-bed, the common heritage of mankind, should remain vested in the Authority, and the rights of any operator should derive from a contract rather than from any other source such as a simple licence to explore the area. The Authority should also be competent to regulate the production of sea-bed minerals and to protect the interests of producers and consumers of those minerals. It should determine how the benefits derived from the exploitation of the sea-bed resources should be distributed among the various States and how sea-bed technology would be transferred to the developing countries.

8. He supported proposals for free passage of ships and other vessels on the high seas, through straits traditionally used for international navigation and through other traditional channels of navigation. The essential national interests of coastal States in safeguarding the quality of the marine environment and preserving their resources should, however, be safeguarded in respect of the question of passage through straits or through the waters enclosed within archipelagos. The concept of archipelagos was being promoted by several developing countries, and a proposal on that subject had been made by several States with which India had friendly relations. His delegation would give sympathetic consideration to the implications of the concept of an archipelago or archipelagic State if the following provisions were given consideration: the body of water enclosed by drawing straight baselines joining the outermost points on the outermost islands constituting an archipelago should be reasonable; the channels of navigation traditionally used by international shipping should be respected; and the principle should apply to the Andaman and Nicobar Islands and also to the Lakswadeep Islands. No distinction should be made between an archipelago that constituted a single State and an archipelago that formed an integral part of a coastal State, nor should an archipelago at some distance from the coastal State be treated differently from one located near a coastal State. The Andaman and Nicobar archipelago and the Lakswadeep archipelago should be entitled to the same status as any other archipelago.

9. On the question of land-locked States, his Government had always tried to accommodate the legitimate interests of land-locked States in its bilateral relations with Nepal, Bhutan and Afghanistan, and it would continue to do so. The proposal on fisheries, sponsored by his delegation, included specific provisions to accommodate the interests of land-locked States in the exclusive fishery zone, and a similar provision had been included in proposals on the exclusive economic zone. The legitimate interests of other geographically disadvantaged States should also be accommodated in a fair way.

10. In connexion with the question of the preservation of the marine environment, he recommended co-ordination between the Inter-Governmental Maritime Consultative Organization in the field of pollution from ships, the United Nations Environment Programme in the field of pollution from land and other sources, and the proposed International Sea-Bed Authority. The rules and standards evolved should take account of the economic condition of developing States and should not be burdensome, although they should promote uniformity. Coastal States should be responsible for enforcing the application of those standards in their economic zones.

11. Mr. DAVIS (Canada) expressed his conviction that the Conference would succeed in adopting modern rules of law to govern man's activities on the seas. His Government was particularly aware that human destiny was inseparably linked to that of the ocean, for Canada had the longest coastline in the world and had many lakes and immense river systems flowing into the sea. Canada had an interest in the protection of all of the oceans, but more especially an interest in the continental shelf and margin. His Government intended to do all it could to maintain freedom of navigation, while maintaining the quality of marine life in the ocean areas adjacent to its coast.

12. The coastal States had special opportunities and special obligations in economic and ecological questions. He therefore urged an extension of coastal State jurisdiction in respect of certain activities, particularly fishing and the protection of the marine environment. Although world shipping should be able to move as freely as possible everywhere, changes in the regulations were essential because of the problems caused by the biological consequences of pollution and of overfishing which were currently beyond the control of the coastal State. Coastal States could, through wise and generous management of their adjacent seas, protect a vital world interest. The United Nations Conference on the Human Environment had specifically underlined the need for conservation of the marine environment and had stressed the obligation of coastal States to manage the marine environment close to their shores.

13. A wide consensus had already emerged on two major issues before the Conference, the breadth of the territorial sea and the concept of the economic zone. There was a clear trend in favour of a 12-mile territorial sea. The concept of the economic zone or patrimonial sea, extending for 200 miles for some purposes and to the outer edge of the continental margin for others, was supported by many countries. That concept embodied a balance between the special legitimate needs of coastal States to protect the environment and the needs of all States for trade and communication by sea. The concept of the economic zone and the concept of the remaining 80 per cent of all ocean space constituting the common heritage of mankind were the two main pillars on which the régime of the seas should be based. The oceans could no longer be divided into the territorial sea on the one hand and the high seas on the other. Functional concepts were needed and must be developed by the Conference.

14. Mankind's concerns in respect of the sea were both environmental and economic. The provisions adopted by the Conference should be based on physical and biological realities. It was important to know where fish stocks were and where they spent their natural lives, to know how far the continental shelf or margin extended seawards off the coast of each country. The Conference should first deal with the conservation and wise management of the precious marine resources, and then draft rules and regulations in line with economic and ecological imperatives.

15. On the question of the mineral resources of the sea-bed beyond the limits of national jurisdiction, he believed that some new form of international co-operation and a strong international authority to manage the resources was needed. Exploitation of the resources of the international sea-bed should be planned and executed with full regard for all the factors involved, including access to the area, minimization of possible adverse economic effects, collection and distribution of financial benefits among States, and preservation of the living marine resources. New problems needed imaginative solutions. The main aim was to devise a system that would work to the benefit of mankind in general and of the developing countries in particular. There could be no real benefit for mankind unless advanced technology was effective, and that would of course require just compensation. He hoped that it would be possible to reconcile those interests.

16. His delegation had a particular interest in the subject of the natural resources of the continental shelf. The basic problem was one of delimitation, not ownership. His delegation's position was that the sovereign rights of coastal States, as defined in the 1958 Geneva Convention on the Continental Shelf[1] and confirmed by the International Court of Justice and in State practice, extended to the limit of the continental margin. The 200-mile economic zone concept was appropriate to the geographic situation of most countries, but the continental margins of some countries were wider than 200 miles and provision should be made for those countries to maintain existing rights to the edge of the continental margin.

17. Turning to the question of fisheries, he said that many countries considered that the living resources of the sea could best be managed by coastal States within the conceptual framework of the economic zone. The concept of freedom of fishing, as traditionally practised, no longer met the needs of the present time. The States bordering on the coastal areas where most fish stocks were found should be given the right and responsibility to manage those stocks in accordance with agreed principles. Coastal States should have the right to exploit as much of the fish stocks under their jurisdiction as they had the capacity and economic interest to exploit under conditions that would allow them to expand their capacity to exploit, or to benefit in other ways from, those resources. That was the only way to conserve the world fisheries and to make full and rational use of them. It would also protect the vital interests of the coastal communities that depended on fishing.

18. The concept of the 200-mile economic zone or patrimonial sea went far towards resolving the fisheries problem. Some additional provisions were, however, necessary. Coastal stocks should be managed on a scientific and functional basis as a whole, and appropriate recognition should be given to the interests of the coastal State with regard to those stocks in areas adjacent to the economic zone. In order to ensure adequate protection and proper management of the anadromous stocks, such as salmon, fishing for those stocks should be prohibited outside the economic zone, and the primary interests of the State in whose rivers those fishes were spawned should be recognized. Management of wide-ranging stocks such as tuna and whales was also needed; the authority of the coastal State over such stocks within their economic zone should be accommodated, and his delegation felt that co-operation between the relevant international commissions and the coastal States concerned could achieve balance of interests. In order to ensure optimum utilization of the living resources of the economic zone, as distinct from those of the continental shelf, foreign States should be allowed to fish for the surplus of stocks not reserved to the coastal State, subject to the authority and regulations of the coastal State, and under equitable arrangements for apportionment of the surplus.

19. Preserving the quality of the marine environment was essential to conserve fishery resources. Coastal States should be responsible for controlling shore-based pollution which constituted the major part of ocean pollution. One example was the great river system of the St. Lawrence which reached nearly 900 miles into the industrialized centre of North America; the success with which his Government and the United States Gov-

[1] United Nations, *Treaty Series*, vol. 499, p. 312.

ernment protected the quality of those waters would affect large areas of the North Atlantic Ocean. All States must undertake to preserve the marine environment from pollution damage from all sources, internal as well as external, and in particular refrain from inflicting such damage upon others. The Conference should provide effective international measures and also endorse the right of coastal States to take further measures against pollution where necessary. Pollution from ships, although not the major source of ocean pollution, was a significant threat to the sea, and how to control such pollution presented some of the most difficult problems facing the Conference. Navigation represented a basic, legitimate and vital use of the sea, but it must be subject to proper regulation so that it would not lead to degradation of the environment. There were precedents, for example, traffic regulations for air navigation and international river systems. The Conference should provide for effective enforcement of internationally agreed standards for the safe operation of ships in every part of the oceans, not only by the State of registration, but by all States concerned. The major problem would be to reconcile the need for harmonization of measures with the need of coastal States, when faced with special circumstances, to adopt special measures, for example, in respect of ice-covered waters, congested traffic situations, shallow or narrow channels and other situations, particularly in semi-enclosed seas and international straits.

20. With respect to the question of straits, he said that the right of passage through international straits should be assured for all States subject to international regulation and to the right of the coastal State to protect itself. A system of guarantees, internationally applied and enforced, was necessary to ensure that coastal States and flag States exercised their rights in economic zones or in international straits in a reasonable manner.

21. Scientific research in areas adjacent to coastal States should be regulated in a constructive and reasonable manner. The law of the sea should be based on up-to-date knowledge of the sea. His Government was committed to support of scientific research to expand knowledge of the ocean and increase human dependence upon it.

22. He drew attention to the fact that his Government had adopted legislation asserting its right to fisheries and pollution control and continental shelf jurisdiction over large areas of the sea adjacent to its coast.

23. Commenting on the archipelago concept, he said that he supported attempts being made to work out a compromise solution taking account of the special position of archipelagos while at the same time recognizing the interests of all States in passage through archipelagic waters. Canada itself was an archipelagic State, and the Arctic archipelago was a classic example of a special area requiring special treatment.

24. The views of his delegation were based on national interests and also on the conviction that a general accommodation of the interests of all States was essential to serve the common interests of all nations in the future.

25. Mr. THOMPSON (Jamaica) said that his delegation had been disturbed by occasional references to anticipated confrontations between the great maritime hegemonies on the one hand and the poorer, weaker nations of the developing world on the other. Jamaica did not share that pessimism, first because it expected that the differing positions to be taken on most of the complex points at issue would draw their support from both great and small Powers, and secondly because the voting procedure which had been adopted would provide an opportunity for all the participants to work together to redress the injustices of the past. To that end, the developing countries in particular, abiding by what he would like to call the discipline of mutual distress, should join in placing their just causes before the Conference. Until now the voiceless former colonies could accurately have been described as the politically disadvantaged States. At the Conference, however, the principles of the independence and sovereignty of nations and the "one nation, one vote" concept, were universally recognized. Moreover, as the recent energy crisis had shown, the world was becoming increasingly interdependent and there was greater respect on the part of the industrial giants for the erstwhile weaker nations. Even so, however, the latter were conditioned by history to judge the former by their deeds rather than their words. The industrialized countries therefore had a heavy responsibility to convince the developing countries of their sincerity.

26. In that connexion his delegation wished to associate itself with those which had paid tributes to the valiant efforts of the liberation movements that were continuing to fight for justice.

27. His delegation would make known in the Committees its position on various matters of substance. The main point to which he wished to address himself at that stage was that the Conference was more likely to be a success if members demonstrated the ability to adjust to each other's positions than if they stubbornly defended preconceived positions. In that connexion, he would like to introduce one qualification with respect to the position taken by some in support of the idea of a patrimonial sea with a breadth of 200 miles. That concept of an enlarged economic zone of control had first been put forward by the developing nations and was gradually gaining acceptance. His delegation was not discouraged by the fact that it meant different things to different people—indeed, that was as it should be, given the diversity of situations in which it was expected to be applied. Having recognized that it had had its origin in the desire of the poorer coastal States to extend their maritime boundaries, and that its objective was to improve the lot of the needy inhabitants of the regions in which those States were situated, delegations must be prepared to show flexibility in its application, for it would be ironic if the very principle conceived by the developing States were to be applied so rigidly as to cut off the source of livelihood of fishermen long established in a particular area or to reduce the condition of an already poor neighbouring country to one of stark destitution. Such an application of the concept would, moreover, deny the just claims of the land-locked nations. His delegation therefore proposed that the principle should be enunciated in terms making provision for the qualifications which would allow for regional flexibility. That position was not a new one, for it had been outlined at the Specialized Conference of the Caribbean Countries on Problems of the Sea at Santo Domingo in 1972.

28. There were various ways in which the merits of the patrimonial sea concept could be assessed. In the strictly diplomatic sense, it could be viewed from the standpoint of whether it contained elements of a compromise between the divergent schools of thought on the question of the limited patrimonial sea. In practical terms, it could be viewed as a means of conserving resources and enabling coastal States to derive the maximum benefit from such marine resources as might exist in the waters off their shores, while at the same time the effect of its application on the concept of the common heritage enshrined in the United Nations Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction[2] would have to be taken into account. One of the fundamental problems confronting developing countries was that of finding ways of protecting their marine resources to the fullest possible extent without undermining the common heritage concept. In pursuing that end it was essential to appreciate the exceptional circumstances of some countries. His own delegation, for example, had considerable sympathy for countries which were in the situation described by Peru in the statement on the subject made by its Minister for Foreign Affairs in May 1970.

29. Thus Jamaica did not adhere to the rigid concept of an exclusive rule for the economic zone. However, as a compro-

[2]General Assembly resolution 2749 (XXV).

mise, it would be prepared to accept an economic zone if rights of access were guaranteed. It would be disastrous for the 20 million people inhabiting the Caribbean islands if such a guarantee of rights of access was not embodied in the same Convention setting forth the concept of the economic zone. The matter was not one which could be settled merely by regional or bilateral arrangements. He drew attention in that connexion to the draft articles on regional facilities for developing geographically disadvantaged coastal States submitted by his country to the sea-bed Committee (*ibid.* sect. 45). Those articles were inextricably bound up with the question of the limits of national jurisdiction and Jamaica's acceptance of those limits. His delegation felt not only that the principle embodied in those articles must be enshrined in a general multilateral treaty but also that they must be so placed as to run parallel with the articles embodying whatever concept was finally adopted, whether that of a patrimonial sea, an economic zone or any other zone. That parallelism would determine Jamaica's attitude toward the limits to be agreed upon. The Conference must take account of the facts of geography, of nature and of the variety of regional peculiarities. His delegation believed that the geographically disadvantaged States of the Caribbean should be afforded equal access to the resources of the waters surrounding them. It did not feel that there would be any infringement of sovereignty if the living resources of the Caribbean beyond the accepted 12-mile limit for territorial waters were considered not in absolute terms of monopoly by the coastal State but in terms of priority. That concept could be given effect by a provision under which a State would allow neighbouring disadvantaged States of the Caribbean area facilities for fishing, limited to their domestic requirements. He wished to emphasize that such a sharing of the regional heritage would not limit exploitation by the coastal States and would certainly exclude the great continental Powers.

30. The formula need not be limited to the Caribbean but could apply elsewhere in similar circumstances with a view to improving the quality of life for the victims of poverty.

31. At the current session of the Conference the President of Venezuela had supported the concepts of freedom of travel, research, transport and communication on the open sea. His delegation associated itself with that position and hoped that delegations would give it careful consideration, particularly when dealing with the question of straits. Another matter of the greatest importance was the need for the Conference to recommend the establishment of a headquarters for the institutional machinery which would put the results of its deliberations into effect. The relevant executive body should be made up of persons of the highest reputation and ability and should reflect the principle of equitable geographical distribution. The kind of authority he had in mind was, of course, light years away from any sort of petty international licensing authority engaged in granting concessions to multinational corporations. The task of the Conference was to establish a new international legal order for the sea, and any such new legal order necessitated machinery for the resolution of differences. It was a fact of life that however well concepts might be formulated or objectives defined, problems of interpretation and application would continue to arise. Hence satisfactory machinery and procedures for the settlement of disputes must be established.

32. In conclusion, he wished to pay a tribute to the generosity of Venezuela, which was the source of the inspiration by which the participants in the Conference were guided. His Government took the opportunity formally to offer for consideration a site in Jamaica to accommodate whatever international maritime authority was decided upon. He had already been assured of wide support for that offer. Jamaica, a developing nation located at the cross-routes of the ocean, had long experience of the problems of the sea and possessed the infrastructure and ancillary facilities required for the establishment of such an institution. Indeed, what place could be more suitable for that purpose than the beautiful island which had once offered Simón Bolívar sanctuary and from which he had written his famous *Cartas de Jamaica*?

Mr. Arias Schreiber (Peru), Vice-President, took the Chair.

33. Mr. PLAKA (Albania) observed that the Conference had been made possible thanks to the efforts of sovereign countries devoted to peace and freedom, including Albania. The fact that it was being held in Venezuela was a reflection of the struggle of the countries of Asia, Africa and Latin America for the defence and consolidation of their national sovereignty and their economic interests. Those countries had made an important contribution to the preparation for the Conference made by the sea-bed Committee and elsewhere, submitting numerous proposals and drafting documents based in particular on the concept of defending the rights of the peoples of the world. In accordance with that concept, it was necessary to change the international law of the sea so that it would benefit the peoples and to put an end to the ruthless plunder of the resources of the sea by the imperialist Powers. The time when imperialism could dictate the law had passed. The need for changes in the law of the sea had become particularly apparent during the past two decades, when many new States had emerged as a result of the struggle against colonialist and imperialist oppression, States which had not participated in the two earlier conferences on the law of the sea. The urgency of the Conference's task was particularly apparent at a time when peace and the vital national interests of coastal States were being increasingly threatened by the policy of aggression and expansion of the two imperialist super-Powers, the United States and the Soviet Union, which were seeking to arrogate to themselves the role of arbiters with respect to the international problems of the day, to establish their hegemony in the world and to dominate the seas. As a result of their aggressive expansionist policies and of their rivalry and collaboration, tension was increasing in the Middle East, Indo-China, Europe, the Mediterranean, the Indian Ocean and other parts of the world. They were continuing their unbridled arms race, producing and perfecting new long-range weapons of mass destruction and increasing their naval forces with a view to unleashing a new world war and dividing the world into new spheres of influence. In that context, changes in the law of the sea which would help countries to defend their national sovereignty assumed special importance. The imperialism of the United States and the social-imperialism of the Soviet Union were seeking, under various fallacious "legal" pretexts, to impose their will, making the law of the sea contingent upon the balance of naval power, to weaken the defence capability of sovereign peoples and countries and to subject them to pressure, blackmail and military threats. In other words, they were seeking to impose "the law of the strongest" and to legitimize their freedom to dominate and plunder the seas.

34. Ocean space beyond the limits of national jurisdiction and its resources were the patrimony of all the peoples and countries of the world and the sovereign countries dedicated to peace were rightly calling for the formulation of new rules of sea law which would favour their legitimate interests. However, the imperialist Powers, and primarily the two super-Powers, continued to put obstacles in the way of the development and modification of the law of the sea because they wished to protect their military, political and economic interests at the expense of the other countries of the world. That was why they had sent their warships, submarines and spy ships to the different parts of the world to demonstrate their strength and intimidate the peoples. However, those peoples clearly understood that the seductive slogans of the United States and the Soviet Union concerning "peace", "disarmament" and "détente" bore no relation to their real policies and aggressive activities. The meetings of Nixon and Brezhnev at Moscow and Yalta did not augur well for the peoples or for world peace; on the contrary, they were but one more indication of the diabolical intent of the two super-Powers to establish, in rivalry and collaboration, their hegemony over both land and sea. While

creating false hopes in order to lull the vigilance of the peoples, those two Powers were ceaselessly strengthening their navies and deploying them at distances of thousands of kilometres from their national territory.

35. Mr. ROMANOV (Union of Soviet Socialist Republics), speaking on a point of order, said that while each delegation was entitled to set forth its views, the Conference was a completely inappropriate forum for the expression of unworthy sentiments which were at variance with the fundamentals of human ethics. He therefore appealed to the President to apply the rule of procedure under which a speaker whose remarks were not relevant to the subject under discussion could be called to order.

36. The PRESIDENT said that the representative of the USSR could speak in exercise of the right of reply later but that in the meantime the representative of Albania should be allowed to exercise the right, which he possessed in common with all other representatives, to continue his exposition of the views of his Government.

37. Mr. PLAKA (Albana), continuing his statement, said that a typical example of the confrontation-collaboration of the two super-Powers was the situation in the Mediterranean, which had been transformed into an area of tension as a result of the presence of the fleets of those two super-Powers and their naval bases in that area. They were endangering the security of the countries of the Mediterranean basin, which resolutely opposed their presence and were demanding that they should remove their forces as quickly as possible. The leader of the Albanian people, Enver Hoxha, had said that Albania, as a country of the Mediterranean, wanted the Mediterranean basin to be a zone of peace and co-operation and had added that it was the duty of all peace-loving countries to demand the removal of those fleets and combat any attempt to impose political hegemony in that part of the world, for the Mediterranean belonged to the Mediterranean peoples and countries. If their aspirations for real détente in the Mediterranean were to be realized, the foreign military bases in their territories would have to be liquidated. Moreover, they should not permit the installation of other foreign bases on their territory, grant port or other facilities to the United States or Soviet fleets, or allow them to visit their countries. The application of those measures in the Mediterranean and in other areas where the fleets of the two super-Powers had appeared would be in accordance with the security and economic interests of all the coastal States and would be an important contribution to world peace.

38. The presence of the fleets of the two Powers in the Indian Ocean likewise served their aggressive purposes and was directed against the countries of the area which were dedicated to peace and freedom, in particular the People's Republic of China, which was resolutely defending the true security of Asia and the world and represented an insuperable obstacle to the realization of the aggressive plans of the two Powers to stifle the national liberation struggle and enslave the peoples. It was the duty of the Conference to establish precise rules to prevent the concentration of large naval units on the high seas or off the coasts of other countries and to prevent military manoeuvres near such coasts. That was particularly urgent in the light of the violation of the territorial waters of sovereign States by the fleets of the two super-Powers, their presence off the coasts of other countries and their naval bases on foreign soil and installations on the sea-bed. His delegation likewise considered that foreign warships should be allowed to enter the territorial waters of coastal States only in accordance with the provisions of the law of the State concerned.

39. The exploitation on a footing of equality of the resources of the sea beyond the limits of national jurisdiction was the legitimate right of all States, great or small, coastal or land-locked. That question too was linked to the efforts of the developing countries to promote their political independence. The great fishing fleets of the two super-Powers were plundering the fishery resources of other countries. Their pirate fishing vessels had been seized in the territorial waters of many coastal States. Four fifths of the fish caught by Soviet vessels did not originate in Soviet territorial waters, and the same was true of the United States. Those two Powers were doing everything they could to limit the sovereignty of coastal States to as narrow a zone as possible, not exceeding 12 nautical miles, in pursuit of their intention to establish military installations and plunder the resources of the sea off the coasts of independent countries. The countries of Asia, Africa and Latin America and other peace-loving countries had risen up in defence of their national sovereignty over their territorial waters and the resources of the sea and had launched a resolute struggle against the two super-Powers which were attempting to impose their hegemony over the seas. To put an end to those efforts of the imperialist Powers it was essential that the rules of international law concerning the sea should be changed in conformity with the inalienable rights of peoples and countries. Albania supported the right of every sovereign country to determine the extent of its territorial waters in a reasonable way, without prejudice to the interests of neighbouring countries or international navigation, in accordance with specific geographical, biological and oceanographical conditions, taking into consideration first of all the requirements of its national security. At a time when the aggressive fleets of the two super-Powers were sweeping the seas in all directions, threatening the independence of sovereign coastal States, Albania maintained that those countries were entitled to fix the limit of their territorial waters at not less than 12 miles and it rejected the dictates of the two super-Powers on that question. It likewise supported the right of the Latin American, African and Asian countries to establish a 200-mile limit for their territorial waters. Since the two super-Powers were traversing the Mediterranean and the Adriatic like sea monsters, Albania was going to reconsider the breadth of its territorial waters beyond the 12-mile limit. It further supported the right of coastal States to establish and exercise jurisdiction over an exclusive economic zone extending to a reasonable limit beyond their territorial waters in conformity with geographical, biological and oceanographic conditions, without prejudice to international navigation. In that connexion, his delegation felt that because of serious defects and omissions which could give rise to wrong interpretations and lead to conflicts between States and to the violation of the sovereign rights of coastal States, adversely affecting the interests of many developing countries, the 1958 Convention on the Continental Shelf should be radically changed and made to conform to the legitimate interests of sovereign coastal States. In certain zones the continental shelf should be defined by the countries concerned in consultation with each other, and where appropriate the continental shelf could be divided between neighbouring coastal States.

40. Since the efforts of many African, Asian and Latin American countries to assert their political and economic sovereignty over the maritime zones along their coasts had recently been receiving the support of an overwhelming majority of sovereign States, the Conference should recognize the changes which had occurred in that field and should establish just rules for the progressive development and codification of the law of the sea. It should assert the legitimate right of sovereign coastal States to conserve and utilize the natural resources in their territorial waters, their exclusive economic zone and their continental shelf. Those provisions should be based on the principles of respect for national sovereignty, the right of self-determination of peoples, non-interference in the internal affairs of countries, and respect for the territorial integrity and equality of rights of all sovereign peoples and countries.

41. His delegation likewise attached particular importance to the establishment of a just régime for straits, which should be established by sovereign coastal States, having regard to freedom of international navigation in accordance with the rules fixed by the coastal State in question and without dis-

crimination against peace-loving sovereign States. It supported the efforts of the coastal States concerned to re-establish their sovereignty over straits or channels used for international navigation the extent of which lay entirely within their territorial waters. Indeed, Albania was directly concerned with that question because of the existence in the Adriatic Sea, off its own waters, of the Strait of Otranto. The régime governing straits which were entirely within the territorial waters of two neighbouring countries and which were not used for international navigation should be decided solely by those two coastal States.

42. The same criterion should be applied in determining the régime of an archipelagic State, which should exercise complete sovereignty over the waters surrounding it and at the same time ensure freedom of navigation through international waterways along its coasts. Albania supported the just struggle of the Panamanian people to recover the Canal Zone usurped by the United States, for that would restore the territorial integrity of Panama, and possession of the Canal Zone was its inalienable right. The régime of straits was particularly important for peaceful countries, particularly in view of the fact that the two super-Powers had adopted the same line of conduct in that regard, seeking to utilize them for the transit of their warships and aircraft for the obvious purpose of intimidating the coastal States in pursuit of their goal of political hegemony. The Conference should therefore support the rights of coastal States with respect to straits and firmly oppose the manoeuvres of the two super-Powers, rejecting any compromise in the matter which would affect the vital interests of the peoples, their security and their national sovereignty. His Government also supported the demands of the land-locked countries to be allowed to engage in the peaceful utilization or exploitation of the seas under bilateral agreements based on respect for the sovereignty of coastal States.

43. All the peace-loving countries represented at the Conference must be on guard against the intrigues and insidious subterfuges, including the so-called consensus, engaged in by the two super-Powers which claimed to be in favour of changing the law of the sea but were in reality adamantly opposed to the legitimate rights of the sovereign coastal States and were redoubling their efforts to perpetuate their privileged position.

44. If the Conference was to achieve its purposes, universal participation should be ensured. For that reason his delegation protested against the injustice done the Provisional Revolutionary Government of the Republic of South Viet-Nam, which, because of the hostile and discriminatory attitude of the United States, had been deprived of its lawful right to participate in the proceedings. That Government was the only authentic representative of the interests of the people of South Viet-Nam and his delegation protested against the representation of the puppet Saigon régime and did not recognize the validity of its activities at the Conference. Similarly, the participation of representatives of the Lon Nol clique constituted an intolerable intervention in the internal affairs of the Cambodian people, for everyone knew that their only lawful representative was the Royal Government of National Union headed by Samdech Norodom Sihanouk. In accordance with that same position, his delegation considered the participation of representatives of the national liberation movements in the work of the Conference indispensable. The struggle waged by the oppressed peoples of Palestine, South Africa, Southern Rhodesia, the Portuguese colonies, Puerto Rico and other colonial territories for freedom and independence was a just struggle which had the support of all progressive humanity. The liberation movements were the sole authentic representatives of their peoples and they should therefore be invited to attend the Conference.

45. He wished to protest against the attempt of the Soviet representative to muzzle not only the delegation of Albania but also the delegations of the countries of Latin America, Asia and Africa and to prevent them from defending their legitimate interests. Everyone knew that the Soviet Union had not been enthusiastic about the proposal to convene a conference on the law of the sea in the first place. Albania had been subjected to pressure by the two super-Powers precisely because it had courageously defended the Marxist-Leninist position which had been betrayed by the Soviet revisionists.

46. The PRESIDENT said he wished to remind members that all delegations had been asked to exercise moderation in making their statements and to confine themselves to the issues under discussion.

47. Mr. CHOWDHURY (Bangladesh) said that the Conference was of historic importance as it was designed to ensure that the seas would be zones of peace.

48. Many of the nations which had become eligible to participate since the 1958 and 1960 Conferences on the Law of the Sea felt that their views had not been represented and that their interests had been ignored at those Conferences. The 1958 Geneva Conventions did not reflect the nature and complexity of the law of the sea and the extent to which the practice of States had developed in the past 17 years. Obviously, any new order in the régime of the sea must adequately reflect the views of the developing countries.

49. His delegation hoped that the Conference would be able to formulate a new law of the sea based not only on respect for the sovereign equality of States and the elimination of all forms of hegemony and dependence, but also on the application of the principles of social and economic justice. Developing countries, as a result of their economic position, had called for the recognition of certain preferential criteria in the determination of the extent and use of ocean space, particularly those of the "common heritage of mankind" and of the "exclusive economic zone", or "patrimonial sea". The Declaration of Principles adopted by the General Assembly in 1970 had in itself virtually constituted the nucleus of a draft treaty on the régime of the sea, sea-bed and ocean floor beyond national jurisdiction and had provided for the development of the "common heritage" concept. Far more important, however, was the attempt by developing countries to seek international acceptance and legitimization of the concept of an economic zone, which would give coastal States exclusive control, short of full sovereignty, over all living and mineral resources as far out as 200 miles. That concept had received the endorsement of the Fourth Conference of Heads of State or Government of Non-Aligned Countries at Algiers, the Organization of African Unity meeting of the Council of Ministers in 1973, and most of the Caribbean and other Latin American States.

50. His delegation believed that the present Conference hinged around two issues of paramount importance, namely the seawards limit of coastal State control and the nature and scope of national jurisdiction over the coastal areas. Those issues naturally gave rise to other matters, such as the international régime and machinery, the position of land-locked States, the question of straits and archipelagos, marine environment, ocean research, the question of revenue sharing and the procedure for the settlement of international disputes. Those issues were interrelated; none of the matters which came up at the Conference could be viewed in isolation.

51. Bangladesh had a population of 75 million living in an area of only 55,000 square miles. If its current annual population growth rate of 3 per cent remained unchecked, its population could reach the staggering figure of 200 million by the turn of the century. Moreover, despite attempts to obtain self-sufficiency in food, Bangladesh remained a food-deficient area.

52. Those facts had to be viewed with concern as they indicated dramatically the economic plight of his country. Bangladesh was making gigantic and dedicated efforts to overcome those problems, and in doing so depended on the sea as its source of additional food supplies. To augment resources vitally necessary for its development, it required maximum utilization of continental margins. In that respect, its disadvantages

were somewhat offset by nature, as Bangladesh was a coastal State with over a thousand miles of heavily indented coastline and numerous offshore islands, so that the sea and its resources provided it with an essential lifeline. Bangladesh was also a fishing nation, and a great many of its people—entire communities in some offshore island areas—depended solely on fishing for their livelihood.

53. Thus, his country's views on national jurisdiction and the extent of its coastal State control grew out of the fact that the sea, the sea-bed and its resources, both living and non-living, renewable and non-renewable, constituted an essential supplement to its economy. That had been the impetus behind his Government's efforts to define the extent of its sovereign rights over the management and control of the ocean, and the limits of its national jurisdiction. The Bangladesh Parliament had already enacted a "Territorial Waters and Maritime Zones Act", which enabled the Government to declare the limits of the territorial waters, contiguous zone, economic zone and continental shelf. Pursuant to that Act the Government had issued notices stating that its territorial waters extended to 12 nautical miles, and its economic zone to 200 nautical miles, from baselines expressed in geographical co-ordinates.

54. His delegation believed that the straight baseline method took into account the diversity of facts and the geographical peculiarities of the coasts of littoral States, and it therefore conceded that straight baselines might be drawn following the depth method. Considerable support of that position was to be found in the Anglo-Norwegian Fisheries Case, where the International Court of Justice had observed that a State must be allowed the latitude necessary to adapt its delimitation to practical needs and local requirements.[3]

55. Bangladesh claimed exclusive jurisdiction over the 200-mile economic zone for exploration and exploitation of all natural resources, both living and non-living, including the sea-bed, subsoil, water surface and water column. He appreciated the statement made earlier in the meeting by the Indian representative to the effect that the interests of Bangladesh and other coastal States should be taken into account by the international community.

56. His delegation also believed that the delimitation of the territorial waters and economic zone should be without prejudice to the régime of the continental shelf. The jurisdiction of coastal States over their continental shelf was an inherent right. Some 85 States had issued laws and decrees regarding their jurisdiction over the shelf. The only point that remained to be determined was the exact extent of such jurisdiction, since the definition found in the 1958 Convention on the Continental Shelf lacked precision and included a criterion of exploitability which was subject to varied interpretations. With a view to removing any possible doubt, Bangladesh had defined its continental shelf as comprising the sea-bed and subsoil of the submarine areas adjacent to the coast of the country but beyond the limits of the territorial waters, up to the outer limits of the continental margin bordering on the ocean basin or abyssal floor. The legislation also envisaged comprehensive control over the utilization of the continental shelf.

57. Bangladesh supported the concept of a contiguous zone, and had declared the existence of such a zone extending seawards to a line six nautical miles measured from the outer limit of its territorial waters. In the zone, Bangladesh would exercise necessary control to prevent and punish the infringement of its customs, fiscal, immigration, sanitary and security laws.

58. Bangladesh, in accordance with its law, had the right to establish conservation zones in areas of the sea adjacent to its territorial waters, and could take conservation measures in such zones for the purpose of protecting the living resources of the sea from indiscriminate exploitation, depletion or destruction. Its law provided that the Government could take such measures as it deemed appropriate for the purpose of preventing and controlling marine pollution and preserving the quality and ecological balance of the marine environment in the high seas adjacent to its territorial waters.

59. His Government believed that the régime of the sea to be established by a new convention must gain the wide support of States. It must ensure that the legitimate interests of land-locked and geographically disadvantaged States were protected. His delegation viewed the position of those States with sympathy and felt that the best interests of all parties could be mutually secured by close bilateral and regional co-operation.

60. With regard to the ocean space beyond national jurisdiction, Bangladesh endorsed the Declaration of Principles contained in General Assembly resolution 2749 (XXV), particularly the principle of the "common heritage of mankind". That declaration should, however, be made real and effective. The international régime should extend to all ocean space, its sea-bed and superjacent waters, and also to the sea itself and all resources of the sea beyond the limits of national jurisdiction. The régime should have appropriate powers for the preservation of the marine environment from pollution. Bangladesh also favoured the establishment of international machinery with full legal personality and with functional privileges and immunities, under the supervision of the United Nations.

61. The new régime of the law of the sea would have an immediate and crucial impact on all regions of the world, including those which were struggling for their right of self-determination. His delegation, therefore, considered that the Conference would not be complete if the representatives of the liberation movements, including that of Palestine, were not admitted as observers. When Bangladesh had fought for its own liberty, it had fought for the liberty of the world, as it firmly believed that life and freedom were indivisible. Wherever peoples were fighting for their liberty, Bangladesh was with them. Bangladesh's support for the people of Palestine, in particular, was total, as it had reiterated many times.

62. His delegation believed that sincere attempts must be made to reconcile the conflicting interests of all nations in order to open the way to a viable and long-lasting agreement on the oceans. It would make constant efforts to achieve such an agreement, remaining aware at all times of national, regional and international interests. If a sense of objectivity, fairness and justice was retained, he was confident that acceptable and enforceable principles could be laid down. Conference participants must renounce their desire for power, and act in a spirit of sympathy, mutual consideration and understanding, fellowship and love. Their concern must be for man and not for States, as the latter existed only for human welfare.

63. Mr. ROMANOV (Union of Soviet Socialist Republics) said that the appeal for moderation and restraint made by the President at the previous day's meeting had been timely and reasonable. The present meeting had also shown the need for such an appeal. The statement which he had already mentioned in his earlier point of order was not worthy of a reply. It came from the same source as the similar statement of the previous day.

64. If the Conference was to deal successfully with pollution of the sea environment and other problems relating to the law of the sea, then the climate at the Conference itself must also be free from any political or other pollution.

65. Mr. PLAKA (Albania) said that the Soviet representative's remarks were a vain attempt to reduce the effect of his delegation's statements.

66. Albania had come to the Conference to seek a new law and to defend the interests of peoples. It had no other intent. If the representative of the Soviet Union thought otherwise, then he should explain what its naval fleets were doing in the Mediterranean and in the Indian and Atlantic Oceans. Obviously, the fleets were there to threaten, intimidate and enslave devel-

[3] *Fisheries Case, Judgment of December 18th, 1951: I.C.J. Reports 1951*, p. 116.

oping countries, and all such countries had a right to be anxious.

67. Not only had the Soviet Union been against the organization of the present Conference, but it had, in its statements, threatened the sovereignty of coastal States and advocated free shipping and access to territorial waters in order to despoil other nations and impose its will on them. Its intentions could not be concealed and showed that the Soviet Union was a revisionist and chauvinist super-Power.

68. The PRESIDENT said that although questions relating to the law of the sea inevitably had political overtones, he wished again to appeal to delegations to exercise restraint in their statements.

The meeting rose at 1.30 p.m.

28th meeting

Wednesday, 3 July 1974, at 3.40 p.m.

President: Mr. H. S. AMERASINGHE (Sri Lanka).

General statements (*continued*)

1. Mr. PINTO (Sri Lanka) said that his Government had already indicated its position on the law of the sea in various bodies concerned with the sea-bed. Consequently, he wished to deal with the question that he considered to be of the highest importance—the exclusive economic zone and, in particular, an exclusive fishery zone, which should be the subject of recognition and codification at the current session of the Conference.

2. In the opinion of his delegation, a State had sovereignty for the purpose of exploiting the available living, non-living, renewable and non-renewable resources of the exclusive economic zone. That meant that all the resources of the zone actually belonged to the coastal State, which was the only State that could take action to conserve and manage them. If the coastal State was unable, because of a lack of technological and financial capacity, to exploit the resources of the zone, it would be open to the coastal State to enter into arrangements with other Governments and entities to exploit the resources so as to generate the maximum possible benefit. The coastal State did not therefore have merely a preferential right to those resources. If that were so, the right of the coastal State would be limited to only those resources that were exploitable. Recognition of the exclusive economic zone would not only protect existing investments but would also offer new incentives for development of the fishing industry by guaranteeing that the Government would have the right to take action to conserve the resources and to control competition. A distinction had to be made between renewable resources, consisting of fish stocks that would be wasted if they were not harvested systematically, and non-renewable resources, consisting of minerals that could remain untapped indefinitely. Consequently, it was to be foreseen that the coastal State would adopt different approaches to the exploitation of the two types of resource.

3. As far as the exclusive fishery zone was concerned, it was essential to recognize that all species of fish in the zone were to be treated as belonging to the coastal State and subject to its exclusive right of exploitation. Nevertheless, in view of the biological characteristics of those resources, the coastal State would recognize that when the fish passed out of its national jurisdiction or into the jurisdiction of another State, the coastal State would lose its exclusive rights to them, and, in view of the mobility of the resource, the coastal State should exploit it with due regard to the interests of the international community and, in particular, of neighbouring States. That would not apply, of course, to such species as anadromous fish, for which special provision would be needed.

4. As to the operation of an exclusive fishery zone, his country was particularly interested in conservation and management on the one hand, and arrangements for full utilization on the other. As far as conservation and management of the zone were concerned, the coastal State should have exclusive jurisdiction for formulating and implementing regulatory measures which, of course, must be based on sound scientific data. The gathering of that data would not present any problems when the data referred to fish stocks whose life cycles were completed within the zone of the coastal State. Nevertheless, in the case of species that migrated from the zone or into the exclusive economic zone of another State, co-operation between all the States concerned might be necessary. Such co-operation would also be necessary to agree on arrangements designed to maintain fish stocks at an optimum level throughout their entire migratory range. Such arrangements might be bilateral or multilateral, depending on the case, or based on the use of a permanent intergovernmental machinery such as the regional commissions of the Food and Agriculture Organization of the United Nations (FAO) when a more regular operation was required. It would of course be necessary to modify the existing statutes or agreements to take into account the recognition of the exclusive fishery zone. He drew attention to the fact that the FAO Fishery Committee for the Eastern Central Atlantic had established two Sub-Committees to deal with fishery management. One of the Sub-Committees, the membership of which was limited to coastal States, was concerned with resources of areas within national jurisdiction; the other, made up of coastal States and distant water fishing nations, was concerned with resources beyond national jurisdiction and matters relating to action affecting other areas. In addition, three of FAO's regional fishery commissions—in the Indian Ocean, in the South China Sea and off the West African coast—were already providing assistance from funds made available by the United Nations Development Programme and certain donor countries.

5. As far as the arrangements for full exploitation of the exclusive zone were concerned, it had been argued that its operation would lead to a closure of access to stocks in large areas of coastal waters and a consequent under-utilization and waste of protein resources. His Government believed that such a result was most unlikely to occur. The central objective of an exclusive fishery zone was to give the coastal State possession of a resource from which direct benefits could be realized immediately. Consequently, the coastal State would be the first one to be interested in exploiting those resources. Such exploitation could take place not only through the levy of charges under a licensing system but also, for example, by the transfer of technology, including the training of personnel. Another, more promising, arrangement during the transitional period prior to the attainment by the coastal State of the requisite level of technology and financial capacity was what had been called "joint ventures", which might be either contractual or involve equity participation and the setting up of a separate legal entity.

6. It was the exclusive right of coastal States to determine the allowable catch and the allocation of quotas to foreign

Annex IN-8

Summary Records of the 5th Meeting of the Second Committee of the Third United Nations Conference on the Law of the Sea, Doc. A/CONF.62/C.2/SR.5, 16 July 1974.

Third United Nations Conference on the Law of the Sea

1973-1982
Concluded at Montego Bay, Jamaica on 10 December 1982

Document:-
A/CONF.62/C.2/SR.5

Summary records of meetings of the Second Committee
5th meeting

Extract from the *Official Records of the Third United Nations Conference on the Law of the Sea, Volume II (Summary Records of Meetings of the First, Second and Third Committees, Second Session)* to state in its proposal that the exercise of sovereignty should be subject to the norms of international law, since that might give rise to all kinds of disputes.

52. In brief, Ecuador was proposing a territorial sea of 200 miles, where the coastal State would exercise its sovereignty over all the geographical space contained therein. That was a new concept, and his delegation intended to present at a later date a draft of complementary norms on the co-existence of different régimes for international navigation within the territorial sea of 200 miles.

53. Finally, he expressed his delegation's disagreement with the view expressed by the representative of the Soviet Union earlier in the meeting to the effect that it was already possible to identify the main trend that was emerging in connexion with the territorial sea, particularly with regard to the establishment of its breadth at 12 miles, because a particular trend had emerged, favouring the establishment of a 200-mile territorial sea.

54. Mr. HERRERA CACERES (Honduras), speaking in exercise of the right of reply, said that his delegation had been conforming to the wish of the Conference in referring to specific situations in its general statement at the preceding meeting. The matter of the Gulf of Fonseca illustrated a common situation in the law of the sea, and it was therefore appropriate to make reference to it in connexion with the régime of internal seas, the territorial sea, baselines, and historic bays, and in order to determine its status vis-à-vis the international community and not as a function of the internal régime of the Gulf, as the representative of El Salvador had done at the beginning of the meeting, when he had attempted to deny the sovereignty of Honduras over its islands and waters. Honduras maintained that the waters of the bay possessed the status of internal waters and, as a consequence, it was logical that the baseline of the territorial sea should be that line which united the natural geographical points of the bay. He agreed with the representative of El Salvador that a dispute existed regarding the territorial and maritime boundaries between Honduras and El Salvador; Honduras, for its part, had always manifested its willingness to settle those boundaries as soon as possible.

55. Mr. GALINDO POHL (El Salvador), speaking in exercise of the right of reply, stressed that the Conference was not an appropriate forum for airing bilateral disputes, and maintained that referring to particular cases to support general ideas was different from formulating positions which encroached upon the established rights of other States. That was what the representative of Honduras had done when he had referred at the previous meeting to the delineation of waters between adjacent States and, at the current meeting, to historic bays, and he cited in that connexion a judgement of the Central American Court of Justice of 1917.[7] On whatever theory the delineation of either the territorial or internal waters was based, Honduras would be deprived of access to the line of entry to the Gulf. What was more, the Honduran representative had even referred to problems of territorial and maritime boundaries, which would only raise further problems. If the Committee agreed, El Salvador intended to pursue the controversy.

56. The CHAIRMAN appealed to all delegations to refrain from referring to bilateral questions. It was not easy for the Chairman to recognize all disputed questions at the moment when they were introduced, and that was why the right of reply was provided for. He would limit himself to asking delegations to refrain from references to bilateral questions which, furthermore, could not be settled in that forum.

The meeting rose at 1.20 p.m.

[7] See *American Journal of International Law*, vol. II, 1917 (New York, Oxford University Press), p. 674.

5th meeting

Tuesday, 16 July 1974, at 3.40 p.m.

Chairman: Mr. Andrés AGUILAR (Venezuela).

Territorial sea (*continued*)

[*Agenda item 2*]

1. Mr. CALERO RODRIGUES (Brazil) said that the drafts before the Committee, which provided that the sovereignty of the coastal State gave it jurisdiction over a belt of sea adjacent to its land territory, were only restating existing international law. Another principle of international law was that the breadth of the territorial sea was established by the coastal State itself. There was no rule of customary or conventional international law which established either the breadth of the territorial sea or a limit beyond which States could not establish for themselves the breadth of that sea. When the old customary limit of 3 miles had become obsolete and wider limits had become customary, three international conferences had been unsuccessful in establishing new limits.

2. When several countries, including his own, had established a 200-mile limit for their territorial sea, they had taken into account three legal considerations: first, a territorial sea was recognized by international law; secondly, international law empowered the coastal State itself to establish the breadth of its territorial sea; thirdly, international law did not set a maximum limit for the breadth of the territorial sea. The 200-mile limit had therefore been established within the framework of existing international law. The extensions had been made with a view to giving effect to the Declaration of Lima adopted in 1970,[1] which recognized, *inter alia,* the inherent right of the coastal State to "explore, conserve and exploit the natural resources of the sea adjacent to its coasts and the soil and subsoil thereof, likewise of the continental shelf and its subsoil, in order to promote the maximum development of its economy and to raise the level of living of its people". Neither the Declaration of Lima nor the Declaration of Montevideo of 1970[2] laid down a 200-mile limit as a general criterion. Both stated that the limits must be set in accordance with the geographical, geological and biological conditions of the area and the need for a rational utilization of its resources.

3. The "legitimate priority" of the interests of the coastal States mentioned in the Declaration of Montevideo was now universally recognized. Few delegations, if any, would deny the need to spell out in the convention the Conference was to adopt the rights of the coastal State over an adjacent sea-belt up to 200 miles in breadth.

4. Some delegations held the view that a 12-mile limit and the traditional régime should be accepted. In that belt of sea the coastal State was sovereign and it had only to allow innocent passage of foreign ships. For the zone beyond the 12-mile limit, there were various schools of thought. In the view of some delegations, the coastal State would have sovereign rights with

[1] Document A/AC.138/28 of 14 August 1970.

[2] Document A/AC.138/34 of 30 April 1971.

regard to the exploration and exploitation of the natural resources or over the resources themselves within an area not exceeding 200 miles in breadth, which would be called the patrimonial sea or the exclusive economic zone. As he understood it, most of the delegations that accepted that view agreed that the coastal State would have sovereign rights in the zone between the limits of its territorial sea and the limit of its economic zone. However, other delegations, which were willing to accept the concept of the patrimonial sea or the exclusive economic zone, clearly wished that belt to be considered a part of the high seas in which the coastal State would have only certain specified preferential rights, not as a projection of its sovereignty but as a kind of contractual concession in a foreign area.

5. Lastly, there were others which considered that the belt of adjacent sea up to 200 miles in breadth was under the jurisdiction of the coastal State as a consequence of its sovereignty. For those delegations there were only two fundamental zones in the oceans, a national sea, extending up to 200 miles in breadth, and an international sea beyond that limit. Most of the countries which held that view called the waters adjacent to the shores of the coastal State its territorial sea. The proposal submitted by the representative of Ecuador at the previous meeting (A/CONF.62/C.2/L.10) was designed to make those views clear, and the Brazilian delegation therefore supported it. However, the concept of the territorial sea upheld by those countries was different from that of the traditional territorial sea. Some of the countries which claimed a 200-mile limit for their territorial sea were willing to recognize freedom of navigation and overflight in that zone; others, of which Brazil was one, had liberalized their concept of innocent passage so as to ensure that there would be no impediment to the passage of ships and aircraft, a necessity for international navigation, transport and communications.

6. One of the main handicaps with which delegations had to deal was the fact that they were trying to work out new concepts using a traditional terminology. Although the list of subjects and issues before the Conference (see A/CONF.62/29) mentioned the territorial sea and the contiguous zone before the high seas, and also mentioned the economic zone, it seemed likely that the Conference would end up by defining only two broad zones, each under a precise legal régime, the international sea and the national sea. For one as for the other an adequate set of legal rules had to be established, and even the traditional freedoms of the seas would have to be subject to regulation in the international zone. The common interest in such activities as navigation, fisheries, the exploitation of mineral resources and the control of pollution would impose mandatory norms of behaviour on all States exercising any activity in that zone. Without prejudice to the competence of international bodies, the residual powers not falling within the set of norms he had mentioned could be exercised by all States. In the same way, the rights and duties of States in the national maritime zone would have to be spelt out. In his view, it was possible to prescribe norms that would guarantee the legitimate interests of both the coastal State and of third States with regard to navigation, fisheries, the laying of cables and pipelines and any other reasonable matter.

7. Since it was normal for the residual powers in the international zone to be exercised by all States, it was also normal that in the national zone such residual powers should be reserved for the coastal State. In that way third States would in fact enjoy a double guarantee: their interests would be clearly enunciated as legal rights, and whenever the coastal State exercised any of its residual powers it would have to take into account the general principles that had led to the enunciation of those rights.

8. The comprehensive approach that he had outlined might be summarized as follows. First, the convention should define as specifically as possible rights and duties for the whole of the ocean space. Secondly, such rights and duties should be basically different for the two zones, national and international. Thirdly, in a national maritime zone the residual powers should be reserved for the coastal State; in the international maritime zone they should belong to all States. The Committee should bend its efforts to framing a specific definition of the rights and duties of each State in each of the two maritime zones. That should be done without attempting to tie the rights and duties to any particular basic position held by delegations. Only after the rights and duties had been defined should an attempt be made to fit them into a general framework, which should encompass as many of the basic positions as possible. The Committee should have in mind Hans Kelsen's distinction between norms of international law, which were statements of mandatory behaviour, and rules of international law, which were legal concepts used to describe international law.[3] If the Conference was to be successful in its task, it should go straight to the heart of the matter and concentrate on drafting a truly normative order for the sea.

9. Mr. RASHID (Bangladesh) introduced his delegation's proposal (A/CONF.62/C.2/L.7) concerning the nature and characteristics of the territorial sea. His delegation supported the traditional concept of the territorial sea, namely, that every coastal State exercised absolute sovereignty beyond its land territory and internal waters over a belt of sea adjacent to its land territory, subject only to the right of innocent passage. Accordingly, his delegation supported the concept on which the United Kingdom proposal (A/CONF.62/C.2/L.3) and the Indian proposal (A/CONF.62/C.2/L.4) were based, but it thought that paragraph 1 of its own proposal made the essential point clearer. The definition of the nature and characteristics of the territorial sea must not be ambiguous or refer to any other rules of law. It should be self-contained and it should be interpreted with reference to the provisions of the Convention and to nothing else. Thus, his delegation could not accept the expression "other rules of international law" in the United Kingdom and Indian texts, since it was susceptible of different interpretations.

10. His country favoured a territorial sea of 12 miles and an economic zone of 200 miles, measured from the baselines. Bangladesh was a coastal State with more than 1,000 miles of indented coastline and many offshore islands. In the monsoon season the rivers of the Ganges delta deposited more than 10 million tons of silt in the Bay of Bengal. Thus, the Ganges delta had no stable low-water line and its navigable channels were continually changing. The only feasible method of demarcation of the landward and seaward areas was a baseline expressed in terms of a certain depth. The present method of determining the baselines, set forth in articles 3 and 4 of the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone,[4] did not take account of the geographical peculiarities of the coastline in States such as his own. The provisions of the new convention dealing with the drawing of baselines should, therefore, take account of such geographical and hydrographical peculiarities of the coastal States as had legal relevance. At the appropriate time his delegation would submit a text concerning the drawing of baselines in such cases.

11. Mr. ROE (Republic of Korea) said that, because of its geographical location and special security concerns, his country had some particular problems with regard to the territorial sea and the right of innocent passage. It was one of the few countries which had not yet declared the breadth of its territorial sea, in expectation that a general consensus would be reached at the Conference. He reaffirmed his country's support for a maximum limit of 12 nautical miles, measured from ap-

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[3] See Hans Kelsen, *General Theory of Law and State*, translated by Anders Wedberg (Cambridge, Massachusetts, Harvard University Press, 1949), pp. 341-343.

[4] United Nations, *Treaty Series*, vol. 516, p. 206.

propriate baselines, in accordance with the provisions of the 1958 Geneva Convention.

12. His delegation thought that the United Kingdom proposal (A/CONF.62/C.2/L.3) was a good basis for consideration of the question of the passage of foreign vessels through the territorial sea. The proposal was an attempt to reconcile the general interests of international communications with the particular and very grave security concerns of coastal States. In general, his delegation could accept the United Kingdom text, but he wished to comment on two points.

13. First, chapter II, article 16, of the text did not provide a satisfactory definition of what constituted innocent passage. Paragraph 2 of that article should have stated positively that the passage of a foreign ship should be considered not innocent if such and such acts were committed, instead of the negative formulation used. Furthermore, in enumerating the acts which were not innocent, the article omitted some important acts which were of major concern to coastal States: acts such as espionage, the collecting of information, or propaganda against the coastal State, or any other warlike or hostile acts or acts which did not have a direct bearing on the passage. Such acts should be specifically mentioned in order to avoid any ambiguity or misinterpretation.

14. Secondly, the passage of warships through a territorial sea which did not constitute a necessary and important route for international navigation should be differentiated from the passage of other types of vessel. A coastal State should have the right to require foreign warships passing through its territorial sea to give prior notification of that passage or to obtain prior authorization for it.

15. Mr. ZULETA TORRES (Colombia) said that his delegation's position concerning the nature and characteristics of the territorial sea was the same as that of many delegations from different parts of the world and with different levels of development and varying legal traditions. According to that position, the territorial sea was defined as a belt of 12 nautical miles measured from the baselines, over which the coastal State exercised full sovereignty, subject to the right of innocent passage. The 12-mile territorial sea was necessarily linked to the acceptance by the international community of an economic zone or patrimonial sea of a maximum breadth of 200 nautical miles. In that zone the coastal State was to have sovereign rights with regard to the exploration and exploitation of the renewable and non-renewable natural resources situated in the superjacent waters or in the sea-bed and the subsoil thereof. It was also to have rights and duties with respect to the protection of the marine environment and the control of scientific research. His delegation understood the combination of territorial sea and economic zone to be an indivisible whole. Such a formulation would reconcile the economic goals of the developing countries, which wished to have jurisdiction over the natural resources adjacent to their coasts, with the need to maintain the right of free navigation and overflight and the laying of cables and pipelines.

16. The notions of territorial sea and economic zone must of course be governed by a clear method of delimitation between States with opposite or adjacent coasts and, if necessary, by a procedure for the peaceful solution of disputes. The concept of an economic zone should be clearly formulated in the convention so that its demarcation would not lead to the closing of any State's territorial or internal waters.

17. Mr. BAKULA (Peru) said that his delegation supported the proposal submitted by Ecuador (A/CONF.62/C.2/L.10) because it corresponded to the rights proclaimed by his own country, which considered that a territorial sea of 200 miles was a reasonable one for many regions but should not be compulsory for all States. The desire to limit the territorial sea to 12 miles was understandable in narrow seas where the distance between States did not permit a higher limit, but the 12-mile limit was not justified in open seas and oceans where States were separated by hundreds of miles. Within the maximum limit, States must be able to establish a breadth of territorial sea suited to the realities of their region. The essential difference between the two positions was that some States wished to impose on the whole world a limit of 12 miles, which was insufficient to protect the rights of other nations, while other States accepted that there could be different limits and that the 12-mile and 200-mile limits could coexist, subject to the protection of the general interests of international communications.

18. Some States maintained that the coastal States could not be granted residual rights of sovereignty or jurisdiction over a territorial sea or economic zone of 200 miles, but that three types of jurisdiction must be recognized: that of the coastal States, that of the flag States, and that of the International Sea-Bed Authority. That argument might be acceptable if the space in question was situated in the middle of the ocean where all States had equal rights, but it was logical that certain coastal States should exercise residual rights over the waters adjacent to their coasts in order to protect the interests of their peoples.

19. The crux of the matter was not the name given to the seas adjacent to the coastal States, but the nature and scope of the rights granted to those States. His delegation would consider any names, such as national zone or national sea, as long as it was understood that the coastal State exercised sovereignty and jurisdiction, without prejudice to the establishment of a dual régime for navigation guaranteeing freedom of passage, or to the adoption of internal regulations guaranteeing national peace and security.

20. Mr. JACOVIDES (Cyprus) drew attention to the proposal on the breadth of the territorial sea submitted by his country to the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction (A/9021 and Corr.1 and 3, vol. III, sect.7). He recalled that it had been decided that all documents of the sea-bed Committee were deemed to be before the Second Committee. The reasons for his delegation's position had been given in the sea-bed Committee and in its general statement at the 40th plenary meeting.

21. Mr. LUPINACCI (Uruguay) expressed his delegation's support for the proposal made by the delegation of Ecuador at the preceding meeting (A/CONF.62/C.2/L.10) which was basically the same as that made by his country (A/9021 and Corr.1 and 3, vol. III, sect. 13) at the July 1973 session of the sea-bed Committee.

22. At the current stage of its work, the Second Committee should not spend too much time on terminology. It was more important to determine the legal nature of the régimes applicable to different zones. His delegation supported the establishment of different régimes in the territorial sea, since the basic concepts of international maritime law were still valid because they were based on logic, although they must be adapted to present-day realities. Two fundamental statutes governed the maritime spaces, one based on the principle of sovereignty and the other on that of freedom. The formula of sovereignty and freedom would always underlie any formulation adopted. Those principles were represented by the two traditional concepts of the territorial sea and the high sea. Any formulation adopted would always mean that one of those principles would prevail over the other, which would be expressed in the final instance by its residual application. Thus, with regard to the territorial sea, whatever limitations might be established for the sovereignty of the coastal State, such as the right of innocent passage, the essence of the concept was apparent in the residual application of the principle of sovereignty. The representative of Pakistan had said at the 4th meeting that there was little difference between a territorial sea with different régimes and the concept of a 12-mile territorial sea combined with an economic zone or patrimonial sea of up to 200 miles, and that in the

latter case the territorial sea and the economic zone formed a single unit, as had just been confirmed by the representative of Colombia, who considered that the territorial sea and the economic zone should constitute an indivisible whole. The concept of different régimes in the territorial sea was therefore more reasonable and technically sounder, because it maintained the single concept of the zone of sovereignty of the coastal State, while allowing different régimes for international communication within that zone. His delegation therefore supported the proposal of the representative of Ecuador, provided that, once the nature and extent of the rights of the coastal State in its adjacent sea and those of third States and the international community had been clearly defined, the Committee agreed to abandon the old terminology and work out a new one.

23. Mr. ZOTIADES (Greece) said that the Conference seemed to have reached near unanimity on a limit of 12 nautical miles for the territorial sea and on the general and uniform application of that rule. His delegation welcomed the Chairman's statement that the Conference's aim was to draft universal rules of general application. It found it juridically difficult to accept an exceptional legal régime for certain seas such as enclosed and semi-enclosed seas. Although all coasts had special characteristics, the rule of law should govern all cases and not leave a wide margin for deviation from basic international law.

24. The point had been made that in semi-enclosed seas the limit of the territorial sea should be determined jointly by opposite or adjacent States. The social needs that had prompted the preparation of the Conference would not be realized if the delimitation of maritime boundaries was left to agreement among States in accordance with equitable principles independent of those of international law. The expression "equitable principles" itself introduced an element of subjectivity and ambiguity.

25. On the basis of international theory and practice, the median line or equidistance principle embodied in article 12 of the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone and widely used in bilateral conventions should apply in the case of narrow seas.

26. It had also been said that the 12-mile limit should not deprive States of access to the high seas, but that would only be valid if the right of innocent passage did not apply to the legal régime of the territorial sea.

27. The Greek delegation had submitted its proposal (*ibid.*, sect. 5) to the sea-bed Committee in the sincere belief that the median line of equidistance should not be either an arbitrary or an absolute rule. That proposal provided the necessary flexibility by the interrelation of the two elements of agreement and equidistance. The principle of the median line placed States in a position of equality in relation to neighbouring States which might be tempted to bargain in a legal vacuum. Failing agreement reached freely and under conditions of equality, the equidistance principle should come into operation as the applicable rule of international law. The existence of the guiding rule of law would mitigate any excessive demands based on special circumstances or on the novel and unacceptable idea put forward at the preceding meeting that islands, *per se*, constituted in general special circumstances.

28. The representatives of both Finland and Uruguay had referred at the preceding and current meetings respectively to the notion of territorial sovereignty. As repeatedly declared by the International Court of Justice, territorial sovereignty embraced the sum total of the territory of the State, be it continental or insular. In paragraph 57 of the judgment of the International Court of Justice in the North Sea continental shelf cases,[5] the Court accepted that departure from the median line of equidistance could not be made in the case of islands but only in that of islets or rocks. In any case, that judgment of the International Court was not relevant to the delimitation of the territorial sea, because it referred to that of the continental shelf. Furthermore, one of the parties had not ratified the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone. It might however be of interest to recall that in paragraph 23 of that judgment, the Court had observed, with reference to the principle of equidistance, that no other method of delimitation had the same practical convenience or certainty of application.

29. Mr. ROBINSON (Jamaica) reiterated his delegation's statement in the sea-bed Committee that Jamaica did not support the concept of the economic zone or the patrimonial sea or sovereign territorial zones beyond 12 miles, but as a compromise it was prepared to accept the establishment of such zones provided that right of access was granted to the geographically disadvantaged developing countries in order to exploit their resources. That position was clearly set forth in the draft articles on regional facilities for developing geographically disadvantaged coastal States (*ibid.*, sect. 45) submitted to that Committee in 1973. His delegation would be unable to accept the concept of a territorial sea beyond 12 miles unless those draft articles were not only embodied in the future convention but also so placed that it was evident that they were an essential qualification of the establishment of the zone itself.

30. Mr. ABAD SANTOS (Philippines) said that his delegation had no objection to the establishment of 12 nautical miles as the breadth of the territorial sea if that was generally acceptable to the Conference. He wished, however, to draw attention to the draft articles on historic waters (*ibid.*, sects. 35, 36 and 37) submitted by his delegation to the sea-bed Committee in 1973. The substance of those draft articles was that any State which had already established a territorial sea with a breadth greater than the maximum provided in the convention to be adopted should not be subject to the limit set out therein. The 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone, in article 7, paragraph 6, recognized the historic rights of coastal States to "historic" bays regardless of their area or width of entrance. A preparatory document for the First United Nations Conference on the Law of the Sea had pointed out that historic rights were claimed in respect not only of bays but also of other maritime areas.[6] That concept had also been recognized by Sir Gerald Fitzmaurice, now one of the Judges of the International Court of Justice, in an article entitled "The law and procedure of the International Court of Justice 1951-1954: General principles and sources of law".[7] His country's position on that historic principle had been expressed not only at meetings of the sea-bed Committee but also at sessions of the General Assembly. On 9 August 1973, at the 72nd meeting of Sub-Committee II of the sea-bed Committee, the head of the Philippine delegation had outlined the history of the territorial waters claimed by his country. Those waters had passed from the sovereignty of Spain to that of the United States in 1898 and their area was specified in a law passed by the latter country in 1932. When the Philippines had become independent in 1946, it had continued to exercise sovereignty over those waters, as expressly stated in its Constitution and statutes. The proposals made by the Philippine delegation in the sea-bed Committee had been that the exceptional status of "historic" waters should be stated in positive law and that the territorial sea under historic title should be excluded from the rules governing the delimitation of that sea. There seemed no valid reason why only historic bays should be excepted from the applicable rules of international law. If no exception was made of other historic waters, the Philippine delegation's acceptance of an approved breadth of territorial sea of 12 miles

[5] *North Sea Continental Shelf, Judgment, I.C.J. Reports 1969*, p. 3.

[6] *Official Records of the United Nations Conference on the Law of the Sea* (United Nations publication, Sales No.: 58.V.4), vol. I, document A/CONF.31/1, para. 8.

[7] *British Year Book of International Law, 1953* (London, Oxford University Press, 1954).

would deprive it of about 230,000 square miles of territorial sea. The head of the Philippine delegation had therefore announced the Philippines' intention of seeking recognition of the present limits of its territorial waters in codified international law at the Third United Nations Conference on the Law of the Sea.

31. Mr. GALINDO POHL (El Salvador) said that the Ecuadorian proposal (A/CONF.62/C.2/L.10) was most pertinent. It was necessary to identify the different trends of thought and to find the common denominator, without prejudice to the peculiarities and nuances of each national position. The proposal was a very precise expression of one of those trends. His country had its own approach and its own arrangements concerning the territorial sea, but he did not wish to discuss them in detail at that time, when the goal was to identify general trends and not to catalogue national positions.

32. El Salvador applied a very special criterion to the terms used. It felt that substance was more important than terminology. Ecuador had insisted that everything should be given a very specific name, and one of the merits of its proposal was that it helped to clarify positions.

33. He wished to comment on the meaning of the term "territorialism". A quarter of a century earlier, when some countries had begun to lay claim to a greater breadth of territorial sea than had then been customary, they had used the terms that were then in current use, but they had used them with a new meaning. The result was that confusion had arisen about the actual meaning of those terms. The idea of territorialism was, paradoxically, not indissolubly linked to the idea of the territorial sea as defined in the 1958 Convention on the Territorial Sea and the Contiguous Zone; on the contrary, territorialism was compatible with silence on the subject of the traditional territorial sea. Territorialism did not necessarily imply the traditional concept of the territorial sea in the entire area in question. It referred to a new and broader concept, which encompassed the old territorial sea in a more comprehensive and diversified framework, without undermining its unity. Territorialism signified plurality within unity.

34. Territorialism was associated with sovereignty, but it was not absolute sovereignty. In a zone with a régime involving innocent passage and freedom of navigation in the respective sub-zones, sovereignty could not but be limited. Why was the word sovereignty used in such a case? It was a concise way of referring to the powers of a State and it was a short and convenient way of saying that the residual powers were to be exercised by the coastal State. If that formula was not adopted, it would be necessary to enumerate all the powers and even to specify that residual powers would be vested in the coastal State. The criteria for the interpretation of the agreed rules would also have to be expressly stated.

35. Territorialism was consonant with a plurality of régimes. The traditional territorial sea was part of a broader synthesis in which that traditional concept found its place, together with new elements. Within territorialism, there might be several different régimes, for example, a régime of innocent passage and a régime of free navigation, but their common denominator was the idea of sovereignty.

36. In addition, territorialism projected the power of the coastal State into a specific space, but that power was limited. Territorialism was therefore spatial, and conferred power over the resources contained in the space in question.

37. Within the plurality of régimes, economic interests and security interests relating to the coastal State coexisted in the zone of innocent passage; in the zone of free navigation, those economic interests still existed but, so far as security was concerned, the coastal State was in a similar position to the other members of the international community, which made that second sub-zone into an economic zone. In the zone of free navigation, which was further from the shore of the coastal State, responsibility for security did not lie with the coastal State but was subject to international rules. The coastal State acted in that case as another member of the international community and was therefore subject to those rules, but without prejudice to its economic rights and interests.

38. It was possible to speak of a national sea, subject to different régimes; one of its sub-zones would be under the régime of innocent passage and the other sub-zone would be the one in which the coastal State had economic interests.

39. The authentic rights of the authentic international community would thus be safeguarded. A distinction should be drawn between the interests of the international community and the interests of the great shipping Powers, which sometimes claimed to speak and act on behalf of the international community.

40. Within the common denominator of the 200-mile rights of the coastal State, two questions remained: the content of those rights and the technique used to express and define them. The great majority of participants in the Conference was in favour of a national zone in which the coastal State would have significant rights. The authentic rights of the authentic international community could be safeguarded in the process.

41. Mr. PLAKA (Albania) said that the Committee was approaching the most important problems connected with the sea, and it was time to consider the points of greatest concern to delegations and to map out strategies for the future.

42. The overwhelming majority of the participants—the countries of Asia, Africa and Latin America and other sovereign and peace-loving States—had declared their determination to defend their legitimate rights in the face of flagrant violations by the imperialist and colonial Powers. A new law of the sea was therefore required, for the old law of the sea had done nothing but perpetuate injustice and serve the political, military and economic interests of the great imperialist Powers. The countries he had mentioned had also shown their desire to see that the new law of the sea should incorporate the changes introduced into the law of the sea by the practice of sovereign coastal States. The major trend was toward a codification of the legal norms relating to the sea with a view to ensuring the national sovereignty and safeguarding the economic interests of the sovereign coastal States in their territorial waters.

43. The United States and the Soviet Union were opposed to that trend, however. They did not accept the changes introduced by the practice of the sovereign coastal States, particularly with regard to the breadth of their territorial sea, and were opposed to the efforts of those States to formulate a law of the sea that would be in harmony with their inalienable rights. The United States and the Soviet Union wished to impose on other sovereign States a 12-mile limit for their territorial sea, regardless of the fact that some countries had already extended their territorial sea beyond that point. Such an attitude was contrary to the principle that every country was free to define the limits of its territorial sea at a reasonable distance from its coast, provided it did not prejudice the interests of neighbouring countries or international navigation—a principle that had been invoked by the two super-Powers themselves in defining their own territorial sea. That principle should be strengthened by the convention to be adopted by the Conference. Such a strengthening was all the more necessary because the independence of the sovereign coastal States was threatened by the warships of the two super-Powers, which ranged up and down the oceans, passing close to the shores of other countries in pursuit of their policy of domination.

44. No international instrument of recognized legal value laid down a maximum limit of 12 nautical miles for the territorial sea, and even the previous conferences had failed to set such a limit. There were important considerations which militated in favour of an extension of the territorial sea. The most important was national security and the second was the fact that

the fishing fleets of the two Powers he had mentioned pillaged the fishery resources of the other countries, even within their territorial waters, as in the case of Peru, Ecuador and other sovereign coastal States, whose territorial waters had been violated by the fishing fleets of the super-Powers.

45. Every sovereign State was entitled to set a limit of not less than 12 miles to its territorial sea. Albania itself was reconsidering the question of the breadth of its territorial sea with a view to its possible extension beyond the existing 12-mile limit.

46. His delegation understood the fully justifiable motives and the circumstances which had obliged some coastal States to extend their territorial waters up to a 200-mile limit. They had taken that decision for reasons of national security and to ensure the survival of their populations. As was well known, fishing was the principal means of livelihood for the peoples of Peru and Ecuador, for example.

47. His delegation supported the Ecuadorian proposal, which provided for a territorial sea 200 nautical miles in breadth. It also supported the position of the Latin American and other countries that maintained that the exclusive economic zone or patrimonial sea should extend up to 200 miles and should be under the sovereignty and national jurisdiction of the coastal State.

48. The super-Powers accepted the idea of an economic zone but they wished to apply a régime to it that would make it in effect an international zone. Moreover, they wished to make the economic zone coterminous with the territorial sea. There were no sound arguments in favour of that stipulation, for each country was free to decide the breadth of its territorial sea in accordance with its own circumstances.

49. The two Powers he had mentioned had proposed a package deal, the main purpose of which was to ensure free passage for their navies and air forces through and over straits that lay within the territorial waters of other States. That was not a fair deal. There was no reason why such passage should be a condition for the establishment of an exclusive economic zone.

50. Their attempts to internationalize the straits located on the limits of the territorial waters of the coastal States must be stopped, and the sovereignty of the coastal States over their straits must be secured. The coastal States had clearly defined their position in the general debate. They had no intention of preventing international traffic through the straits used for international navigation, but they were fully entitled to take whatever steps were necessary to protect their national security, particularly in view of the frequent and unjustified movements of the warships and military aircraft of the super-Powers through and over their territorial waters. The passage of warships through those waters and through straits located in territorial waters should be governed by the law of the coastal States; they should receive prior notification of such passage and no passage should be attempted without their consent. That would be in the best interests of international peace and security.

51. The discussions in the Second Committee should lead to the elaboration of a new law of the sea which would rule out domination and establish a régime of equity and justice, conditions favouring good-neighbourly relations and international co-operation, the economic development of the coastal and land-locked States, particularly the developing countries, and protect their interests and national security. In view of the efforts of the two super-Powers to sow discord among the coastal States and the land-locked and geographically disadvantaged countries, i.e., those that were interested in the establishment of an exclusive economic zone, and the straits States, the countries of Asia, Africa and Latin America and all other peace-loving countries should unite and fight for their legitimate rights. The problems of the sea with which the Committee had to deal were complex and there would be difficulties to surmount but all those problems should be resolved through consultation and direct and open discussion in the Committee itself. Delegations should not allow themselves to be inveigled into other discussions by indirect and covert approaches, particularly when the super-Powers were behind them.

52. No decision should be taken in haste. Each problem should be discussed in a spirit of justice and there should be no infringement of the rights of sovereign States and peoples by a compromise which would safeguard only the interests of the super-Powers. Priority should be given to substance and that must reflect and reinforce the inalienable rights of the peoples, their economic interests and their national security.

53. Everyone knew that if a new law of the sea was to emerge, it would be born from a struggle between the sovereign coastal States, which rightly wished to secure their inalienable rights, and the big imperialist maritime Powers, particularly the two that were seeking to preserve their military, political and economic interests and their privileged position with regard to the sea. The interests of those two groups of States were conflicting and mutually exclusive. For that reason, any compromise put forward at the instigation of the super-Powers carried with it a risk that damage would be done to the essential interests of the sovereign States and should therefore be rejected. The overwhelming majority of the participants in the Conference were sovereign and peace-loving States. They must defend their rights to the utmost, and not recoil before any pressure or blackmail from the two super-Powers; they would then be sure to triumph.

54. The Albanian delegation was ready to combine with other justice-loving countries in their efforts to achieve that end.

55. Mr. MOVCHAN (Union of Soviet Socialist Republics), speaking in exercise of the right of reply, said that a certain delegation had read out a text in plenary meeting and it now seemed that it was going to read the same text with regard to every agenda item. The Soviet delegation had already replied in plenary meeting to the effect that the topics before the Conference should be dealt with in a constructive spirit. Everyone present was tired of hearing the same tune. Was it not time to change the record? The statement he was referring to was certainly out of keeping with the general effort to work in harmony. His own delegation would continue to observe the Chairman's request that proceedings be conducted in a constructive manner.

56. Mr. PLAKA (Albania), speaking in exercise of the right of reply, said that the statement by the representative of Soviet social-imperialism had merely underlined the validity of his own statement. The Soviet position was contrary to that of the majority of delegations and did not even warrant a reply. The Soviet revisionists wanted to sell their imperialist policy as a socialist policy but took fright when their mask was torn off. Their policy of aggression and expansion was generally known and condemned. They could not escape the responsibility they bore for it.

57. The CHAIRMAN appealed to the Committee to conduct its business in a spirit of harmony. He had no wish to criticize the views of any delegation, but the Committee must focus on the substance of its work. There had already been a general debate in plenary meeting in which delegations had had the opportunity to express their general views on the law of the sea. He urged all delegations to avoid bringing up matters which would occasion the exercise of the right of reply.

Organization of work

58. Mr. KEDADI (Tunisia) said that, although the general discussion had been useful because it enabled many delegations which had not been members of the sea-bed Committee to express their views, it was now necessary to find means of speeding up the work of the Second Committee. Since most of the draft articles submitted recently were very similar to those

submitted to the sea-bed Committee, he was afraid that the discussion might merely duplicate that in the various sessions of that Committee unless a different approach was adopted.

59. From the discussion so far, he had identified three schools of thought, namely, those in favour of a territorial sea not exceeding 12 miles, those in favour of a narrow territorial sea linked to an economic zone not exceeding 200 miles in breadth, and those in favour of an extended territorial sea which would include that economic zone. The four main subjects under discussion were the right of innocent passage, the territorial waters of archipelagic States, full sovereignty for the coastal State over a limited zone and jurisdiction over a wider zone, and delimitation. It might be possible to begin by adopting a general text which reflected the basic ideas of each school of thought on each subject. Then the proponents of each school of thought could meet, if possible under the chairmanship of one of the Vice-Chairmen, to submit amendments to the basic text and try to reach agreement on a text acceptable to all. The Chairman would then reconcile the three points of view and produce a single text which would be the basis for drafting articles of the future convention related to the territorial sea.

60. The CHAIRMAN said that those suggestions were very similar to the one he intended to make to the officers of the Committee.

The meeting rose at 6.15 p.m.

6th meeting

Wednesday, 17 July 1974, at 11 a.m.

Chairman: Mr. Andrés AGUILAR (Venezuela).

Organization of work

1. The CHAIRMAN said that the officers had made a series of recommendations designed to facilitate the work of the Committee. First, participation in the debate should be limited to delegations of countries that had not participated in the work of the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction or delegations that had new proposals to make. Naturally, delegations that had comments on those proposals would be entitled to speak.

2. Mr. ANDERSEN (Iceland) supported the proposal of the officers and said that he would not take part in the debate.

3. Mr. MAHMOOD (Pakistan) asked whether comments could be made on the proposals already formulated.

4. The CHAIRMAN, after replying in the negative to the representative of Pakistan, said that the officers had considered the possibility of limiting the time for statements and had decided, secondly, that it was preferable to continue relying on the self-discipline of representatives and to fix 10 minutes as a point of reference. Thirdly, the officers appealed to representatives to refrain from repeating proposals they had already submitted. Fourthly, the officers felt that sufficient time had been allocated to consideration of the question of the territorial sea and proposed that the list of speakers be closed and that the Committee should move on to the stage of reconciliation of positions in informal meetings.

5. Mr. THEODOROPOULOS (Greece) asked whether representatives could submit texts or amendments at the informal meetings.

6. The CHAIRMAN replied that the aim of the informal meetings was to consider general formulas and that it would not be appropriate to submit specific proposals. If there were no objections, he would take it that the Committee agreed with the recommendations of the officers.

It was so decided.

Territorial sea (*continued*)

[*Agenda item 2*]

7. Mr. DJALAL (Indonesia) said that the nature of the rights of the coastal States over the territorial sea could be summed up by the word "sovereignty". Sovereignty meant jurisdiction and the exercise of all rights and other powers over that space, subject to the limitation inherent in the right of innocent passage for foreign vessels. His delegation believed that the sovereign rights of the coastal State extended to the air space, the water column, the sea-bed and the resources of the territorial sea. The latter should be measured from the baselines, which could be the low-water mark along the coasts, or straight lines in the case of coasts with deep indentations or in front of which there were strings of islands, or in the case of archipelagic States. For that purpose, it was of fundamental importance that the concept of "archipelagic waters" should be taken into account in determining the nature and characteristics of the territorial sea, and his delegation agreed with the formula whereby the sovereignty of the coastal State would extend beyond its land area and internal waters and, in the case of archipelagic States, its archipelagic waters, to a belt of sea adjacent to its coasts called the territorial sea. In any event, in determining the sovereignty of the coastal States, reference to the States or the archipelagic waters could not be omitted and, in the view of his delegation, the territorial sea should be measured from the archipelagic waters and not from the coast or internal waters. For that reason his delegation could not accept the relevant text proposed by the United Kingdom delegation (A/CONF.62/C.2/L.3). It should be added that chapter II, part I of the United Kingdom draft, which referred to the nature and characteristics of the territorial sea, was similar to articles 1 and 2 of the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone,[1] which had not been ratified by Indonesia.

8. Finally, his delegation would have no difficulty in accepting the 12-mile limit for the territorial sea on the condition that, in the case of Indonesia, it would be determined from the baselines applicable to archipelagic States.

9. Mr. SCERNI (Italy) said that his delegation found the definition of the territorial sea in the United Kingdom draft satisfactory. Furthermore, he agreed in principle with the conclusions set out at the 4th meeting by the representative of the Soviet Union with respect to the three points which could already be identified in order to pass on to the other items on the very heavy agenda. The territorial sea should be regarded as an area fully within the sovereignty of the coastal State and the external limit, which, in his opinion, could be fixed at 12 miles, should be regarded as a kind of border of the State, as the representative of Finland had said at the same meeting. Beyond that border, a sea space might be established in which the coastal State would not exercise exclusive sovereign juris-

[1] United Nations, *Treaty Series*, vol. 516, p. 206.

Annex IN-9

Note Verbale from the High Commission of India to the Joint Secretary, Ministry of External Affairs of India, 19 September 1974.

3591. JS(BD)/PM 24/9/74
5396/ DS(BD)/74 2579

4480/BD I/74
S/X

ভারতীয় হাই কমিশন
HIGH COMMISSION OF INDIA
Road No-2, Dhanmondi R.A
Dacca

Deputy High Commissioner

No. DAC/POL/111/1/74.

19 September 1974

24.9.74.

My dear Sankar,

This Mission had reported to you on Act XXVII of 1974 passed by the Bangladesh Parliament, which dealt with Bangladesh's sovereignty on its adjacent seas. The Foreign Ministry of Bangladesh made an announcement on the 15th September extending its economic jurisdiction to 200 nautical miles measured from the baseline set at 10 fathoms (60 feet). A summary of the notification is given below:

D.S.(BD)

> The zone of the high seas extending upto 200 nautical miles measured from the baseline set at the depth of 10 fathoms (60 feet) will form Bangladesh's economic zone. The economic zone will be beyond the territorial waters of 12 nautical miles at nearest point of the baselines for the economic zone.
>
> The delimitation of the economic zone will enable Bangladesh to have exclusive right to living, non-living, renewable and non-renewable resources found on the sea-bed and subsoil. This will also enable Bangladesh to control the navigation.

Retain carefully on Maritime boundary file. x.

3/10

-x. pl. also put up that file

3/10

2. I also reproduce below the latitudinal and longitudinal coordinates of eight points on the baseline mentioned in the notification, which states that "the baseline from which the territorial waters shall be measured sea-ward are straight lines linking successively the baselines points set up below:"

Baseline Point No.	Latitude	Longitude
1	21°12'00"N	89°06'45"E
2	21°15'00"N	89°16'00"E
3	21°29'00"N	89°36'00"E
4	21°21'00"N	89°55'00"E
5	21°11'00"N	90°33'00"E
6	21°07'30"N	91°06'00"E
7	21°10'00"N	91°56'00"E
8	20°21'45"N	92°17'30"E

...../2-

3. I am sure that this information would be useful for Dr. Jagota when he comes for discussions in Bangladesh some time next month.

4. I also enclose a copy of the text of the notification in full for your records.

All good wishes

Yours sincerely,

Mani

Encl: 1.

(J.N. Dixit)

Shri K.P.S. Menon
Joint Secretary (BD)
Ministry of External Affairs
New Delhi

Copy, with a copy of the enclosure, forwarded to

Shri S.P. Jagota
JS(L&T), MEA, New Delhi.

Shri N. Krishnan
JS(UN), MEA, New Delhi.

Annex IN-10

Note Verbale from the High Commission of India to the Ministry of Foreign Affairs of Bangladesh, 31 October 1974.

No. DAC/POL/111/1/74

The High Commission of India in Dacca presents its compliments to the Ministry of Foreign Affairs, Government of the People's Republic of Bangladesh, and, upon instructions from the Government of India, has the honour to state as follows:

It will be recalled that at a meeting held in New Delhi on the 9th May, 1974, between the Foreign Secretaries of India and Bangladesh, it was agreed that the maritime boundary between India and Bangladesh should be settled. Official-level talks were to be held in Dacca, in early June 1974, in order to arrive at joint recommendations to be made to the two Governments on the Indo-Bangladesh maritime boundary. The Bangladesh Foreign Secretary had kindly undertaken to send an invitation for the talks on his return to Dacca. Since an invitation was not received in time for these talks, it was agreed that the talks may be held after the conclusion of the Caracas Conference on the Law of the Sea, and talks were contemplated about the middle of October 1974.

2. In the meantime, the Government of India's attention has been drawn to a Gazette notification issued by the Government of Bangladesh in April 1974, which establishes a 200-mile Bangladesh economic zone, to be measured from a straight baseline joining a series of eight baseline points from which the breadth of the territorial sea is to be measured. The Government of India came to know of these baseline points only at the end of September 1974. It appears that the baseline points follow the 10-fathom line, with respect to which the Bangladesh Government had also made a proposal at the end of the Caracas Conference on the Law of the Sea.

3. While appreciating the desire of the Bangladesh Government to reserve the waters adjoining their coast for the exclusive use of their citizens, the Government of India is constrained to point out that such baselines should not and cannot be used for determining the maritime boundary between Bangladesh and India. This maritime boundary is to be drawn

......./2-

in accordance with the well-known and established rules of international law on the subject. Examination of the implications of the baseline points mentioned for the maritime boundary between Bangladesh and India shows that baseline point No. 1 extends substantially into the Indian area. The basis of the location of this point is not known to the Government of India.

4. It will be appreciated that a unilateral action taken by one party, however well-motivated, should not adversely affect the interests of its friendly neighbour. It is accordingly desirable that the question of the maritime boundary between India and Bangladesh should be discussed between officials of India and Bangladesh immediately so that joint recommendations can be made to the two Governments. This course of action would avoid any possible differences or disputes in the area, particularly when both Governments are eager to explore and exploit the resources of the sea and the continental shelf in their respective zones.

5. The attention of the Government of India has also been drawn to the fact that the Government of Bangladesh are entertaining applications or offers for award of contracts for exploration of the area, and that a Letter of Intent has already been issued to one Ashland Oil Company for off-shore oil exploration of the continental shelf adjoining the Indian area. It is suggested that, pending the settlement of the maritime boundary between the two countries, the Government of Bangladesh desist from any exploration of the area considered as Indian by the Government of India and ensure that no exploration work is carried out by any party, whether by the Ashland Oil Company or any other, on behalf of the Government of Bangladesh in such area.

6. The Government of India will be ready to hold technical-level talks with the Government of Bangladesh on the question of determining the maritime boundary between India and Bangladesh either at Dacca or at Delhi and at any time in the near future as may be convenient to the Government of Bangladesh.

...../3-

The High Commission of India in Dacca avails itself of this opportunity to renew to the Ministry of Foreign Affairs, Government of the People's Republic of Bangladesh, the assurances of its highest consideration.

DACCA, the 31st October 1974.

Ministry of Foreign Affairs
Government of the People's Republic of Bangladesh
DACCA

Annex IN-11

Note Verbale from the High Commission of Bangladesh to the Ministry of External Affairs of India, 13 December 1974.

Phones : 615668
619257
Cables : BANGLADOOT

গণ প্রজাতন্ত্রী বাংলাদেশ দূতাবাস
নূতন দিল্লী

(54)

HIGH COMMISSION FOR THE
PEOPLE'S REPUBLIC OF BANGLADESH
NEW DELHI

December 13, 1974.

The High Commission for Bangladesh in New Delhi presents its compliments to the Ministry of External Affairs of the Government of India and has the honour to advert to the note verbale of the High Commission of India in Dacca No.DAC/POL/111/1/74, dated 31st October, 1974.

Upon instructions from the Government of Bangladesh, the High Commission has the honour to state as follows:-

A The Bangladesh Territorial Waters and Maritime Zones Act, 1974 was enacted on 14th February, 1974. In March, 1974 the Deputy Legal Adviser, Ministry of Foreign Affairs, Government of Bangladesh, visited New Delhi and consultations took place with the Legal Adviser, Ministry of External Affairs, Government of India, regarding the contents of this legislation.

B Pursuant to sections 3(1) and 5(1) of the Act, notifications were published in the official Bangladesh Gazette on the 16th April, 1974 notifying the baselines expressed in geographical coordinates from which the territorial sea and economic zones of Bangladesh are to be measured. Upon the publication of these notifications, Bangladesh Government informally apprised the Government of India of the action taken and, at the first available opportunity, the Foreign Secretary of Bangladesh during his visit to New Delhi in early May, 1974 made a proposal to the Foreign Secretary of India that the two side(s) should immediately discuss and settle the delimitation of the maritime boundaries between India and Bangladesh. At that stage it was indicated that the Indian side would require a little time to consider the matter and it was agreed that the Legal Adviser in the Ministry of External Affairs of the Government of India was to visit Bangladesh shortly for talks. The Bangladesh Government proposed through its High Commission in New Delhi and the Indian High Commission in Dacca that the Legal Adviser in the Ministry of External Affairs, Government of India may visit on 10th June, 1974. This date was not convenient for him. Owing to the commitments and pre-occupations of the officers concerned, firm dates for the visit could not be settled earlier than for 29th November, 1974 though a number of different dates were suggested from both sides.

The Government of Bangladesh would in this connection invite attention to the speech delivered on 3rd July, 1974 at the plenary session of the Caracas Conference where the leader of the Bangladesh delegation stated, *inter alia*, as follows:-

C "Pursuant to this Act, Government of Bangladesh issued two notifications

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Phones : 615668
619257
Cables : BANGLADOOT

গণ প্রজাতন্ত্রী বাংলাদেশ দূতাবাস
নূতন দিল্লী

HIGH COMMISSION FOR THE
PEOPLE'S REPUBLIC OF BANGLADESH
NEW DELHI

regarding territorial waters and economic zone. The territorial waters extends to 12 nautical miles from the baselines expressed in geographical coordinates and the economic zone to 200 nautical miles from the baselines".

(Reference provisional summary records of 27th Plenary meeting --- A/Conf.62/S.R. 27 dated 8th July, 1974.)

It was in this background that the Government of Bangladesh has proceeded on the basis that the friendly Government of India was fully in the picture on the actions taken to declare and define Bangladesh's baselines in terms of geographical coordinates. Therefore, the statement in the Indian note that the Government of India came to know of the notifications of April, 1974 only at the end of September, 1974 has come as a surprise.

Having initiated consultations with the Government of India, the Bangladesh Government has consistently proceeded on the basis that mutual consultations between the two Governments which it considers to be one of the most valuable features of the close and friendly ties binding the two countries, have in effect been going on since March, 1974. Indeed it has all along been the understanding of the Bangladesh Government that delimitation of the maritime boundary with India did not present any difficulty, and it would appear that upon this shared assumption, both India and Bangladesh entered into contracts for exploration in their off shore areas.

With respect to the suggestion of the Government of India that pending the settlement of the maritime boundary between the two countries the Government of Bangladesh desist from any exploration of the area considered as Indian by the Government of India and ensure that no exploration work is carried out by any party, the Government of Bangladesh has taken care to enter into contracts for exploration entirely within the area which forms part of its territorial sea and continental shelf. The Bangladesh Government, therefore, does not consider that there is any reason to refrain from proceeding with work in its contracted areas.

With respect to the considerations set out in the note under reference regarding baselines, the Government of Bangladesh considers that these and other matters may be settled to mutual satisfaction in the discussions which have already been initiated. The Government of Bangladesh shares with the Government of India the confidence that delimitation of the maritime boundary may be worked out in an equitable manner by mutual agreement between the two countries, safeguarding the interests of India and Bangladesh in the Bay of Bengal.

Contd...P/3.

Phones : 615668
619257
Cables : BANGLADOOT

গণ প্রজাতন্ত্রী বাংলাদেশ দূতাবাস
নূতন দিল্লী

HIGH COMMISSION FOR THE
PEOPLE'S REPUBLIC OF BANGLADESH
NEW DELHI

-: 3 :-

The Government of Bangladesh now has the honour to propose that in view of the shared concern to avoid any possible misunderstanding in this matter the Foreign Secretaries of India and Bangladesh should meet at the earliest opportunity. The Foreign Secretary of Bangladesh will be happy to proceed to New Delhi in the second week of January, 1975.

The High Commission for Bangladesh in New Delhi avails itself of this opportunity to renew to the Ministry of External Affairs, Government of India, the assurances of its highest consideration.

PEOPLE'S
NEW DELHI

The Ministry of External Affairs,
Government of India,
New Delhi.

Annex IN-12

Press Release of 2 April 1975 on the talks held between the Foreign Ministers of India and Bangladesh at New Delhi from 29 March to 2 April 1975.

181

Ministry of External Affairs
Press Relations Section
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JOINT PRESS RELEASE

New Delhi, April 2, 1975
Chaitra 12, 1897

His Excellency Dr. Kamal Hossain, Foreign Minister of the People's Republic of Bangladesh paid an official visit to India from 29th March, 1975 to 2nd April, 1975 at the invitation of the Foreign Minister of India, Shri Y.B. Chavan.

Dr. Kamal Hossain was received by the President and met the Prime Minister twice. He also met the Defence Minister, Sardar Swaran Singh and the Deputy Chairman of the Planning Commission, Shri P.N. Haksar.

The two Foreign Ministers held detailed and wide-ranging talks on matters of mutual interest. The talks were held in an atmosphere of cordiality and complete understanding. Negotiations on the delimitation of the maritime boundary have advanced to a stage where both sides felt confident of finding an expeditious and mutually satisfactory solution. The talks will be resumed soon.

.-.-.-.-.-.-.-.-.-.-.

Annex IN-13

India's Territorial Waters, Continental Shelf, Exclusive Economic Zone and Other Maritime Zones Act, No. 80, 28 May 1976.

The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976, Act No. 80 of 28 May 1976

Short title and commencement

1. (1) This Act may be called the Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976.

(2) Sections 5 and 7 shall come into force on such date or on such different dates as the Central Government may, by notification in the Official Gazette, appoint; and the remaining provisions of this Act shall come into force at once.

...

Definition

2. In this Act, "limit" in relation to the territorial waters, ..., the exclusive economic zone or any other maritime zone of India, means the limit of such waters, shelf or zone with eference to the mainland of India as well as the individual or composite group or groups of islands constituting part of the territory of India.

Sovereignty over, and limits of territorial waters

3. (1) The sovereignty of India extends and has always extended to the territorial waters of India (hereinafter referred to as the territorial waters) and to the seabed and subsoil underlying, and the airspace over, such waters.

(2) The limit of the territorial waters is the line every point of which is at a distance of twelve nautical miles from the nearest point of the appropriate baseline.

(3) Notwithstanding anything contained in subsection (2), the Central Government may, whenever it considers necessary so to do having regard to international law and State practice, alter, by notification in the Official Gazette, the limit of the territorial waters.

(4) No notification shall be issued under subsection (3) unless resolutions approving the issue of such notification are passed by both Houses of Parliament.

Use of territorial waters by foreign ships

4. (1) Without prejudice to the provisions of any other law for the time being in force, all foreign ships (other than warships including submarines and other underwater vehicles) shall enjoy the right of innocent passage through the territorial waters.

Explanation - For the purposes of this section, passage is innocent so long as it is not prejudicial to the peace, good order or security of India.

(2) Foreign warships including submarines and other underwater vehicles may enter or pass through the territorial waters after giving prior notice to the Central Government:

Provided that submarines and other underwater vehicles shall navigate on the surface and show their flag while passing through such waters.

(3) The Central Government may, if satisfied that it is necessary so to do in the interests of the peace, good order or security of India or any part thereof, suspend, by notification in the Official Gazette, whether absolutely or subject to such exceptions and qualifications as may be specified in the notification, the entry of all or any class of foreign ships into such area of the territorial waters as may be specified in the notification.

Contiguous zone of India

5. (1) The contiguous zone of India (hereinafter referred to as the contiguous zone) is an area beyond and adjacent to the territorial waters, and the limit of the contiguous zone is the line every point of which is at a distance of twenty-four nautical miles from the nearest point of the baseline referred to in subsection (2) of section 3.

(2) Notwithstanding anything contained in subsection (1), the Central Government may, whenever it considers necessary so to do having regard to international law and State practice, alter, by notification in the Official Gazette, the limit of the contiguous zone.

(3) No notification shall be issued under subsection (2) unless resolutions approving the issue of such notification are passed by both Houses of Parliament.

(4) The Central Government may exercise such powers and take such measures in or in relation to the contiguous zone as it may consider necessary with respect to,:

(a) The security of India, and

(b) Immigration, sanitation, customs and other fiscal matters.

(5) The Central Government may, by notification in the Official Gazette:

(a) Extend with such restrictions and modifications as it thinks fit, any enactment, relating to any matter referred to in clause (a) or clause (b) of subsection (4), for the time being in force in India or any part thereof, to the contiguous zone, and

(b) Make such provisions as it may consider necessary in such notification for facilitating the enforcement of such enactment, and any enactment so extended shall have effect as if the contiguous zone is a part of the territory of India.

Continental shelf

6. (1) The continental shelf of India (hereinafter referred to as the continental shelf) comprises the seabed and subsoil of the submarine areas that extend beyond the limit of its territorial waters throughout the natural prolongation of its land territory to the outer edge of the continental margin or to a distance of two hundred nautical miles from the baseline referred to in sub-section (2) of section 3 where the outer edge of the continental margin does not extend up to that distance.

(2) India has, and always had, full and exclusive sovereign rights in respect of its continental shelf.

(3) Without prejudice to the generality of the provisions of sub-section (2), the Union has in the continental shelf, -

(a) sovereign rights for the purposes of exploration, exploitation, conservation and management of all resources;

(b) exclusive rights and jurisdiction for the construction, maintenance or operation of artificial islands, off-shore terminals, installations and other structures and devices necessary for the exploration and exploitation of the resources of the continental shelf or for the convenience of shipping or for any other purpose;

(c) exclusive jurisdiction to authorise, regulate and control scientific research; and

(d) exclusive jurisdiction to preserve and protect the marine environment and to prevent and control marine pollution.

(4) No person (including a foreign Government) shall, except under, and in accordance with the terms of a licence or a letter of authority granted by the Central Government, explore the continental shelf or exploit its resources or carry out any search or excavation or conduct any research within the continental shelf or drill therein or construct, maintain or operate any artificial island, off-shore terminal, installation or other structure or device therein for any purpose whatsoever.

(5)....The Central Government may, by notification in the Official Gazette, -

(a) declare any area of the continental shelf and its superjacent waters to be a designated area; and

(b) make such provisions as it may deem necessary with respect to, -

(i) the exploration, exploitation and protection of the resources of the continental shelf within such designated area; or

(ii) the safety and protection of artificial islands, off-shore terminals, installations and other structures and devices in such designated area; or

(iii) the protection of marine environment of such designated area; or

(iv) customs and other fiscal matters in relation to such designated area.

Explanation. - A notification issued under this sub-section may provide for the regulation of entry into and passage through the designated area of foreign ships by the establishment of fairways, sealanes, traffic separation schemes or any other mode of ensuring freedom of navigation which is not prejudicial to the interests of India.

(6) The Central Government may, by notification in the Official Gazette, -

(a) extend with such restrictions and modifications as it thinks fit, any enactment for the time being in force in India or any part thereof to the continental shelf or any part [including any designated area under sub-section (5)] thereof; and

(b) make such provisions as it may consider necessary for facilitating the enforcement of such enactment,

and any enactment so extended shall have effect as if the continental shelf or the part [including, as the case may be, any designated area under sub-section (5)] thereof to which it has been extended is a part of the territory of India.

(7) Without prejudice to the provisions of sub-section (2) and subject to any measures that may be necessary

for protecting the interests of India, the Central Government may not impede the laying or maintenance of submarine cables or pipelines on the continental shelf by foreign States:

Provided that the consent of the Central Government shall be necessary for the delineation of the course for the laying of such cables or pipelines.

Exclusive economic zone

7. (1) The exclusive economic zone of India (hereinafter referred to as the exclusive economic zone) is an area beyond and adjacent to the territorial waters, and the limit of such zone is two hundred nautical miles from the baseline.

(2) Notwithstanding anything contained in subsection (1), the Central Government may whenever it considers necessary so to do having regard to International Law and State practice, alter, by notification in the Official Gazette, the limit of the exclusive economic zone.

(3) No notification shall be issued under subsection (2) unless resolutions approving the issue of such notification are passed by both Houses of Parliament.

(4) In the exclusive economic zone, the Union has, -

(a) sovereign rights for the purpose of exploration, exploitation, conservation and management of the natural resources, both living and non-living as well as for producing energy from tides, winds and currents;

(b) exclusive rights and jurisdiction for the construction, maintenance or operation of artificial islands, off-shore terminals, installations and other structures and devices necessary for the exploration and exploitation of the resources of the zone or for the convenience of shipping or for any other purpose;

(c) exclusive jurisdiction to authorize, regulate and control scientific research;

(d) exclusive jurisdiction to preserve and protect the marine environment and to prevent and control marine pollution; and

(e) such other rights as are recognised by International Law.

(5) No person (including a foreign Government) shall, except under, and in accordance with, the terms of any agreement with the Central Government or of a licence or a letter of authority granted by the Central Government, explore or exploit any resources of the exclusive economic zone or carry out any research or excavation or conduct any research within the exclusive economic zone or drill therein or construct, maintain or operate any artificial island, off-shore terminal, installation or other structure or device therein for any purpose whatsoever:

Provided that nothing in this sub-section shall apply in relation to fishing by a citizen of India.

(6) The Central Government may, by notification in the Official Gazette,-

(a) declare any area of the exclusive economic zone to be a designated area; and

(b) make such provisions as it may deem necessary with respect to,-

(i) the exploration, exploitation and protection of the resources of such designated area; or

(ii) other activities for the economic exploitation and exploration of such designated area such as the production of energy from tides, winds and currents;/or

(iii) the safety and protection of artificial islands, off-shore terminals, installations and other structures and devices in such designated areas;

(iv) the protection of marine environment of such designated area; or

(v) customs and other fiscal matters in relation to such designated area.

Explanation

A notification issued under this sub-section may provide for the regulation of entry into and passage through the designated area of foreign ships by the establishment of fairways, sealanes, traffic separation schemes or any other mode of ensuring freedom of navigation which is not prejudicial to the interests of India.

(7) The Central Government may, by notification in the official Gazette, -

(a) extend, with such restrictions and modifications as it thinks fit, any enactment for the time being in force in India or any part thereof to the exclusive economic zone or any part thereof; and

(b) make such provisions as it may consider necessary for facilitating the enforcement of such enactment, and any enactment so extended shall have effect as if the exclusive economic zone or the part thereof to which it has been extended is a part of the territory of India.

(8) The provisions of sub-section (7) of section 6 shall apply to the laying or maintenance of submarine cables or pipelines on the seabed of the exclusive economic zone as they apply in relation to the laying or maintenance of submarine cables or pipelines on the seabed of the continental shelf.

(9) In the exclusive economic zone and the air space over the zone, ships and aircraft of all States shall, subject to the exercise by India of its rights within the zone, enjoy freedom of navigation and overflight.

Historic waters

8. (1) The Central Government may, by notification in the Official Gazette, specify the limits of such waters adjacent to its land territory as are the historic waters of India.

(2) The sovereignty of India extends, and has always extended, to the historic waters of India and to the seabed and subsoil underlying, and the airspace over, such waters.

Maritime boundaries between India and States having coasts opposite or adjacent to those of India

9. (1) The maritime boundaries between India and any State whose coast is opposite or adjacent to that of India in regard to their respective territorial waters, contiguous zones, continental shelves, exclusive economic zones and other maritime zones shall be as determined by agreement (whether entered into before or after the commencement of this section) between India and such State and pending such agreement between India and any such State, and unless any other provisional arrangements are agreed to between them, the maritime boundaries between India and

such State shall not extend beyond the line every point of which is equidistant from the nearest point from which the breadth of the territorial waters of India and of such State are measured.

(2) Every agreement referred to in sub-section (1) shall, as soon as may be after it is entered into be, published in the Official Gazette.

(3) The provisions of sub-section (1) shall have effect notwithstanding anything contained in any other provision of this Act.

Publication of charts

10. The Central Government may cause the baseline referred to sub-section (2) of section 3, the limits of the territorial waters, the contiguous zone, the continental shelf, the exclusive economic zone and the historic waters of India and the maritime boundaries as settled by agreements referred to in section 9 to be published in charts.

Offences

11. Whoever contravenes any provision of this Act or of any notification thereunder shall (without prejudice to any other action which may be taken against such person under any other provision of this or of any other enactment) be punishable with imprisonment which may extend to three years, or with fine, or with both.

Offences by companies

12. (1) Where an offence under this Act or the rules made thereunder has been committed by a company, every person who at the time the offence was committed was in charge of, and was responsible to the company for the conduct of the business of the company, as well as the company shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly.

Provided that nothing contained in this sub-section shall render any such person liable to any punishment provided in this Act if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1) where an offence under this Act or the rules made thereunder has been committed by a company and it is proved that the offence has been committed with the consent or the connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

...

Explanation

For the purposes of this section,- (a) "company" means any body corporate and includes a firm or other associations of individuals; and (b) "director", in relation to a firm, means a partner in the firm.

Place of trial

13. Any person committing an offence under this Act or any rules made thereunder or under any of the enactments extended under this Act or under the rules made thereunder may be tried for the offence in any place in which he may be found or in such other place as the Central Government may, by general or special order, published in the Official Gazette, direct in this behalf.

Previous sanction of the Central Government for prosecution

14. No prosecution shall be instituted against any person in respect of any offence under this Act or the rules made thereunder without the previous sanction of the Central Government or such officer or authority as may be authorized by that Government by order in writing in this behalf.

Power to make rules

15. (1) The Central Government may, by notification in the Official Gazette, make rules for carrying out the purposes of this Act.

(2) In particular and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely: -

(a) regulation of the conduct of any person in the territorial waters, the contiguous zone, the continental shelf, the exclusive economic zone or any other maritime zone of India;

(b) regulation of the exploration and exploitation, conservation and management of the resources of the continental shelf;

(c) regulation of the exploration, exploitation conservation and management of the resources of the exclusive economic zone;

(d) regulation of the construction, maintenance and operation of artificial islands, off-shore terminals, installations and other structures and devices referred to in sections 6 and 7;

(e) preservation and protection of the marine environment and prevention and control of marine pollution for the purposes of this Act;

(f) authorisation, regulation and control of the conduct of scientific research for the purposes of this Act;

(g) fees in relation to licences and letters of authority referred to in sub-section (4) of section 6 and sub-section (5) of section 7 or for any other purpose; or

(h) any matter incidental to any of the matters specified in clauses (a) to (g).

(3) In making any rule under this section, the Central Government may provide that a contravention thereof shall be punishable with imprisonment which may extend to three years, or with fine which may extend to any amount, or with both.

(4) Every rule made under this Act and every notification issued under sub-section (5) of section 6 or subsection (5) of section 7 shall be laid, as soon as may be after it is made or issued, before each House of Parliament while it is in session for a total period of thirty days which may be comprised in one session or in two or more successive sessions and if, before the expiry of the session immediately following the session or the successive session aforesaid both Houses agree in making any modification in the rule or the notification or both Houses agree that the rule or notification should not be issued, the rule or notification shall, thereafter, have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule or notification.

Removal of difficulties

16. (1) If any difficulty arises in giving effect to the provisions of this Act or of any of the enactments extended under this Act, the Central Government may, by order published in the Official Gazette, make such provisions not inconsistent with the provisions of this Act or, as the case may be, of such enactment, as may appear to it to be necessary or expedient for removing the difficulty: Provided that no order shall be made under this section -

(a) in the case of any difficulty arising in giving effect to any provision of this Act, after the expiry of three years from the commencement of such provision;

(b) in the case of any difficulty arising in giving effect to the provisions of any enactment extended under this Act, after the expiry of three years from the extension of such enactment.

(2) Every order made under this section shall be laid, as soon as may be after it is made, before each House of Parliament.

Annex IN-14

Joint press statement issued on the conclusion of Indo-Bangladesh talks on delimitation of maritime boundary, 24 March 1978 reproduced in A. S. Bhasin (ed.), *India - Bangladesh Relations: Documents 1971-2002*, Vol. IV, 2003, p. 1919.

812. Joint press statement issued on the conclusion of Indo-Bangladesh talks on delimitation of maritime boundary.

New Delhi, March 24, 1978

The Indian and Bangladesh delegations held talks from 22-23 March, 1978 on the delimitation of maritime boundary between the two countries. The Bangladesh delegation to the talks was led by Mr. Mohammed Siddiqur Rahman, Additional Secretary, incharge of the Ministry of Ports, Shipping and Inland Water Transport and included Mr. M.M. Rezaul Krim, Deputy High Commissioner of Bangladesh in New Delhi; Mr. Harunur Rashid, Director-General (South & South-East Asia) in the Bangladesh Ministry of Foreign Affairs; Mr. M.S. Ali, Legal Adviser in the Ministry of Foreign Affairs; and Mr. Abu Hena, a Chief Hydrographer. The Indian delegation was led by Shri J.S. Mehta, Foreign Secretary and included Shri Muchkund Dubey, Joint Secretary Incharge of the Bangladesh Division, Dr. S.P. Jagota, Joint Secretary, Legal & Treaties Division, Ministry of External Affairs, and Shri S.K. Chib, Joint Secretary, Ministry of Mines.

The talks were characterised by utmost cordiality and good-neighbourliness.[1] The talks, which were held after an interval of about three years, were useful, reviewing the position, helping the two delegations to understand each other's points of view and preparing the ground for further discussions. It was agreed to resume negotiations in Dacca as soon as possible.

♦ ♦ ♦ ♦ ♦

1. Complete *secrecy* was maintained on the progress of the negotiations and the two teams would only say that the talks, held after an interval of three years, "were useful in reviewing the position, helping the two delegations to understand each other's points of view and preparing the ground for further discussions."Intensive negotiations had been held in 1974 and 1975 between the two countries at official as well as Ministerial levels. At the last round of talks held between the then Foreign Ministers Mr. Y.B. Chavan, and Dr Kamal Hossain, they had expressed their confidence in reaching a mutually satisfactory solution to the problem. [Between 1974 and 1977, India had settled its maritime boundaries with Sri Lanka, Maldives and Indonesia, and in all these settlements the general principle adopted was the median line, though in very exceptional cases this was slightly modified. With Sri Lanka, the boundary was delineated in the Palk Straits, Gulf of Mannar and Bay of Bengal. With Maldives the maritime boundary was settled in the Arabian Sea and between Kerala coast and Maldives. So also with Indonesia, it was settled between Sumatra and Nicobar as well as the Indian Ocean and Andaman Sea.]

Annex IN-15

Report on the Indo-Bangladesh Talks on Maritime Boundary, 5 December 1980 reproduced in A. S. Bhasin (ed.), *India - Bangladesh Relations: Documents 1971-2002*, Vol. IV, 2003, pp. 1930-1931.

should be no further resort to force and effective steps should be taken to prevent recurrence of such incidents. Flag meetings between the Border Security Force and the Bangladesh Rifles were held on 17th and 25th November, 1980, with a view to restoring normalcy in this area. No further firing has been reported since 26th November, 1980.

♦ ♦ ♦ ♦ ♦

823. Report on the Indo-Bangladesh talks on maritime boundary.

Dacca, December 5, 1980

Bangladesh and India have agreed to resolve the question of delimitation of maritime boundary in a spirit of mutual understanding and good neighbourly relations. The four-day official-level talks between the two neighbours that ended in Dacca on December 5, 1980 made efforts to find out a mutually acceptable solution to the question of delimitation of maritime boundary. A joint press statement, issued at the end of the talks, described it as “useful and constructive”. The talks were held in an atmosphere of cordiality and understanding. The two sides have decided to resume the talks “as early as possible” in 1981, the joint statement said.

The Bangladesh side was led by Mr. A.H.S. Ataul Karim, Additional Foreign Secretary and the Indian delegation in the talks was led by Dr. S.P. Jagota, Additional Secretary of the Ministry of External Affairs.

It may be mentioned that the talks on delimitation of maritime boundary between Bangladesh and India started since 1974 and this meeting was the seventh round of talks between the two neighbours.

Talking to newsmen at the state guest house “Meghna” after the talks, the leader of Bangladesh delegation, Additional Foreign Secretary Mr. Ataul Karim said that the negotiations with India on delimitation of maritime boundary were in progress. Referring to the next round of talks, he said “let us hope that the talks on delimitation of maritime boundary will end in 1981".

Replying to a question, the leader of the Indian delegation Dr. S.P Jagota said, “We want a mutually acceptable solution to the question of delimitation of maritime boundary.” He termed the issue as “sensitive” and said “we don’t want to hurry”. Asked how long time the two countries would need to solve the issue, he said, “we are moving towards a mutually acceptable agreement”.

Asked whether the question of the South Talpatty Island in the Bay of Bengal also came up for discussion, Mr. Karim said, “We are exchanging additional data on the island in accordance with the decision of the two Foreign Ministers and the issue of the newly emerged island would be taken up separately by the two sides for a solution." The two Foreign Ministers had agreed in their August meeting that the issue would be resolved peacefully at an early data, Mr. Karim said.

♦ ♦ ♦ ♦ ♦

824. Question In the *Lok Sabha :* "Census work in Indian enclaves surrounded by Bangladesh".

New Delhi, August 20, 1981

Will the Minister of External Affairs be pleased to state :

(a) whether Government of India have made any proposal to the Bangladesh Government to enable the Indian Census Party to go the Indian Enclaves (131 enclaves, 29 sq. miles, population about one lakh) surrounded by Bangladesh for census work there;

(b) if so, what are the details in this regard and reaction of the Bangladesh Government thereto;

(c) whether Government of India have allowed the Bangladesh Census party along with the Bangladesh Police personnel to enter into Bangladesh enclaves (i.e. Dahagram, Angarpota etc.) surrounded by India through Tin Bigha on 6th July, 1981 without scheduled passport and without following visa routes;

(d) if so, the reasons therefor; and

(e) whether it is a fact that there had been no Census work in Indian enclaves surrounded by Bangladesh since 1951 while Bangladesh was allowed to do the Census work in their enclaves in 1961; if so, the reasons thereof?

The Minister of External Affairs (Shri P.V. Narasimha Rao) :

(a) and (b). The Government have not made any proposal to the Bangladesh Government to carry out census in the 119 Indian enclaves, comprising a total area of 69.414 sq. kms. in the adverse possession of Bangladesh.

(c) and (d). At the request of the Bangladesh Government we had extended facilities to ensure the safe passage of a Bangladesh census party through Tin Bigha territory to enable it to conduct census operations in the enclaves of Dahagram and Angarpota on the 6th July, 1981. The Agreement between the Governments of India and Bangladesh

Annex IN-16

Letter from the representative of Bangladesh to the President of the Conference, Doc. A/CONF.62/L.140, 28 April 1982.

Third United Nations Conference on the Law of the Sea

1973-1982
Concluded at Montego Bay, Jamaica on 10 December 1982

Document:-
A/CONF.62/L.140

Letter dated 28 April 1982 from the representative of Bangladesh to the President of the Conference

Extract from the *Official Records of the Third United Nations Conference on the Law of the Sea, Volume XVI (Summary Records, Plenary, First and Second Committees, as well as Documents of the Conference, Eleventh Session)*

III. *Should those private companies be allowed to continue to enjoy such status if the States of which they are nationals should fail to ratify the convention? Is not the whole purpose of enumerating the companies in a decision of the Conference to make it possible for the States concerned to refuse to ratify the convention as soon as the companies receive the benefits?*

9. These questions involve basically political issues. According to paragraph 8 (*a*) of draft resolution II, the pioneer investors are to be required to apply to the Authority, within six months of the entry into force of the convention, for a plan of work for exploration and exploitation. A certifying State is to be deemed to be a sponsoring State for the purposes of annex III, article 4 of the convention, and must, upon the entry into force of the convention, assume the obligations as such. No plan of work for exploration and exploitation may be approved unless the certifying State is a party to the convention. It is further specified that, in respect of the entities referred to in paragraph 1 (*a*) (ii) of the draft resolution (i.e. the four consortia), the plan of work for exploration and exploitation "shall not be approved" unless all the States at present whose natural or juridical persons comprise those entities are parties to the convention (draft resolution II, para. 8 (*c*)). If any such State fails to ratify the convention within a period of six months after it has been notified that an application is pending, its status as a pioneer investor or certifying State as the case may be, "shall terminate", unless the Council, by a majority of three fourths of its members, decides to postpone the termination date (*ibid.*). The termination of the status as a certifying State will in turn terminate any right acquired by any pioneer investors it had certified (*ibid.*, para. 10 (*a*)).

10. Explicit provisions are also made in subparagraph 10 (*b*) and (*c*) of draft resolution II, permitting the pioneer investors to change their nationalities. This reflects another political decision that the Conference has made. A registered pioneer investor may alter its nationality and sponsorship from that prevailing at the time of its registration to that of any State Party to the convention which has "effective control" over it. Such change in nationality is not to affect any right or priority conferred on a pioneer investor. Thus, even though changing nationality and sponsorship is permitted, the requirement of "effective control" must be maintained. So long as there is a requirement of "effective control", "flag of convenience" abuses cannot occur.

11. It is understood that these consequences were presented as political compromises between the proposals of the different interest groups. Certain States had insisted earlier that in the case of the entities referred to in paragraph 1 (*a*) (ii) of draft resolution II, all the States whose natural or juridical persons comprise these entities must be signatories to the convention at the time the entities apply for pioneer investor status; other States strongly objected to this. The present compromise is to require all those States to become parties to the convention when the entities apply for a plan of work.

IV. *Why must a decision of the Conference establish an inequitable system for the granting of the status of "pioneer investor" to juridical persons of States enumerated in paragraph 1 (a) (ii) in draft resolution II? Why should the companies of the latter States be accorded an essentially privileged position?*

12. These also are political questions on which the Conference will have to make a decision. It is true that under subparagraph 1 (*a*) (i) of draft resolution II, as presently drafted, the States therein must sign the convention from the outset, while not all the States referred to in subparagraph 1 (*a*) (ii) must do so. There is also the third category, subparagraph 1 (*a*) (iii), where the States referred to must also be signatories at the outset. The requirement is therefore somewhat different for the three categories of pioneer investors. It may be relevant to point out that, if paragraph 5 of the draft resolution is interpreted to mean that only certifying States which are also signatory States may participate in the conflict resolution envisaged therein, the States mentioned in paragraph 1 (*a*) (ii) may need to become signatories in order to participate effectively in resolving conflicting claims.

DOCUMENT A/CONF.62/L.140

Letter dated 28 April 1982 from the representative of Bangladesh to the President of the Conference

[*Original: English*]
[*28 April 1982*]

I have been instructed by my Government to recall the national position in respect of the drawing of baselines from which areas of national maritime jurisdiction are measured. As you are aware, from the very beginning of the Third United Nations Conference on the Law of the Sea, the Bangladesh delegation has brought to the attention of the Conference the unique configuration of its coastline associated with peculiar geomorphological and geological conditions obtaining off-shore—conditions that lead to a highly fluctuating low-water mark and areas of shallow water so unstable and variable as not to be amenable to conventional charting. Except for the channels leading to the two riverine ports of Chalna and Chittagong, the off-shore area has not historically been navigable and that situation continues to remain so. These considerations have a manifest impact on the drawing of the baseline in an area where the waters immediately off-shore have a closer affinity to the land than to the ocean.

In this background, Bangladesh proposed a formulation based upon depth criteria and bathymetric factors which in the circumstances of the case mark the limits of navigation and charting. When the Bangladesh proposal was originally made, it received substantial and favourable support from a large number of delegations and it is our estimate that such support still exists. It is in this background that the Bangladesh Government considers that article 7 of the draft convention (A/CONF.62/L.78)[36] cannot preclude the founding of its baseline on depth criteria and bathymetric factors.

[36] See *Official Records of the Third United Nations Conference on the Law of the Sea*, vol. XV (United Nations publication, Sales No. E.83.V.4).

I should be grateful if you would arrange to have this communication registered and distributed to delegations as an official document of the Conference.

(*Signed*) A. K. H. MORSHED
Representative of Bangladesh
to the Third United Nations Conference
on the Law of the Sea

DOCUMENTS A/CONF.62/L.141 AND ADD.1*

Report of the President to the Conference

[*Original: English*]
[*29 April 1982*]

1. I hope this will be the last report which I shall make to the Conference. You will recall that on 23 April 1982, I submitted to you a report in accordance with rule 37 of the rules of procedure. That report is contained in document A/CONF.62/L.132 and Add.1. Yesterday and this morning, 53 delegations made statements on that report and on the proposals contained in the addendum to the report. This afternoon and this evening, I shall study carefully the records of that debate and, based upon my assessments of that record, I shall make an appropriate recommendation to the plenary meeting tomorrow morning.

2. After the exciting, momentous and, for me, exhausting events of 26 April, I had wrongly assumed that my work was done. This was unfortunately not to be the case. The representatives of the Group of 77 and the representatives of the group of Eastern European (socialist) States approached me and Mr. Engo to hold further informal consultations on the draft resolution governing preparatory investments in pioneer activities relating to polymetallic nodules, as contained in annex IV of A/CONF.62/L.132. In addition, the representatives of a number of industrialized countries requested Mr. Engo and I to hold further consultations on some remaining difficulties which they had on provisions of Part XI of the draft convention and its annexes. Following appropriate consultations, Mr. Engo and I, with the able assistance of my good friend from Fiji, Mr. Satya Nandan, held intensive informal consultations on 27 and 28 April. In this report, I shall attempt to give you an account of the results of those consultations.

3. The representatives of the Group of 77 made three requests with respect to the draft resolution in annex IV of document A/CONF.62/L.132. First, they maintained that the size of the pioneer area contained in paragraph 1 (*e*) is too large and should be reduced. This position was supported by Japan. The representatives of the Group of 77 also requested that the relinquishment procedure in paragraph 1 (*e*) should be accelerated and the areas relinquished should not be in bits and pieces but in contiguous areas. Secondly, the Group of 77 requested that in paragraph 9 (*a*), the Enterprise should be guaranteed production authorization in respect of two mine sites instead of one and that the production authorization of the Enterprise should enjoy priority over the pioneer investors. Thirdly, the Group of 77 requested the industrialized countries that they should assist the Enterprise in financing the exploration and exploitation of the second mine site.

4. The third demand of the Group of 77 was strongly opposed by the Soviet Union and others, who argued that this was an unacceptable attempt to reopen the negotiations on financial matters which had been conducted in negotiating group 2 and which had been settled.

5. In respect of the first and the second demands, a deal was struck whereby in return for the Group of 77 not insisting on its position on paragraph 1 (*e*), the industrialized countries will agree that the Enterprise should have production authorization for two mine sites and such production authorization shall enjoy priority over the pioneer investors. This proposed reformulation of paragraph 9 (*a*) in contained in the addendum to this report.

6. In respect of paragraph 1 (*a*) (ii), the Soviet Union, supported by the other members of the group of Eastern European (socialist) States made two complaints. Their first complaint was that it was legally impermissible and inappropriate for an international diplomatic conference, such as this, to decide to grant the status of a pioneer investor to private companies which will be identified by means of a reference to a United Nations document. The legal opinion of the Legal Counsel of the United Nations was sought. Mr. Suy's legal opinion and the reply of the Soviet Union thereto are contained in document A/CONF.62/L.133. The response of the Legal Counsel to the Soviet Union's reply is contained in document A/CONF.62/L.139. The United Nations Legal Counsel is of the opinion that the approach adopted in paragraph 1 (*a*) (ii) is legally permissible and consistent with the practice of the United Nations. I concur with this opinion.

7. The second complaint of the Soviet Union and its colleagues from the Eastern European (socialist) Group was that paragraph 1 (*a*) (ii) discriminates against the States referred to in 1 (*a*) (i) and 1 (*a*) (iii). Their argument was that in the case of the States referred to in 1 (*a*) (i) and 1 (*a*) (iii), every State must sign the convention before its State enterprise, its natural or juridical person could qualify as the pioneer investor. In the case of paragraph 1 (*a*) (ii), if a consortium consists of four companies from four States, it is not required that all four States must sign the convention before the consortia could be registered as a pioneer investor. On principle, there was merit in the Soviet complaint.

8. However, in return for this concession, the representatives of the Group of 77 were able to extract from the industrialized countries an even greater concession in paragraph 8 (*c*). In paragraph 8 (*c*), no plan of work for exploration and exploitation shall be approved for any of the consortia referred to in paragraph 1 (*a*) (ii) unless all the States whose natural or juridical persons comprise those consortia are parties to the convention. This requirement is even higher than that contained in the draft convention and in annex III. For this reason, I believe that the concession by the Group of 77 in paragraph 1 (*a*) (ii) is more than compensated by the concession by the industrialized countries in paragraph 8 (*c*).

9. I should also like to point out that the principle of non-discrimination is a double edged sword. The principle of non-discrimination means, in law, treating equals equally and giving differential treatment to those who are not equals. One could point out that the Soviet Union is a relative newcomer in the development of sea-bed mining technology, equipment

*Incorporating document A/CONF.62/L.141/Add.1/Corr.1, of 30 April 1982; document A/CONF.62/L.141/Add.1 contained in the annex to this report.

Annex IN-17

Letter from the representative of India to the President of the Conference,
Doc. A/CONF.62/L.148, 30 April 1982.

Third United Nations Conference on the Law of the Sea

1973-1982
Concluded at Montego Bay, Jamaica on 10 December 1982

Document:-
A/CONF.62/L.148

Letter dated 30 April 1982 from the representative of India to the President of the Conference

Extract from the *Official Records of the Third United Nations Conference on the Law of the Sea, Volume XVI (Summary Records, Plenary, First and Second Committees, as well as Documents of the Conference, Eleventh Session)*

DOCUMENT A/CONF.62/L.146

Letter dated 29 April 1982 from the representative of Sierra Leone to the President of the Conference

[*Original: English*]
[*29 April 1982*]

I take this opportunity to underscore the importance my Government attaches to the Third United Nations Conference on the Law of the Sea and to its equitable and just outcome. As evidence of this, my Government, at great cost and sacrifice, has sent a delegation to every one of the sessions of the Conference since its inception.

My delegation is constrained to register serious reservations to some of the proposals contained in document A/CONF.62/L.132, in particular with respect to annex IV of draft resolution II governing preparatory investment in pioneer activities relating to polymetallic nodules. The decision to allocate 150,000 square kilometres as the size of the exploratory area is not based on objective criteria and, given the number of areas to be allocated to the so-called "pioneer investors", considerably reduces that area of the sea-bed that could be exploited by the Authority.

My delegation also believes that the decision to allocate a minimum of eight sites to the "pioneer investors", as against one to the Enterprise, is inequitable.

It is the considered conclusion of my delegation that the draft resolution relating to preparatory investment grants implicit recognition to the unilateral legislations enacted by certain participants of the Conference and which the Conference has declared illegal. The draft resolution in its present form would delay the coming into operation of the parallel system of exploration and exploitation of the sea-bed resources or at least reduce the Authority to a licensing agent. As regards Part XI, the draft resolution in a way makes the draft convention superfluous. For all these reasons, we have come to the conclusion that this resolution is too high a price to pay to get the industrialized countries to become parties to the convention.

I will respectfully request you to circulate this letter as a document of the Conference.

(*Signed*) A. G. KOROMA
Representative of Sierra Leone
to the Third United Nations Conference
on the Law of the Sea

DOCUMENT A/CONF.62/L.147

Report to the plenary of the Conference on the recommendations of the Drafting Committee presented by the Chairman of the Drafting Committee on behalf of the President and the Chairman of the First Committee

[*Original: English*]
[*29 April 1982*]

1. At an informal plenary meeting of the Conference held on 16 April 1982 consideration was given to the recommendations of the Drafting Committee contained in documents A/CONF.62/L.93 and A/CONF.62/L.94, together comprising approximately 800 proposals.

2. The recommendations of the Drafting Committee approved during the informal plenary meeting of the Conference held on 16 April 1982 are set out in the addendum to the report of the Drafting Committee (A/CONF.62/L.142/Add.1).

DOCUMENT A/CONF.62/L.148

Letter dated 30 April 1982 from the representative of India to the President of the Conference

[*Original: English*]
[*30 April 1982*]

1. The Indian delegation to the Third United Nations Conference on the Law of the Sea has seen on 29 April 1982 the text of the letter dated 28 April 1982, from the representative of Bangladesh addressed to you, which was circulated to all delegations as document A/CONF.62/L.140 on the same date.

2. In this connection, I have the honour to state as follows:

The proposal concerning the drawing of baselines in the deltaic area referred to in the aforementioned letter by the representative of Bangladesh was made as an informal suggestion with respect to the contents of paragraph 2 of article 7 of the informal composite negotiating text[39] at the seventh session of the Conference held at Geneva from 28 March to 19 May 1978. Their proposal would have allowed the establishment of straight baselines joining base points at sea rather than base points located along the coastline. With reference to their suggestion, and the claim that it had received substantial support, I, as representative of India at the Conference, had made the following statement at the 104th plenary meeting on 18 May 1978:

"54. . . . the informal suggestion made by Bangladesh with respect to the content of paragraph 2 of article 7 (C.2/Informal meeting/6) would have the effect of establishing a new rule of international law, under which a coastal State would be able to establish straight baselines from base points at sea, and would therefore require wide acceptance by the international community before it could come

[39] See *Official Records of the Third United Nations Conference on the Law of the Sea*, vol. VIII (United Nations publication, Sales No. E.78.V.4).

into force. As his delegation has stated at an informal meeting of the Committee on 28 April, such a suggestion must be considered in the light of the distance from the coastline of the base points for the future baselines; the effect which the new baselines would have on the general direction of the coastline; the possibility that the baselines would be used in fixing the outer limits of the territorial sea or exclusive economic zone, or maritime boundaries with neighbouring coastal States; and the effects on navigation in the enclosed internal waters. It was therefore gratified that Bangladesh was willing to discuss its suggestion with the other States interested in the matter and to raise it again at the Conference's next session. That attitude on the part of Bangladesh showed that its suggestion could not be regarded as having already obtained the substantial support to which reference was made in subparagraph 2 of paragraph 9 of document A/CONF.62/L.28."[40]

3. The suggestion of Bangladesh was not discussed with India after the aforementioned statement, nor has the Bangladesh suggestion been raised at the Conference since 1978, except at the present session and particularly in the form of the letter dated 28 April 1982, referred to at the outset.

[40] *Ibid.*, vol. IX (United Nations publication, Sales No. E.79.V.3).

4. In view of the above, it will not be correct to say that article 7 of the draft convention (A/CONF.62/L.78)[41] cannot preclude the founding of a baseline on depth criteria and bathymetric factors, as stated by the representative of Bangladesh. In fact, the Conference has not accepted the suggestion of Bangladesh.

5. Article 7, paragraph 2, of the draft convention reads as follows:

"2. Where because of the presence of a delta and other natural conditions the coastline is highly unstable, the appropriate points may be selected along the furthest seaward extent of the low-water line and, notwithstanding subsequent regression of the low-water line, the straight baseline shall remain effective until changed by the coastal state in accordance with this Convention."

I shall be grateful if you will kindly arrange to have this communication registered and distributed to the delegations as an official document of the Conference.

(*Signed*) S. P. JAGOTA
Representative of India
to the Third United Nations Conference
on the Law of the Sea

[41] *Ibid.*, vol. XV (United Nations publication, Sales No. E.83.V.4).

DOCUMENT A/CONF.62/L.149

Letter dated 30 April 1982 from the representative of Burma to the President of the Conference

[*Original: English*]
[*30 April 1982*]

In his letter dated 28 April 1982 addressed to you and circulated to all delegations in document A/CONF.62/L.140 of the same date, the representative of Bangladesh asserts that his delegation's proposal concerning the establishment of a straight baselines system on the depth criteria and bathymetric factors had received, and continues to enjoy "substantial and favourable support from a large number of delegations" and further that his Government considers that "article 7 of the draft convention (A/CONF.62/L.78)[41] cannot preclude the founding of its baselines" on such a basis.

In this connection, my delegation is of the view that the above-mentioned assertions are not borne out by the history of negotiations on the proposal at the Conference, particularly in the broadly representative informal negotiating group on baselines established during the third session. Nor are they supported by the text of article 7, paragraph 2 of the draft convention embodying the results of the said negotiations, which specifies in precise and unambiguous terms the fundamental rule that straight baselines may be drawn only from land-point to land-point, and not from sea-point to sea-point.

I should be grateful if you would kindly arrange to have this letter distributed to all delegations as an official document of the Conference.

(*Signed*) S. HLAING
Representative of Burma
to the Third United Nations Conference
on the Law of the Sea

DOCUMENT A/CONF.62/L.150

Letter dated 28 April 1982 from the representative of Ecuador to the President of the Conference

[*Original: Spanish*]
[*30 April 1982*]

In accordance with the letter dated 13 April 1982 which I addressed to you and which is contained in document A/CONF.62/L.128, I am to inform you, as Chairman of the Ecuadorian delegation to the eleventh session of the Third United Nations Conference on the

Annex IN-18

Letter from the representative of Burma to the President of the Conference,
Doc. A/CONF.62/L.149, 30 April 1982.

Third United Nations Conference on the Law of the Sea

1973-1982
Concluded at Montego Bay, Jamaica on 10 December 1982

Document:-
A/CONF.62/L.149

Letter dated 30 April 1982 from the representative of Burma to the President of the Conference

Extract from the *Official Records of the Third United Nations Conference on the Law of the Sea, Volume XVI (Summary Records, Plenary, First and Second Committees, as well as Documents of the Conference, Eleventh Session)*

into force. As his delegation has stated at an informal meeting of the Committee on 28 April, such a suggestion must be considered in the light of the distance from the coastline of the base points for the future baselines; the effect which the new baselines would have on the general direction of the coastline; the possibility that the baselines would be used in fixing the outer limits of the territorial sea or exclusive economic zone, or maritime boundaries with neighbouring coastal States; and the effects on navigation in the enclosed internal waters. It was therefore gratified that Bangladesh was willing to discuss its suggestion with the other States interested in the matter and to raise it again at the Conference's next session. That attitude on the part of Bangladesh showed that its suggestion could not be regarded as having already obtained the substantial support to which reference was made in subparagraph 2 of paragraph 9 of document A/CONF.62/L.28."[40]

3. The suggestion of Bangladesh was not discussed with India after the aforementioned statement, nor has the Bangladesh suggestion been raised at the Conference since 1978, except at the present session and particularly in the form of the letter dated 28 April 1982, referred to at the outset.

[40] *Ibid.*, vol. IX (United Nations publication, Sales No. E.79.V.3).

4. In view of the above, it will not be correct to say that article 7 of the draft convention (A/CONF.62/L.78)[41] cannot preclude the founding of a baseline on depth criteria and bathymetric factors, as stated by the representative of Bangladesh. In fact, the Conference has not accepted the suggestion of Bangladesh.

5. Article 7, paragraph 2, of the draft convention reads as follows:

> "2. Where because of the presence of a delta and other natural conditions the coastline is highly unstable, the appropriate points may be selected along the furthest seaward extent of the low-water line and, notwithstanding subsequent regression of the low-water line, the straight baseline shall remain effective until changed by the coastal state in accordance with this Convention."

I shall be grateful if you will kindly arrange to have this communication registered and distributed to the delegations as an official document of the Conference.

(*Signed*) S. P. JAGOTA
Representative of India
to the Third United Nations Conference
on the Law of the Sea

[41] *Ibid.*, vol. XV (United Nations publication, Sales No. E.83.V.4).

DOCUMENT A/CONF.62/L.149

Letter dated 30 April 1982 from the representative of Burma to the President of the Conference

[*Original: English*]
[*30 April 1982*]

In his letter dated 28 April 1982 addressed to you and circulated to all delegations in document A/CONF.62/L.140 of the same date, the representative of Bangladesh asserts that his delegation's proposal concerning the establishment of a straight baselines system on the depth criteria and bathymetric factors had received, and continues to enjoy "substantial and favourable support from a large number of delegations" and further that his Government considers that "article 7 of the draft convention (A/CONF.62/L.78)[41] cannot preclude the founding of its baselines" on such a basis.

In this connection, my delegation is of the view that the above-mentioned assertions are not borne out by the history of negotiations on the proposal at the Conference, particularly in the broadly representative informal negotiating group on baselines established during the third session. Nor are they supported by the text of article 7, paragraph 2 of the draft convention embodying the results of the said negotiations, which specifies in precise and unambiguous terms the fundamental rule that straight baselines may be drawn only from land-point to land-point, and not from sea-point to sea-point.

I should be grateful if you would kindly arrange to have this letter distributed to all delegations as an official document of the Conference.

(*Signed*) S. HLAING
Representative of Burma
to the Third United Nations Conference
on the Law of the Sea

DOCUMENT A/CONF.62/L.150

Letter dated 28 April 1982 from the representative of Ecuador to the President of the Conference

[*Original: Spanish*]
[*30 April 1982*]

In accordance with the letter dated 13 April 1982 which I addressed to you and which is contained in document A/CONF.62/L.128, I am to inform you, as Chairman of the Ecuadorian delegation to the eleventh session of the Third United Nations Conference on the

Annex IN-19

Summary Records of the 191st Plenary Meeting of the Third United Nations Conference of the Law of the Sea, Doc. A/CONF.62/SR.191, 9 December 1982.

Third United Nations Conference on the Law of the Sea

1973-1982
Concluded at Montego Bay, Jamaica on 10 December 1982

Document:-
A/CONF.62/SR.191

191st Plenary meeting

Extract from the *Official Records of the Third United Nations Conference on the Law of the Sea, Volume XVII (Plenary Meetings, Summary Records and Verbatim Records, as well as Documents of the Conference, Resumed Eleventh Session and Final Part Eleventh Session and Conclusion)*

191st meeting

Thursday, 9 December 1982, at 10 a.m.

President: Mr. T. T. B. KOH (Singapore)

Statement by the President

1. The PRESIDENT: I should like to inform representatives that this morning the Collegium held its last meeting. As I said in my opening statement, on Monday, the Collegium of this Conference is quite a unique institution. It is not to be found in the rules of procedure; it has evolved in response to the need felt by the Conference for leadership and I think that my colleagues and I in the Collegium have been fortunate in that we have been able to work very well together.

2. In my opening statement I paid a tribute to Mr. Arvid Pardo, who has contributed two important, indeed seminal, ideas to the work of this Conference. My tribute to him has been echoed by almost everyone who has addressed the Conference. I am very pleased that Mr. Pardo is with us today and I should like him to stand so that we may express our tribute to him in the usual way—that is, with a round of applause.

Statements by delegations (*continued*)

3. Mr. BHATT (Nepal): The delegation of Nepal joins other delegations that have expressed their thanks and appreciation to the Government and the people of Jamaica for the excellent arrangements they have made for the holding of the final session of the Third United Nations Conference on the Law of the Sea.

4. I should also like to convey to you, Mr. President, the compliments of my delegation for the statesmanlike manner in which you have discharged the difficult task entrusted to you by the international community. We should like to congratulate you on your perseverance in bringing the work of the Conference to a successful conclusion. We also thank the Special Representative of the Secretary-General, Mr. Bernardo Zuleta; the Executive Secretary, Mr. David Hall; and the staff of the Secretariat for their assistance in the work of the Conference. My delegation would like to pay a tribute to the leadership given during his presidency by the late Mr. Hamilton Shirley Amerasinghe of Sri Lanka.

5. This final session of the Third United Nations Conference on the Law of the Sea brings to an end the long and arduous process of negotiations to establish a new régime of the sea. It has taken almost 10 years for the Conference to reach a broad consensus on the complex issues before it. Owing to the divergent interests of the participants, the final document is naturally a compromise text. It represents the consensus, with the widest support, of the international community. My delegation is gratified that the common efforts of the international community have reached a successful conclusion. We earnestly hope that the spirit of co-operation and understanding shown during the course of negotiations will guide our activities in the implementation of the provisions of the Convention.

6. The views of my delegation on questions of particular interest to us have been expressed on many occasions in the past sessions of the Conference. The provisions relating to land-locked countries, particularly Part X of the Convention, are of special importance to us. We are not wholly satisfied with regard to the rights of transit of land-locked countries in article 69 of the Convention. Similarly, provisions relating to the sharing of resources in the continental shelf and to the exclusive economic zone do not correspond to our aspirations.

7. During the course of the Conference, Nepal, with 11 other delegations, proposed a common heritage fund, but the concept did not find enough support. We hope that in future this concept will be able to gain wider support from the international community.

8. The progressive development of the law of the sea from 1958 to 1982 has taken the form of the present Convention. This positive development is one of the stages along the long road towards the establishment of a more just and equitable régime of the law of the sea. We hope this process will continue in the future as well.

9. The delegation of Nepal was deeply conscious of the difficulties involved in reaching consensus on issues on which States had different views and of the essential need for such a consensus if the Convention were to receive the widest possible support. In this spirit of co-operation and compromise, Nepal voted in favour of the draft convention on 30 April 1982. We hope that this Convention will receive support from all the participants in the Conference.

10. Mr. ANDERSEN (Iceland): This is indeed a historic occasion, as we meet in Jamaica to sign the Final Act of the Third United Nations Conference on the Law of the Sea and the long-awaited United Nations Convention on the Law of the Sea. It marks the culmination of the process of evolution that was started almost 35 years ago. Its origins can be found in the fourth session of the General Assembly held in 1949.[1]

11. At that time the International Law Commission had just been established, and that Commission had suggested three topics on its priority list for the starting of the codification and progressive development of international law. These topics were treaties, arbitration and the régime of the high seas. I was then the representative of Iceland on the Sixth Committee—the Legal Committee—of the General Assembly, and I proposed that the law of the sea should be included in its entirety in the list of priorities, and not only the régime of the high seas, because one cannot know where the high seas begin unless one knows the extent of coastal jurisdiction. This proposal was objected to by some who contended that the extent of the territorial sea was clearly established at three nautical miles and that there was no coastal jurisdiction over the living resources of the sea beyond that distance.

12. The Icelandic proposal was adopted, and in the following years Iceland always advocated the policy that a clear distinction should be made between the territorial sea, on the one hand, and the extent of fishery limits, on the other, and that the various elements of the law of the sea were so interrelated that they should be dealt with as a whole. That policy was confirmed by General Assembly resolutions on several occasions, in 1953, 1954, 1957, 1973 and so on.

13. As we know, the International Law Commission was never able to agree on the extent of the territorial sea or fishery limits and it proposed that an international conference be convened. That is why the three United Nations Conferences were eventually convened, the first in 1958, the second in 1960 and the third in 1973. Thus we do have a continuous development extending over a period of almost 35 years.

14. At long last we now have the results ready in the Convention before us. For a country like Iceland, wholly dependent on the resources of the sea surrounding our coast, the text of the Convention represents formidable results because

[1] General Assembly resolution 374 (IV).

it recognizes the sovereign rights of the coastal State over the resources within the exclusive economic zone of 200 miles and over the sea-bed resources of the continental shelf even beyond 200 miles. Within the exclusive economic zone the coastal State makes all the decisions regarding the total allowable catch, as well as its own capacity to utilize that catch and the disposition of any surplus. These decisions of the coastal State cannot be referred to any third party for its decision.

15. These policy guidelines were all contained in Icelandic Law No. 44 of 5 April 1948 concerning the Scientific Conservation of the Continental Shelf Fisheries, and the basic provisions of the Convention dealing with the territorial sea, the economic zone and the continental shelf were incorporated into Icelandic legislation by Law No. 41 of 1 June 1979 concerning the Territorial Sea, the Economic Zone and the Continental Shelf.

16. On this occasion, in addition to recording the satisfaction of the Icelandic people at the historic achievements of the Third United Nations Conference on the Law of the Sea, I want to avail myself of this opportunity to thank all delegations for their co-operation and friendship during the long years that went into the making of this Convention. The same sentiments go to you, Mr. President, and to the entire Collegium, as well as to the members of the Secretariat, without whose exemplary efforts we would not have been able to reach our goal today. I pay a tribute also to the memory of your distinguished predecessor, President Amerasinghe.

17. The Icelandic delegation will be pleased to sign the Final Act of the Conference and the United Nations Convention on the Law of the Sea tomorrow, 10 December 1982. After all, the Icelandic people has been waiting for this result for 35 years.

18. Mr. HAN Xu (China) (*translation from Chinese*): First of all, please allow me, on behalf of the delegation of the People's Republic of China, to express our congratulations on the convening of the final session of the Third United Nations Conference on the Law of the Sea and on your assumption, Sir, of the presidency of this historic Conference. At the same time, I wish to take this opportunity to extend our thanks to the Government and people of Jamaica for providing all the facilities for the Conference.

19. With the concerted efforts of all the participating States, the Third United Nations Conference on the Law of the Sea adopted on 30 April this year the United Nations Convention on the Law of the Sea, after nearly nine years of long and difficult consultations.

20. Through a review of the progress of the Conference, we have seen clearly that the third-world countries waged unremitting struggles to oppose maritime hegemonism and reform the unreasonable and unjust old maritime régimes and put forward many reasonable propositions and proposals, thus providing a good basis for formulating the United Nations Convention on the Law of the Sea and making important contributions to the success of the Conference.

21. Generally speaking, the new Convention is quite an improvement on the old one. The new Convention has laid down a number of important legal principles and régimes for safeguarding the common heritage of mankind and the legitimate maritime rights and interests of all States and brought about a change in the former situation, in which the old law of the sea served only the interests of a few big Powers. This is conducive to the fight against maritime hegemonism, the establishment of a new international economic order, and the promotion of friendly co-operation and exchanges between the peoples of all countries.

22. The Chinese Government has always supported the third-world countries in their struggle against maritime hegemonism, stood for the formulation of a new convention on the law of the sea which ensures the legitimate rights of States, and actively participated in the work of drafting the Convention. The Chinese delegation voted in favour of the present Convention at the Conference in New York last April. Now, the Chinese Government has decided to formally sign the United Nations Convention on the Law of the Sea.

23. However, we cannot but point out that there are still shortcomings and even serious defects in the provisions of quite a few articles in the Convention. The Convention is not entirely satisfactory to us. At the previous sessions of the Conference we repeatedly pointed out that in the articles of the Convention relating to innocent passage through the territorial sea there were no clear provisions regarding the régime of the passage of foreign warships through the territorial sea. A considerable number of States, including China, time and again submitted an amendment in this regard. To respond to the call of the President of the Conference, those sponsors of the amendment did not insist on a vote at the session held last April so that the draft convention on the law of the sea could be adopted by consensus. The statement made by the President of the Conference at that session showed clearly that this would not affect the principled position of the sponsors demanding that their security be ensured. In addition, the relevant provisions in the Convention also contain shortcomings as regards the definition of the continental shelf and the principle of delimitation of the exclusive economic zones and the continental shelf between opposite and adjacent States. The Chinese delegation has stated its principled position on this matter.

24. It should also be pointed out that resolution II of the Conference, governing preparatory investment in pioneer activities relating to polymetallic nodules, has done too much in the way of meeting the demands of a few industrialized nations and given them and their companies some privileges and priorities. We consider that inappropriate. In future, that resolution must be implemented strictly in conformity with the provisions of the Convention, and the fundamental principle of the international sea-bed resources being the common heritage of mankind must not be prejudiced in any way. It goes without saying that any acts concerning exploitation in the international sea-bed beyond the limits of the United Nations Convention on the Law of the Sea, such as unilateral legislation or the so-called mini-treaty, are illegal and null and void.

25. Although the United Nations Convention on the Law of the Sea has been adopted, the struggle over maritime issues will be a protracted one. As a member of the third world, China will continue to make joint efforts with the other third-world countries and all peace-loving and justice-upholding countries in a persistent endeavour against any maritime hegemonist acts, in order to maintain world peace and international security and promote the progressive cause of mankind.

26. In addition, we consider it necessary to point out that the session of the United Nations General Assembly held this year adopted once again by an overwhelming majority the resolution to accept the credentials of Democratic Kampuchea. The Coalition Government of Democratic Kampuchea is the sole legitimate Government of Kampuchea and has an indubitable right to participate in the Third United Nations Conference on the Law of the Sea.

27. Mr. KIM CHUNG (Viet Nam) (*interpretation from French*): We are at last gathered in this charming city of Montego Bay to celebrate the success of our Conference, one of the loftiest undertakings embarked upon under the auspices of the United Nations. On this solemn occasion, where each delegation present here may rightly feel satisfied at having made in one way or another its contribution to the monumental endeavour represented by the United Nations Convention on the Law of the Sea, my delegation wishes above all to

address its sincere thanks to the Government and people of Jamaica for the hospitable and warm welcome they have extended to this session devoted to the adoption and signing of the Final Act of the Conference and the opening of the Convention for signature. I should like also, on behalf of the delegation of the Socialist Republic of Viet Nam, warmly to congratulate the President of the Conference, all the members of the Bureau, the Special Representative of the Secretary-General, the Executive Secretary and all the members of the Secretariat for the dedicated and tireless efforts they have exerted over nearly a decade, leading to this most happy conclusion.

28. At this historic moment our deep thanks go also to Mr. Pardo, and we pay a tribute to the memory of the late President Hamilton Shirley Amerasinghe. They laid the first stones of this common endeavour and made an invaluable contribution to it.

29. Concerning, first of all, the meaning and general scope of the Convention, my delegation is pleased to note that a new legal order for the seas and oceans has indeed been refined and ushered in, a régime that takes due account of the sovereignty of States and the particular legitimate interests of each category of States and at the same time is essentially successful in settling a variety of complex problems pertaining to different maritime zones, in a spirit of understanding, conciliation and mutual co-operation. This new legal order will make a beneficial contribution as a first step in the establishment of a just and equitable new international economic order, notably by adopting a delicate compromise on a legal régime and on legal machinery for the management, exploration and exploitation of the sea-bed area that constitutes the common heritage of mankind. The new Convention is the fruit of a great collective undertaking that meets the legitimate interests of all categories of countries, and especially the interests and needs of the developing countries. The Convention thus constitutes without a doubt a success for the United Nations of undeniably historic proportions, contributing—as it must—to the strengthening of peace, security, co-operation and friendly relations among all nations of the world.

30. For that reason, although we are not entirely satisfied with certain provisions of the Convention, my delegation willingly subscribes to the global compromise and the method for the overall settlement of all law-of-the-sea problems, which make the Convention an indivisible package excluding any selective application. We have the honour to inform this Conference that we have been authorized and mandated by our Government to sign the Convention and the Final Act of the Conference tomorrow.

31. In view of the universal scope of the Convention, which directly affects the interests of all peoples, my delegation believes that the national liberation movements, which are the authentic representatives of peoples struggling for self-determination and independence and, moreover, are authentic potential States, such as the South West Africa People's Organization and the Palestine Liberation Organization, should also be admitted to sign the Convention and to be full-fledged parties to it.

32. My delegation also believes that the Council of Ministers of the People's Republic of Kampuchea, the sole authentic and legal representative of the Cambodian people, has the right to sign the Convention on behalf of the Kampuchean people. My delegation therefore opposes any attempt to allow the representatives of the genocidal Pol Pot régime to sign the Convention and believes that any such signature would be totally lacking in legal validity.

33. Another negative fact that should be pointed out is that the present Administration of the United States is bent on thwarting the process of implementation of the Convention. It does not confine itself to not signing the Convention itself: it is endeavouring, by means of pressure and relying on complacency, to induce other countries not to sign or to delay signing. We must point out, however, that the Conference has already granted the United States and certain other Western countries exorbitant privileges by allowing them to benefit from the rights and advantages reserved for pioneer investors, without themselves having to sign the Convention, through multinational consortiums. My delegation shares the view of delegations which have already spoken that this involves inequitable and unjustified discrimination against certain other countries, such as the Soviet Union. Not satisfied with such a prerogative, however, the United States has also sought to derogate from the relevant provisions of the Convention by concluding on 2 September 1982 an agreement which in fact aims at dividing up the sectors of the international area, independently of the Convention. In this respect, my delegation fully supports the statement made by the spokesman for the Group of 77 on 6 December 1982 that any unilateral act or multilateral agreement incompatible with the provisions of the Convention pertaining to the international sea-bed area would be devoid of any international validity (*185th meeting, para. 156*).

34. I come now to my Government's position on certain specific aspects of the application of the Convention.

35. First of all I should like to recall in this regard that my Government already made a declaration defining Viet Nam's territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf in a way essentially in conformity with the relevant provisions of the Convention. With a view to ensuring strict and judicious implementation of that declaration, my Government has promulgated a number of texts, notably a declaration defining the baseline from which we measure the breadth of the territorial sea of Viet Nam's continental territory.

36. As a coastal country, and, what is more, a country bordering a semi-closed sea, which we call the Eastern Sea and which is known on international navigation charts as the South China Sea, Viet Nam is prepared to foster broad international co-operation for the rational use of the seas for the benefit of all concerned. In particular, my country sincerely hopes to be able to promote active co-operation with the other States bordering this sea, in conformity with article 123 of the Convention, for this kind of co-operation would be in keeping with our oft-repeated wish to contribute to the development of friendly political, economic and other relations among the various countries of South-East Asia that could transform that region into a zone of peace, stability, friendship, co-operation and prosperity.

37. My Government hopes that it can settle with the countries concerned all disputes pertaining to various maritime zones, including the delimitation of maritime boundaries, through negotiations on the basis of mutual respect for the independence and national sovereignty of each country, in accordance with the spirit of mutual friendship and understanding and respect for equality and the legitimate interests of all, so as to achieve the proper observance of the principles of equity and to avoid excessively infringing upon the national interests of any one of the parties concerned.

38. It is on the basis of this consistent position in favour of the peaceful settlement of disputes that my delegation vigorously opposes any recourse to the threat or use of force by any country, whether it be to carry out acts of aggression, occupation and annexation against islands, archipelagos or maritime spaces of other countries or to impose its own solutions to disputes with other countries. In this spirit, my delegation believes that it is necessary once again to denounce the occupation by force of arms of the Vietnamese Hoang Sa Archipelago and the open threat to annex the Truong Sa Archipelago as well, since that occupation and that threat of

annexation are flagrantly illegal, and run counter to article 301 of the Convention and the fundamental principles of the United Nations Charter.

39. Given the impressive number of delegations that have come to Montego Bay to sign the Final Act of the Conference and the Convention, I wish to conclude my statement on an optimistic note by expressing my conviction that the unwavering solidarity and militant vigilance of the developing countries and the socialist countries, which have enabled them to adopt the United Nations Convention on the Law of the Sea, will certainly continue to thwart any attempt aimed at undermining the effectiveness of the Convention or running counter to its objectives.

40. Finally my delegation reserves its country's right to make declarations in conformity with articles 287, 298 and 310 as appropriate and as the situation may require at the time of ratification of the Convention.

41. Mr. ADDERLEY (Bahamas): First of all, I should like to convey through you, Mr. President, the sincere appreciation of my delegation to the Government and the people of Jamaica—a sister nation of the Americas—for the offer to act as host to these ceremonies and for the courtesies so generously extended to us.

42. The Bahamas will sign the Convention and Final Act. We shall ratify the Convention; we propose to implement the Convention and shall be bound by its terms, thereby indicating our commitment to the rule of international law.

43. The Third United Nations Conference on the Law of the Sea began in New York nine years ago, when its rules of procedure were drafted. That was the first year of Bahamian sovereign independence. The Conference's first substantive session was held in Caracas in 1974, when the Bahamas attended for the first time. Today, almost a decade later, we meet here in Montego Bay to sign the Final Act and the Convention. This is a historic occasion for us and, we believe, for the world. The accomplishments of the Conference, which we shall acknowledge by our signatures, are perhaps unparalleled in the history of international co-operation.

44. When we began in Caracas, we did so in the absence of agreed proposals. Rather, we proceeded on the basis of proposals submitted by interested groups of States; we examined their content and tried, on the basis of their common elements, to produce main trends. This approach to treaty-making may have been novel, but it has now proved its usefulness, as evidenced by the fact of these ceremonies.

45. The two previous United Nations Conferences on the Law of the Sea—in 1958 and 1960—and, indeed, the Conference for the Codification of International Law held at the Hague in 1930, were mostly affairs for lawyers. This Conference has differed in that, apart from the mixture of experts from many other disciplines, the political element has always been predominant. My delegation sincerely hopes that the political will which prevailed in the drafting and adoption of this Convention will continue so as eventually to ensure its universal acceptance.

46. The objective of the Conference was a "package deal". It was in this context that serious-minded delegations accepted that it would be impossible to satisfy each other's individual concerns. In this spirit, compromise agreements have been reached.

47. These accomplishments demonstrate the capability of more than 160 sovereign States to work out rational accommodations for diverse and competing interests. It is perhaps in this that the true significance of the Convention is to be found, rather than in its complexities and all-encompassing nature. These achievements will become even clearer when nation-States come to the realization that they are all neighbours and components of this planet Earth and that the Convention represents the best assurance of the avoidance of conflicts through the application of law.

48. The Commonwealth of the Bahamas is committed to the rule of law and, in particular, to the rule of international law. We have a long tradition of parliamentary rule, of which we are, we believe with justification, extremely proud. This year we celebrate 273 years of elected Parliament through years of colonialism, internal self-government and independence. We are therefore pleased to see in the Convention clarified in legal terms those areas of the law of the sea that had been left murky by previous Conferences. We believe that it is the duty of all States committed to the rule of law which have over the years made significant contributions to the achievements of this Conference to participate in the Convention.

49. In this regard, while the Convention is not perfect, it represents the accommodation of the interests of all. The Convention, which no doubt makes an extraordinary contribution to international law and international order, affords an excellent opportunity to all States to register their approval of this historic and momentous effort. It is my delegation's hope that they will do so. History dictates that they should do so because it was the history of the inequitable law of the sea of past eras that caused the international community to respond to the just demands of the developing world for a more equitable law of the oceans. We do not wish to contemplate failure. We share the view that the success of this Convention is pivotal to East-West, North-South relations, since it impinges upon the interests of all mankind—the inhabitants of States rich or poor, land-locked or coastal and developed or developing.

50. The Third United Nations Conference on the Law of the Sea has united the efforts of mankind in the endeavour to found international peace and security on international law. The result of the Conference is a Convention that seeks to harmonize the aspirations of all mankind through law. All States professing a belief in the rule of law, sovereign equality and the equitable distribution of social and economic justice owe a sacred obligation not to impede this treaty.

51. There were sceptics who in 1945 prophesied that the United Nations would fail. Yet today, 37 years later, it still stands as a monument to human endeavour to avert international conflict and promote social, economic and political justice.

52. It has been said that the oceans may very well be man's last frontier. If this be so, then humanity should not bereave itself of this opportunity for a collective effort to harness the resources of the oceans as the common heritage of all mankind.

53. The possession of power, wealth and military capabilities does not entitle the possessor to the right to be ambivalent or to be heedless of the responsibility incumbent upon all leaders to do justice.

54. I wish to express the gratitude of my delegation to the Conference for its most favourable consideration of the problems of mid-ocean archipelagos, heretofore left unresolved by the law of the sea. To our mind, the provisions of the Convention relevant to archipelagos strike a just balance between competing interests, in that on the one hand accommodation is provided for the legitimate aspirations of archipelagos to be regarded as a single entity and on the other the interest of the international community in the free and unobstructed movement of legitimate international maritime traffic is guaranteed.

55. In Caracas, in 1974, when I addressed this Conference I referred to the uniqueness of the geography of the Bahamas. This same geography affected our approach and was a determinant of our policies with respect to the law of the sea as it related to archipelagos. Our islands are formed of limestone and they stand upon a complex platform that extends beyond

the land frontier to form what are referred to as the Great and Little Bahama Banks. These features are permanently submerged, but the waters that cover them are so shallow that in most places they are non-navigable except by vessels of the shallowest draught. The Convention now recognizes the legal status of the Bahama Banks.

56. The special problem of archipelagos which perhaps distinguishes them from continental States is that the sea lanes which thread them have some of the characteristics of international straits through which rights of transit exist. We recognize that in the interests of commerce, communications and global defence these traditional freedoms of transit need to be preserved. We have no disposition to inhibit the freedom of navigation and overflight.

57. With regard to the provisions of the Convention in respect of the delimitation of the maritime spaces between opposite and adjacent States, which has been one of the key areas of difficulty for the Conference, my delegation is not entirely at ease. Our preference for a clear statement of the law that the median line should be mandatory is well known to the Conference, as is our preference for mandatory and binding dispute settlement procedures. Recognizing the virtual impossibility of achieving these desires, we are, in the spirit of accommodation and compromise, prepared to accept the provisions on delimitation contained in the Convention.

58. I should now like to turn to the mining of the deep seabed. We belong to the school of thought that claims the resources of the international area to be the common heritage of mankind. The Conference's negotiations led us to believe that all participating States shared this belief. We felt that the task of the Conference was then to work out acceptable arrangements which would transform the common heritage into meaningful reality. To our mind, the provisions of the Convention, together with the resolution for the protection of preparatory investment, accomplishes this. We would have preferred a unilateral rather than a parallel system of exploitation but we are, along with the rest of the developing world, prepared to accept the present system as a compromise. In doing so we barred ideological differences and concentrated instead on obtaining the best possible formula which we felt should have been acceptable to all.

59. In conclusion, I wish on behalf of the Bahamas to pay a special tribute to Mr. Arvid Pardo, without whose vision we would not have been here today, and to the late Mr. Hamilton Shirley Amerasinghe for the role he played in these negotiations. And, Mr. President, I would be remiss if I were not to congratulate you on your patience, ingenuity and indeed brilliance, without which we might not have been here either. I also congratulate the respective Chairmen of the Committees and the Chairman of the Drafting Committee—the original four wise men and now five, including the Rapporteur-General. Our sincere gratitude goes to the members of the Secretariat for their unrelentingly tireless efforts on our behalf over the long years of these negotiations.

60. Mr. MIR-MEHDI (Islamic Republic of Iran):[2] Mr. President, it is a great pleasure for me to address this meeting on behalf of the Government of the Islamic Republic of Iran. First of all, I should like to thank the Government of Jamaica for acting as host to this final session of the United Nations Conference on the Law of the Sea. Since this is the first time that I see you in the Chair, Mr. President, I avail myself of this opportunity to express the appreciation of my delegation for your vigilant and capable leadership in handling your difficult task during the Conference's final sessions, which terminated in the adoption of the United Nations Convention on the Law of the Sea with the overwhelming support of the participants.

61. It is, however, regrettable that the result of a decade of tireless and dedicated efforts provided by hundreds of distinguished lawyers, diplomats and specialists, including you, Mr. President, your predecessor the late Hamilton Shirley Amerasinghe and the members of the Collegium, and despite all the concessions made by developing nations with the hope of reaching a universally accepted treaty, the selfish and short-sighted position of one delegation barred the Convention from getting adopted through consensus. As a result, the implementation of this Convention, which could be considered one of the most important instruments for regulating all legal, economic and political aspects of the seas and oceans of the world and could provide a logical approach to North-South issues, was unfortunately disturbed before birth by the destructive hands of a pretentious so-called advocate of democracy.

62. It was hoped that the product of this lengthy Conference would be a promising framework helping to eliminate greed and selfish economic prejudices and ultimately helping to produce a new system for the exploitation of the enormous riches of the sea-bed which lie beyond the limits of national jurisdiction and which, at the twenty-fifth session of the General Assembly, had been proclaimed the common heritage of mankind, on the initiative of Mr. Arvid Pardo, to whom we all should pay a tribute. In fact, this opportunistic and contradictory attitude of the United States delegation is in line with the overall hegemonistic policy of that imperialist Power.

63. Moreover, the frustrating path pursued by a handful of States, which apparently intend to conclude a separate arrangement, called a "mini-treaty", is an alarming threat to the interests of the world community and should be taken seriously. It would indeed be a very dangerous move if those countries tried to overlook their moral obligations pertaining to the United Nations resolutions in respect of the New International Economic Order. However, those countries should keep in mind that the world community will stand firm in the defence of its legitimate rights as regards the common heritage of mankind and will, by every means, protect the resources of the international sea-bed from plunder by any intruder, whether through unilateral action or by means of a so-called mini-treaty.

64. Considering the present state of international relations, which is becoming bleaker every day due to unjust economic relations between countries producing raw materials and the industrial world, if the basic principles and the spirit of the Convention, which provide for the just and equitable distribution of the resources of the seas, take the form of reality, one of the most important victories of this century will indeed be achieved, provided that justice and right, not might, prevail and the developing States are allowed to have access to the technological know-how accumulated by the powerful States at the price of the misery of the poor and the powerless.

65. In fact the main cause of the serious crises dominating the world economy today are rooted in an unjust international economic order and the exploitative policies that world imperialism is implementing for the sake of preserving its material interests and political and cultural hegemony.

66. Despite all these misgivings and difficulties we have had as regards some sections of the Convention—particularly the questions of the innocent passage of warships through the territorial sea, the participation of national liberation movements such as the Palestine Liberation Organization, the priorities and privileges provided for some industrial countries in connection with the sea-bed régime—for the sake of unanimity in the pursuit of common goals together with the Group of 77, the delegation of the Islamic Republic of Iran voted in favour of adopting the Convention.

[2] Mr. Mir-Mehdi spoke in Persian; the English version of his statement was supplied by the delegation.

67. The Government of the Islamic Republic of Iran has participated with great interest in the past sessions of the Conference. Now I wish to inform the Conference that I have been empowered to sign the Final Act and the Convention on behalf of my Government, and we intend to participate actively in the establishment of the Preparatory Commission for the International Sea-Bed Authority and the International Tribunal for the Law of the Sea.

68. Nevertheless, at this solemn moment the delegation of the Islamic Republic of Iran avails itself of this opportunity to place on record its understanding in relation to certain provisions of the Convention. The main objective is the avoidance of eventual future interpretations of the following articles in a manner incompatible with the original intention and the previous position or in disharmony with national laws and regulations of the Islamic Republic of Iran.

69. It is, then, the understanding of the Islamic Republic of Iran that, first, notwithstanding the intended character of the Convention as one of general application and of a law-making nature, certain of its provisions are merely the product of *quid pro quo* and do not necessarily purport to codify the existing customs or established usage regarded as having an obligatory character. Therefore it seems natural and in harmony with article 34 of the 1969 Vienna Convention on the Law of Treaties[3] that only States parties to the United Nations Convention on the Law of the Sea shall be entitled to benefit from the contractual rights created therein. Those considerations pertain specifically but not exclusively to the following: the right of transit passage through straits used for international navigation—Part III, section 2, article 38, the notion of the exclusive economic zone—Part V, and all matters regarding the international sea-bed area and the concept of the common heritage of mankind—Part XI.

70. Secondly, in the light of customary international law, provisions of article 21, read in conjunction with article 19, on the meaning of innocent passage, and article 25, on the rights of protection of coastal States, recognize, though implicitly, the rights of coastal States to take measures to safeguard their security interests, including the adoption of laws and regulations regarding, *inter alia*, the requirement of prior authorization for warships willing to exercise the right of innocent passage through the territorial sea.

71. Thirdly, the right referred to in article 125 regarding access to and from the sea and freedom of transit of land-locked States is derived from mutual agreement among States concerned, based on the principle of reciprocity.

72. Fourthly, the provisions of article 70 regarding the rights of States with special geographical characteristics are without prejudice to the exclusive right of the coastal States of enclosed and semi-enclosed maritime regions—such as the Persian Gulf and the Sea of Oman—with large populations predominantly dependent upon the relatively poor stocks of living resources of those regions.

73. Fifthly, islets situated in enclosed and semi-enclosed seas which potentially can sustain human habitation or an economic life of their own but which, owing to climatic conditions, resource restriction or other limitations, have not yet been put to full development, fall within the provisions of paragraph 2 of article 121, concerning the régime of islands, and therefore have full effect in the boundary delimitation of various maritime zones of the interested coastal States.

74. Furthermore, with regard to compulsory procedures entailing binding decisions, the Government of the Islamic Republic of Iran, while fully endorsing the concept of settlement of all international disputes by peaceful means, and while recognizing the necessity and desirability of settling in an atmosphere of mutual understanding and co-operation issues relating to the interpretation and application of the United Nations Convention on the Law of the Sea, will at this time not pronounce itself on the choice of procedures pursuant to articles 287 and 298 and reserves its position, which it will declare in due time.

75. Finally, the delegation of the Islamic Republic of Iran would like to congratulate each and every member of the Third United Nations Law of the Sea Conference on the achievement of this difficult and monumental task. At the same time, it wishes once again to express its sincere gratitude to the Government and people of Jamaica for their warm and cordial hospitality.

76. Mr. GOUZHENKO (Union of Soviet Socialist Republics) (*interpretation from Russian*): After ten years of intensive work, the Third United Nations Conference on the Law of the Sea is approaching its conclusion. The Conference has faced a highly important and complex task in working out a new legal order for the peaceful use of the waters and resources of the oceans of the world, which cover more than two thirds of the surface of our planet—that is, in solving problems that affect the vital interests of many States. What, then, are the results of the work of the Conference?

77. We believe that the main result of the Conference is the fact that, despite numerous difficulties and obstacles, through the collective efforts of its participants it has succeeded in working out and adopting a comprehensive United Nations Convention on the Law of the Sea, a single international legal document regulating all the major questions of human activity in the waters of the oceans and on the sea-bed and its subsoil.

78. The new Convention not only specifies, develops and codifies the traditional law of the sea but also introduces as norms of international law new concepts which take into account the realities of the contemporary world. In particular, the Convention defines for the first time the régime governing the use of the sea-bed and its resources beyond the limits of the continental shelf, which have been proclaimed the common heritage of mankind. The exploration and exploitation of the resources of that area will be organized, implemented and controlled on behalf of mankind as a whole by a new international organization—the International Sea-Bed Authority—the structure and activities of which are based on the principles of the equality of States and the inadmissibility of discrimination against any social and economic system and have due regard for the interests of different groups of States.

79. The new Convention represents a complex and indivisible package of closely interrelated compromise solutions to all major problems of the law of the sea. And, like any compromise, the Convention cannot of course accommodate completely all the participants—and, incidentally, the interests of the USSR cannot be completely accommodated in it either—but, on the whole, it takes account of the interests of each of them to the same extent. That is why it proves to be acceptable to an overwhelming majority of States.

80. We consider that the new Convention may serve as an important instrument in strengthening international co-operation, law and order and peace on the seas. It may also present a serious obstacle for those who would try to carry out the policy of arbitrary control and *diktat* on the oceans. Consequently, the Convention may make an important contribution to the strengthening of peace and security and will have great significance within the framework of the common struggle for the establishment in international relations of principles of equality and mutual respect and of ensuring that nothing done is to the detriment of the interests of another. The Convention was worked out in such a way that it has become convincing proof of the fact that States, if they are guided by these principles and take into account each other's interests,

[3]See *Official Records of the United Nations Conference on the Law of Treaties, documents of the Conference* (United Nations publication, Sales No. E.70.V.5).

may solve on a compromise and mutually acceptable basis the most complex international problems, including those with respect to which the interests of different groups of States frequently diverge considerably. At the same time, the history of the drafting and the adoption of the United Nations Convention on the Law of the Sea has clearly demonstrated that any attempts to undermine such a settlement of international problems or to ignore the interests of other countries cannot succeed in the present world.

81. The support given the Convention by an overwhelming majority of States has shown that this majority is determined to struggle for the introduction into international relations of all the positive experience that has been accumulated by humanity in this field in a period of relaxation of tension. Thus the United States Convention on the Law of the Sea proves once again the truth of a recent statement made by the General Secretary of the Central Committee of the Communist Party of the Soviet Union, Mr. Yuri V. Andropov, that the policy of détente is in no way a thing of the past, as is alleged by some imperialist circles, and that the future belongs to the policy of détente.

82. Taking into account the important international legal and political significance of the new Convention, the Soviet Union, which resolutely and consistently advocated its adoption, intends to sign the Convention tomorrow. We hope that the number of countries which will sign it tomorrow will be sufficient to start the normal activities of the Preparatory Commission to establish the International Sea-Bed Authority and the International Tribunal for the Law of the Sea. The Soviet Union is ready to co-operate closely within the Commission's framework with other member States which have signed the Convention to ensure the Commission's effective implementation of its functions.

83. Today, summing up the results of the Conference's work, we consider it necessary to reaffirm our position of principle with regard to some provisions of resolution II, regulating preliminary investments in pioneer activities concerning the exploration of the polymetallic nodules, which was put to the vote as part of the Convention package. It is regrettable that that resolution contains different requirements for different groups of countries. However, those shortcomings of resolution II do not diminish the significance of the new Convention on the Law of the Sea and cannot influence the positive position of the USSR towards this Convention.

84. In signing the Convention the Soviet Union will refrain from declarations under article 310 of the Convention. Although these declarations do not change the legal force of the Convention, we feel they might provoke counter-declarations and, generally speaking, complicate the situation with respect to the Convention. Therefore we support the President's appeal addressed to all States which intend to sign the Convention to refrain from statements interpreting the substance of its provisions.

85. Unfortunately, similar declarations have been made and some of them have gone far beyond the framework of article 310 and can be regarded only as clear attempts to distort certain provisions of the Convention. That is why the Soviet Union reserves its right to take a stand on such declarations at a later stage.

86. At the time of signing the Convention the Soviet Union intends to exercise its right to choose the procedures for the settlement of disputes by submitting the relevant declarations in writing. They will state in particular that the Soviet Union will not accept the compulsory procedures entailing binding decisions on disputes related to sea boundary delimitations, disputes concerning military activities and disputes with respect to which the Security Council of the United Nations is exercising the functions entrusted to it by the United Nations Charter.

87. The problem of participation in the Convention is linked to certain political questions with respect to which the Soviet Union reaffirms its position of principle. We believe that only the Government of the People's Republic of Kampuchea, the sole legitimate representative of the Kampuchean people, has the right to represent Kampuchea in the international arena and, *inter alia*, to sign the United Nations Convention on the Law of the Sea.

88. The Soviet Union stands for the full participation in the Convention of the national liberation movements, such as the Palestine Liberation Organization.

89. We firmly believe that if the participation in the Convention of self-governing Associated States should entail a change in the status of the strategic Trust Territory of the United States, the Pacific Islands (Micronesia), then any change in the status and conditions of the Trusteeship Agreement should be sanctioned by the Security Council, in accordance with Article 83 of the United Nations Charter.

90. If we compare our Conference with a ship on the ocean, it should be recognized that the sailing of this ship is characterized by difficult conditions, particularly towards the end of the voyage. The United States has charted a course aimed at torpedoing the Convention, concluding separate agreements to carry out activities in the sea-bed bypassing and violating the Convention. At the same time, without undertaking any obligations under the Convention, it would like to enjoy the rights, privileges and benefits that the Convention confers upon the States parties. The United States representatives declare that one may, as it were, recognize some provisions of the Convention while ignoring others. However, one cannot adopt a selective approach to the norms of international law. The Convention is not a basket of fruit from which one can pick only those one fancies. As is well known, the new comprehensive Convention has been elaborated as a single and indivisible instrument, as a package of closely interrelated compromise decisions.

91. On this basis we completely share the statement made on behalf of the Group of 77 by its Chairman and similar statements made by you, Mr. President, as well as by representatives of many countries to the effect that if a State assumes obligations under the Convention it enjoys the rights envisaged in it. However, if it does not assume such obligations it is naturally deprived of the rights provided in the Convention for its participants.

92. We also support the statements made by many countries to the effect that any separate agreements, any "mini-treaties", concluded in circumvention of the Convention are illegal; they will have no legal validity.

93. The international community has the necessary means, including those provided for in the Convention and in the United Nations Charter, to counteract any attempts to violate the Convention and to secure its strict observance.

94. I should like to express the hope that all countries will sooner or later be won over by a sense of reality and thus become parties to the Convention on the Law of the Sea, that they will strictly observe its provisions and that the Convention will become an important factor in the strengthening of peace and security, the relaxation of international tension and the development of fruitful co-operation and friendly relations among all States.

95. In conclusion, the Soviet delegation would like to pay a tribute once again to the memory of Mr. Hamilton Shirley Amerasinghe and to express its gratitude to you, Mr. President, and to the members of the Collegium and to all those who have contributed to the drafting of the Convention, as well as to the people and Government of Jamaica for providing us with an opportunity to hold the closing session of the Conference in this country.

96. Mr. OMAR (Libyan Arab Jamahiriya) (*interpretation from Arabic*): In a few hours we will be signing the Final Act and the Convention on the Law of the Sea. This monumental event will mark this era and have important consequences in the years to come. We shall thus put an end to a long process which we began more than 10 years ago. During that process we faced many difficulties and complications owing to the many diverse interests. We proceeded in a piecemeal manner, solving one dilemma only to face another. The objective at times seemed at hand, but then faded away into the distance. But the overwhelming majority of the international community eventually succeeded in realizing its objective.

97. There is no doubt that all countries did their utmost and displayed the greatest patience, but the developing countries shouldered a greater burden in their efforts and in the patience they exercised and the sacrifices they made in the common interest. Indeed, they made so many concessions that there was no room left for them to make any more. Hence, we express our admiration and appreciation to the developing countries for their extremely responsible position, which demonstrated a full awareness of the interests of the international community.

98. When we sign the Final Act tomorrow, we will have entered a more critical and more important phase, one that demands greater readiness to make even more efforts, firmer resolve and increased vigilance, as well as good faith, to prevent the loss of the achievements of the past years and the exploitation of the riches of the seas and oceans by a handful of States, as well as the transformation of the provisions of this Convention into a dead letter.

99. Tomorrow we will witness the signing of the most important document of modern times. It is a Convention intended to establish a legal régime for the seas and oceans and designed to ensure their use exclusively for peaceful purposes. Thus this régime will be an important contribution to the maintenance of international peace and security and to the establishment of a more just and more equitable international economic order that takes account of the interests and needs of all mankind, and especially those of the developing countries, be they coastal or land-locked. This régime is designed also to strengthen co-operation and relations among States in accordance with the principles of justice and equality and to promote the social and economic progress of all peoples of the world.

100. The most important element in the United Nations Convention on the Law of the Sea is its provision that the sea-bed and ocean floor and the subsoil thereof beyond the limits of national jurisdiction and their resources are the common heritage of all mankind.

101. On the basis of this principle, no State may claim or exercise sovereignty or sovereign rights over any part of the area or its resources and no State or juridical or natural person may appropriate any part thereof. Such claims, exercise of sovereignty or sovereign rights, and appropriations will never be allowed. This provision implies that activities in the area are to be conducted in the interests of all mankind, regardless of the geographical location of States, and are to give due regard to the interests and needs of the developing peoples and countries that have not yet attained full independence or other forms of self-government.

102. We all know the circumstances in which the negotiations on the provisions of Part XI of the Convention were held. We also know that many concessions were made by the developing countries. It is a fact that every effort was made and that we finally achieved a consensus constituting an element of the "package deal". Hence, it shows a lack of good will even to talk about a possible re-opening of negotiations on these provisions. Moreover, any attempt by a State or small group of States to circumvent the provisions of Part XI or other parts of the Convention would without any doubt run counter to the will of the overwhelming majority of the international community and with the provisions of the Convention itself, which are accepted by this majority as a basis for all issues related to the law of the sea. Furthermore, circumventing the provisions of the Convention would have no legal validity capable of commanding international recognition.

103. The Libyan Arab Jamahiriya will stand in solidarity with the developing countries and all peace-loving peoples and States in confronting any such attempt and will support any peaceful effort to preserve what has so far been achieved.

104. One of the most important elements of the Convention is that it accords Namibia, represented by the United Nations Council for Namibia, the right to sign the Convention. It also allows the national liberation movements to sign the Final Act and to be represented in the relevant organs with observer status. Although that represents less than what we have advocated, we consider it to be a positive step in the development of international law and support for the principles of freedom, equality and justice.

105. One of the speakers yesterday referred to non-recognition of the Palestine Liberation Organization (PLO). What he said does not change reality in the slightest, because the PLO enjoys wide international recognition and has no need to be recognized by the régime to which that speaker belongs. Moreover, what that speaker said in no way affects the contents of resolution IV of the Final Act.

106. The Convention includes numerous positive elements; but, at the same time, it has shortcomings in some aspects and ambiguities in others, thus representing less than what we had aspired to. Nevertheless, in the last session we stood by the developing countries and others in supporting and voting for the Convention, since it was a "package deal", in the hope that in future we would be able to remedy those shortcomings, clarify the ambiguities and develop the Convention's provisions in the interests of all.

107. The Libyan Arab Jamahiriya will sign the Final Act tomorrow. We would have wished to sign the Convention as well, but certain necessary domestic procedures have not yet been completed. Even though the Libyan Arab Jamahiriya will not participate in the signing of the Convention tomorrow, it hopes to join the signatories in the near future.

108. I would not wish to conclude without expressing thanks to the Government and the people of Jamaica for their warm welcome and generous hospitality. Also, I should like to thank you, Mr. President, and say how much we appreciate your notable contribution and that of your predecessor, Hamilton Shirley Amerasinghe, the praiseworthy initiative of Mr. Pardo, as well as the arduous efforts of the Chairmen of the main Committees, the other members of the Bureau and the staff of the Conference secretariat. Here I want to refer in particular to the work done by Mr. Zuleta, the personnel of the translation and interpretation services and all those unknown soldiers who contributed to this creative endeavour.

109. Mr. PRADHAM (Bhutan): This gathering here in this beautiful city of Montego Bay, Jamaica, marks the culmination of nearly a decade of negotiations by the international community to bring about a law of the sea. This long-drawn process involved nations from every part of the globe—nations with varying backgrounds, differing interests and at times complex problems. All their views were fully heard during the course of numerous meetings and, although it was not possible to meet all the demands of each and every participant, compromises or consensus formulas were invariably worked out. The Governments of many countries relinquished several of their initial proposals in order to serve the interests of mankind as a whole. The entire process that led to what we have now arrived at was arduous and difficult, but the end result is truly historic.

110. The delegation of the Kingdom of Bhutan had always hoped that the United Nations Convention on the Law of the Sea would receive the seal of approval from all nations of the world. Unfortunately, however, some countries, especially some of the big Powers, have not seen fit to give their consent at this stage.

111. As I mentioned earlier, the final text was definitely not able completely to satisfy each and every country. For instance, the land-locked countries, of which my own country, Bhutan, is one, have had to be satisfied with very little. Like many others, my delegation had earlier expressed some concerns, particularly at the resumed ninth session in 1980, and those concerns remain today. My delegation is not fully satisfied with the provisions relating to the rights of land-locked countries.

112. We also regret that better and more equitable resource-sharing criteria with regard to the continental shelf and the exclusive economic zones could not be provided in the Convention. However, it is our hope that in the very near future the problems of the land-locked countries will become better understood and that steps will be initiated, especially by the transit States concerned, to alleviate their specific difficulties.

113. In spite of what I have just stated, my delegation has noted the many positive aspects of the Convention. We have realized the importance and significance of concluding a law of the sea as a matter of urgency. The absence of such a law would create a host of difficulties for the countries of the world in utilizing the seas and its resources in a civilized and orderly manner. Without proper regulations, many disputes could arise in this context and quite easily have serious implications for international peace and security.

114. The sea and its resources beyond the limits of national jurisdiction are the common heritage of mankind. The Convention most appropriately includes this concept of the common heritage of mankind, a concept in which Bhutan has strongly placed its belief. The resources derived from the international area, under proper supervision and control, must benefit all mankind and all nations, big or small, coastal or land-locked.

115. The control of pollution and the preservation of marine life and the marine environment will become increasingly difficult if nations lack information and guidelines for activities pertaining to the seas. We cannot take this aspect lightly, for without proper control pollution of the marine environment could adversely affect all life on our planet.

116. For the reasons, among others, that I have just given, and above all for international peace and security, my Government has decided to sign the Convention.

117. At this stage I should like to express the appreciation of my delegation to the Government of Jamaica for having offered to act as host to this final session of the Conference. We are equally grateful for the warmth and hospitality that we have enjoyed since our arrival in this very beautiful city of Montego Bay.

118. I should also like to take this opportunity to thank and remember all those who contributed to making this laudable venture of ours a success. Mr. Arvid Pardo gave birth to the Conference and promoted the principle of the common heritage of mankind. Our earlier President, the late Ambassador Hamilton Shirley Amerasinghe, guided us skilfully through a maze of problems. The Special Representative of the Secretary-General, Mr. Bernardo Zuleta, the secretariat and the members of the Collegium have left their indelible mark on our work.

119. Finally, Mr. President, we appreciate your own most admirable contribution to the success of this Conference. Had it not been for your untiring efforts, dedication and diplomatic skills it would have been difficult to reach this goal. I should like to conclude therefore by warmly congratulating you.

120. Mr. MARTINA (Netherlands Antilles): Mr. President, it is a great honour for me and my country to be able to attend this final session of the Third United Nations Conference on the Law of the Sea for the purpose of signing the Final Act and opening the Convention for signature.

121. The Netherlands Antilles attaches great importance to the Third United Nations Conference on the Law of the Sea and has, pursuant to General Assembly resolution 3334 (XXIX), adopted on 17 December 1974, attended the sessions of the Conference in its capacity of observer. It is in that capacity that we are present here today to sign the Final Act of the Conference, an act which guarantees our future participation in the Preparatory Commission and the International Sea-Bed Authority.

122. Being comprised of six islands, the Netherlands Antilles finds great support in the article on the régime of islands, which stresses the fact that islands and other land territories should be treated as equals when determining their respective territorial sea, contiguous zone, exclusive economic zone and continental shelf.

123. The same can be said with regard to resolution III, on the rights and interests of Territories which have not attained independence or self-government. That resolution safeguards our rights to and interests in the resources of our Territories recognized by the Convention and emphasizes the fact that these rights and interests should be exercised for the benefit of our people.

124. Equally supportive are the articles on archipelagic States. The Government of the Netherlands Antilles has for quite some time already endorsed the principle of archipelagic States.

125. Anticipating the coming into existence of these articles, the Government, during the bilateral negotiations on maritime boundaries with the Republic of Venezuela which have resulted in a treaty with that country, took as its point of departure the principle laid down in these articles.

126. My Government also attaches great importance to the articles on global and regional co-operation. Ocean management and resources of the sea are playing an ever-increasing role in national development strategy and in the changing structure of international economic relations. At the same time, ocean management adds a new dimension to development strategy, while it requires the establishment of new institutional and legal infrastructures and new forms of national and international, intergovernmental and non-governmental organization and co-operation. It is important that we of the third world join in this new phase of economic development from the beginning by promoting international and regional co-operation for the protection and preservation of the marine environment and marine scientific research for peaceful purposes, as well as in the development and transfer of marine technology.

127. We are well aware of the tireless efforts which have been made towards the conclusion of a legal régime of the seas that is workable in the present-day world. It is our sincere hope that the industrialized countries will give all the necessary support so that this régime will be acceptable to all in the end. We have now come a long way by producing this final text which stresses the need for effective international co-operation and organization in the development and management of the seas as a shared resource of all countries. It might be said that the United Nations Convention on the Law of the Sea is like a global constitutional bill of rights for all countries, in which the exploitation of fish, mineral and energy potential is regulated.

128. We are truly honoured that a country in the Caribbean region, Jamaica, has been chosen as the seat of the Interna-

tional Sea-Bed Authority and we hope that this will be a contribution to the beginning of a new international economic order for the Caribbean region in which all countries will have the opportunity to participate and share in the common heritage of mankind.

129. Mr. President, I should like to express our gratitude to you, the Chairman of the Main Committees and all those who, in one way or another, have contributed to the successful conclusion of the Conference and the adoption of the new Convention.

130. In conclusion, I should like, on behalf of the Government and the people of the Netherlands Antilles, to say how grateful we are to the Government and the people of Jamaica for acting as host to this most historic event for mankind and how much we appreciate the warm reception and hospitality, which, we can say with pride, is characteristic of the Caribbean people.

131. Mr. PAPOULIAS (Greece) (*interpretation from French*): First of all, my delegation wishes to express sincere thanks to the Government and the people of Jamaica for their warm welcome to the representatives to the final session of the Conference and for the entirely satisfactory services they have provided.

132. On this solemn occasion of the conclusion of the work of the Third United Nations Conference on the Law of the Sea, I should like to congratulate you, Mr. President, for having brought to a successful conclusion the long and difficult negotiations that led to the conclusion of the new Convention which has been adopted by the Conference. You have certainly performed your lofty duties successfully, showing remarkable skill and a thorough knowledge of the highly difficult and complex subjects involved.

133. I consider it a duty also to express my gratitude to the Special Representative of the Secretary-General of the United Nations, Mr. Zuleta, as well as to the secretariat for their valuable contribution to the work of the Conference and their dedication to the cause of the law of the sea.

134. I should like to take this opportunity to pay a tribute to the memory of the first President of the Conference, the late Hamilton Shirley Amerasinghe of Sri Lanka, who made an immense contribution to the progress of the work of the Conference for many long years.

135. The Third United Nations Conference on the Law of the Sea is generally considered as a historic international meeting, mainly because of the active participation of the largest number of countries that have ever participated in any international conference. As a result, many new States, as well as liberation movements, have had an opportunity to play an active role in the negotiations, thus making a notable contribution to the establishment of international rules governing the law of the sea and the exploitation of the resources of the sea-bed, which, in 1967, were declared unanimously to be the common heritage of mankind.

136. This Conference has been of paramount importance, for it has had to carry out the difficult task of settling particularly thorny and complex problems, some of which were being raised for the first time within the international community. Thus its work was difficult because of its very nature and also because the task involved finding solutions capable of reconciling to the greatest possible extent opposing interests with regard to interrelated problems. From the outset, the Conference had set itself the goal of seeking solutions acceptable to all, if possible, and had declared that the problems were indivisible and should be considered and accepted as a whole. Hence the Conference expressed the wish to have the Convention adopted only after ensuring the broadest possible support and, preferably, by consensus. It is truly regrettable that it was not possible to achieve a consensus.

137. It can be said that, taken as a package, the text of the Convention, and in particular the parts dealing with questions falling within the competence of the Second and Third Committees, is as balanced as possible. However, I must add that my country does not find all the provisions of these parts satisfactory; there are even some points on which we do not agree. Nevertheless, taking all the solutions arrived at as a whole, we have accepted this text. These provisions regulate problems of the greatest importance, such as territorial waters, maritime spaces under national jurisdiction and the rights relating thereto, freedom of navigation, the resources of the sea, pollution and the conservation of the marine environment. As is generally recognized, these provisions are applicable as a whole and to all the seas without distinction.

138. Any attempt to give preferential application to certain parts of the Convention, to the exclusion of others, or any claim aimed at preventing the application of the provisions of the Convention to certain areas, must be absolutely rejected, for that would be completely contrary to the letter and spirit of the new Convention.

139. Similarly, it should be stressed at this time that all the clauses have been accepted by near-consensus, since almost all the countries that abstained in the vote when the Convention was adopted stated that they accepted all the parts of the Convention, with the exception of Part XI, on the sea-bed. If I am not mistaken, the same is true for the four countries that voted against it. Given this fact, and also the practice of States, it is clear that these provisions can be, and practically speaking are, considered to be already part of customary international law. Such is the case, for example, of the provision fixing the maximum breadth of the territorial sea at 12 miles, a provision which is already being applied by a substantial majority of States Members of the United Nations. That also goes for the articles referring to freedom of navigation and the régime with respect to islands, and other articles.

140. With regard to Part XI of the Convention, Greece regrets that its articles are not entirely satisfactory and could not win general approval. Nevertheless, we hope that, within the framework of the application of the Convention, the outstanding difficulties will be smoothed away, making it possible for a number of countries concerned to sign the Convention.

141. Finally, my delegation would like to recall that Greece is a member of the European Economic Community and that it has transferred competence to the Community in certain matters governed by the Convention. Detailed declarations on the nature and extent of such competence will be made in due course, in accordance with the provisions of annex IX of the Convention.

142. In conclusion, I should like to confirm that Greece will sign the Final Act and the United Nations Convention on the Law of the Sea. I would add that Greece also intends to submit, at the proper time, an interpretative declaration, in accordance with article 310, concerning articles 36, 38, 41 and 42. The aim of this interpretative declaration will be to facilitate the just and effective application of the provisions concerning transit passage through straits used by international shipping.

143. I should like to take this opportunity to express the wish that the greatest possible number of countries throughout the world will sign the Convention, for it is without question an important factor in the evolution of international law towards progress and development.

144. Mr. BOEL (Denmark): I wish to start by making a statement on behalf of the European Economic Community and its 10 member States.

145. As will be commonly known by now, the member States of the European Economic Community have transferred competence to that Community in various and important fields, including matters falling within the scope of the United Nations Convention on the Law of the Sea. By

way of example I shall just mention those concerning conservation and management of sea fisheries. Provisions allowing for participation by international organizations like the European Economic Community are therefore a matter of importance not only for the Community and its member States but also for other States.

146. Against this background we congratulate you, Mr. President, on your efforts during the negotiations on the clauses concerning participation in the Convention by international organizations. Thanks to your constructive and imaginative leadership and to the contributions of the whole Conference a solution has been reached which all delegations find generally satisfactory. Indeed, the provisions of article 1, paragraph 2, and article 305, together with those of annex IX, allow for the participation of the European Economic Community in the Convention. This complex set of rules constitutes a compromise, as is so often the case in the Convention—a compromise which, even if it falls short of what we have proposed, is acceptable to us.

147. We also welcome the fact that, as a consequence, the European Economic Community has been expressly admitted as a signatory to the Final Act.

148. The Final Act, which will be signed shortly by the European Economic Community, marks the milestone of more than nine years of arduous work by the Conference.

149. From the Community's point of view, many of the results obtained in matters within Community competence are generally satisfactory, particularly with regard to fisheries and the marine environment. The Community believes that in this respect the Convention on the Law of the Sea constitutes a major contribution to the progressive development of international law.

150. That concludes my statement on behalf of the European Economic Community and its 10 member States.

151. Speaking now for the Danish delegation, I wish through you, Mr. President, to thank the Government of Jamaica for serving as host of the final session of the United Nations Conference on the Law of the Sea.

152. This is a unique event in the history of international law. The Convention on the Law of the Sea is the most comprehensive treaty ever drafted. It is a modern constitution for the uses of the ocean. It deals with all conceivable peaceful human activities in an area larger than 70 per cent of the surface of our globe. It has been worked out by the largest Conference in the history of the United Nations. The result embodied in the 320 articles and related annexes and resolutions reflects a willingness to co-operate and to accept compromise solutions, expressed in two basic concepts: the consensus principle and the "package deal" principle.

153. My country attached and still attaches great importance to the achievement of a universally acceptable convention text. That was why Denmark, together with other like-minded countries in the group of 12—the so-called Friends of the Conference or, as some people called them, the good Samaritans—tried so hard to reach a compromise which could bridge the remaining gap between certain industrialized countries and the Group of 77. While consensus eluded us in the last resort, we continue to hope that the Convention will in due course be universally accepted. It is in the nature of things that no international agreement of this scope can be entirely satisfactory to all countries. This applies to Denmark too. Our understanding of certain specific points of particular interest to my country was made clear in our statement made on 31 March 1982.[4] In that spirit, my delegation appreciated the outcome of the Conference and voted for it. On that basis the Danish Government subsequently evaluated the Convention.

154. As a coastal State with a multitude of islands, Denmark has vital interests in the resources of the sea, the sea-bed and its subsoil, as well as in the preservation and protection of the marine environment. Greenland and the Faroe Islands are regions whose populations are almost entirely dependent on fisheries; and Denmark is a seafaring nation. Recognizing—as stated in the so-called gentlemen's agreement—"that the problems of ocean space are closely interrelated and need to be considered as a whole", my Government arrived at the conclusion that, on balance, the Convention is in the national interest.

155. It was also important to the Danish Government that the Convention, by placing particular emphasis on the interests of the developing countries, would constitute a major progressive step in the development of North-South relations. Furthermore, support of the Convention would be a sign of confidence in the United Nations as the appropriate forum for such negotiations.

156. Last but not least, by dispelling any uncertainties concerning the state of the law of the sea, the Convention constitutes an essential contribution to international stability and world order. Conversely, a breakdown of efforts to define universally accepted legal rules in this field would increase the areas of potential international conflicts and confrontations that we seek to reduce.

157. For all those reasons, the Danish Government has decided to sign not only the Final Act but also the Convention at this final session. I recall, in this connection, that my country is a member of the European Economic Community—for which I spoke only a moment ago—and that it has transferred competence to the Community in certain matters governed by the Convention. Detailed declarations on the nature and extent of such competence will be made in due course, in accordance with the provisions of annex IX of the Convention.

158. Let me emphasize now that in the Danish view there is no satisfactory alternative to the set of rules laid down in this Convention. That is why Denmark, together with other like-minded countries, sponsored the recent General Assembly resolution 37/66 of 3 December 1982, calling upon all States to consider signing and ratifying the Convention at the earliest possible date and also appealing to the Governments of all States to refrain from taking any action directed at undermining the Convention or defeating its object and purpose.

159. That same resolution constitutes a bridge between this Conference, which is now coming to an end, and the next phase of our work. At this juncture the Convention is, if I may say so, like a hermit crab leaving its first shell and looking for a new home. During that interval, we all know, the hermit crab is very vulnerable. So we shall have to protect the Convention and we shall have to construct a new house for it. It will be up to the Preparatory Commission to lay the foundation of this new house. It should be sufficiently large and solid to hold all nations and sufficiently attractive to convince all nations in due course that it is worth while living together with the Convention.

160. When contributing to the work of the Preparatory Commission, my country will wish to facilitate the earliest possible ratification of the Convention. We hope that others will adopt the same attitude. We are conscious of the fact that the rules, regulations and procedures which the Commission is going to work out will constitute important elements of the future international sea-bed mining code. That code must ensure that decisions will not be arbitrary but that they will be based on objective rules and on fairness, equity and normal business practice taking account of the interests of those who

[4] See *Official Records of the Third United Nations Conference on the Law of the Sea*, vol. XVI, 163rd plenary meeting.

have already signed or acceded to the Convention and of those who may later do so.

161. In order to achieve this, to allay concerns with regard to Part XI and to reinforce general confidence in the Convention, it is vitally important that as many countries as possible participate in the work of the Preparatory Commission in a spirit of compromise and consensus. I shall therefore conclude by expressing the hope of my delegation that we shall all of us meet again in the Preparatory Commission, including colleagues from countries which do not feel in a position to sign the Convention at this stage.

162. Mr. KHAN (Bangladesh): The Bangladesh delegation considers it both an honour and a pleasure to participate in the final session of the Third United Nations Conference on the Law of the Sea amidst the breath-taking and exquisite surroundings of Montego Bay. We should like to express our sincere gratitude to the Government and the people of Jamaica for their friendly hospitality and the excellent arrangements they have provided for this Conference.

163. Bangladesh, a populous Asian country, takes pride and satisfaction in the fact that the long and arduous negotiations that have led to the present historic session were presided over by two distinguished sons of Asia from two sister island-Republics close neighbours of Bangladesh. My delegation would like to pay a tribute to the memory of Mr. Amerasinghe, whose contribution to the work of this Conference is only too well known. We wish also to express our deep gratitude to you, Mr. President, for the effective and fair manner in which you steered the Conference to a successful conclusion. You have brought to the work of this Conference eminent Asian virtues of patience, forethought and rigorous discipline of mind and spirit, without which its success would not have been achieved. Through you, Sir, we express our gratitude to Mr. Zuleta and all the other members of the secretariat of the Conference for their co-operation.

164. We should like also to acknowledge the inspiration and impetus given to our work by Mr. Pardo of Malta.

165. The genesis and the duration of the Third United Nations Conference on the Law of the Sea span almost exactly our own history as a free and independent nation. Bangladesh participated in the Caracas session of the Conference barely two years after its independence. Indeed, that participation was one of the first major diplomatic exercises undertaken. That is why the Government and the people of Bangladesh attach special significance to the monumental work achieved in elaborating a universal régime for the seas covering a vast range of interests and activities for the orderly and regulated use of the oceans and its resources.

166. The task of formulating a comprehensive Convention on the Law of the Sea has not been easy. We are mindful that this great international legislative enterprise is the first in which developing countries have been able to participate as equal partners. Their interests and their aspirations have influenced the final outcome. Nevertheless, Bangladesh feels that the full potential of the present Convention can be realized only through universal participation. We therefore join many previous speakers in appealing to those countries that have yet to make up their minds to join in this Convention in the interest of a universal legal order for the seas and oceans.

167. We hope that some nations, great as they are, appreciate the immediate significance of a correct legal relationship with the Convention. This Convention establishes the means by which the coastal nations extend their sovereignty over adjacent marine resources and enjoy immediate tangible benefits with regard to fishing and navigational rights—a just and equitable framework to protect and conserve the resources of the world's oceans for the benefit of the entire world community.

168. The people of Bangladesh have historically been a seafaring people. The limited land resources available to us and the disparity between those resources and the subsistence needs of the 90-million-strong population of Bangladesh make it imperative to recognize the potential of the oceans as a tangible promise for the future.

169. We have to acknowledge that not all our hopes have been realized in this Convention. We believe that the unique geographical circumstances of our coastline and the peculiar conditions associated therewith warrant adequate treatment. It is also impossible not to agree with the assessment by some representatives that the scheme of the Convention gives too much to some and too little to many others. Yet the Convention, with all its imperfections, offers a viable package deal which must be taken as a whole in the spirit of mutual co-operation and friendship.

170. We believe that the activities of no State, however powerful or technically advanced, should acquire legitimacy through unilateral exploration and exploitation of what is the common heritage of mankind. We also believe that the Convention will give an impetus to the establishment of regional arrangements for exploration and exploitation of sea resources that in the view of my delegation will be mutually beneficial to the countries of the region.

171. We sincerely believe that if nations are truly guided by a spirit of mutual understanding and co-operation and by an objective assessment of the Convention, the hopes of mankind will materialize through this Convention. Bangladesh feels happy and satisfied that this Convention provides adequate and equitable scope for the resolving of differences among States in the spirit of friendship and co-operation.

172. We are also happy that the Convention will be open for signature by Namibia, represented by the United Nations Council for Namibia, with which Bangladesh is closely associated. At the same time, the signing of the Final Act of the Convention by the Palestine Liberation Organization is welcomed by my delegation.

173. We also believe that the Convention offers developing countries such as Bangladesh the opportunity to participate in the activities of the various organs set up under the Convention and that such participation is bound to stimulate domestic development of technical infrastructures in relation to exploration and exploitation of the resources of the ocean. We are also pleased that the Convention provides for distribution of the oceans' wealth between developed and developing nations.

174. The Convention before us contains many inadequacies but, in the spirit of our commitment to international law, peace and good order and solidarity with the people of the developing world and of the non-aligned and the Islamic countries, I have been entrusted by my Government to sign the Convention. However, at the appropriate time Bangladesh will avail itself of the provisions of article 310 to make a declaration on matters of our vital national interests.

175. In conclusion, Bangladesh joins all States in hoping that the final session, based on the principles and objectives of the United Nations, will be a memorable chapter of fruitful co-operation and understanding and sharing of the benefits of the greater part of the globe for the good of mankind.

176. Mr. TANNIS (Saint Vincent and the Grenadines): Mr. President, it is a profound pleasure for my delegation to be at this final session of the Third United Nations Conference on the Law of the Sea and to see you presiding over it. I should like to express my gratitude for the extraordinary guidance you have given us since your appointment to this high office and in bringing this work to a successful conclusion.

177. The Government and the people of Saint Vincent and the Grenadines, as members of the Caribbean Community, to

which Jamaica belongs, are particularly delighted that these historic ceremonies are taking place in this our sister Caribbean Community State. We are further delighted because we believe it represents a profound sense of accomplishment for the Jamaican Government and people. I wish to express my delegation's gratitude to the Government of Jamaica for its hospitality to us and for the excellent arrangements made for this meeting. This fact helps to demonstrate the involved commitment of both the Government and the people to this Conference as well as to subsequent related events.

178. I wish to pay a tribute to the late Hamilton Shirley Amerasinghe, our past President, who dedicated 12 years of his life to these negotiations. I believe that because of the concern he showed he has found time to be with us here in spirit. We are also grateful to the Special Representative of the Secretary-General and to the Executive Secretary and the secretariat, the Rapporteur-General and the Collegium of the Conference for the leadership provided and the dedication shown in order to bring this Conference to its closing stage.

179. It is with a sense of great satisfaction and pride that my country will tomorrow sign both the Final Act of the Conference and the Convention itself.

180. Saint Vincent and the Grenadines voted in favour of the Convention on 30 April 1982,[5] even though the Convention does not adequately address all the problems that could arise. The Convention, however, represents a very significant advance over the early principles established by Grotius and clearly enunciates several new principles which must now guide the conduct of nations in maritime matters. In my Government's view this Convention represents the best guarantee of the rights of small States. However, no convention so ambiguous in scope can be expected to meet all the conflicting needs and interests within the international community or solve the problems of all States within the framework of its provisions. It is a package of compromises and should be understood by all to be so; such compromise must not be viewed as though each exists in isolation. No State, therefore, can expect to accept certain parts and reject others. Nor can any State expect to enjoy prescribed rights without assuming prescribed responsibilities.

181. It is my delegation's view that this Montego Bay Convention must be accepted as a package, in its entirety, and must not be sectionalized. It is to be hoped that whatever differences exist today will soon disappear and that the signing of this Convention will bring ultimate harmony of ideas and unanimity of views within the international community.

182. The Convention represents for the first time a truly universal law in which the rules governing title to and uses of all living and non-living resources of the sea, sea-bed and ocean floor are defined.

183. It has established an international régime and machinery for exploring and exploiting the resources of the international sea-bed area, which are accepted to be the common heritage of all mankind. It is gratifying, for reasons already stated, that Jamaica was selected by the international community to be the permanent home of the International Sea-Bed Authority. My Government looks forward to the Preparatory Commission's beginning its work at the earliest date and working expeditiously to enable the Authority to function effectively as soon as the Convention enters into force.

184. By clearly spelling out rights, the Convention in many respects provides the basis for reducing conflicts, thereby ensuring greater peace and greater security. Because of this collective agreement established under the Convention, we now clearly know what is our entitlement with regard to territorial jurisdiction, contiguous zone and exclusive economic zone. We know our entitlement to the resources of the seas and oceans. We also know our obligations under the Convention. Since we are armed with such knowledge, the path towards good-neighbourliness and better working relationships between nations ought to be clear. Therefore, Saint Vincent and the Grenadines says: Tomorrow we shall sign not only a Convention on the Law of the Sea but also an instrument for peace, harmony and security between nations.

185. Mr. ELFAKI (Sudan) (*interpretation from Arabic*): On behalf of the people and the Government of the Sudan, it is a great honour for me to address the Conference and say how happy we are that it has been convened to sign the United Nations Convention on the Law of the Sea and the Final Act of the Third United Nations Conference on the Law of the Sea.

186. We are gratified that, after years of continued and strenuous efforts, the international community has now succeeded in achieving the first comprehensive convention of its kind in the history of mankind, defining and codifying the uses of the sea and the exploitation of its various resources in the interest of all peoples and nations. We are also delighted that, among others that have been given the right to do so under article 305, Namibia, represented by the United Nations Council for Namibia, will sign the Convention and that the national liberation movements that participated in the Conference are also entitled to sign the Final Act, as observers, in accordance with resolution IV. It had been our hope that the entire international community would adopt this pioneering Convention by consensus and would sign it tomorrow. It is regrettable that some States have failed to join us. We sincerely hope that those States will have an opportunity to review their positions in such a way as to enable them to accede to the Convention at a subsequent date, especially since, after its entry into force, it will constitute the basic guiding principle for international relations in the area of the sea. In this connection I would think that no State in the world could do without the Convention if it observes and respects international legitimacy and international law in the uses of the sea and the exploitation of its resources.

187. We have already mentioned on several occasions during past sessions of the Conference that the Convention, the preparation of which took a decade, is founded on basic facts and new characteristics of relations among peoples and nations today, foremost among which is the convergence and interdependence of interests in a small world in which every region is affected by events and developments in the most remote region on all levels—political, economic and social. These facts and characteristics demonstrate the vast difference between contemporary international relations and those of the past, which, for the most part, were marked by rivalry, divergence and diversity of interests and attempts at achieving gains at the expense of others. Hence this new Convention will, of necessity, not fully meet all our individual aspirations and wishes as sovereign peoples and nations having varied, albeit interdependent, interests; but it is the result of a compromise which all of us can live with and accept, because it envisages our common good. From that point of view, the new Convention could establish a practical and genuine nucleus for relations and co-operation among States in various fields of life in the service of the peoples and the common interests of all nations.

188. With this understanding of the character and quality of the Convention, and in the context of the principle of consensus and convergence of interests which we chose as the basis for our work from the outset, the Democratic Republic of the Sudan will sign tomorrow, 10 December 1982, both the Convention and the Final Act, in spite of our prior conviction that many of the Convention's provisions fall short of our

[5] *Ibid.*, 182nd plenary meeting.

aspirations and wishes and fail to meet fully our individual desires and interests. In accordance with article 310 of the Convention, the Government of the Sudan will make the declarations and statements it deems necessary to clarify its positions on the content of some of the articles. In this brief statement, I shall confine myself to emphasizing the importance of some basic issues which will play a fundamental role in ensuring the implementation of the Convention, foremost among which is full commitment to its future implementation, including the annexes, in all earnestness, sincerity and good faith, on the basis of the principle of consensus and mutual consent which we have already accepted in a gentlemen's agreement and which is incorporated in the declaration adopted by the United Nations General Assembly[6] at its twenty-eighth session, and included in the rules of procedure of the Conference adopted at its second session, in 1974.[7]

189. Moreover, in the implementation of the Convention, we have to bear in mind constantly that it is based on, and is inspired by, the established general principles of international law and is not at variance with them, and that it also respects the full right of all nations and peoples to maintain their independence, sovereignty and territorial integrity and to protect their national security and to ensure no interference in their internal affairs in any form whatsoever.

190. As indicated in paragraph 5 of its preamble the Convention is designed to establish

"... a legal order for the seas and oceans which will facilitate international communication and will promote the peaceful uses of the seas and oceans, the equitable and efficient utilization of their resources, the conservation of the living resources and the study, protection and preservation of the marine environment".

191. Hence this Convention—which we shall sign tomorrow, God willing—is but a positive beginning for opening a new chapter of co-operation among developed and developing countries which will play a major role in preserving the rights of the developing countries in general and of the land-locked, geographically disadvantaged countries and the developing countries producers of minerals in particular, in keeping with equity, justice and equality, in the faithful implementation of the principle of the common heritage of mankind, the protection of the interests of all peoples and nations, and the continuous endeavour to establish a firm basis for the New International Economic Order.

192. It gives us pleasure to note that for the first time this Convention has managed to establish within the framework of international law a régime for the protection and preservation of the marine environment. Our understanding of the principles of freedom of navigation, innocent passage and transit passage is in harmony with those established general principles. In this regard, we should like to confirm the President's statement in the 176th plenary meeting of the Third United Nations Conference on the Law of the Sea, on 26 April 1982,[8] on article 21, concerning the régime of the coastal State relating to innocent passage—namely, that the withdrawal of the amendment submitted by a number of States was without prejudice to the right of the coastal State to adopt procedures necessary to protect its security in accordance with article 19, on the meaning of innocent passage, and article 25, on the rights of protection of the coastal State.

193. We should also like to state that our understanding of the definition in paragraph 2 of article 70 of the term "geographically disadvantaged States" applies to all parts of the Convention where that term is used.

194. We should also like to affirm that our signing this Convention and the Final Act of the Conference in no way implies recognition of any State which we do not recognize or accept to deal with.

195. The importance of the Convention—which we shall sign at this session—and its annexes and the four resolutions that supplement it and define all arrangements necessary for its implementation and the establishment of the organs provided for therein, is that it is the culmination of a major, strenuous endeavour by all the countries of the world, Members and non-Members of the United Nations, self-governing Territories, Associated States, recognized national liberation movements with observer status at international organizations and bodies as well as the culmination of the strenuous efforts made for many years by the United Nations Secretariat at all levels. This is a monumental and historic achievement, a true victory for the will of the peoples and their sincere desire to achieve freedom, justice and peaceful coexistence.

196. On this occasion we should like to extend thanks and appreciation to all those who have contributed their intellect, efforts and initiatives to this monumental accomplishment. Foremost among them is the late Hamilton Shirley Amerasinghe, former President of this Conference, and the much-lamented Mr. Mustapha Yasseen, the co-ordinator of the Arabic language group in the Drafting Committee.

197. Mr. President, your major personal role in this historic endeavour needs no comment. It suffices to say that today we have a complete Convention on the Law of the Sea, covering all aspects, ready for signature and supported by the overwhelming majority of the peoples and nations of the world. We express our thanks and appreciation to you, Sir, and to the Chairmen of the main Committees and the regional groups who have worked with you and made an invaluable contribution to this important Convention.

198. We also extend thanks to all those unknown soldiers in the United Nations Secretariat, under the leadership of Mr. Bernardo Zuleta, the Special Representative of the Secretary-General, for their assistance and efforts which have enabled the international community to achieve its objective.

199. Finally, on behalf of the delegation of Sudan, I should like to express thanks, appreciation and gratitude to the Government and people of friendly Jamaica for the warm welcome and generous hospitality and the efforts and arrangements made for the signing of this important international instrument on time in their beautiful country.

200. Mr. BASSOLE (Upper Volta) (*interpretation from French*): At a time when the countdown has begun for the signing of the United Nations Convention on the Law of the Sea, I should like, on behalf of my country, to pay a well-deserved tribute to all those who have for so long kept their shoulders to the wheel to make possible the successful climax of our negotiations.

201. Upper Volta is grateful to everyone involved for having done such useful work, all the more so since the noble ambition which has motivated us all was—and at the price of countless difficult concessions and great efforts—to make the sea a supplier of sustenance for the entire international community.

202. This was a great undertaking and the long years that separate us today from the first meeting of the United Nations devoted to the law of the sea give sufficient proof of the complexity of this undertaking. That complexity is doubtless due to the difficulty of reconciling interests that were very often contradictory, but also to the trouble we have had shedding the habits of daily practice which had made some of us feel that "everything was for the best in the best of worlds".

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[6] See *Official Records of the General Assembly, Twenty-eighth Session, Plenary Meetings*, 2169th meeting.

[7] See *Official Records of the Third United Nations Conference on the Law of the Sea*, vol. I, 19th plenary meeting.

[8] *Ibid.*, vol. XVI.

203. It would take far too long to undertake another exhaustive analysis of this collective work. For, like any other human undertaking, it has many imperfections.

204. My delegation feels that perhaps more was bitten off than could be chewed. Indeed, in this great work the share for the legitimate interests of the land-locked and geographically disadvantaged countries has not always been obvious.

205. Nevertheless, we are among those who feel that the Convention submitted to us for signature is a compromise—the compromise most acceptable to the international community. For, in a sincere, deep desire to make the oceans a true common heritage of mankind, it has tried to draft provisions covering all the questions dealing with the seas.

206. My delegation feels that this is an extremely important legal document, one capable of contributing—if it is properly used—to the strengthening of international peace, security and co-operation.

207. This great contribution to international law could, if its objectives were applied, serve as a stimulus to the establishment of this more just new international economic order which the international community has been attempting—so far unsuccessfully—to bring into being.

208. We feel that this document can help to bring about the realization of the noble ideals of the United Nations Charter, and my country will therefore sign tomorrow the Final Act of the Conference and the United Nations Convention on the Law of the Sea.

209. But, in the meantime, my delegation takes this opportunity to express from this rostrum to the people of Jamaica and their Government our deep gratitude not only for the great quality and warmth of the welcome we have received here at Montego Bay but also, and in particular, for having made it possible for this long-awaited child—which will become tomorrow the bearer of our hopes—to be born on the banks of this beautiful Caribbean Sea.

210. Mr. HOUNTON (Benin) (*interpretation from French*): From Caracas to Montego Bay, the road has been long, exhausting and full of hurdles, but we have arrived.

211. The brevity of my statement will be an expression of our gratitude to you, Mr. President, for your tireless efforts and our gratitude for the efforts of your collaborators and predecessors in achieving this victory to be celebrated tomorrow. We associate ourselves with previous speakers in paying this tribute.

212. We should also like to thank, on behalf of the people and Government of Benin and on behalf of our delegation, the people and Government of Jamaica for the generous hospitality they have extended to us in this jewel of the Caribbean.

213. Caracas and Montego Bay are two names that will remain in history and in the hearts of peoples that truly cherish peace and justice. For if the Convention that we are to sign here does not satisfy all our concerns, it does at least constitute an important step towards the restoration of more just and more equitable relations. It provides a more acceptable legal basis for the exploitation of the ocean resources and for the peaceful use of the seas and oceans. We hope that in its implementation the principles and purposes of the United Nations Charter will not be neglected.

214. The documents before us for signature contain clear achievements, and the speakers who have preceded me have described them well: confirmation of the sovereignty of States over the continental shelf; standardization of the breadth of the territorial sea; solutions to the problems of pollution and the environment; prospects for more fruitful co-operation among all States; and, above all, the fact that in its article 136 this Convention establishes the area as the common heritage of mankind. In so doing, the Convention brings about a more equitable distribution of the resources of our planet among all countries—coastal, geographically disadvantaged or land-locked—and among all peoples, oppressed or sovereign.

215. The sea belongs to all and must benefit all, rich and poor alike.

216. It is regrettable that so simple a truth should be difficult to understand for some who, nevertheless, easily grasp the nature of article 17, which requires that at the price of our security and sovereignty we accept free passage of their warships.

217. By co-sponsoring the amendment contained in document A/CONF.62/L.77, my country indicated its disapproval of such a provision, which was not, indeed, the only shortcoming militating against the developing countries. However, in the interests of mankind, we voted for the adoption of the Convention. The lacunae to which some have pointed cannot justify their reluctance—as if they are completely unaware of the merits of the compromise embodied in the Convention.

218. We do not believe that merely to gain their support it is necessary to add a single minute to the 88 weeks that have already been devoted to this gigantic task which has been pursued since 1973. The framework of the Convention cannot satisfy all the interests at stake, but it does preserve the essentials.

219. We have arrived at a historic stage and the Convention provides a basis, we are certain, for helping to usher in a real North-South dialogue. It is by its acceptance and implementation that we will be able to judge the true will that exists for the establishment of a new economic order, the true desire to eradicate hunger and poverty from our world. The hesitations and rejections that have been expressed cannot halt this irreversible process, for we must move forward. However, the door will remain open.

220. In short, this Conference may be assured that the people of Benin will discharge its moral duty to mankind.

221. The People's Republic of Benin, a member of the Group of 77 and of the African Group, voted in favour of the Convention last April, and we shall sign it.

222. Mr. MINKO MI-ENDAMNE (Gabon) (*interpretation from French*): My delegation is very pleased to be attending the solemn ceremony of the last session of the Third United Nations Conference on the Law of the Sea.

223. At the outset I should like, on behalf of the people and Government of Gabon, to extend our deep gratitude to our Jamaican friends and brothers and their Government for their generous hospitality and praiseworthy efforts in acting as host to the final session of the Conference on the Law of the Sea here at Montego Bay.

224. I wish to pay a sincere tribute, on behalf of my delegation, to the late Mr. Hamilton Shirley Amerasinghe, the first President of the Conference, for his important contribution to the achievement of a new codification of the law of the sea.

225. I take this opportunity also to congratulate you, Mr. President, on your unceasing efforts, along with the Collegium, and on your great skills as a diplomat, without which our Conference might not have achieved the positive result embodied in the final adoption, on 30 April in New York, of the United Nations Convention on the Law of the Sea.[5]

226. Our thanks go as well to all those who, by their goodwill, have contributed to the adoption of the universal Convention on the Law of the Sea.

227. In response to your appeal, Sir, I shall be brief. I shall be brief even at the risk of being unable to say everything I had intended to say. Fortunately for me, many of my ideas have already been expressed by the very able speakers who have preceded me to the rostrum.

228. There is no need to recall once again here the many attempts of the international community over the past 20 years to achieve a codification of an international legal régime of the sea. Unfortunately, all tended to promote an unjust international order for the sea and consecrate the supremacy of the great maritime nations at the expense of the weak nations and new States acceding to international sovereignty.

229. The declaration of principles governing the sea-bed and the ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction, adopted by the General Assembly in resolution 2749 (XXV), which proclaimed the new concept of the common heritage of mankind, laid the first true foundations for a new international legal régime of the sea and genuine co-operation among nations.

230. There have been 10 long years of arduous and delicate negotiations costly to the poor countries in human and material efforts, and the Government and the people of Gabon are pleased that they have successfully concluded with the adoption of a universal Convention establishing new and most just legal norms.

231. Nevertheless, we recognize that this instrument suffers from serious inadequacies and shortcomings which many States find difficult to accept and which, furthermore, my delegation constantly pointed out throughout the negotiations of the Conference. In particular, these deal with the right of innocent passage of warships in the territorial waters of coastal States; limitation of production; and the definition of a system of compensation adequately protecting developing countries producers of the same minerals as those to be exploited in the sea-bed.

232. However, my delegation, like many others, in a spirit of compromise gave up its legitimate claims and, since April 1982, we have considered the new Convention as the sole instrument, within the framework of the United Nations system, guaranteeing the legitimate interests of all nations on the basis of mutual respect. Hence the Government and the people of Gabon firmly support the ideals expressed in the provisions of the new Convention and will contribute as best they can to their realization. Accordingly, Gabon will, without reservations, be a party to the new Convention and will participate with due attention in the work of the Preparatory Commission.

233. Finally, my delegation urges all those who have participated in the drafting of this great, historic work for mankind but who may still have some doubts about it to join us, on 10 December, in signing our universal common work, a true bulwark of peace, security, international co-operation and development.

234. Mr. POMPEE (Haiti) (*interpretation from French*): Mr. President, I should like to join preceding speakers and congratulate you, on behalf of my delegation, on the impeccable way in which this Conference is being held. These congratulations go as well to the Government of Jamaica, which has done everything possible to make our stay here a pleasant one.

235. No one can dispute that the objectives of North-South dialogue constitute an essential condition for the international community to achieve once again a more just balance and a less dangerous situation.

236. While the avalanche of rhetoric on this subject may already have reached the saturation point, the present session offers both the North and the South the prospects of a future with fishing resources, petroleum resources, manganese nodules—and much more. So, since we are dealing with matters relating to the sea, we can easily understand why Montego Bay, with its natural beauty, was chosen as the site for this session by the representatives during the session at Geneva.

237. The Convention to be opened for signature is the culmination of lengthy efforts for the benefit of all, since those who are already rich may become even richer and those who are poor may become less poor, in view of the extensive resources of the sea-bed: immense fishing resources and considerable petroleum resources, the proven reserves of which, according to estimates prepared for the United Nations, may reach 170 billion barrels for oil and 2 to 3 trillion barrels for exploitable marine resources.

238. As for polymetallic nodules, which are generally made up of manganese, nickel, copper and cobalt, the sea-bed is covered with them.

239. The basic principle that industrialized countries could adopt would be an open-door policy in the area of transfer of technology, because the use of the sea involves interactions, interpenetrations and mutual ties.

240. Those who are hesitating should recall that sea-bed resources are destined to play an important role in human survival and the quality of human life and that North and South must share life on this earth.

241. Tomorrow my country will sign both the Final Act and the Convention without any reservations.

The meeting rose at 1.05 p.m.

192nd meeting

Thursday, 9 December 1982, at 3 p.m.

President: Mr. T. T. B. KOH (Singapore)

Statements by delegations (*concluded*)

1. Mr. CLINGAN (United States of America): I wish first to express my delegation's gratitude for the generous hospitality of the Government of Jamaica, for its invitation to serve as host for these proceedings in this beautiful environment, and for the excellent arrangements it has provided. I should also like to express our appreciation to you, Mr. President, to the other officers of the Conference and to the members of the secretariat, all of whom have laboured in these negotiations over many years.

2. I am here to sign, on behalf of the United States, the Final Act of the Conference. It had been our hope that we would be here for another purpose as well. The United States approached the work of the Conference early this year with renewed dedication and hope. As the President of the United States said on 29 January 1982, the United States remained committed to the multilateral process for seeking agreement on the law of the sea. With that in mind, the United States delegation participated fully in the eleventh session and sought a final result that would command global consensus. Unfortunately, the Conference did not achieve that result.

3. The United States recognizes that certain aspects of the Convention represent positive accomplishments. Indeed, those parts of the Convention dealing with navigation and

Annex IN-20

A. H. A. Soons, "The Effects of a Rising Sea Level on Maritime Limits and Boundaries", *Netherlands International Law Review*, Vol. 37, 1990, pp. 207-232.

THE EFFECTS OF A RISING SEA LEVEL ON MARITIME LIMITS AND BOUNDARIES

by A.H.A. Soons*

1. INTRODUCTION

The sea level is rising. One of the causes of this phenomenon is the so-called 'greenhouse effect'. This concept refers to the rising of the temperature of the atmosphere as a result of the increase of the concentration of carbon dioxide and several other gases in the atmosphere. One of the consequences of this rise in temperature is the melting of land ice, in particular glaciers and the ice-caps of Greenland and perhaps Antarctica. This melting water enters the ocean, which results, in combination with the expansion of sea water as a consequence of its higher temperature, in a rising of the sea level.[1]

The greenhouse effect probably also entails other negative consequences for the global biosphere, such as an increased chance of tropical cyclones, storm depressions and abundant rainfall for some parts of the globe and droughts for others, as well as changes in flora and fauna. Apart from the greenhouse effect, other sources of atmospheric pollution also threaten the quality of life on earth, resulting in damage to the ozone layer, the creation of tropospheric ozone and acid rain. These dangers to the environment have recently attracted much attention. A large number of international meetings, scientific and governmental, have already been held. It has become clear that *preventive* measures are urgently needed, and that international co-operation is required for the taking of such measures. Much work is presently being undertaken within the framework of the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC). Public international law plays a part in this context,

* Member of the Board of Editors. Professor of Public International Law and Director of the Netherlands Institute for the Law of the Sea, Faculty of Law, University of Utrecht, The Netherlands.
This article is based on the inaugural lecture delivered by the author on April 13, 1989.

1. J.G. Titus, 'The Causes and Effects of Sea Level Rise', in H.G. Wind, ed., *Impact of Sea Level Rise on Society* (1987) pp. 104-125; S.H. Schneider, 'The Greenhouse Effect: Science and Policy, *Science* (1989) pp. 771-781; J.D. Milliman, 'Sea Levels: Past, Present and Future, *Oceanus* (1989) pp. 40-44.

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XXXVII-NILR 1990, 207-232

in particular the relatively recent field of international environmental law. That role, however, will not be discussed in this article.[2]

The present article mainly concerns the (potential) *consequences* of the greenhouse effect for the sea level. It can be expected that some of these consequences will occur in any case, within the next century. Even if the production of carbon dioxide and other harmful gases is substantially reduced within a short period of time, the effects of the present situation will remain noticeable over a long period. Estimates about the extent of the effects (as far as the rise in the sea level is concerned) vary substantially: from 40 centimeters to 1.5 meters (and even more) in the next one hundred years. That may not seem much. There are, however, also other causes of sea level rise. In addition to a rise in an absolute sense, as a consequence of the increase of the volume of sea water caused by the greenhouse effect, the sea level often rises in a relative sense. This is the result of phenomena on a regional or local scale, and therefore varying in extent according to the geographical area involved. Examples of such phenomena are earth-crust movements like collapses and compacting. These phenomena may result in an additional sea level rise (locally) of several decimeters or more.[3]

It will be clear that such permanent, substantial rises of sea level can have serious negative effects for low-lying coastal areas and islands. In particular, coastal areas lacking any (or any appreciable) shoreline protection are threatened: the sea slowly advances landward, islands disappear or become uninhabitable. Preventive measures are expensive and very often not practicable. In areas where shoreline protection does exist, additional measures will often still have to be taken.[4] Also the Netherlands will inevitably have to defend itself in due time against this phenomenon. But the greatest problems will occur elsewhere in the world: the low-lying and densely populated river deltas in Bangla Desh, India, Burma, Thailand, Vietnam, Cambodia and China. And, in particular, the archipelagic States in the Pacific, Indian and Atlantic Oceans, consisting of atolls and low-lying islets, such as Kiribati, Tuvalu, Tokelau, the Marshall Islands, the Maldives and the Bahamas. Most atolls and islets of these countries do not protrude above sea level for more than one meter; the highest natural point is generally less than three meters above sea level. However, almost 500,000 people live on these atolls and islets.[5] The par-

2. For an overview, see V.P. Nanda, 'Trends in International Environmental Law', *California Western International Law Journal* (1989-1990) pp. 187-206.

3. Titus, loc. cit. n. 1; Schneider, loc. cit. n. 1; Milliman, loc. cit. n. 1. It should be noted that earth crust movements may also lead to a relative *dropping* of the sea level. Also, as a result of biological processes (formation of coral) an atoll may keep pace with the rising sea level. These aspects will not be dealt with in this article.

4. J.E. Bardach, 'Global Warming and the Coastal Zone', *Climatic Change* (1989) pp. 117-150. L. Rodgers-Miller and J.E. Bardach, 'In Face of a Rising Sea', *Ocean Yearbook* (1988) pp. 177-190.

5. 'Greenhouse Effect Experts Predict Devastation in Asia', *International Herald Tribune*, 31 December 1988/1 January 1989, p. 2; 'The Greenhouse Effect. Say Goodbye to Kiribati, the

ticular concerns of the latter States have been clearly expressed in the 'Malé Declaration' on Global Warming and Sea Level Rise, adopted at the Small States Conference on Sea Level Rise held at Malé, 14-18 November 1989.[6]

Understandably, up until now all attention concerning the consequences of sea level rise for human society has concentrated on this imminent loss of land and the possibilities to take preventive measures (or at least measures to minimize the loss).[7]

This imminent loss of land is also relevant from the point of view of public international law. In extreme situations it will even endanger the continued existence of a State. This issue will be briefly dealt with at the end of this article. It was certainly no exaggeration that during the environmental conference held in London in March 1989 the representative of Kiribati referred to the greenhouse effect as 'a threat to the very existence of my country'.[8]

This article, however, focuses on an aspect of sea level rise to which so far very little attention has been paid, viz., the effects of sea level rises on the location of maritime limits and boundaries and, as a consequence of this, on the extent of sea areas under the jurisdiction of coastal States.[9]

As will be shown, for a number of countries the sea level rise is more a problem concerning the potential loss of sea areas rather than the loss of land areas.

Before starting to analyse this issue it is necessary to first briefly explain a few relevant concepts of the international law of the sea. This involves in the first place the concept of the 'baseline', i.e., the line from which in principle the breadth of the sea areas in which coastal States are entitled to exercise jurisdiction is measured. Subsequently, for an adequate understanding of the issues attention will briefly be paid to the regimes of the various maritime zones under coastal State jurisdiction.

When discussing these concepts of the international law of the sea, reference will mainly be made to the provisions of the UN Convention on the

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Marshall Islands, Tokelau, Tuvalu, the Great Barrier Reef', *Pacific Islands Monthly* (April/May 1989) pp. 17-21. Specifically on the Maldives: 'Maldives Face Extinction', *The Indian Ocean Review* (1988) no. 4, p. 11; 'The Idyllic Islands of the Indian Ocean: The Maldives', ibid., pp. 12-13.

6. Text in *Environmental Policy and Law* (1990) pp. 58-59. See also the *Conference Statement* of the International Conference on Global Warming and Climate Change: Perspectives from Developing Countries. New Delhi, February 21-23, 1989, 19 pp.

7. See the contributions in Wind, ed., op. cit. n. 1; Bardach, op. cit. n. 4.

8. *The Times*, March 6, 1989, p. 3.

9. Two papers have recently been published:

E. Bird and V. Prescott, 'Rising Global Sea Levels and National Maritime Claims', *Marine Policy Reports* (1989) pp. 177-196.

D. Freestone and J. Pethick, 'International Legal Implications of Coastal Adjustments under Sea Level Rise: Active or Passive Policy Responses?', in UNEP/WMO/USACE/EPA/NOAA, *Changing Climate and the Coast. Report to the Intergovernmental Panel on Climate Change from the Miami Conference on Adaptive Responses to Sea Level Rise and Other Impacts of Global Climate Change*, vol. 1 (May 1990) pp. 237-256.

Law of the Sea of 1982, hereinafter referred to as the Law of the Sea Convention.[10] Although this Convention has not yet entered into force,[11] most of the provisions contained therein which are relevant for examining the issues under consideration can in essence be regarded as reflecting rules of present customary international law in this field, which in principle is binding upon all States.[12]

2. THE BASELINE

States bordering the ocean are entitled to exercise certain forms of jurisdiction over sea areas contiguous to their coasts in several zones. These zones are situated landward or seaward of a line which is called the 'baseline'. The zones on the seaward side of the baseline may in most cases extend to a certain distance, measured from this line. The location of that baseline is thus decisive.

The normal baseline is constituted by the *low-water line* along the coast.[13] The reference to the coast here includes the coast of islands.[14] The low-water line refers here to the one marked on large-scale charts officially recognized by the coastal State.[15] There are many kinds of low-water lines; that highly technical issue, however, will not be dealt with here.[16] In the case of islands situated on atolls or of islands having fringing reefs, the baseline is the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognized by the coastal State.[17]

In certain, exceptional situations, however, a coastal State is entitled to employ, instead of the low-water line, another line as the baseline. In those cases the line is referred to as the *straight baseline*, since it involves imaginary lines connecting appropriate fixed geographical points. This method of straight baselines may be employed by the coastal State in localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity.

10. UN Doc. A/CONF. 62/122; ILM (1982) p. 1261.

11. Art. 308 of the Law of the Sea Convention provides that it will enter into force 12 months after the date of deposit of the sixtieth instrument of ratification or accession. In August 1990 the Convention had been ratified by 44 States.

12. See on this issue, R.R. Churchill and A.V. Lowe, *The Law of the Sea*, 2nd edn. (1988) pp. 4-17.

13. Art. 5 of the Law of the Sea Convention (all further references in these footnotes to treaty articles are from the Law of the Sea Convention, unless expressly stated otherwise). On the baseline, see Churchill and Lowe, op. cit. n. 12, pp. 26-50.

14. Art. 121, para. 1.

15. Art. 5.

16. On this issue, see: D.P. O'Connell, *The International Law of the Sea*, vol. I (1982) pp. 173-183; D.C. Kapoor and A.J. Kerr, *A Guide to Maritime Boundary Delimitation* (1986) pp. 16-18.

17. Art. 6.

The drawing of straight baselines must not depart to any appreciable extent from the general direction of the coast, and the sea areas lying within the lines must be closely linked to the land domain. Straight baselines may 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 or except in instances where the drawing of baselines to and from such elevations has received general international recognition. In determining particular straight baselines the coastal State may take account of economic interests peculiar to the region concerned, the reality and the importance of which are clearly evidenced by long usage.[18]

Another situation in which straight baselines may be drawn involves a coastline which is highly unstable, because of the presence of a delta and other natural conditions. In such a case the appropriate points may be selected along the furthest seaward extent of the low-water line and, notwithstanding subsequent regression of the low-water line, the straight baselines shall remain effective until changed by the coastal State.[19] This provision, which has particular significance for the problem of sea level rise, will be specifically referred to below.

Straight baselines may furthermore be drawn across the mouths of rivers which flow directly into the sea and,[20] provided certain conditions are met, between the natural entrance points of a bay when the distance between those points does not exceed 24 nautical miles.[21]

Finally, there is one other situation in which straight baselines may be drawn, and which is of great importance for the issue under consideration, viz., that of mid-ocean archipelagos. An archipelagic State (i.e., a State constituted wholly by one or more archipelagos)[22] may draw straight archipelagic baselines joining the outermost points of the outermost islands and drying reefs of the archipelago, provided that within such baselines are included the main islands and an area in which the ratio of the area of the water to the area of the land (including atolls) is between 1 to 1 and 9 to 1. The length of such baselines may, apart from a few exceptions, not exceed 100 nautical miles.[23]

18. Art. 7.

19. Art. 7, para. 2. On the *travaux préparatoires* and the significance of this provision, see T. Scovazzi, 'La linea di base rette', in T. Scovazzi, ed., *La linea di base del mare territoriale* (1986) pp. 120-127.

20. Art. 9.

21. Art. 10.

22. Art. 46 defines an archipelago as 'a group of islands, including parts of islands, interconnecting waters and other natural features which are so closely interrelated that such islands, waters and other natural features form an intrinsic geographical, economic and political entity, or which historically have been regarded as such'.

23. Art. 47.

3. MARITIME ZONES

This section will provide a brief exposition of the regime of the various maritime zones in which coastal States, according to the rules of public international law, are entitled to exercise some form of jurisdiction. These areas can be divided into two categories.

The first category includes sea areas under the sovereignty of the coastal State. These are the maritime internal waters, the archipelagic waters and the territorial sea.

The second category includes the sea areas in which coastal States exercise limited, functional jurisdiction. These are the contiguous zone, the continental shelf, the exclusive economic zone and the (exclusive) fisheries zone.

The *maritime internal waters* include the waters landward of the baseline which have open connection with the ocean.[24] These waters fall under the territorial sovereignty of the coastal State, in the same way as its land territory.[25]

The *archipelagic waters* constitute the waters enclosed by the archipelagic baselines mentioned above. These areas equally fall under the sovereignty of the coastal State (the archipelagic State),[26] with the proviso, however, that this State must respect certain rights of passage for foreign vessels, similar to those in the territorial sea.[27] Examples of archipelagic States are the Bahamas, the Seychelles, the Maldives, Indonesia, the Philippines, Kiribati, Fiji and the Marshall Islands.

The *territorial sea* includes the area seaward of the baseline, with a breadth not exceeding 12 nautical miles (approximately 22 kilometers).[28] It should be noted that, in cases of low-tide elevations, their low-water line only counts as a baseline of the territorial sea if the low-tide elevations are situated wholly or partly at a distance not exceeding 12 nautical miles from the mainland or an island.[29]

The sovereignty of the coastal State extends to its territorial sea.[30] There exists, however, an important limitation on this sovereignty: ships of all States enjoy the right of innocent passage through the territorial sea.[31] In those parts of the territorial sea which constitute an international strait, international shipping may exercise an even further-reaching right of transit passage.[32]

24. Art. 8, para. 1.
25. Art. 2, para. 1. A limitation of this sovereignty (the right of innocent passage) may exist in some parts of maritime internal waters according to Art. 8, para. 2.
26. Art. 49.
27. Arts. 52-54.
28. Art. 3.
29. Art. 13.
30. Art. 2, para. 1.
31. Arts. 17-32.
32. Arts. 34-44.

The *contiguous zone* is an area beyond and contiguous to the territorial sea, in which the coastal State may exercise the control necessary to prevent any infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea, and to punish any infringement of these laws and regulations committed within its territory or territorial sea. The contiguous zone may not extend beyond 24 nautical miles from the baseline.[33]

Completely new is the rule that in this area the coastal State also has a certain authority over objects of an archaeological and historical nature located on the seabed.[34]

The *continental shelf* of a coastal State comprises the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines where the outer edge of the continental margin does not extend up to that distance.[35] The outer limit of the continental margin, which is defined in the Law of the Sea Convention in a highly complicated way, can in some cases be located at a distance of several hundred nautical miles beyond the 200-mile line.[36]

The coastal State exercises sovereign rights over the continental shelf for the purpose of exploring it and exploiting its natural resources.[37] In practice these natural resources are mostly oil and gas.

The *exclusive economic zone* (EEZ) is an area, beyond and adjacent to the territorial sea, up to 200 nautical miles (approximately 370 kilometers) from the baseline.[38] In this zone the coastal State has sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, both living and non-living. The zone comprises the waters, the seabed and its subsoil. The sovereign rights of the coastal State also include other activities for the economic utilization of the zone, such as the production of energy from the water, currents and winds. In addition, the coastal State has in its EEZ certain jurisdiction with regard to the establishment and use of artificial islands, installations and structures, the conduct of marine scientific research, and the protection and preservation of the marine environment. In the EEZ, however, all States enjoy freedom of navigation.[39]

33. Art. 33.
34. Art. 303, para. 2.
35. Art. 76, para. 1.
36. Art. 76, paras. 2-8.
37. Art. 77. Para. 4 of this article defines the natural resources of the continental shelf as the mineral and other non-living resources of the seabed and subsoil, as well as the living organisms belonging to sedentary species. In addition, the coastal State has jurisdiction with respect to marine scientific research (Art. 246 et seq.) and with respect to artificial islands and installations (Art. 80 jo. Art. 60).
38. Arts. 55 and 57. In the area up to 200 nautical miles, the EEZ and the continental shelf thus coincide.
39. Art. 56. The content and scope of these rights and jurisdiction of the coastal State, and of the rights of other States, are further defined in Arts. 58-73, 246 et seq. (marine scientific research) and Part XII (protection and preservation of the marine environment).

Finally, mention should be made of the *(exclusive) fisheries zone.* Geographically it concerns the same area as the EEZ (i.e., a zone extending up to 200 nautical miles from the baseline), but the coastal State's jurisdiction within the zone is limited to the exploration and exploitation of the living resources.[40]

Beyond these maritime zones within which coastal States have certain jurisdiction is the *high seas.*[41] There, the principle of the high freedom of the seas still applies.[42] For the exploration and exploitation of the natural resources of the seabed and subsoil of the high seas (beyond the continental shelf; now referred to as the International Seabed Area), an entirely new legal regime is provided for by the Law of the Sea Convention. This regime is based on the principle that these resources (mainly the so-called 'manganese nodules') are to be considered the common heritage of mankind.[43] These areas, however, are not directly relevant for the problem of sea level rise.

As stated above, the maritime zones referred to may extend up to a certain maximum distance from the baseline, e.g., 12 or 200 nautical miles. Those maximum distances can obviously only be reached when there are no opposite coastal States situated at a distance of less than 24 or 400 nautical miles, respectively. If such opposite coastal States are present, then the coastal States involved will have to reach agreement on the delimitation of their respective areas. If agreement has been reached this is usually recorded in a delimitation treaty. The negotiations preceeding such a treaty are often complex and protracted, because many factors may be involved and the interests may be great. If no agreement is reached, the governments concerned may decide to have the the boundary determined by a third party, such as an Arbitration Tribunal or the International Court of Justice.[44]

The provisions in the Law of the Sea Convention on the delimitation of the territorial sea on the one hand, and the EEZ and continental shelf on the other, are not identical. For the delimitation of the territorial sea it is provided that, failing agreement between the coastal States involved to the contrary, neither of the two States is entitled to extend its territorial sea beyond the median line between the baselines of the two States, except in cases where it is necessary by reason of historic title or other special circumstances to delimit the territorial sea of the two States in a way which is at variance therewith.[45]

40. The concept of an '(exclusive) fisheries zone' is not included in the Law of the Sea Convention. It has been developed in the past two decades in customary international law.

41. Art. 86.

42. Art. 87 et seq.

43. Part XI of the Law of the Sea Convention.

44. Churchill and Lowe, op. cit. n. 12, pp. 153-163. O'Connell, op. cit. n. 16, vol. II, chapters 16-18. J.R.V. Prescott, *The Maritime Political Boundaries of the World* (1985) pp. 81-106.

45. Art. 15.

The delimitation of the EEZ or the continental shelf between two States must be effected by agreement, on the basis of international law, in order to achieve an equitable solution.[46] If the States concerned cannot reach agreement and engage a third party, the latter therefore has to apply principles and rules which result in an equitable boundary delimitation.[47] Pending the establishment of the boundary the States concerned should, in a spirit of understanding and co-operation, make every effort to enter into provisional arrangements of a practical nature and, during this transitional period, should not jeopardize or hamper the reaching of a final agreement. Such interim-arrangements are without prejudice to the final delimitation.[48]

4. THE EFFECTS OF SEA LEVEL RISE ON MARITIME LIMITS AND BOUNDARIES

4.1 Introductory remarks

When analyzing the (potential) effects of sea level rise on maritime limits and boundaries, a distinction should be made between, on the one hand, situations where a delimitation agreement between the coastal States is in force for the sea area concerned or a boundary has been established through a decision of the International Court of Justice or an Arbitral Tribunal, and, on the other hand, situations where there is no delimitation agreement in force.

First, the situations where a delimitation agreement is lacking will be dealt with. The consequences of the application of the general rules concerning baselines in the case of sea level rise will be examined. The location of most maritime boundaries has not yet been fixed by treaty, although in some of those cases there is no disagreement between the States involved about where the boundary should be.[49]

After this examination it is appropriate to briefly consider the interests involved: what are the practical consequences of shifting maritime boundaries?

Subsequently, the possibilities which exist for coastal States to prevent or reduce the potentially negative effects of sea level rise on the location or extent of sea areas under their jurisdiction will be examined.

Finally, the situations in which for the sea area involved a delimitation agreement is in force or a boundary has been established through international arbitration or adjudication will be dealt with.

46. Arts. 74, para. 1 and 83, para. 1.

47. B. Kwiatkowska, 'The ICJ Doctrine of Equitable Principles Applicable to Maritime Boundary Delimitation and its Impact on the International Law of the Sea', in A. Bloed and P. van Dijk, eds., *Forty Years International Court of Justice: Jurisdiction, Equity and Equality* (1988) pp. 119-158.

48. Arts. 74, para. 3 and 83, para. 3.

49. At present there exist approximately 100 maritime delimitation treaties which are in force.

4.2 Situations without delimitation agreement

4.2.1 *Application of the general rules*

First, the consequences of the application of the general international legal rules concerning the ***normal baseline***, i.e., the low-water line, will be examined. As a consequence of sea level rise, this line is shifting landward or, in cases of low-lying islands and low-tide elevations, may even disappear completely.

The horizontal distance over which the baseline shifts in a landward direction obviously depends on the gradient of the land surface in the area involved: the lesser the gradient, the greater the distance. In some areas a rise in the sea level of half a meter can shift the baseline for tens of kilometers.

Because of the landward shift of the baseline, the outer limits of the territorial sea and EEZ will also shift landward accordingly.[50] The extent (area) of these sea areas remains the same; only the location of the inner and outer limits changes.

As far as the continental shelf is concerned the consequences are less clear. The Law of the Sea Convention contains a remarkable provision in Article 76, paragraph 9, which reads as follows:

> 'The coastal State shall deposit with the Secretary-General of the United Nations charts, and relevant information, including geodetic data, ***permanently*** describing the outer limits of its continental shelf. The Secretary-General shall give due publicity thereto' (emphasis added).

As far as the continental shelf's outer limit extending beyond 200 nautical miles is concerned, this provision is not that remarkable, since in that case the outer limit is primarily determined by geological and morphological factors which are not affected by sea level rise. That outer limit thus remains. The breadth of the continental shelf, however, increases since the outer limit of the territorial sea has shifted landward (the continental shelf in the legal sense starts beyond the territorial sea). When, however, it is the outer limit of the continental shelf extending exactly to 200 nautical miles that is involved, this provision is remarkable for it would also fix that boundary, notwithstanding possible later regressions of the baseline. This is the more remarkable since such a provision has not been included for the outer limit of the EEZ, even though the regime of the EEZ includes jurisdiction over seabed resources.

It is not clear if this provision was originally meant to apply exclusively to the continental shelf extending beyond 200 nautical miles, and that the effect

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There exist 400 (potential) maritime boundaries. See E.D. Brown, ***Sea-Bed Energy and Mineral Resources and the Law of the Sea***, vol. III (1986) pp. III. 4.19-33.

50. These conclusions apply ***mutatis mutandis*** to the contiguous zone and the (exclusive) fisheries zone. These two zones will not be mentioned separately in the following expositions.

just mentioned therefore is unintentional. More probable is that this provision was intended to permanently fix the boundary between the continental shelf and the international seabed area, in view of the legal security which is of great importance for the holders of concessions for mining activities.[50a] In this connection there are no convincing reasons for treating a continental shelf limit beyond 200 nautical miles any differently from a 200-nautical mile continental shelf limit. It would seem unjust if, for example, an outer limit located because of geological or morphological factors at 210 nautical miles from the baseline would become fixed, whereas a 200-nautical mile limit would not be. Thus the effect of this provision is that also the 200-nautical mile outer limit of the continental shelf, in case of regression of the baseline, remains unchanged and that the breadth of the shelf increases.[51] An area of seabed which formerly came under the regime of territorial sea then comes under the regime of the continental shelf.

A totally different situation occurs when an island or a low-tide elevation disappears entirely. In such a case it is possible that the extent of the territorial sea and EEZ decreases. Whether or not, and to what extent, that will be the case, depends on the geographical configuration.[52] Especially in the case of islands the extent of the sea area lost can be substantial.[53] The farther the disappeared island was located from a remaining baseline (the coast of the mainland or of a remaining other island), the greater the loss of sea area. The extent of the loss is determined, among other factors, by the area of the (former) island, but even in cases of the smallest islets substantial areas may be involved. For example: if the islet was situated at a distance of 24 nautical miles from the remaining baseline, the extent of the territorial sea may decrease by approximately 1500 square kilometers.[54] The extent of the EEZ may even decrease by approximately 8,000 square kilometers.[55] If the islet was situated at a distance of 200 nautical miles from the remaining baseline, then the loss

50a. See B.H. Oxman, 'The Third United Nations Conference on the Law of the Sea: the Ninth Session (1980)', AJIL (1981) p. 230.

51. The consequence that as a result of this the outer limits of the continental shelf and the EEZ will be located separately should in itself not raise any objections: this is already the case with the continental shelf extending beyond 200 nautical miles. Should the outer limit recede, the seabed area involved would become included in the international seabed area.
Art. 76, para. 9 is a typical treaty provision and raises a number of questions. For example: what would be the consequences if the coastal State did not deposit the charts and relevant information? The drafters of this provision will probably not have thought about a rising sea level, and particularly not about significant changes in the location of the baseline.

52. For example, a concave or convex coastline, and the presence of other islands and low-tide elevations.

53. In the case of disappearing low-tide elevations there may only be effects when they were located at a distance of less than 12 nautical miles from the mainland or an island. Had they been located farther than 12 nautical miles, they would not have generated a territorial sea.

54. The area of a circle with a radius of 12 nautical miles is 1,548 square kilometers.

55. The exact extent of the loss depends on the location of the remaining baselines.

of the EEZ-area can amount to over 215,000 square kilometers.[56] In an extreme case, when the islet was located farther than 400 nautical miles, the loss of the EEZ-area would even amount to 431,000 square kilometers.[57] Such cases are not purely theoretical; they may occur in particular in the Pacific Ocean.[58]

It should be emphasized, however, that the losses of EEZ-area just mentioned may not occur in all cases, because the islet involved already before its disappearance did not generate an EEZ. Although every island has its own territorial sea, according to Article 121, paragraph 3 of the Law of the Sea Convention rocks which cannot sustain human habitation or economic life of their own have no EEZ or continental shelf. The term 'rock' in this provision should not be taken literally; presumably it is intended to cover all naturally formed areas of land permanently above the sea level of certain minimal dimensions. Whether or not this provision, which is new, can already be considered part of existing customary international law is difficult to determine. The main problem in this connection is that the two conditions referred to in the provision, viz., (1) no possibility of sustained human habitation, and (2) no possibility of economic life of its own, can be interpreted in rather different ways because they have been rather obscurely phrased. These various possible interpretations will not be discussed here. To answer the question if this provision is already part of customary international law, a detailed survey of State practice would be necessary.[59]

It should be noted that in the future the following phenomenon may occur: an island, as a result of a rising sea level, will fall within the scope of this provision and therefore, although it will not yet have disappeared entirely, it will still lose its EEZ.

A remarkable situation again arises with respect to the limits of the continental shelf in the case of a disappearing island. As a consequence of the provision in Article 76, paragraph 9 of the Law of the Sea Convention already mentioned, the outer limit of the continental shelf may be permanently fixed.

56. This is the area of a half circle with a radius of 200 nautical miles. Also in this case the exact extent of the loss depends on the location of the remaining baselines.

57. The area of a circle with a radius of 200 nautical miles is 431,014 square kilometers.

58. It is also possible that, as a result of sea level rise, the island becomes a low-tide elevation. Should it be located beyond 12 nautical miles from the mainland or an island, then the effect would be identical to the complete disappearance of an island. Should it be located within 12 nautical miles it will continue to serve as baseline.

59. J.M. van Dyke and R.A. Brooks, 'Uninhabited Islands: Their Impact on the Ownership of the Ocean's Resources', *Ocean Development and International Law Journal* (1983) pp. 265-300. J.M. van Dyke, J. Morgan and J. Gurish, 'The Exclusive Economic Zone of the Northwestern Hawaiian Islands: When do Uninhabited Islands Generate an EEZ ?', San Diego LR (1988) pp. 435-494. B. Kwiatkowska and A.H.A. Soons, 'The Entitlement to Maritime Areas of Rocks which Cannot Sustain Human Habitation or Economic Life of Their Own', 21 NYIL (1990) (in press).

Once the outer limit of the continental shelf has been established at a distance of 200 nautical miles (or even more) from an island, which island then subsequently disappears entirely, the coastal State would maintain sovereign rights over a seabed area (which may be of considerable extent), while the object which generated these sovereign rights no longer exists.

So far, the situations considered involved those in which neighbouring coastal States were absent. Should they be present, however, but no delimitation agreements are in force, the shifting of the baseline as a result of sea level rise may still cause changes to the outer limit. This will, for example, be the case when two coastal States are situated less than 24 nautical miles from each other. If no delimitation agreement has been concluded, and special circumstances are absent, the boundary will be the median line.[60] This median line will shift somewhat when the baselines of both States have shifted in an asymmetrical way as a result of sea level rise. When two States are located less than 400 nautical miles opposite each other, the same could apply to the boundary between their respective EEZs and continental shelves, but here the median line plays a much less prominent role than in the case of the territorial sea.[61] The situation in such cases can be very complex, and the circumstances are unique in every case. Therefore it is impossible to arrive at any general conclusions.

We now turn to cases where the baseline is not formed by the low-water line, but by *straight baselines*. These straight baselines connect points located on the mainland, on islands along the coast and, in exceptional cases, on low-tide elevations (viz., when lighthouses or similar installations which are permanently above sea level have been built on them or in instances where this has received general international recognition). The question which arises here is whether, in case the points established by the coastal State have permanently become located below the surface of the sea as a result of sea level rise,[62] the coastal State is obliged to substitute those points by new ones which do meet the applicable criteria. The same question arises with respect to the baseline drawn across the mouth of rivers and bays and, in the case of archipelagos, the archipelagic baselines drawn by the archipelagic State.

Before answering this question it is useful to deal briefly with the special provision included in the Law of the Sea Convention for the particular situation of a coastline which is highly unstable because of the presence of a delta and other natural conditions. Here, situations are involved where the coastline is permanently changing, sometimes regressing (landward), sometimes pro-

60. Art. 15.
61. Arts. 74 and 83.
62. In cases where a point was located on an island which through sea level rise has become a low-tide elevation, but on which no lighthouse or similar installation is present, it could be argued that a situation of 'international recognition' as referred to in Art. 7, para. 4, is involved.

gressing (seaward). The coast of Bangla Desh is a good example.[63] Article 7, paragraph 2 in such cases offers the coastal State the opportunity at a certain moment to draw straight baselines between fixed points along the furthest seaward extent of the low-water line. The article further provides that, notwithstanding subsequent regression of the low-water line, the straight baselines remain effective until changed by the coastal State.[64] The intention of this provision was that the outer limit of the maritime zones (territorial sea, EEZ) of the coastal State concerned does not change permanently. Sea level rise would in such situations have an accelerating effect on the regression of the low-water line, but the straight baselines drawn would prevent this from having (for the time being) any effect on the seaward limits of the maritime zones concerned.

The provision that these straight baselines remain effective until changed by the coastal State raises the question whether the coastal State is obliged to do this at some point in time, in order to bring them in accordance with the changed factual situation, or whether the coastal State is entirely free in deciding to change or not to change the baselines. It is submitted that it was not the intention of this provision to grant the coastal State a discretionary power in this respect. If that were the case the reference in the provision to subsequent change by the coastal State would not have been necessary. This reference implies that the coastal State is supposed to make the necessary changes, for example when the discrepancy between the former and the new situation has become quite substantial or when through various causes the instability of the coastline has been substantially reduced. The coastal State has, however, been left a certain degree of freedom to decide when (and therefore also: how frequently) it will effect the changes. Whether this original intention will actually be implemented may be doubtful. The consequences thereof will be further discussed below.

Returning now to the other straight baselines, it is submitted that under the present rules of international law the coastal State is also supposed to replace the former points which disappeared under the sea surface by new ones which are in compliance with the applicable criteria.[65] Here, too, it will have to be awaited to see if this will actually be done.

When coastal States adapt their straight baselines this will generally mean that the extent of their maritime internal waters decreases. The same applies to the extent of archipelagic waters. The territorial sea and EEZ areas will generally not decrease, but they will shift landward. The outer limit of the con-

63. Scovazzi, op. cit. n. 19.

64. Ibid. See also Prescott, op. cit. n. 44, p. 70. This provision has not yet been applied in practice. Bangla Desh has established a baseline in 1972 using points located seaward of the low-water line.

65. Also in other respects the baselines and sea areas enclosed should still comply with the other criteria listed in Art. 7, para. 3.

tinental shelf remains unchanged. In the case of neighbouring coastal States the same conclusions apply as those indicated above when discussing the consequence of shifts in the low-water line.

4.2.2 *The interests involved*

It is now appropriate to briefly consider the interests involved in changes in the location of maritime limits and boundaries. A distinction can be made between a shift of the limit or boundary line, and a decrease in the extent of the sea area.

Shifting of the limit or boundary is of particular importance with respect to the exercise of jurisdiction. For activities at sea it is essential to know in which maritime zone they take place: the regimes differ, sometimes only in detail, sometimes substantially. To give a few examples:

When, as a result of sea level rise, the outer limit of the territorial sea shifts landward this can mean that in the sea area concerned the regime of the EEZ is substituted for that of the territorial sea. For international navigation this would entail the replacement of the right of innocent passage by the freedom of navigation: national legislation of the coastal State can only be applied to a very limited extent to foreign vessels. Warships of other States will have greater flexibility of movement there. The powers of the coastal State with respect to wrecks are more limited.

Archaeological and historical objects, which because of the regression of the baseline are no longer situated within the contiguous zone (up to 24 nautical miles), can no longer be protected by the coastal State.

Landward shifting of the outer limit of the EEZ may mean that the jurisdiction of the coastal State with respect to fishing, the conduct of marine scientific research and the protection of the marine environment would be replaced by the regime of the freedom of the high seas. It is, however, also possible that those activities will then be conducted in the EEZ of another (neighbouring) coastal State, thus being subject to different national legislation.

The *decrease of the extent* of sea areas under the jurisdiction of a coastal State mainly has repercussions for the economic interests of the State concerned, in particular fishing interests. (Should the outer limit of the continental shelf not have been permanently fixed, the great economic interests associated with the exploitation of oil and gas would also be involved.) Among other things, this may mean less income from fishing licenses, but also less possibilities for the coastal State to take conservation and management measures with respect to the fish stocks in the area involved (even though its own fishermen keep on fishing there).

A decrease in the extent of sea areas may especially occur in the case of archipelagic States and other States with islands along the coast. Such a decrease may involve areas of several tens of thousands of square kilometers or even several hundred thousand square kilometers. Coastal States would not wish to see that happen, and will undoubtedly attempt to prevent this from happening. The remaining part of this article will deal with the question whether or not, and if so, which, possibilities would exist for this purpose.

4.2.3 *Artificial conservation of the baseline*

The most obvious means to prevent or reduce the negative effects of sea level rise is the artificial conservation of the baseline. As far as the *low-water line* is concerned, this means the construction or reinforcement of sea defences (shoreline protection). This is at the present time already being done frequently. Further sea level rises will necessitate large financial investments. For many countries of the world, however, the costs associated with the conservation of the entire present low-water line may turn out to be unsurmountable (quite apart from the huge technical problems involved).[66]

Artificial conservation of the coastline, including that of islands, is fully permitted under public international law: this is proved by abundant State practice. One marginal note may still be made here, with respect to extreme situations. In Article 121, paragraph 1 of the Law of the Sea Convention an island is defined as 'a *naturally formed* area of land, surrounded by water, which is above water at high tide' (emphasis added). One could argue that islets, which would have disappeared entirely as a result of sea level rises but have been maintained exclusively by artificial means, no longer comply with the requirement of being 'naturally formed'. They will have become 'artificial' islands.[67] According to Article 60, paragraph 8 of the Law of the Sea Convention artificial islands in the EEZ 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 EEZ or the continental shelf.

It is submitted, however, that this provision, apart from the fact that it relates to the EEZ, is concerned exclusively with newly constructed artificial islands. The artificial conservation of an island once formed by nature does not result in its losing its international legal status of 'island'.[68] This is also the case if the artificial conservation was exclusively intended to preserve the baseline for the purpose of maritime delimitation. Maintaining sea areas may for one coastal State (for example, the Maldives) represent an equivalent and legitimate interest as compared to another coastal State (for example, the Netherlands) maintaining its land territory.[69]

66. See the contributions in Wind, ed., op. cit. n. 1.

67. On artificial islands, see N. Papadakis, *The International Legal Regime of Artificial Islands* (1977); A.H.A. Soons, *Artificial Islands and Installations in International Law*, Occasional Paper No. 22, Law of the Sea Institute (University of Rhode Island), July 1974, 30 pp.

68. Papadakis, op. cit. n. 67, pp. 91-97.

69. The same conclusion could arguably apply with respect to low-tide elevations, although this would not seem practicable (and would be very expensive).

It is also submitted that the artificial conservation of an islet exclusively for the purpose of preventing it from degenerating, as a result of sea level rise, to the status of 'rock' as provided in Article 121, paragraph 3 of the Law of the Sea Convention (and thus no longer generating an EEZ) should be considered as permissible.[70]

That some States are of this opinion may be concluded from the fact that several States (including Iceland and Japan) have recently invested great efforts and costs to reinforce islets and rocks located far offshore which were in danger of disappearing under water.[71] As far as could be ascertained no protests have been made by other States against these actions.

In the case of *straight baselines* the question may be raised whether it is allowed to construct a lighthouse (or similar installation) on a disappearing island on which a connecting point for straight baselines is located, exclusively for the purpose of preserving the point for the drawing of straight baselines. It is submitted that, quite apart from the fact that it may be difficult to prove that the construction of a lighthouse is exclusively for this purpose, such action may be regarded as permissible.[72]

4.2.4 *Historic waters*

As indicated previously, in many cases it will not be possible to artificially maintain the original baseline. Would there still be another possibility for coastal States to maintain their original sea areas, notwithstanding the regression of the baseline as a result of sea level rise?

It is conceivable that a coastal State, notwithstanding the landward shifting of the baseline, maintains the outer limits of its territorial sea and of its EEZ where they were originally located.[73] As a consequence, the breadth of its territorial sea would gradually become more than 12 nautical miles, and the outer limit of its EEZ would be located ever further than 200 nautical miles from the baseline.

70. This is totally different from artificially 'extending' a rock (Art. 121, para. 3) to become an island (Art. 121, para. 1); that situation will not be discussed here.

71. Iceland during 1985 reinforced the islet of Kolbeinsey, located approximately 60 nautical miles north of Iceland, which was about to disappear below sea level.
Japan has recently artificially preserved, at enormous costs (240 million US dollars), two rocks (Okino-tirishima, or Parece Vela) in the Western Pacific, hoping to preserve in this way approximately 400,000 square kilometers of EEZ. See A.L. Silverstein, 'Okinotirishima: Artificial Preservation of a Speck of Sovereignty', Brooklyn JIL (1990) pp. 409-431.

72. It would also seem permissible to artificially conserve a low-tide elevation as referred to in Art. 7, para. 4.

73. The outer limit of the continental shelf has already been fixed as a result of the provisions of Art. 76, para. 9.

In justifying its course of action the coastal State may wish to invoke historic rights in the sea area concerned where it already used to exercise sovereignty, or sovereign rights, as the case may be.

This involves the doctrine of so-called 'historic waters'. Since many years, public international law has recognized the possibility that the sovereignty a coastal State extends, in exceptional cases based on historic title, to an area of the sea which according to the general rules concerning baselines would not fall under its sovereignty, but under the regime of the high seas. Historic waters can be defined as waters over which the coastal State, in deviation of the general rules of international law, has been exercising sovereignty, clearly and effectively, without interruption and during a considerable period of time, with the acquiescence of the community of States. Such areas are governed by the regime of maritime internal waters.[74]

In the case of sea level rise, however, the coastal State would be claiming a certain sea area as its territorial sea or EEZ. It therefore does not concern historic waters in the traditional sense, but it would involve a new category of historic waters. For such cases one could require, *mutatis mutandis*, that the following conditions be met: the coastal State should, right from the start of the regression of the baseline, continue to exercise in the area concerned, in the same way as it used to do before, sovereignty or sovereign rights, and this should be acquiesced in by the community of States.[75] Acquiescence by the community of States may be inferred from the absence of protests by interested States.

A number of objections can be made against the development of such a new category of 'historic waters'. In the first place, the qualification of 'historic' implies that the coastal State only acquires a legitimate title after the passing of a certain period of time since the changes in the baseline have occurred. Before that it possessed a legitimate title (i.e., distance from the baseline); that title no longer exists; thus, a new title has to come into existence. This causes a great measure of uncertainty with respect to the situation between the shifting of the baseline and the coming into existence of the new legitimate title. In addition, the length of the period of time required is not clear.

In the second place, it seems better to restrict the doctrine of 'historic waters' to its present contents. The issue of sea level rise differs too much from the original issue for which this doctrine was developed to now bring both under the same denominator. Among other things, different sorts of jurisdic-

74. L.J. Bouchez, *The Regime of Bays in International Law* (1964) pp. 199-302 (in particular p. 281); O'Connell, op. cit. n. 16, pp. 417-438.

75. The coastal State will have to indicate expressly that it maintains the original limits. A problem could be caused by the fact that published charts may periodically indicate the changed low-water line (baseline). Art. 16, para. 2, requires coastal States to deposit a copy of these charts with the Secretary-General of the United Nations. In such cases the coastal State should thus explicitly comment on the new low-water line with respect to its function (or rather, non-function) as a baseline.

tion are involved (sovereignty over maritime internal waters, on the one hand, sovereignty over the territorial sea and sovereign rights plus jurisdiction in the EEZ, on the other). Actually, historic titles *sui generis* would rather be involved here.

The third and most important objection, however, is as follows. Traditionally, historic waters have been viewed as very exceptional deviations from the general rules for which, it is true, general criteria exist which have to be met, but where each time unique situations have been involved. In the case of sea level rise, however, a great number of similar situations are involved, which are predictable. It concerns a general category of geographic situations which should be treated equally. It would be unjust if in one case a coastal State does succeed to maintain its sea area in this way, whereas in another case the coastal State would not, even though the cause of the phenomenon is the same in both cases. Such a situation rather calls for the development of a general rule which in similar cases can be applied by all coastal States.

4.2.5 *A new rule of customary international law*

Another possibility therefore for coastal States to prevent imminent loss of sea areas as a result of sea level rise would be the development of a new general rule. The contents of such a general rule could be that coastal States are entitled, in the case of landward shifting of the baseline as a result of sea level rise, to maintain the outer limits of the territorial sea and of the EEZ where they were located at a certain moment in accordance with the general rules in force at that time. This new rule would in the first place have to be a rule of customary international law. It could also be included in a general treaty (for example, as an amendment of the Law of the Sea Convention).[75a] A strong argument in support of the acceptance of such a rule of customary law is the provision in Article 76, paragraph 9, concerning the fixing of the outer limit of the continental shelf, which may serve as a precedent.

For such a rule of customary law to be created it is necessary that a number of coastal States in practice will apply this rule and that (potentially) affected (interested) States which have been given notice of this policy refrain from protesting. The more publicity is given to this practice, without causing any protests, the quicker the customary rule can come into being. Discussion, and preferably even acceptance, of the practice at the appropriate international fora can also contribute to this. At a certain point of time it will be possible to conclude that the rule has become generally accepted and has already become part of customary international law.

75a. The Convention can be amended by normal procedure, involving a diplomatic Conference, but only after 10 years from its entry into force (Art. 312). It can also be amended (even before that date) by a simplified (written) procedure in accordance with Art. 313. These procedures do not apply to provisions relating to activities in the international seabed area.

This process is somewhat similar to that of the creation of historic waters, but the difference is that in this case from a certain moment all coastal States may invoke the existence of this rule. At which exact point of time that will be is difficult to state *in concreto*, but that is always the case with rules of customary international law.

4.3 Situations with a delimitation agreement

4.3.1 *Application of the general rules*

This section deals with a completely different situation, viz., that in which there is a delimitation agreement in force for the sea area concerned. This implies that two coastal States are situated either less than 400 nautical miles from each other (in which case the EEZ and/or continental shelf have been delimited), or less than 24 nautical miles from each other (in which case a territorial sea boundary is involved).

Such agreements may involve the formal establishment of the median line between the two coastal States as the boundary line (or a boundary line based on the median line). In many instances, however, another line has been established as the boundary, in particular because of special circumstances such as the geographical configuration of the coastlines or the presence of islands. Sometimes it involves a combination of both systems.[76] When the median line has been chosen as the boundary line, this may be incorporated in the boundary agreement in two ways. The method used most often is to establish the median line (at least, a boundary line based thereon) by way of lines drawn between points the exact location of which has been determined by geographical coordinates.[77] Another, much less frequently used method involves the mere reference in the agreement to the median line as forming the agreed-upon boundary line.[78]

The question may arise what the consequences will be for the boundary lines established by these agreements of changes in the geographical configuration (especially the location of baselines) as a result of sea level rise – changes, therefore, of the original circumstances on which the agreed boundary was based.

76. Churchill and Lowe, op. cit. n. 12, pp. 153-161; Prescott, op. cit. n. 44, pp. 81-106; O'Connell, op. cit. n. 16, vol. II, chapters 16-18.

77. Agreement between the Government of the Kingdom of the Netherlands and the Government of the United Kingdom of Great Britain and Northern Ireland relating to the Delimitation of the Continental Shelf under the North Sea between the two Countries, London, 6 October 1965; Trb. 1965 No. 191

78. An example is provided by the maritime delimitation treaty between Tonga and France (Wallis and Futuna), 11 January 1980. See *The Law of the Sea. Maritime Boundary Agreements (1970-1984)*, United Nations (1987) pp. 273-275.

In cases where the delimitation agreement explicitly refers to the median line the boundary may shift as a result of sea level rise: asymmetrical changes of the baselines of both States will lead to changes in the location of the median line. The States concerned have deliberately opted for a (potentially) fluctuating boundary line.

In all other cases, where the boundary line has been fixed, it must in principle be concluded that changes in the geographical configuration as a result of sea level rise will not result in changes in the boundary line. 'In principle' means that there may be exceptions. Which circumstances may conceivably lead to the adjustment of an agreed boundary line?

4.3.2 *Adjustment of boundaries established by agreement*

It is obvious that the two coastal States concerned by mutual agreement may decide to adjust the boundary line. What is more interesting, however, is the question whether one of the two States may demand that an adjustment be made and, in the absence of agreement thereon, may unilaterally terminate the delimitation agreement. (The establishment of a new boundary is obviously only possible by mutual agreement.)

In the first instance, for the purpose of answering this question a distinction could be made between two situations. The first situation involves delimitation agreements which explicitly provide that the boundary is meant to be definitive, notwithstanding future changes in the baselines of the parties. To be equated with this situation are the cases where in another way (for example, from the *travaux préparatoires* or parliamentary debates on the delimitation agreement) the same intention of the parties can be explicitly determined. An example of such a case is the continental shelf delimitation agreement between the United Kingdom and the Netherlands of 1965, which in fact involves fixing the median line.[79] When in subsequent years the Netherlands baseline shifted seaward in some areas (through both natural and artificial processes, up to over 7 kilometers), this had no effect whatsoever on the location of the boundary of the continental shelf with the United Kingdom.

In such cases, it is submitted, one party to the delimitation agreement cannot unilaterally decide to terminate the agreement because of the shifting of a baseline.

The second situation concerns delimitation agreements which do not explicitly refer to the boundary line being definitive notwithstanding changes in the location of the baseline. Would there be any grounds which may be invoked to justify unilateral termination of a delimitation agreement? It is conceivable

79. See n. 77 *supra*. From the debates in the Dutch Parliament it appears that it was the explicit intention of the Parties to determine the boundary definitively. See Bijl. Hand.T.K. 1965/1966, 8409, No. 3.

that a State would wish to invoke a change of circumstances since the conclusion of the agreement. In exceptional cases it is possible for a State to invoke a fundamental change of circumstances in order to terminate a treaty; public international law makes this subject to the fulfilment of very stringent conditions.[80] In the first place, it should involve a change of circumstances which was not foreseen by the parties at the time of the conclusion of the treaty. It can be disputed whether sea level rises can in all cases be considered as an unforeseen circumstance. Furthermore, it should involve changes to the original circumstances the existence of which constituted an essential basis of the consent of parties to be bound by the treaty, and the effect of the changes should radically transform the extent of obligations still to be performed under the treaty. Thus, a very substantial change in the location of the baseline should be involved (for example, as a consequence of the complete disappearance of an island).

However, treaties establishing a boundary (which must be deemed to include maritime delimitation agreements) have explicitly been excluded from this possibility to invoke a fundamental change of circumstances.[81] The main reason for this is that any possibility for calling into question boundary agreements would result in a permanent source of serious international political tension.[82] It must therefore be concluded that in accordance with the present rules of international law a State is not entitled to invoke changed circumstances as a result of sea level rise in order to unilaterally terminate a delimitation agreement. Theoretically it is conceivable that in the future a new rule of customary international law will develop which creates an exception for invoking fundamental changes as a result of sea level change, but it is submitted that this is not very likely.

It is also conceivable that a coastal State which is confronted with the disappearance of an island near its shore, which belonged to a neighbouring State and which under a delimitation agreement generated a considerable area of sea to the detriment of the former State, would consider the disappearance of that island as the loss of the object that was indispensable for the execution of (part of) the delimitation agreement and therefore considers itself no longer bound to perform its obligations under the agreement.[83] Such a position would seem very difficult to defend since it remains very well possible for this State to continue to respect the boundary line of the delimitation agreement.

80. See Art. 62, para. 1, of the Vienna Convention on the Law of Treaties of 1969 (hereinafter referred to as the Vienna Convention). This provision can be considered as reflecting customary international law.

81. Art. 62, para. 2 of the Vienna Convention.

82. K.H. Kaikobad, 'Some Observations on the Doctrine of Continuity and Finality of Boundaries', BYIL (1983) pp. 119-141. A. Wyrozumska, 'Treaties Establishing Territorial Regimes', Polish YIL (1986) pp. 261-265.

83. Cf., Art. 61 of the Vienna Convention.

It can therefore be concluded that sea level rise has no effects on maritime boundaries between two States when these boundaries have been fixed by treaty, unless the two States agree otherwise.

4.4 Boundaries established through arbitration or adjudication

A third category of situations concerns sea areas where the boundary line has been established by an arbitral decision or a judgment of the International Court of Justice. A number of such cases already exist. For example, in recent years Arbitral Tribunals have established maritime boundaries between France and the United Kingdom, between Guinea and Guinea-Bissau and between Guinea-Bissau and Senegal. The International Court of Justice has established maritime boundaries between Tunisia and Libya, between Malta and Libya and between the United States and Canada (Gulf of Maine).[84] In all instances the maritime boundary was established in a binding way at the joint request of both coastal States. In all instances the boundary line was fixed.

The question if it will in the future be possible for one of the two coastal States concerned to no longer accept the boundary line as binding because of changed circumstances in the geographical configuration as a result of sea level rise, and to demand negotiations on a new location of the boundary line, should be answered in the negative. The legal situation here is in essence the same as in the situation of boundaries established by agreement discussed in the previous paragraph.[85]

5. THE EXTINCTION OF A STATE

This section will briefly deal with the most far-reaching and dramatic potential consequence of sea level rise: the physical disappearance of a State. This would seem far-fetched and purely hypothetical. Still, there are governments of island-States and archipelagic States, such as Kiribati and the Maldives, which are concerned about this issue[86] and have already discussed it at inter-governmental level. Of course, islets and atolls can be maintained artificially, but quite apart from the enormous costs associated therewith other factors are also involved, such as the exhaustion of potable water and the decline of the surface which may undo those efforts almost completely. At a certain point of time, because of various social considerations it may be considered better to move the entire population to areas not threatened by sea level rise, including areas belonging to the territory of another State.[87]

84. Kapoor and Kerr, op. cit. n. 16, pp. 89-100. See also the literature referred to in nn. 47 and 76 *supra*.

85. See n. 82 *supra*.

86. 'Maldives Face Extinction', *The Indian Ocean Review* (December 1988) p. 11.

87. *International Herald Tribune*, 31 December 1988/1 January 1989, p. 2.

One possibility would be for the threatened State to take over, by treaty of cession (e.g., by purchase) territory from another State (which could be a distant one). Another possibility is that the entire population emigrates to one or more other States.

In the first case, the State continues to exist, since the conditions set by international law for the existence of a State are still met: (1) territory; (2) population; (3) government; and (4) capacity to enter into international relations.[88] A question may still arise with respect to the sea areas which were generated by the disappeared (or at least completely uninhabitable) islands. On the basis of the expositions in the preceding section, these areas may still belong to the State concerned.

In the second case, in which the entire population has emigrated and is situated in the territory of one or more other States, the second condition mentioned for the existence of a State (viz., a population) is no longer met. A 'population in exile' does not seem to be sufficient for this purpose.[89] If in addition there is no island territory left it can be concluded that the State no longer exists. Since the State has ceased to exist, also the limits and (possible) boundaries of its former sea areas will have lapsed.[90] The areas will thereafter either belong to the high seas and the international seabed area, or to the maritime zones of neighbouring States which are situated at a distance of less than 200 (*casu quo* 12) nautical miles of the former State. Delimitation agreements that may have been concluded by the former State are terminated because one of the parties has ceased to exist without there being a successor State.

There is, however, a much more attractive solution for the problems resulting from the complete emigration of a population, and that is to establish (by treaty) a fusion of the 'disappearing' State and another (neighbouring) State. In that way the remaining uninhabitable islands may still generate maritime areas for the new State, and also the pre-existing maritime delimitation treaties may remain effective. Alternatively, the same results can be achieved by letting the 'disappearing' State join another State. Only the latter State will then continue to exist, but it will include the remaining maritime territory of the 'disappearing' State.

88. N.M. Shaw, *International Law*, 2nd edn. (1986) pp. 126-130. J.H.W. Verzijl, *International Law in Historical Perspective*, vol. II (1969) pp. 62-131.

89. Cf., however, the position of the Sovereign Order of Malta, as a precedent for retaining *sui generis* international legal personality by an entity no longer qualifying as a State: Shaw, op. cit. n. 88, p. 152; Verzijl, op. cit. n. 88, pp. 28-32.

90. One could think of an entity, charged with the management of the sea areas involved for the benefit of the 'population in exile', as a *sui generis* subject of international law.

6. CONCLUSIONS

The conclusions that may be drawn from the preceding observations are the following.

In the first place, the existence of fixed maritime boundaries is of great importance. Maritime boundaries can be fixed through delimitation agreements or decisions of Arbitral Tribunals or the International Court of Justice. The boundary between the continental shelf and the international seabed area can be fixed unilaterally by the coastal State. Sea level rises will leave fixed maritime boundaries unaffected, unless the coastal States otherwise agree. Coastal States which may expect negative effects for the location of their baselines as a result of sea level rise therefore are well advised to try to arrive at fixed maritime boundaries soon. Incidentally, chances are of course that the neighbouring State concerned is fully aware of this and is therefore not in a hurry to negotiate.

Next, it can be concluded that, in the absence of fixed boundaries, artificial conservation of baselines deserves consideration. In view of the costs associated therewith a careful selection will have to be made of the locations where this should be done. This selection is one which is totally different from the choices which have to be made with respect to the construction or reinforcement of sea defences in order to prevent other negative effects of sea level rise, such as loss of land territory. In that case a balancing is involved of the costs against the revenues of the social activities taking place on the land territory. In the case of artificial works for the purpose of conservation of baselines a balancing is involved of the costs against the revenues which the sea area that may be lost can generate.

A less expensive, but probably also less dependable means for these States to prevent negative consequences as a result of sea level rise for the extent of their maritime zones is to contribute towards the creation of a new rule of customary international law which allows coastal States in case of sea level rise to maintain the original outer limits of their maritime zones. This requires an explicit policy of the coastal States concerned in this field, as indicated above: they will have to maintain their former limits in practice and will have to attempt to gain approval for this practice in the relevant international fora. This would seem to be an acceptable aspiration, in particular in view of the discrepancy which otherwise would occur between the situation of these States and the situation of States which have been able, in some way or another, to fix their maritime boundaries.

In this connection it is recommended that in the studies which will be conducted for the governments of the coastal States most threatened by sea level rise, on the social consequences of sea level rise for their countries, attention will also be paid to the aspect of the changes of baselines and the potential loss of sea area. That would make it possible for those governments to already conduct an adequate policy also on this issue in the earliest stages of their efforts to cope with this important phenomenon.

Finally, it should be stressed that this article contains only a general overview of some of the problems involved and their possible solutions: the issues will have to be studied in much more detail in the years to come.

Annex IN-21

D. A. V. Stow, K. Amano, P. S. Balson, G. W. Brass, J. Corrigan, C. V. Raman, J. J. Tiercelin, M. Townsend and N. P. Wijayananda, "Sediment Facies and Processes on the Distal Bengal Fan, Leg 116", in J. R. Cochran, D. A. V. Stow *et al*. (eds.), *Proceedings of the Ocean Drilling Program, Scientific Results*, Vol. 116, 1990, pp. 377-396.

Cochran, J. R., Stow, D.A.V., et al., 1990
Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 116

31. SEDIMENT FACIES AND PROCESSES ON THE DISTAL BENGAL FAN, LEG 116[1]

Dorrik A. V. Stow,[2,3] Kazuo Amano,[4] Peter S. Balson,[5] Garrett W. Brass,[6] Jeffrey Corrigan,[7] C. V. Raman,[8] Jean-Jacques Tiercelin,[9] Mark Townsend,[10] and N. P. Wijayananda[11]

ABSTRACT

Three closely-spaced sites (Sites 717, 718, and 719) were drilled on the distal Bengal Fan in the central Indian Ocean at a water depth of 4735 m and to a maximum penetration of 962 mbsf. This paper presents a synthesis of results from both shipboard and shore-based studies, with particular emphasis on the lithofacies, their depositional processes, and sediment source.

The sediment record at all three sites can be divided into five distinct lithologic units: Units I, III, and IV are mud-rich with relatively low accumulation rates (<70 m/m.y.), whereas Units II and V are silt-rich with high rates of sedimentation, in parts in excess of 350 m/m.y. The oldest sediments recovered are early Miocene in age, approximately 17 Ma.

Seven sediment facies are recognized. Light-gray silt and mud turbidites (Facies 1 and 2) are the most dominant throughout, and were derived from rapid erosion of the Himalayas. Transport was to the Ganges delta/shelf region and then resedimentation occurred downslope, in some cases in very large powerful turbidity currents that traveled over 2500 km and deposited beds up to 2.5 m thick. Dark-gray, organic-rich, mud turbidites (Facies 3) are interbedded with the other facies, particularly in the mud-rich units. They have a distinctive clay and silt mineral composition that indicates derivation from the continental margin off southeast India and Sri Lanka. Biogenic turbidites (Facies 4), comprising nannofossils, foraminifers, and clay, are much less common. Two types are identified, one from the outer shelf/upper slope off Sri Lanka and the other from a local seamount source. Pelagic clays and calcareous pelagic clays (Facies 5 and 6) are developed as thin caps over some of the mud and biogenic turbidites. They mostly have a low to absent biogenic content, indicating deposition below the carbonate compensation depth for all but the last 2 m.y., as well as significant early diagenetic dissolution of siliceous microfossils. Continuously bioturbated, structureless muds of part turbidite and part pelagite aspect (Facies 7) are interpreted to have been deposited from a thick suspension cloud above and beyond the distal feather edge of the "true" turbidity current. These sediments are here termed "hemiturbidites."

The effects of Himalayan uplift, eustatic and local sea-level fluctuations, local tectonics related to intraplate deformation, and fan channel/lobe processes have closely interacted to produce the observed sedimentary record of the past 17 m.y. on the Bengal Fan. Different stages of Himalayan uplift and erosion can be recognized from the composition of distal fan turbidites.

INTRODUCTION

Three sites were drilled on the Bengal Fan during ODP Leg 116. These sites (717, 718, and 719) were closely spaced on the extreme distal portion of the fan in the central Indian Ocean at a water depth of 4735 m (Fig. 1). They are located some 50 km beyond any of the fan channels documented by Emmel and Curray (1984) in an essentially smooth, very low-gradient (<0.5 m/km), area that either forms part of a terminal lobe or a smooth lower fan.

In the immediate vicinity of the sites drilled there are local irregularities in relief that are the surface expression of underlying deformed ocean crust and overlying sedimentary section (Weissel et al, 1980; Geller et al., 1983). These positive relief features are up to a few tens of meters above the surrounding seafloor just 3 km south of Site 718 (Fig. 2), and may protrude locally up to 800 m.

The Bengal Fan is one of the world's major elongate submarine fans (Curray and Moore, 1971; Curray et al., 1982; Emmel and Curray, 1984) covering 3×10^6 km^2. It is 2800–3000 km long, 830–1430 km wide, and over 10 km thick beneath the northern Bay of Bengal. Fewer than 100 piston cores have been recovered from the surface sediments, and only one spot-cored DSDP site (Leg 22, Site 218) has previously been drilled into the fan (Von der Borsch, Sclater, et al., 1974).

The size and location of the Bengal Fan is clearly related to collision of the Indian and Eurasian plates and consequent uplift of the Himalayan Mountains. Denudation of the Himalayas has supplied enormous volumes of sediment to the fan via the Ganges-Brahmaputra river systems and delta. Sediments are fed efficiently across the shelf in the northern Bay of Bengal via a delta front trough, the Swatch-of-No-Ground, which is presently connected to only one active fan channel that weaves its way across the full length of the fan. Many other (presently inactive or abandoned) channels mark the fan surface and extend for various distances along its length. Several canyons and channels also cut across the east Indian and Sri Lankan margins, extending into the western part of the fan (Fig. 1).

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[1] Cochran, J. R., Stow, D.A.V., et al., 1990. *Proc. ODP, Sci. Results*, 116: College Station, TX (Ocean Drilling Program).

[2] Geology Department, University Park, Nottingham, U.K.
[3] Present address: Geology Department, The University, Southampton, S09 5NH, U.K.
[4] Department of Earth Sciences, Ibaraki University, Bunkyo 2-1-1, Mito 310, Japan.
[5] British Geological Survey, Keyworth, Nottingham, N912 599 U.K.
[6] Marine Geology and Geophysics, RSAMS, University of Miami, Miami, Florida 33249-1098, U.S.A.
[7] Department of Geological Sciences, University of Texas, Austin, Texas 78713-7909, U.S.A.
[8] Department of Geology, Andhra University, Visakhapatnam 530003, India.
[9] GIS Océanologie et Géodynamique, Université de Brétagne Occidentale, 29287 Brest Cedex, France.
[10] Geology Department, University Park, Nottingham, U.K.
[11] Oceanography Unit, NARA, Crow Island, Mattakjuliya Colombo 15, Sri Lanka.

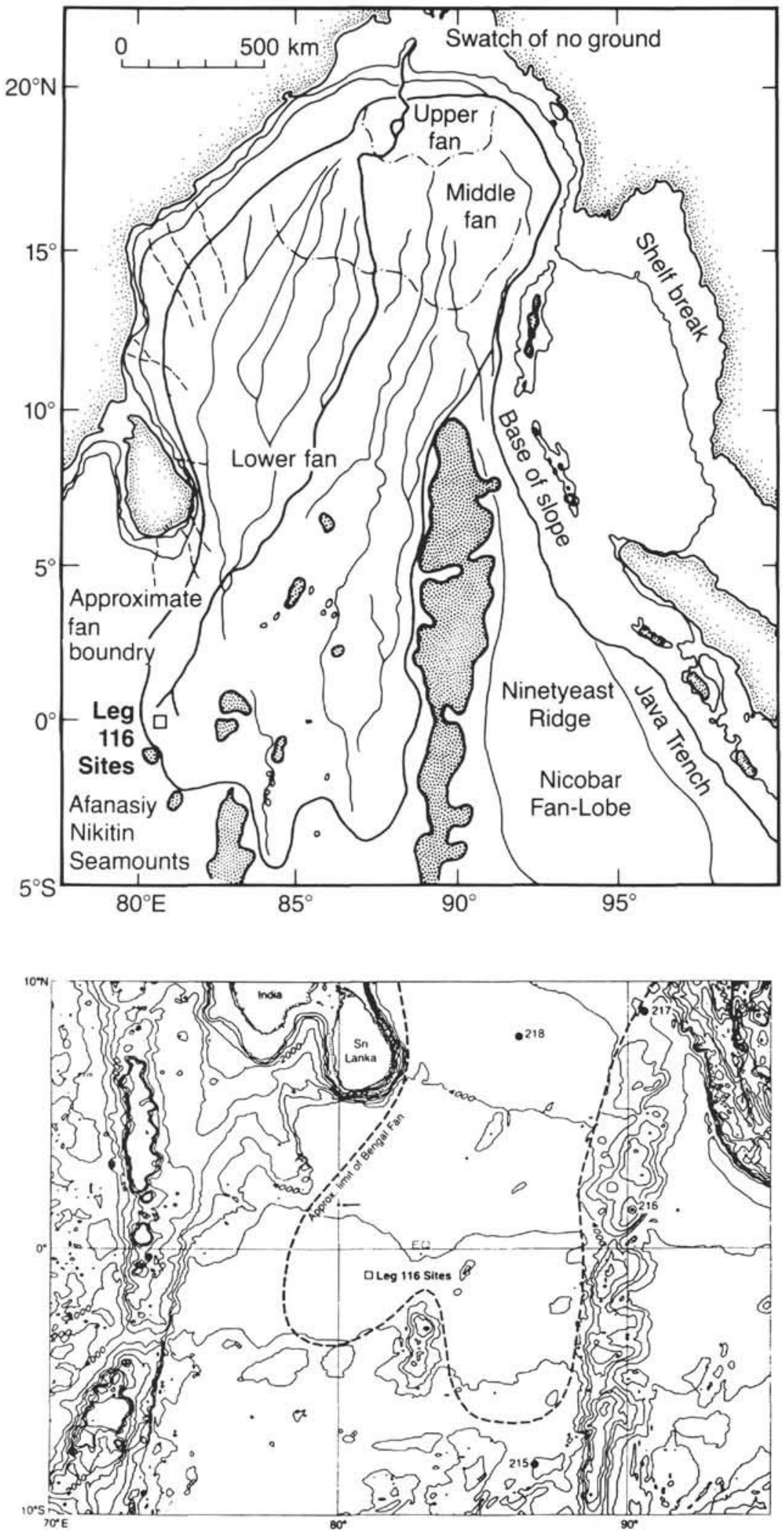

Figure 1. Map of the Bengal Fan (modified after Emmel and Curray, 1984) and location of Leg 116 sites. Solid and dashed lines show channels on the fan and across the Indian–Sri Lankan margins. Seamounts and other topographic highs are indicated by heavy shading. Inset shows detailed bathymetry (contours in meters) in the area of ODP Sites 717, 718, and 719, and DSDP Sites 217, 218, and 219.

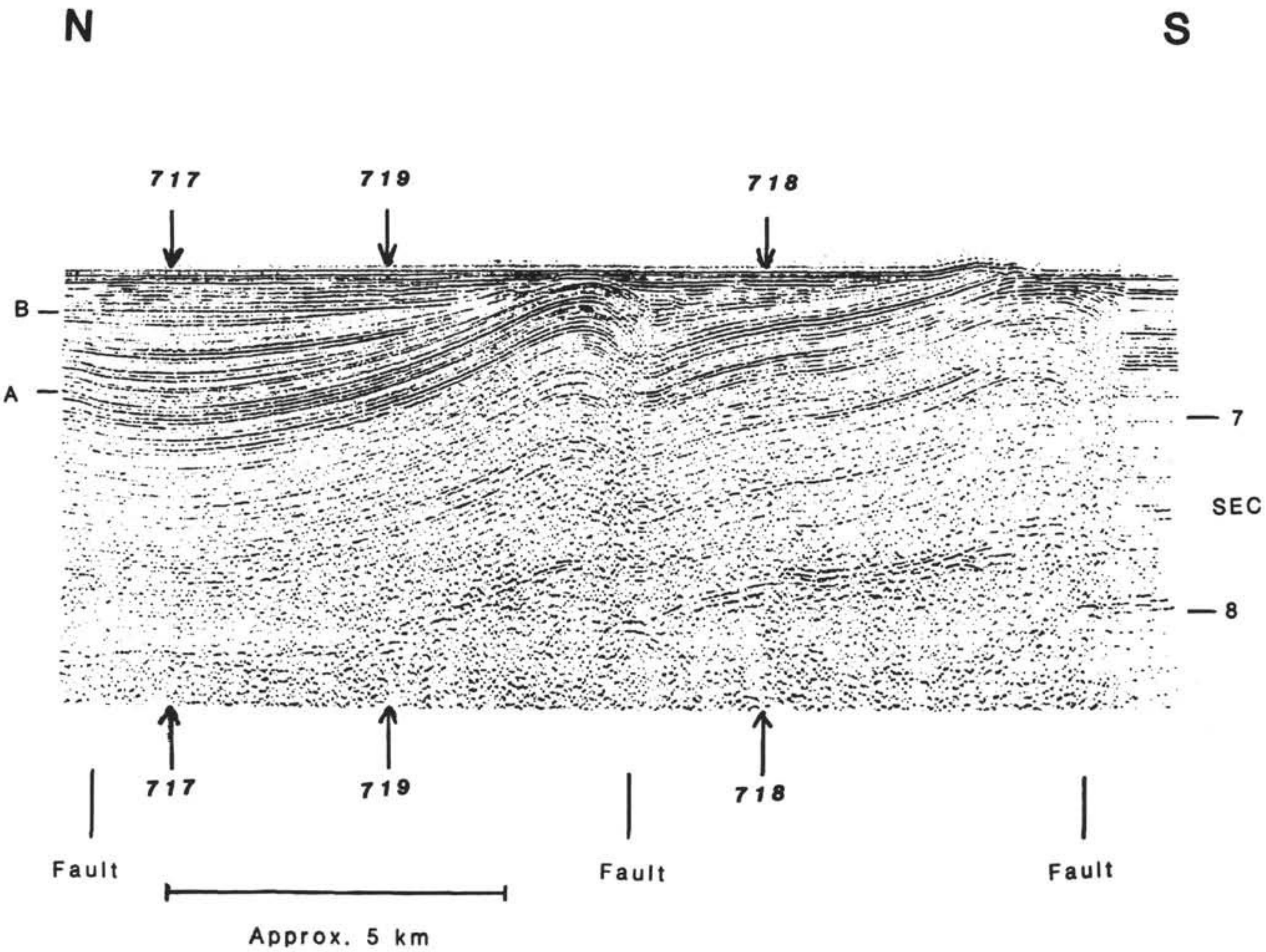

Figure 2. Single-channel seismic reflection profile across the three Leg 116 sites. Prominent unconformities are at A and B. Note slight seafloor relief above up-tilted ends of fault blocks. Y-axis: two-way traveltimes.

This paper summarizes many of the data obtained from both shipboard and shore-based studies, and synthesizes our results with particular emphasis on the lithofacies, their depositional processes, and sediment source. We draw heavily on the various specialist papers also published in this volume, and will not repeat here the methods employed for these different studies. Clay mineralogy and geochemical data of sediments are in back-pocket microfiche.

LITHOSTRATIGRAPHY

All three sites penetrated a similar sequence of sediment facies and lithologic units, although the thicknesses of these units show significant variations between sites due to their relative positions on two adjacent fault blocks (Fig. 3). At each site, five major lithologic units are recognized, from top to bottom (also see back pocket for Chapter 31):

Unit I—the topmost 2–6 m of pelagic clayey oozes and mud turbidites.

Unit II—100–150 m of sandy silt, silt-to-mud, and mud turbidites.

Unit III—10–150 m of thin to thick mud turbidites interbedded with pelagic clays and biogenic turbidites.

Unit IV—70–230 m of interbedded silt and mud turbidites with pelagic clays and rare biogenic turbidites.

Unit V—the lower section at all three sites (up to 775 m thick at Site 718) is dominated by silt and silt-to-mud turbidites. The upper part is more silt-rich (Unit Va), whereas reddish brown and green-colored, thin-bedded turbidites and pelagic clays are more common in the lower part (Unit Vb).

Coring was continuous at each site although core recovery was very variable, being poor in the silts and generally good in the mud-dominated sections. Average recovery was 60% at Site 717, 30% at Site 718, and 40% at Site 719. Good suites of wireline logs were obtained through parts of the sections at the two most poorly-recovered sites (718, 719), so that lithologic interpretations could be made for the nonrecovered intervals.

Biostratigraphic control is based on closely-spaced samples that for the most part contain a sparse, relatively solution-resistant, mainly nannofossil biota that has been resedimented in turbidity currents. However, a very consistent biostratigraphy was evident at each of the three sites, allowing reasonably accurate dating of the lithologic units and estimation of sediment accumulation rates (Gartner, this volume).

The oldest sediments penetrated (at Site 718) are early Miocene in age, dating from about 17 Ma. Much of the ensuing Miocene section of Unit V accumulated at average rates of between 70 and 200 m/m.y., although the silts were probably deposited more rapidly than the intervening muds. The topmost Miocene and Pliocene sediments of Units IV and III are mainly slowly accumulated (<70 m/m.y.) muds and thinner interbedded silty horizons. At the top of Unit III, there is either a hiatus or an extremely condensed section that repre-

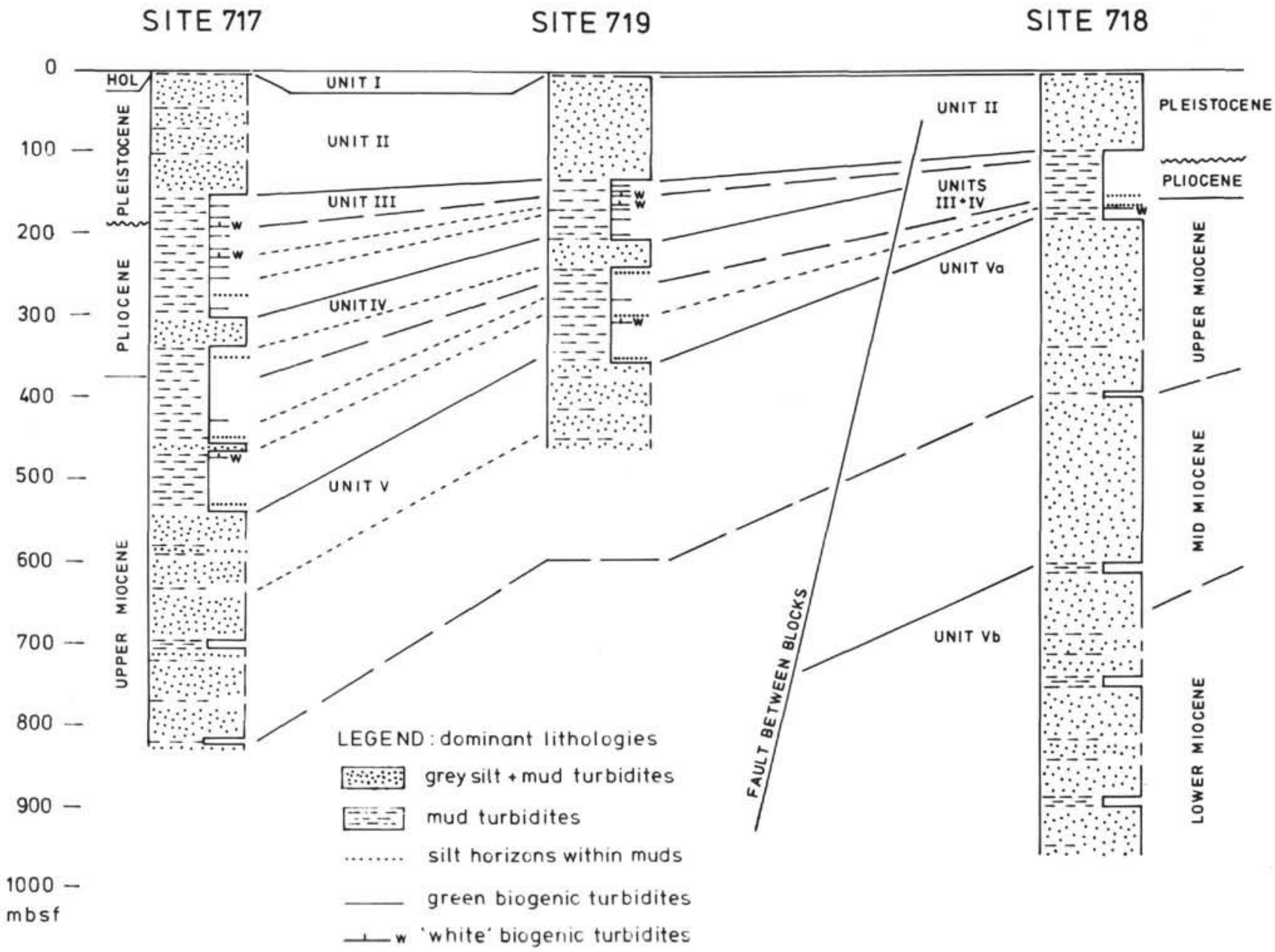

Figure 3. Summary lithostratigraphic sections for Sites 717, 718, and 719, showing lithologic units and correlations.

sents approximately 1 m.y. of the early Pleistocene. Late Pleistocene silts of Unit II accumulated most rapidly, at a rate in excess of 350 m/m.y. The topmost Holocene/Pleistocene sediments of Unit I accumulated relatively slowly at 15–25 m/m.y.

SEDIMENT FACIES

Seven different facies were recognized during the shipboard description of cores from each of the three sites drilled (Cochran, Stow, et al., 1989). Subsequent laboratory studies have generally confirmed these facies and provided more detailed information on their features, which we outline below. The differentiation of facies on the basis of grain size is shown in Figure 4 (see also Balson and Stow, this volume). Compositional characteristics in relation to source areas are discussed in a subsequent section.

Facies 1: Silt and Silt-mud Turbidites (Fig. 5)

The entire sequence at all three sites is dominated by turbidites, the most common of which are the light gray colored silt and mud turbidites (Facies 1 and 2), which together make up approximately 68% of the recovered section. Facies 1, the more silty of these and under-represented due to poor recovery of unconsolidated silts, occurs in thin to very thick beds (7–160 cm, average 40 cm). Some of the beds are almost wholly of silt with only a few cm of mud overlying 100–150 cm silt or sandy silt. Others have only 5 cm of silt at the base and a thick mud cap; these are gradational to Facies 2 turbidites, which have less than 5 cm silt. The bases of beds are generally sharp and may be erosive; the tops are also sharply defined by the base of the succeeding turbidite.

Apart from their normal grading, the thicker beds are typically structureless or, more rarely, show a faint horizontal lamination near the base. Thinner beds may show a range of turbiditic structures associated with graded, laminated units as described for Facies 2 below. Bioturbation is mostly rare to absent.

Where thickly developed, the base of these turbidites consists of poorly sorted sandy silt (sand content up to 40%) with a mean grain size around 4.5 to 5.0 phi. There is a gradual upward decrease in sand content, a corresponding increase in silt, but low clay content (about 5%) throughout the turbidite until the uppermost few centimeters, where the clay content increases, the mean size decreases from 5.5 to 7.0 phi, and the sorting improves. In the thinner turbidites of Facies 1, the base consists of poorly sorted silt with 15% sand, the clay content is generally low, and the turbidite tops show a rapid increase in clay with associated fining and improvement in sorting. The maximum size of quartz grains at the base of the thicker beds is coarse sand grade (1.0 to 0.5 phi), although wood fragments up to 2 cm long are locally abundant.

The composition of Facies 1 sediments varies according to both their grain size (relative siltiness) and their depth within the sediment column (or lithologic unit). This last aspect is discussed more fully in a subsequent section on sediment source. The silt-sand fraction is dominated by quartz (60%–90%), with minor feldspar (4%–36%), carbonate (mainly do-

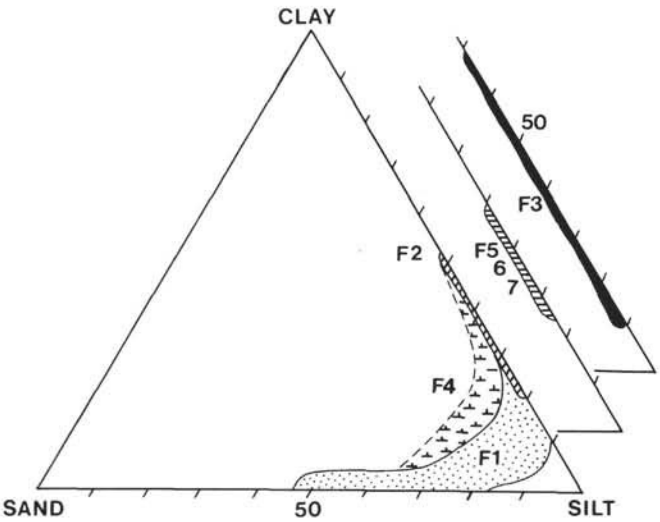

Figure 4. Triangular grain-size plot showing sand-silt-clay percentages of the different sediment facies (areas designated F1, F2, etc).

lomite, 1%–16%), and more than 25 species of heavy minerals (1%–5%). The organic carbon content is mostly <0.5%, only exceeding 1% where there is a concentration of woody debris. The clay fraction ranges from an illite-chlorite-dominated assemblage in the coarser grained beds, to illite-kaolinite-chlorite in the finer grained beds. Smectite is generally low to absent.

Facies 2: Light-gray Organic-poor Mud Turbidites (Fig. 6)

The light-gray mud turbidite facies appears to be gradational with Facies 1 (above) and is defined as having less than 5 cm of silt at the base of a graded mud unit. Within this facies there is also a spectrum of turbidite types. At one end of the spectrum the beds are thick to very thick (30–250 cm) with, at most, a few thin silt laminae above a sharp flat base. At the other extreme, they are typical thin-bedded turbidites with one or several basal silt laminae overlain by 2–20 cm of mud.

There is also a range of internal structures, from essentially structureless, thick-bedded muds with slight normal grading, to thin-bedded graded laminated units showing micro-cross-lamination, fading ripples, low-amplitude ripples, distinct, indistinct, and wispy silt laminae. The basal silt lamina may show micro-scouring or loading and small-scale flame structures. Bioturbation is rarely intense, but in the medium and thick-bedded units there may be significant burrowing down from the tops of beds so that the muddy tops of the turbidites grade imperceptibly into an overlying pelagic clay.

Facies 2 turbidites consist of moderately sorted clayey silt that fines upward very slightly, at least through the lower part of the bed, and then remains fairly constant in size through the upper part. Typically, the mean grain size is in the range 6.5–7.5 phi with a clay content between 25% and 60%. The "cleaner" basal silt laminae, where present, tend to be coarser and more poorly sorted.

The composition of the coarser fraction is very similar to that of the silty turbidites (above); organic carbon content is low and bioclastic material rare. The clay fraction, however, is commonly an illite-kaolinite-smectite assemblage with only minor chlorite. As with the finer grained beds of the silty turbidite facies, there is a trend toward more smectite-kaolinite and correspondingly less illite-chlorite with decreasing grain size.

Facies 3: Dark-gray Organic-rich Mud Turbidites (Fig. 7)

As with Facies 2 above, the dark-gray mud turbidites are thin- to very thick-bedded (10–180 cm) and mud dominated. Where silt laminae are present at the base, they rarely extend for more than a few centimeters upward and, more typically, for only a few millimeters. The bases of beds are commonly sharp and flat or micro-scoured, whereas the tops are distinctly gradational into overlying pelagites or "hemiturbidites" (see below). There appears to be a gradation of types from more uniformly dark colored, with only slight upward color grading, to beds with a dark basal turbidite mud, an intermediate mixed-colored, bioturbated mud, and an upper more thoroughly bioturbated, light-colored, probably pelagic mud. They occur at all three sites and are second in importance to the light-gray silt and mud turbidites of Facies 1 and 2.

In terms of sedimentary structures and textures the dark-gray mud turbidites are again very similar to the light-gray ones described above. The thin silty bases are commonly micro-laminated and cross-laminated; the bed may pass up through a graded laminated unit to graded and then to ungraded mud. Bioturbation from the top downward is typically better developed in these than in the light-gray muds. Where fully developed, a vertical succession of five tiers of biogenic sedimentary structures is recognized. These are, from top down: (1) an uppermost homogeneous layer resulting from surface grazing organisms 1 cm thick, (2) a layer down to about 5 cm dominated by *Phycosiphon*, (3) *Planolites* down to 10 cm, (4) *Chondrites* down to 15 cm, and (5) *Zoophycos* as the deepest burrowing trace down to about 20 cm.

The bulk of these turbidites consists of moderately sorted clayey silts and silty clays with a mean grain size between 7.0 and 8.0 phi, and a clay content between 25% and 65%. The basal part may be a poorly sorted silt (mean size around 6.0 phi) with <1% sand content. Normal grading is ubiquitous but slight, and may be absent in the upper parts of thick beds.

The dark-gray turbidites have a very distinctive composition. The clay assemblage is exclusively smectite-kaolinite with no trace of either illite or chlorite. The quartz-feldspar silt fraction contains an unusual accessory heavy mineral suite including abundant M_g-rich ilmenite, An-rich plagioclase, Mg-rich garnet, and brown hornblende. In addition, the muds typically contain a significant amount (5%–10%) of calcareous nannofossils and up to 2.5% organic carbon as fine-grained, dispersed woody debris. Iron sulfides are very common as microscopic framboids, thin mycelia, and larger pyritized burrows, microfossils, and concretions. Partly as a result of the iron monosulfides and ilmenite content, these beds commonly show a high magnetic susceptibility signature that is typically highest in the basal silts and decreases upward through the turbidite (Sager and Hall, this volume).

Facies 4: Biogenic Mud Turbidites (Fig. 8)

This facies comprises two types of biogenic turbidite: (1) normally graded beds of olive-gray and greenish gray-colored calcareous silty clays that range in thickness from 10 to 190 cm, and (2) thinner bedded (typically 3–15 cm), whitish colored silt turbidites, either with a high percentage of benthic foraminifers or of mainly unidentifiable carbonate silts. Both occur as a minor facies within the mud-rich Units III and IV, and the whitish turbidites also appear deeper in the section in Unit Vb at Site 718.

1. The greenish turbidites are typically sharp based, in some cases showing a distinctly erosive nature, and may have a basal silt layer up to about 8 cm thick. These silts commonly show internal lamination and cross-lamination, and the lower parts of thick beds may display a faint horizontal lamination. Otherwise the beds appear structureless and are bioturbated to a greater or lesser extent from the top downward.

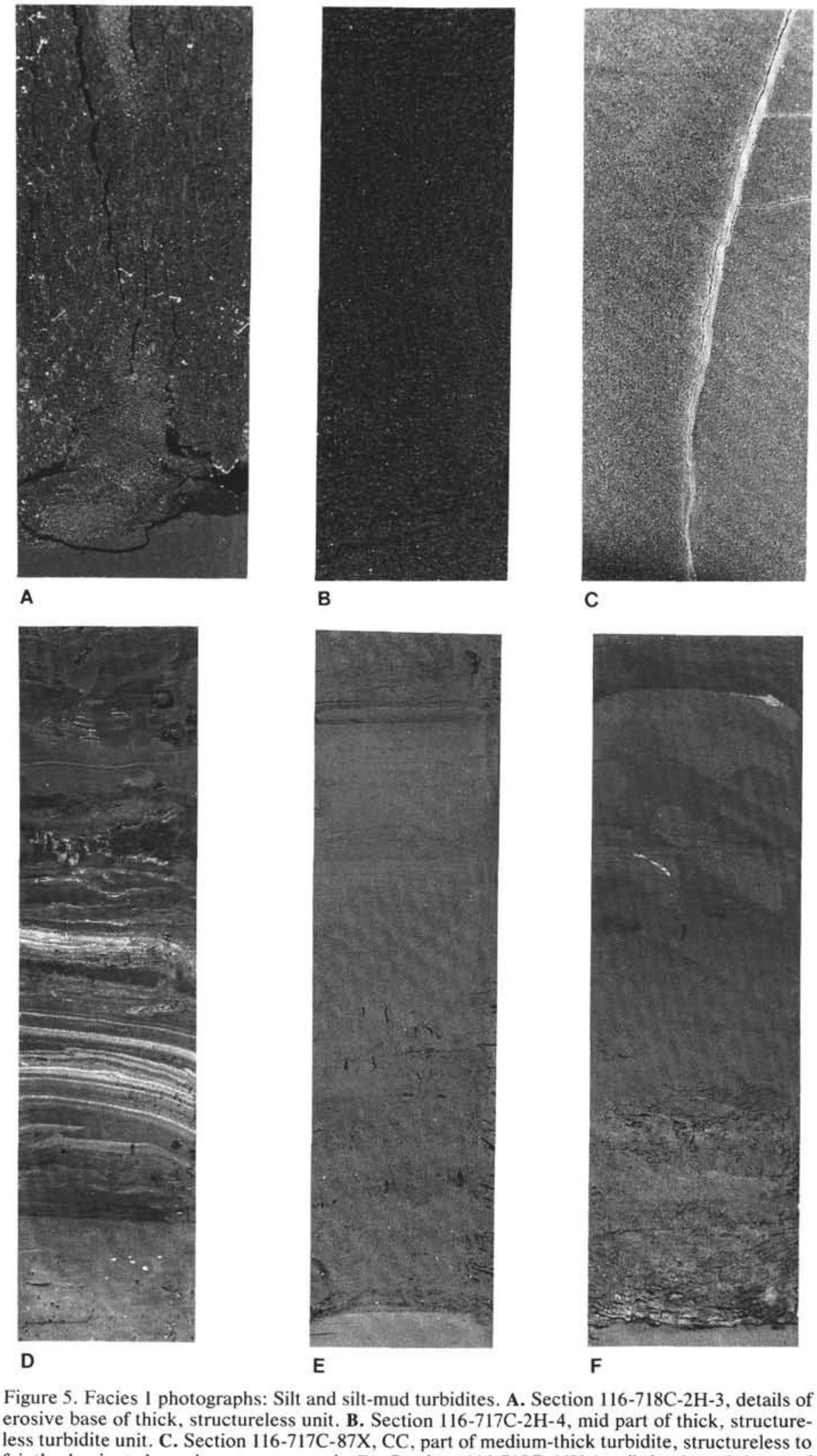

Figure 5. Facies 1 photographs: Silt and silt-mud turbidites. **A.** Section 116-718C-2H-3, details of erosive base of thick, structureless unit. **B.** Section 116-717C-2H-4, mid part of thick, structureless turbidite unit. **C.** Section 116-717C-87X, CC, part of medium-thick turbidite, structureless to faintly laminated, carbonate-cemented. **D.** Section 116-718C-46X-1, silt-laminated base of medium-thick turbidite, syn-sedimentary fault and micro-cross-lamination. **E.** Section 116-718C-32X-1, muddy silt base of medium-thick turbidite. **F.** Section 116-717C-42X-3, muddy silt base of thin turbidite.

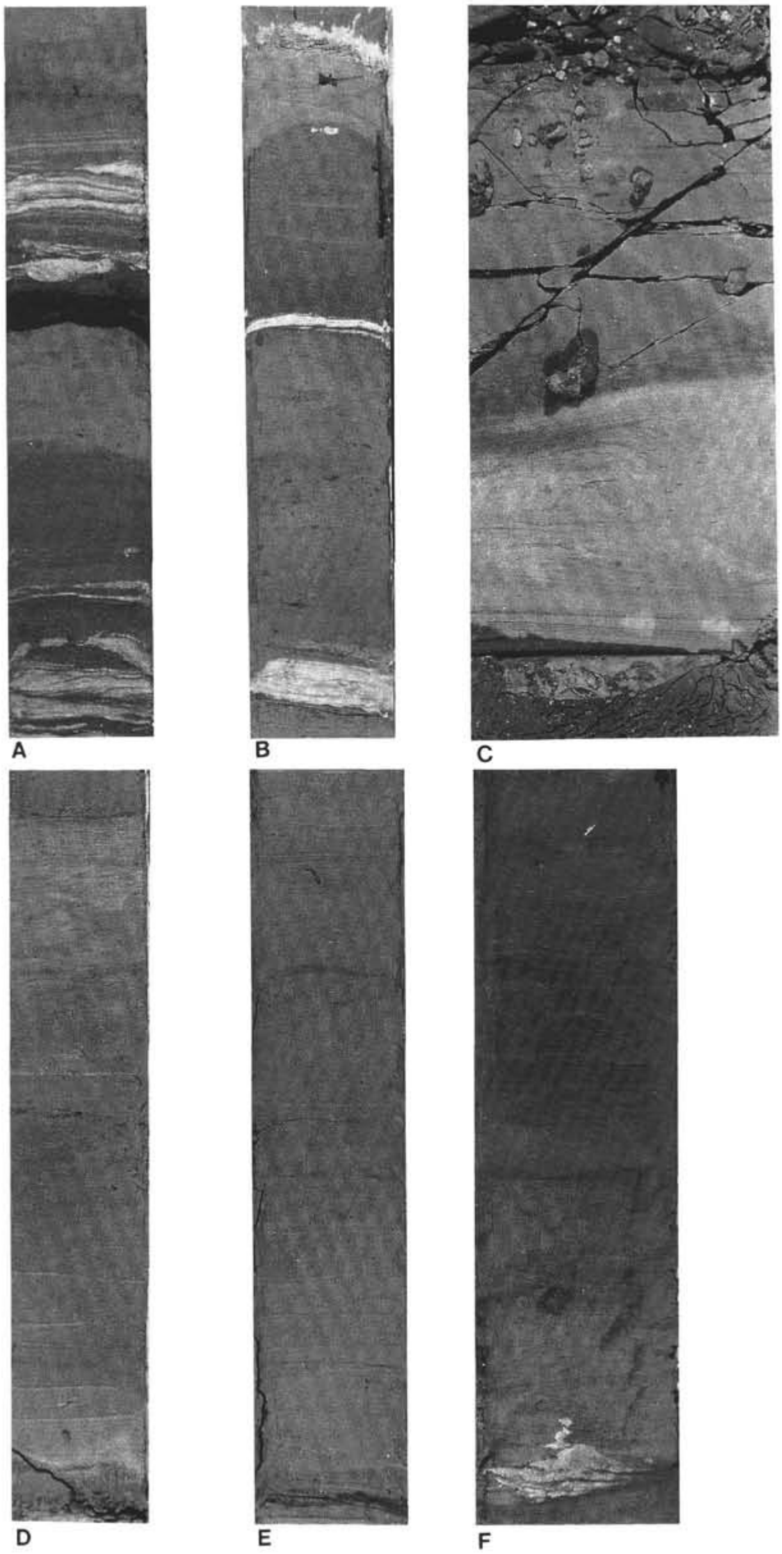

Figure 6. Facies 2 photographs: light-gray organic-poor mud turbidites. **A.** Section 116-718C-14X-5, thin turbidites with silt-laminated bases, scours, and micro-cross-lamination. **B.** Section 116-719A-31X-6, as in **A.** **C.** Section 116-718C-94X-6, thin turbidite grading from green silt at base to red mud at top, micro-lamination, cross-lamination, convolution, and scours. **D.** Section 116-719A-1H-3, medium-thick turbidite with little basalt silt. **E.** Section 116-717C-27X-6, base of thick turbidite with little silt. **F.** Section 116-719A-31X-2, thin turbidite with thin silty base.

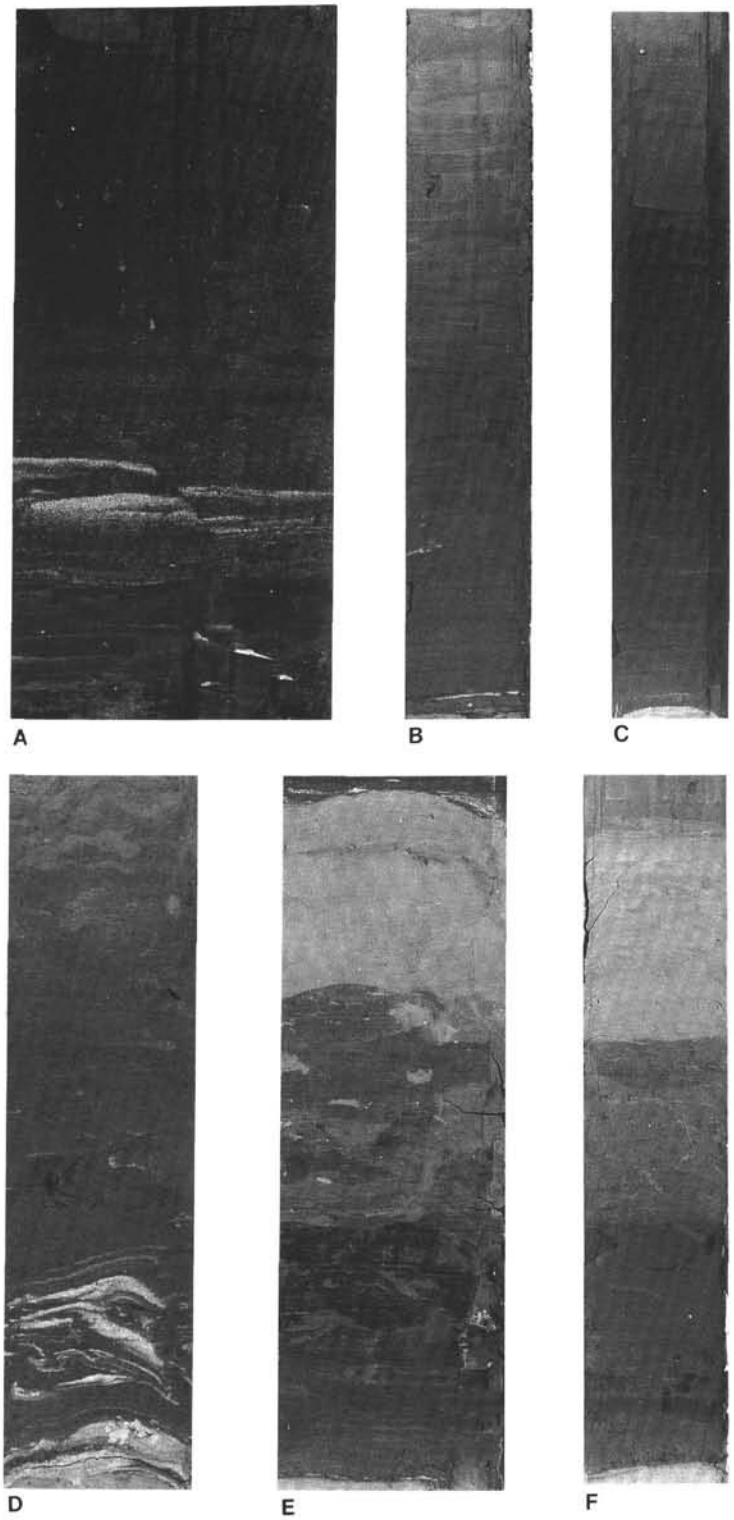

Figure 7. Facies 3 photographs: dark-gray, organic-rich mud turbidites. **A.** Section 116-717C-35X-6, detail of silty base of thick turbidite, syn-sedimentary fault. **B.** Section 116-717C-27X-4, medium-thick turbidite. **C.** Section 116-719A-16X-5, medium-thick turbidite. **D.** Section 116-718C-14X-3, thin turbidites with silty base and convolute lamination. **E.** Section 116-718C-14X-4, thin turbidite grading up to pale-gray pelagite, thin silt lamina at base. **F.** Section 116-719A-16X-6, same as **E.**

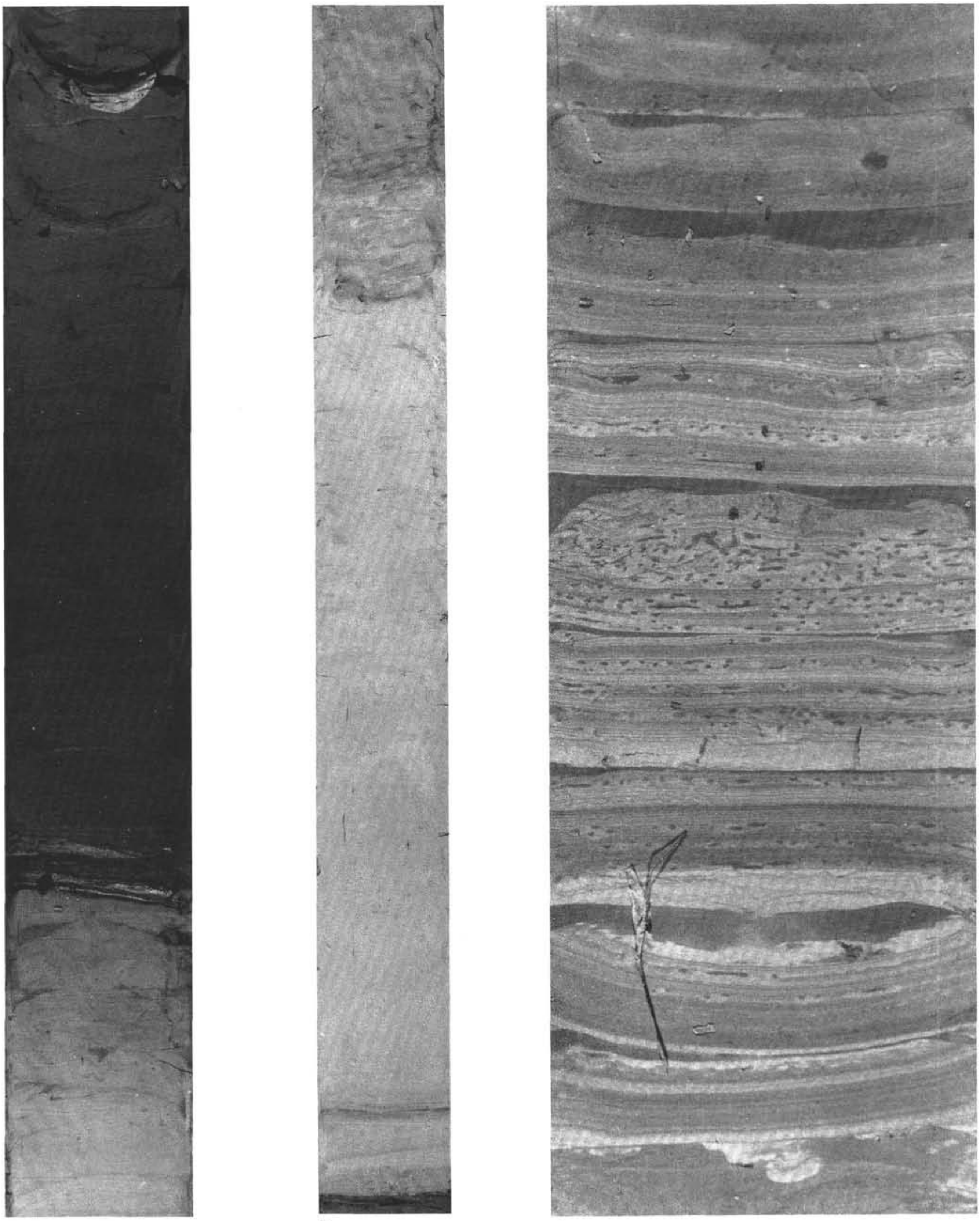

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Figure 8. Facies 4 photographs: biogenic mud turbidites. **A.** Section 116-717C-27X-5, lower part of thick green foraminifer-nannofossil turbidite. **B.** Section 116-717C-28X-5, medium-thick white foraminifer turbidites. **C.** Section 116-718C-78X-5, repeated thin carbonate (foraminifer) silt-laminated turbidites.

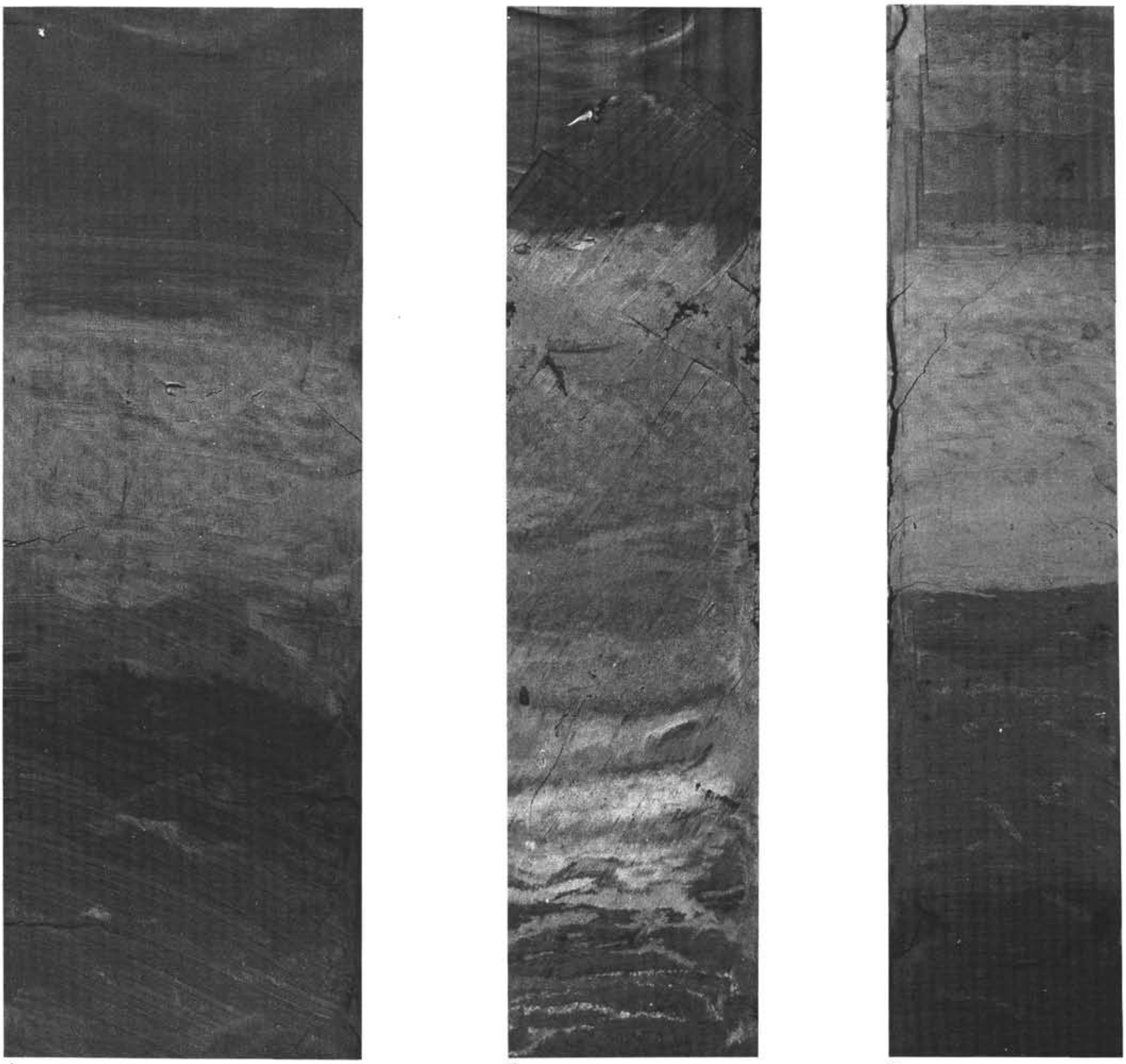

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Figure 9. Facies 5 photographs: pelagic clays (light-colored unit). **A.** Section 116-717C-21X-4, thin bioturbated pelagite. **B.** Section 116-717C-24X-3, thin bioturbated pelagite; dark band is manganiferous chemical front. **C.** Section 116-719A-16X-6, thin bioturbated pelagite.

These turbidites consist of poorly sorted clayey silt with a basal sandy silt that may contain up to 20% sand. Sand content gradually decreases upward through the turbidite, but remains present almost throughout. Clay content is 30%–40% through most of the bed, but decreases downward to less than 10% near the base. The mean grain size at the base is typically 5.0 to 6.0 phi, rapidly fining upward to around 6.5 phi and then more gradually to 7.5 phi near the top. Sorting improves upward through the bed from a poorly sorted basal silt.

In terms of composition, these are bioclastic turbidites with up to 50% carbonate content. Nannofossils are dominant, foraminifers are abundant in the basal silts together with unidentified calcareous debris. The benthic foraminifer assemblage is typical of outer shelf to upper slope depths. In the few samples analyzed, the clay fraction is composed of smectite-kaolinite-illite, with trace amounts of palygorskite and some gibbsite. Organic carbon contents are low (0.2% to 0.8%).

2. The whitish turbidites have been less well studied in the laboratory. They are sharp-based, normally graded silts and sandy silts, with internal lamination and cross lamination. They are generally more carbonate-rich than the greenish turbidites, with up to 60% or 70% carbonate. The benthic foraminifer assemblage indicates bathyal to lower slope depths. The "unidentifiable" carbonate grains appear, in some cases, to be highly corroded remains of foraminifer tests.

Facies 5: Pelagic Clays (Fig. 9)

The turbidites at all three sites drilled are separated, in some cases, by thin to medium-thick intervals of bioturbated

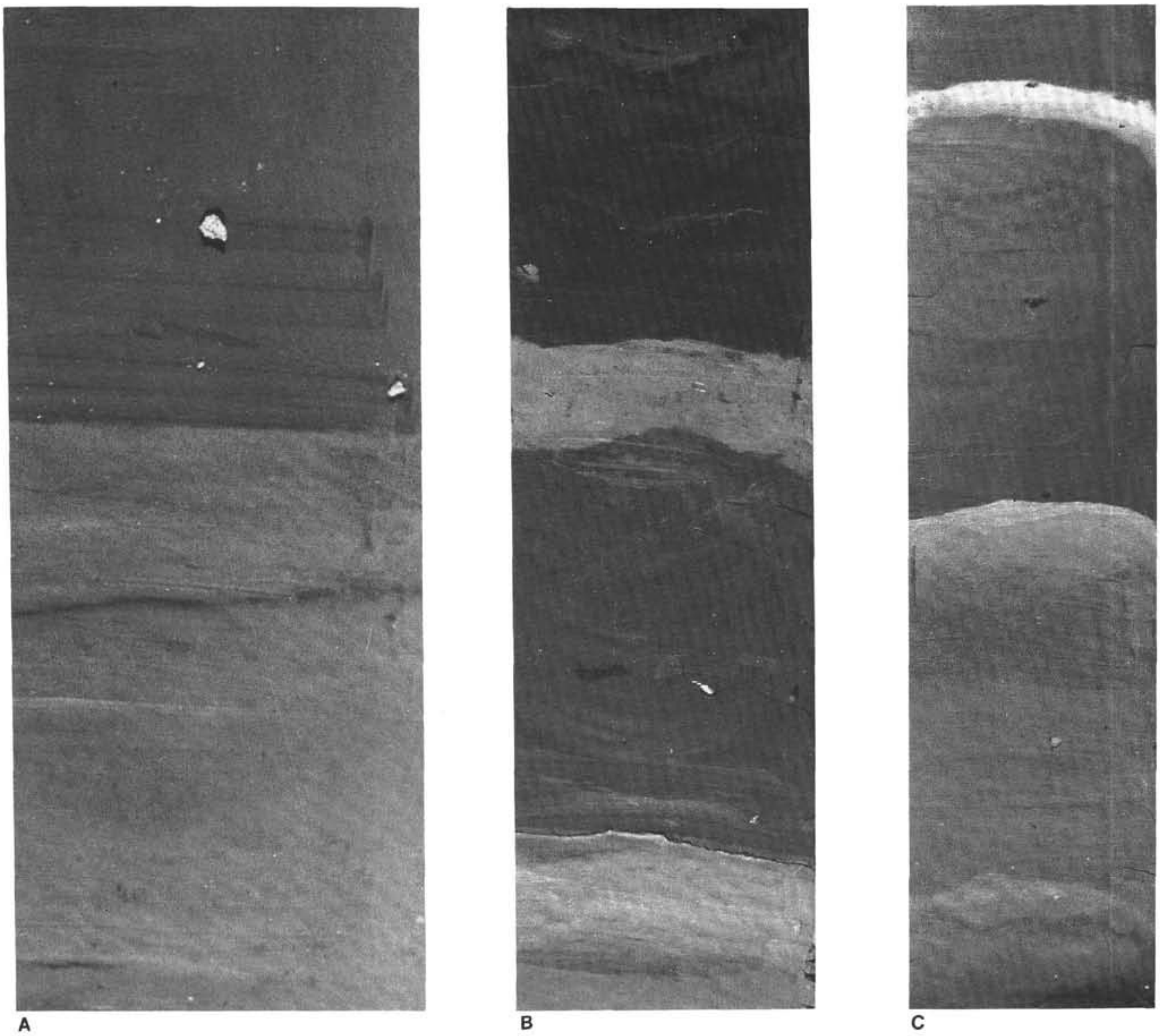

Figure 10. Facies 6 photographs: pelagic calcareous clays (thin, light-colored units between darker mud turbidites). **A.** Section 116-717C-10X-1, very thin bioturbated pelagite with dark manganiferous chemical front about 3 cm below base of dark turbidite. **B.** Section 116-717C-21X-4, very thin bioturbated pelagites. **C.** Section 116-717C-22X-5, very thin bioturbated pelagites.

clays and silty clays that are interpreted as pelagic in origin, but deposited below the carbonate compensation depth. Light-gray to whitish colored pelagic clays are most common and thicker (15–25 cm) in the mud-rich Units I, III, and IV, and thin (<5 cm) to absent in the silt-rich Units II and V. Certain intervals within Unit V contain mottled greenish and reddish colored clays that are also interpreted, in part, as pelagic. These occur near the base of Sites 717 and 718.

The pelagic clays are characterized by intense bioturbation that typically extends downward into the underlying turbidite. The normal tiering structure of biogenic traces can be recognized within the thicker intervals, as described for Facies 3 above. No primary sedimentary structures are apparent. A faint brownish purplish color lamination, typically found 5–15 cm below the tops of beds, is interpreted as a diagenetic chemical front or redox boundary within the sediment column. The bases of beds are completely gradational, so that it is not really possible to clearly distinguish turbidite from pelagite, whereas the tops of beds are sharply defined by the base of the succeeding turbidite.

The grain size of pelagic intervals is typically uniform and very fine grained (mean size 7.5–8.0 phi) with a relatively high clay content (in excess of 40%). In terms of composition, they are very similar to the light gray mud turbidites (Facies 2), with a clay assemblage of smectite-kaolinite-illite, very little biogenic material apart from rare highly corroded nannofossils, and low organic carbon contents.

Facies 6: Pelagic Calcareous Clays (Fig. 10)

In the upper parts of the section recovered at all three sites, the pelagic intervals between turbidites have an increasing amount of biogenic material upward through the section. This biogenic component is dominated by nannofossils, with fewer foraminifers and siliceous microfossils, the latter only being common in the topmost core at Site 717. Typically, these pelagic intervals are thin (0.5–10.0 cm), whitish colored,

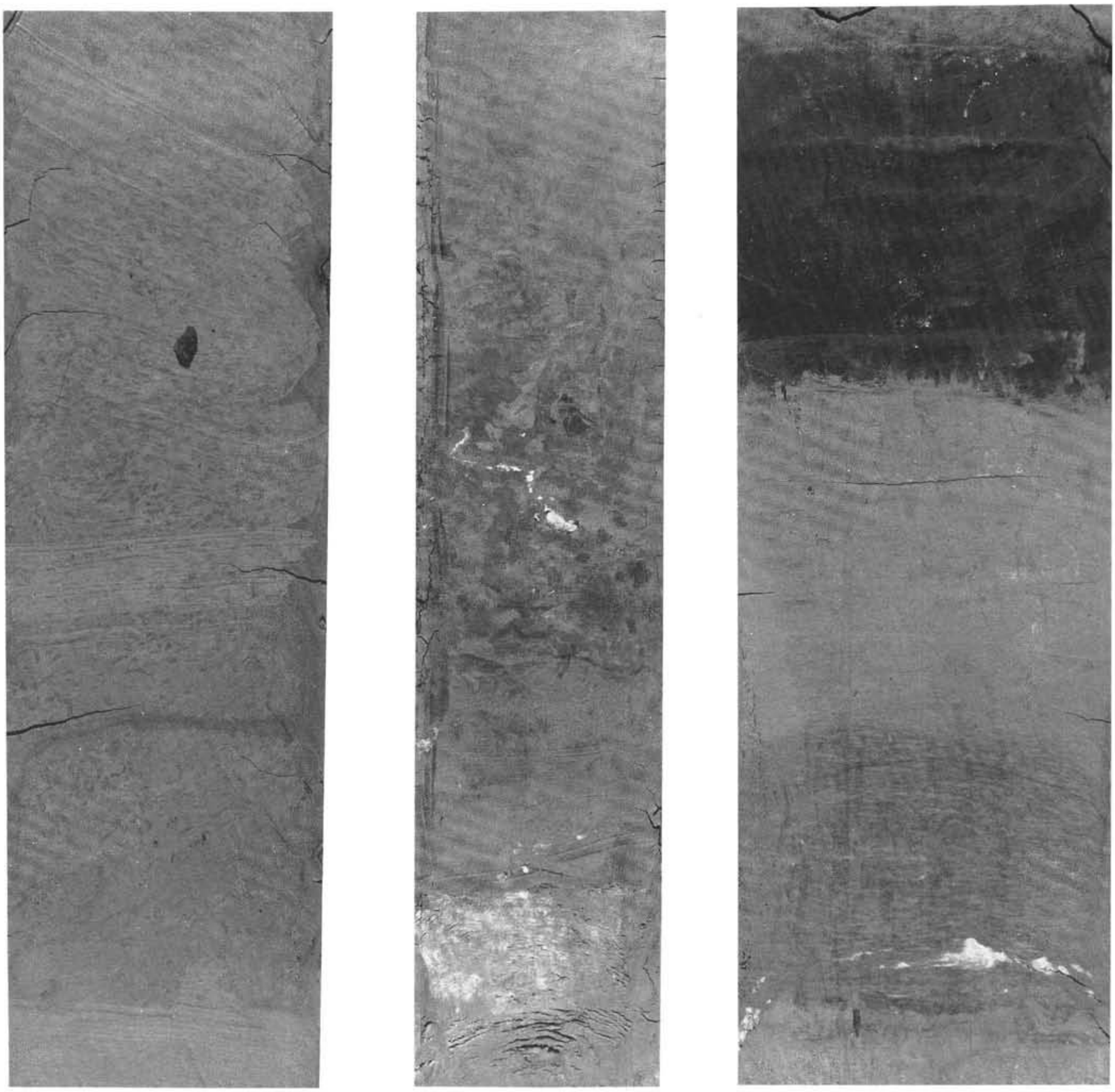

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Figure 11. Facies 7 photographs: structureless bioturbated muds (termed "hemiturbidites" by Stow and Wetzel, this volume). **A.** Section 116-717C-26X-6, part of thick bioturbated unit. **B.** Section 116-718C-11X-3, part of thick bioturbated unit **C.** Section 116-718C-20X-1, detail of contact at base of hemiturbidite. Note that bioturbation continues throughout.

thoroughly bioturbated, and otherwise very similar to the non-calcareous pelagites described above (Facies 5). They were deposited under conditions of a deepening carbonate compensation depth that allowed preservation of at least part of the biogenic fraction.

Facies 7: Bioturbated Muds—"Hemiturbidites" (Fig. 11)

One relatively common and distinctive sediment type found at each of the three sites drilled showed characteristics intermediate between the mud turbidites and pelagites outlined above. These sediments are described in detail in a separate paper (Stow and Wetzel, this volume), in which they have been called "hemiturbidites." They are most common in the mud-rich Units III and IV at Sites 718 and 719.

Typically, the hemiturbidites are thick (50–100 cm) turbidite-like beds similar in some ways to either the light gray or the dark gray mud turbidites of Facies 2 and 3. They may have a thin (about 5 cm) basal zone of structureless turbidite mud overlain by a thick bioturbated interval. In other cases the basal turbidite is either thicker or completely absent. Where the bioturbated mud interval is only relatively thin, it is difficult to distinguish from the bioturbated top of a turbidite or from a normal pelagite. Indeed, there appears to be a complete gradation between the three facies types.

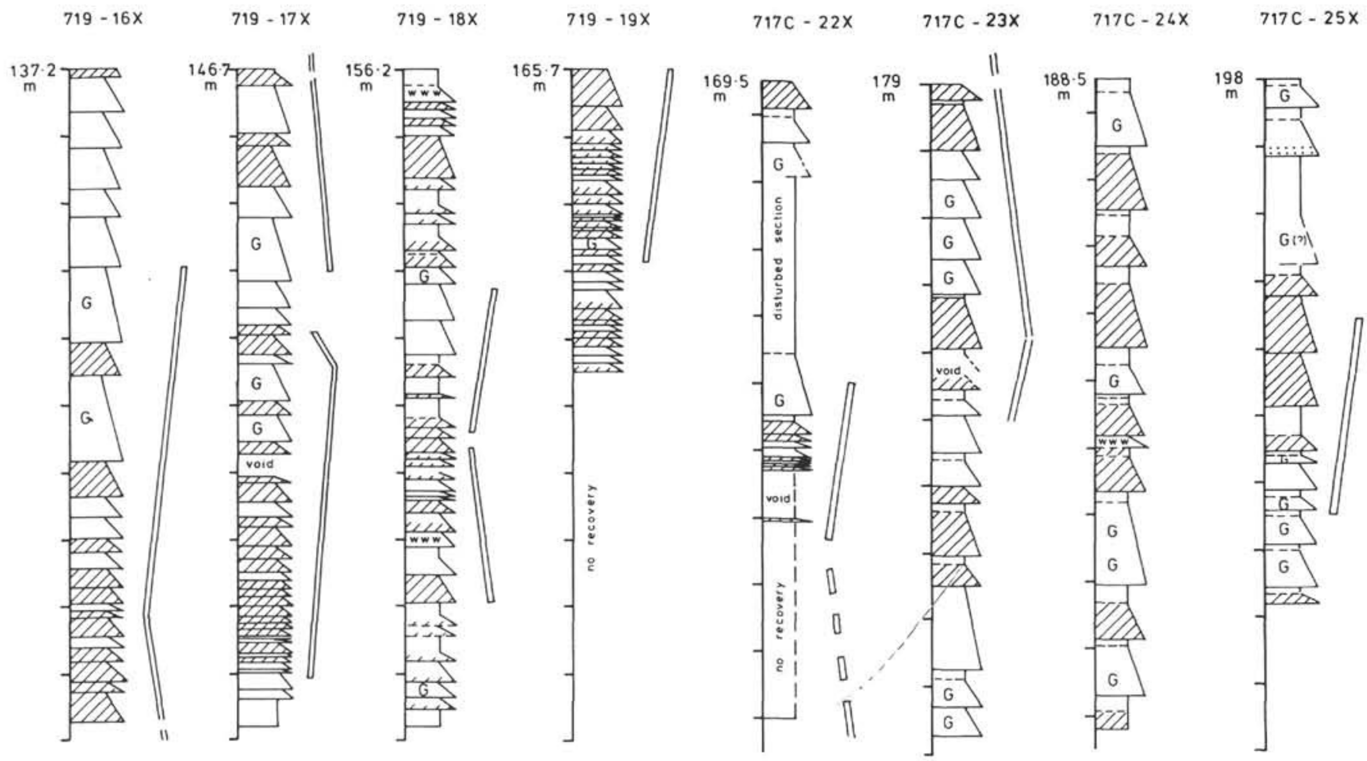

Figure 12. Schematic core logs from Leg 116 sites showing typical small-scale sequences of turbidite thickness. Thinning upward and thickening upward patterns are indicated by double lines to the right of the core sections. Facies 1 and 2 (blank ornament, graded beds), Facies 3 (oblique hachure, graded beds), Facies 4 (graded beds; G = greenish, W = whitish), Facies 5, 6, and 7 (blank ornament at tops of graded beds).

The nature of the bioturbation is distinctive, in that the normal tiering zonation is disrupted by the development of the shallower tiers (homogeneous surface tier and shallow Phycosiphon tier) at deeper levels within the beds as well as through much of the bed thickness. Bioturbation thus appears to have been continuous with sedimentation rather than being a top-downward, post-depositional process.

Only the very finest sediment is present in the hemiturbidites (mean size 7.5–8.5 phi), but in some cases an extremely subtle normal grading can be detected both from grain-size measurements and from variation in geotechnical properties such as bulk density. Where the beds pass from a darker colored basal part into a lighter colored upper part, there is a compositional grading apparent from the smectite-kaolinite clay mineral assemblage typical of Facies 3 to the smectite-illite-kaolinite assemblage that characterizes the pelagic clays. Slight enrichment in nannofossils and in organic carbon is confined to the darker gray intervals.

FACIES DISTRIBUTION

Vertical Facies Distribution: Cycles and Sequences

The first-order distribution of facies observed at all three sites drilled on the distal fan is their partition into mud-rich and silt-rich intervals, here designated as lithologic units (Fig. 3). This occurs at a scale of about 100–500 m, with Units II, part of IV, and V being dominated by silt turbidites of Facies 1 together with minor mud turbidites and Units I, III, and most of IV being dominated by mud turbidites, pelagites, and hemiturbidites of Facies 2, 3, 4, 5, and 7.

A second-order distribution of facies occurs within these lithologic units on a scale of a few tens of meters. Within the silty units and particularly evident in Unit V at Site 718, there is an alternation between 5- and 20-m-thick intervals of thin-bedded turbidites and pelagic clays, and somewhat thicker sections (up to 60 m) of medium to thick-bedded silt and silt-mud turbidites without identifiable silt layers. Within the mud-rich units, particularly unit IV, the reverse is apparent, in that thinner horizons of silt turbidites alternate with thicker sections of muds. In both cases, these mesosequences of variation in turbidite coarseness and thickness are of an oscillation of symmetrical type (e.g., Ricci Lucchi 1975, Stow, 1985).

A third-order distribution of facies or small-scale (2–10 m) cyclicity in turbidite bed thickness is observed in both wireline logs and cores at each of the three sites. These are varying degrees of organization into patterns of bed thickness variation, from moderately well ordered to completely random (Fig. 12). The well-ordered microcycles are typically 2–10 m in thickness and involve between 10 and 30 turbidite beds. Thinning upward, thickening upward and symmetrical cycles are observed that show, with some internal variability, progressive increase and decrease in bed thickness, from about 10 cm to 120 cm. However, the majority of the section shows no very well defined microcycles and is characterized by either showing partial cycles or with what appears to be random thickness variation. In no cases do the beds remain of constant thickness (within 10% variation) for more than a few consecutive beds.

Horizontal Distribution: Turbidite Correlation

The five lithologic units identified first at Site 717 can be correlated across the 8 km between the three sites drilled (Fig. 3), although the thicknesses of each vary markedly and the distinction between Units III and IV is not clear at Site 718. Individual turbidites within the silt-rich Units II and V cannot be correlated between sites. This is at least partly because of the very poor recovery of silty sections and because of the uniform nature of the turbidites themselves.

More accurate site-to-site correlation, however, is possible within the mud-rich Units III and IV using distinctive white bioclastic turbidites as marker beds. In this way it has been possible to correlate a bed at Site 717 (Core 116-717-24X, 194 mbsf) with a bed at Site 719 (Core 116-719-18X, 156.5 mbsf), and hence to observe the lateral thickness variation of the overlying and underlying turbidite packages over a distance of about 3 km. In general terms, the thin-bedded turbidites at Site 719 correlate with thicker-bedded turbidites at Site 717, over a few meters immediately adjacent to the white marker horizons. However, one cannot be confident about correlation of other non-distinctive beds or extension of the correlation vertically with precision, as too many individual turbidites appear to pinch out completely between the two sites (Fig. 13).

The thinning of some beds and disappearance of others can be explained by the fact that Site 719 was located part way up a tilted fault block that was active during sedimentation (Cochran, Stow et al., 1989). Southward-moving turbidity currents were affected by the slight (? few tens of meters) seafloor relief and either veered off to the side or continued on up the slope, depositing thinner beds, perhaps due to an increase in flow velocity.

Still fewer beds can be correlated with any degree of certainty from Site 719 to Site 718, which sits part way up the fault block immediately to the south, some 5 km from Site 719. Very few turbidity currents appear to have traversed the elevated nose of the more northerly of the two adjacent blocks and then deposited material to the south. Only one distinctive white turbidite near the base of Unit IV can be correlated between all three sites (Fig. 3).

SEDIMENT COMPOSITION AND SOURCE

The location, size, and thickness of the Bengal Fan point clearly to the principal source of sediment being the rapid denudation of the Himalayan orogenic belt. Detailed petrographic and mineralogic studies have indeed confirmed this inference and provide evidence for temporal variation in the denudation history of the Himalayas as well as for a more varied input to the distal fan (Fig. 14).

The dominant, light-gray silt and mud turbidites (Facies 1 and 2) are the main and constant signature of Himalayan erosion. The coarse-fraction major mineralogy (quartz-feldspar-micas) as well as the clay mineral assemblage (illite-chlorite-kaolinite) and stable isotope compositions for H, 0, Sr, and Nd, all indicate a provenance that includes the metamorphic and igneous crystalline rocks of the High Himalayas and the lower grade metamorphics and sedimentary series of the Low Himalayas. These facies are compositionally very similar to those of the Ganges-Brahmaputra river system, the soils of the Indo-Gangetic plain, and recent marine sediments from the proximal and medial Bay of Bengal and from the Indus Fan (Bouquillon et al., Brass and Raman, Yokoyama et al., all this volume).

Comparison of the silt mineralogy (both heavy and light fractions) from the light-gray turbidites, with petrological studies of the Himalayas (Gansser, 1964; Ishida and Ohta, 1973; Sinha Roy, 1977) and of the sub-Himalayan Siwalik Group (Gill, 1951; Sinha, 1970; Chaudhri, 1972), allows us to infer an evolving source region as the Himalayas were uplifted and progressively denuded (Bouquillon et al., this volume). The oldest sediments (17–15 Ma), dominated by quartz and dolomite with scarce Ca-plagioclase and hornblende, were derived from the Precambrian and Paleozoic sedimentary and low-grade metamorphic rocks of the Lower Himalayas. The main metamorphic terrain of the High Himalayas was first unroofed at about 15 Ma, with more widespread unroofing from about 11 Ma, as shown by the more abundant Ca-plagioclase, Ca-amphibole, pumpellyite, epidote, and associated heavy mineral suite. The appearance of enstatite, chrome spinel, and serpentinite, followed by olivine in the most recent sediments, attests to the unroofing of a large peridotite body in the High Himalayas between 3.5 and 0.5 Ma.

Dating of single crystals of detrital muscovite and K-feldspar by the $^{40}Ar/^{39}Ar$ technique gives a broad range of ages for each mineral, but with minimum ages that are approximately the same as the depositional age as determined biostratigraphically. The results indicate that a large proportion of material in the Bengal Fan is first-cycle detritus that can be ascribed to a significant pulse of uplift and rapid erosion in the Himalayas. Available data in the drainage basin suggest that the source of the youngest material (i.e. <8 Ma) is the rocks of both the High and Low Himalayas north of the Main Boundary Thrust (Copeland et al., this volume). Detrital apatites dated by fission-track methods give ages that are only 0–10 m.y. older than the depositional ages (Corrigan and Crowley, this volume). This provides further evidence of very high rates of denudation from source areas similar to the present-day Himalayas, and rapid transportation to the distal Bengal Fan.

The dark-gray, organic-rich, mud turbidites (Facies 3) have a different and distinctive composition and were most probably derived from the western margin of the Bay of Bengal and ultimately from the southern parts of India and Sri Lanka. The smectite-kaolinite clay assemblage, and the D and O stable isotope ratios that indicate soil profile clays, are very similar to those found in the Ceylon Basin as well as along the southeastern coast of India. The relatively high gibbsite content together with the kaolinite is similar to Tertiary laterite formations in southern India (Bouquillon et al., this volume). The Mg-rich ilmenite and An-rich plagioclase are compositionally similar to those of the Deccan Trap basalts, which would also provide a likely source for the smectite clays. The pyrope garnet, brown hornblende, and other distinctive heavy mineral species suggest derivation from the greenschist to granulite facies metamorphic terrains that flank the Deccan Traps in south India and Sri Lanka (Crawford, 1974; Rao, 1974; Yokoyama et al., this volume). The thermal demagnetization curves for these dark-gray turbidites are also similar to those of Deccan Trap basalts (Sager and Hall, this volume).

The dark-gray turbidites also contain small but significant percentages of resedimented nannofossils and terrestrial organic matter. The occurrence of the former and the preservation of the latter both imply that the sediment accumulated first in a shelf or outer slope setting in an area of low-oxygen bottom waters. The western margin of the Bay of Bengal would fit well with this scenario.

The biogenic turbidites (Facies 4) have another, altogether different source. The more common greenish colored ones contain small-sized, well-preserved benthic and planktonic foraminifers, pyritized radiolarians, mollusc, echinoid and ostracod fragments, plant debris, and minor terrigenous material, in the coarser grained fraction. The benthic foraminifer assemblage was derived from an outer shelf–upper slope water depth (Iaccarino and Proto-Decima, this volume). The finer grained fraction comprises nannofossils and a smectite-kaolinite-illite clay assemblage, with minor but significant palygorskite (Bouquillon et al., this volume). The most likely source for these sediments appears to be a low-latitude, open shelf–slope setting in an area of good primary productivity and little terrigenous supply such as the shelf off Sri Lanka with additional input of some eolian clays and silts. The palygorskite of the northern Indian Ocean and of the Sri Lankan Basin is believed to have been derived ultimately from the saline

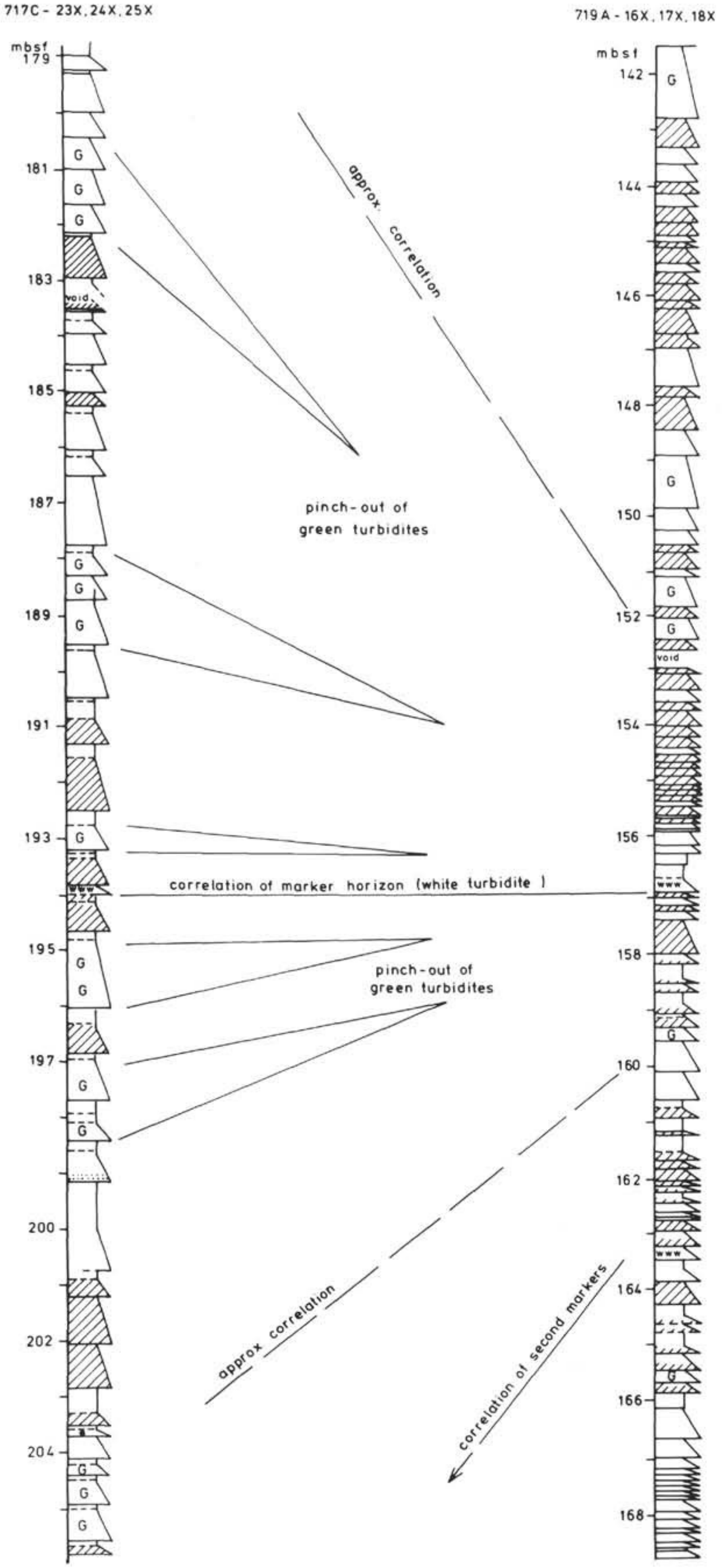

Figure 13. Bed-to-bed correlation of individual turbidites and turbidite packets between Sites 717 and 719. Facies 1 and 2 (blank ornament, graded beds), Facies 3 (oblique hachure, graded beds), Facies 4 (graded beds; G = greenish, W = whitish), Facies 5, 6, and 7 (blank ornament at tops of graded beds).

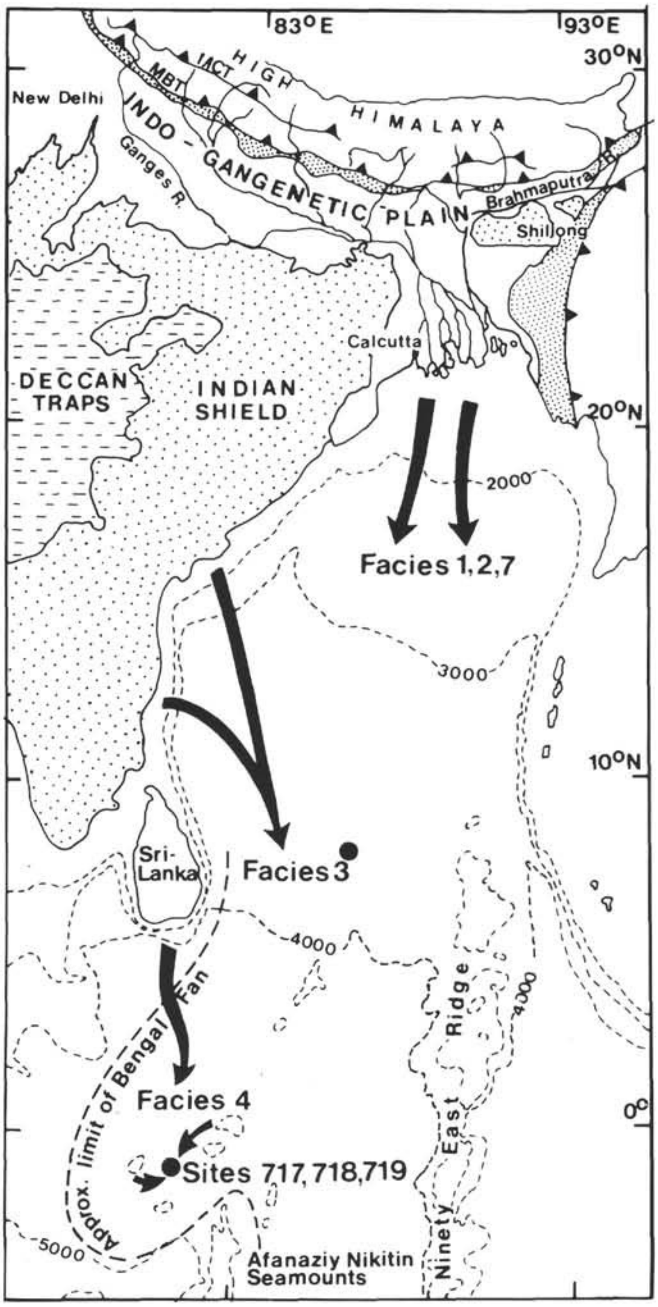

Figure 14. Map of northeast Indian Ocean and surrounding land areas (after Bouquillon et al., this volume) showing main sources of sediment for the Bengal Fan with major supply routes.

deserts of Somalia and Arabia (Kolla et al., 1976; Bouquillon and Debrabant, 1987; Chamley et al., 1989).

The whitish colored biogenic turbidites are less abundant, contain less terrigenous material, and have received little detailed study. The biogenic fraction is dominated by both planktonic and benthic foraminifers, many of which show evidence of extreme dissolution. The assemblages suggest a deeper water, slope–lower bathyal origin, most likely on a local seamount far from the influence of terrigenous input. The dissolution may, in part, have resulted from resedimentation to below the carbonate compensation depth (CCD) and also from early diagenesis.

The pelagic clays and pelagic calcareous clays (Facies 5 and 6) are some of the finest grained sediments encountered and comprise little other than clays, very fine silts, and biogenic material (Facies 6 only). The clay fraction is a mixed assemblage, but without chlorite—presumably because of its relatively coarser grain size derived from the same sources as the turbidites, but with the addition of a minor wind-blown component. The nannofossil-foraminifer assemblages are believed to have suffered the effects of selective dissolution and so are relatively restricted in diversity (Iaccarino and Proto-Decima, this volume). Planktonic foraminifers have apparently undergone the most dissolution; the benthic assemblage suggests the influence of cold abyssal water masses. Apart from the very topmost core section, siliceous microfossils are very rare—this is most probably due to dissolution during early diagenesis (Takahashi, this volume).

The fine-grained nature also applies to the hemiturbidites (Facies 7) and the light-gray parts of these beds have a composition, and presumed source, very similar to the pelagic clays (without the biogenic component). Where the hemiturbidites are darker gray in color or have a dark-gray basal unit, then the composition and source is more closely analogous to the dark-gray turbidites (Facies 3). This apparent mixing of source areas is due to the transitional nature of hemiturbidites between hemipelagic and turbiditic (Stow and Wetzel, this volume).

PROCESSES AND CONTROLS ON A DISTAL FAN

Turbidity Current Processes

Turbidity currents clearly have been the dominant process operating on the distal Bengal Fan since the early Miocene. Three main types and corresponding sources of turbidity currents can be inferred, as represented by the different facies. The most common, giving rise to the light-gray turbidites (Facies 1 and 2) present throughout the sections at all three sites, shows a distinctive Himalayan source. Erosion, fluvial transport to the Ganges delta/shelf, and resedimentation down-fan over a distance in excess of 2500 km all took place relatively rapidly.

The average frequency of these events reaching the area of Sites 717–719 on the distal fan is approximately 1 per 1000 yr, although we assume that the fan-wide frequency would have been much greater. In some cases the turbidity currents deposited in excess of 1.0 m of silt and sandy silt (maximum grain size up to coarse sand) at the base of a still thicker graded bed. In other cases, a similar thickness of very fine-grained, graded to structureless mud was deposited, and in still other cases thin-bedded silt-laminated and mud turbidites resulted. These features attest to both the existence of very large and powerful flows that were able to travel hundreds of kilometers over extremely low gradients, as well as to the great variability of flows that reached the distal part of the fan. We infer that the origin of such currents was the major slumping of rapidly deposited, unstable sediments in the delta slope region of the upper fan. Such slumps most likely led to the development of the Swatch-of-no-Ground delta front trough that currently feeds the main active fan channel, as has been shown for the formation of the Mississippi delta front trough (Coleman et al., 1983).

Turbidity currents were also derived from slumping of the outer shelf and upper slope of the southeast Indian continental margin and then moved downslope via channels that acted as tributaries to the main fan channel feeding the distal fan. These currents were less frequent, about one per 10 k.y., and deposited the dark-gray, organic-rich turbidites (Facies 3). They appear to have been more common during the deposition of Units III and IV of late Miocene and Pliocene age than at other times, although this might simply be an effect of masking by Himalayan-derived material at other times.

Of still less frequent occurrence were the turbidity currents that brought biogenic debris to the distal fan. Those that deposited the greenish colored turbidites (Facies 4) occurred approximately once every 100 k.y. and are believed to have originated from slumping on the steep slope off Sri Lanka.

The characteristics of the turbidites deposited by these different flows are very similar to many others described from deep marine settings (e.g., Piper, 1978; Kelts and Arthur, 1982; Stow and Piper, 1984; Stow et al., 1986). They are typically of the T_{5-8}, T_{6-8}, or T_{7-8} type (Stow and Shanmugam, 1980), or the E2–E3 turbidites of Piper (1978), but may also show some of the lower divisions of silt-laminated mud. They appear to have been deposited from single large turbidity currents, with no evidence of ponding or reflections causing multiple repetition of turbidite divisions.

Pelagic Processes

With such rapid and continuous turbidite sedimentation even on this distal part of the fan, there is relatively little in the way of pelagic sediment preserved. Thin pelagic beds do occur, however, at the tops of many of the mud and biogenic turbidites within Units I, III, and IV, and also above the thin-bedded greenish colored silt-mud turbidites that are characteristic of Unit Vb at Site 718. Pelagic clayey oozes (Facies 6) are only present within the top meter of the section. Calcareous pelagic clays (also Facies 6) with residual, solution-resistant microfossils occur in sediments back to about 2 Ma (middle part of Unit III), and then give way down-section to pale gray to whitish gray-colored pelagic clays with an absence of fossils (Facies 5). Greenish and reddish brown, unfossiliferous pelagic clays become more common from about 10 Ma to the base of the recovered section.

The rapid and progressive down-section decrease in the carbonate content of the pelagites indicates that the CCD was well above the sediment surface in the early Miocene central Indian Ocean. The CCD became deeper with time through the Miocene and Pliocene. From about 2–3 Ma to the present the seafloor appears to have been somewhere between the CCD and the lysocline.

Hemiturbidite Deposition

The sediments described in this paper as Facies 7 and called hemiturbidites by Stow and Wetzel (this volume), occur in association with, but are distinctive from, the normal turbidites and pelagites. In many respects they appear to be transitional between these two types and, we suggest, are most probably deposited by a process transitional between a true turbidity current and slow pelagic settling.

It is clear that a turbidity current, having traveled over 2500 km and deposited thick mud turbidites on an extremely low gradient, will eventually die out. Indeed, many flows probably die out before reaching the distal fan. In its final stages, a muddy turbidity current most probably becomes extremely dilute and begins to mix upward or to peel off into the water column, hence leaving its very finest material as a dilute suspension cloud that extends perhaps up to more than 1 km above the ocean floor. Further material is added to this cloud as the tail of the turbidity current arrives in the area over a period of, perhaps, a few days to a week or more. Material from this suspension then settles slowly to the seafloor together with any pelagic material in the water column, and is deposited over the distal feather edge of the muddy turbidite from the original current, as well as beyond the point that the "true turbidite" has reached.

Sedimentation from this suspension cloud is sufficiently slow that bioturbation continues throughout. Very approximate estimates, made on the basis of rates of bioturbation in the deep sea and the nature of the burrowing, suggest that deposition of a 1-m thick hemiturbidite took in the order of 2–12 months (Stow and Wetzel, this volume). Although admixed with a certain amount of pelagic rain, the composition of the bed remains essentially turbiditic and very slight normal grading can be observed, especially where the bed overlies a thin turbidite unit.

The process of hemiturbidite deposition proposed here (Fig. 15), or something very similar, has been inferred previously (e.g., Stanley, 1983), and it would appear to be the logical extension of deposition from a turbidity current at its extreme distal end. Some degree of ponding or marked change in gradient might in fact enhance the development of a suspension cloud, and it might be that the slight positive relief afforded by the protruding noses of east–west trending fault blocks in the area has affected southward-flowing turbidity currents in this way. It is also possible that this extreme flow dilution and slow sedimentation may be more common for unconfined than for channelized turbidity currents.

Tectonic vs. Sea-level Controls

The two major controls on sedimentation on the distal Bengal Fan, at least from the early Miocene to Holocene, were Himalayan uplift (tectonics) and eustatic changes in sea level (Cochran, Stow, et al., 1989). However, it has proved impossible in this study to disentangle the effects of one from those of the other (Fig. 16).

In a general way, the dominance of silty turbidites with Himalayan signature through much of the Miocene and in the late Pleistocene is probably related to two distinct phases of Himalayan uplift (Gansser 1964, 1981) corresponding to beginning of motion on the main central thrust (MCT) at 18–20 Ma, and to the most recent phase of activity on the main boundary thrust (MBT) at about 1 Ma. Rapid sedimentation rates during these periods (Units V and II) and single-crystal dating results that indicate a short time period from uplift through erosion and transportation to deposition, both argue for strong tectonic influence on sedimentation. The very rapid sedimentation rate during most of the last 0.8 Ma, as seen at Site 717 in particular, can be correlated to the deposition of very thick molasse in the central Himalayas during the Pleistocene (Searle et al., 1987; Le Fort, 1989). However, the exact nature and timing of Himalayan uplift is still a matter of some controversy (see discussion in Cochran, this volume).

The composition of the silt fraction in the turbidites is seen to change systematically from the base to top of the sections examined (Yokoyama et al., this volume). That this can be closely related to uplift history in the Himalayas again emphasizes the importance of Himalayan events even some 4000 to 5000 km down the transport pathway.

On many deep-sea fans and other turbidite systems studied, a close correlation has been observed between eustatic sea-level fluctuation and the supply of coarse detritus via turbidity currents (e.g., Stow et al., 1983; Shanmugam and Moiola, 1986). There is no reason to suppose that the Bengal Fan should be any different, and when the most recent low-frequency curve of eustatic sea-level change is compared with the sedimentary record from the distal fan sites there is good correspondence in some but not all parts (Fig. 16). In particular, the mud-rich Units III and IV correlate with a period of generally higher sea level, at least initially. Higher relative sea levels would tend to trap the coarser grained material on the shelf areas and slow the overall rate of resedimentation to the deep fan. This in turn would have allowed for the greater influence of slumping and resedimentation from the southeast Indian and Sri Lankan margins, so that turbidites from these sources are interbedded with mud

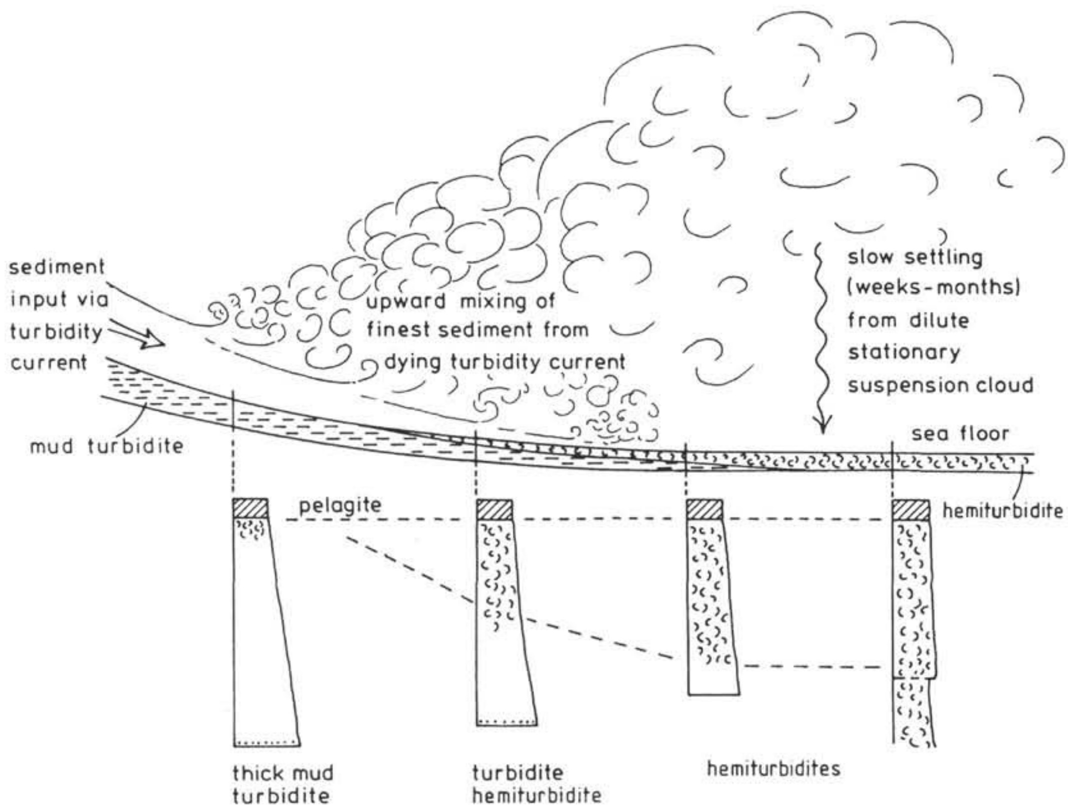

Figure 15. Schematic diagram of the hemiturbidite depositional process (see text for discussion).

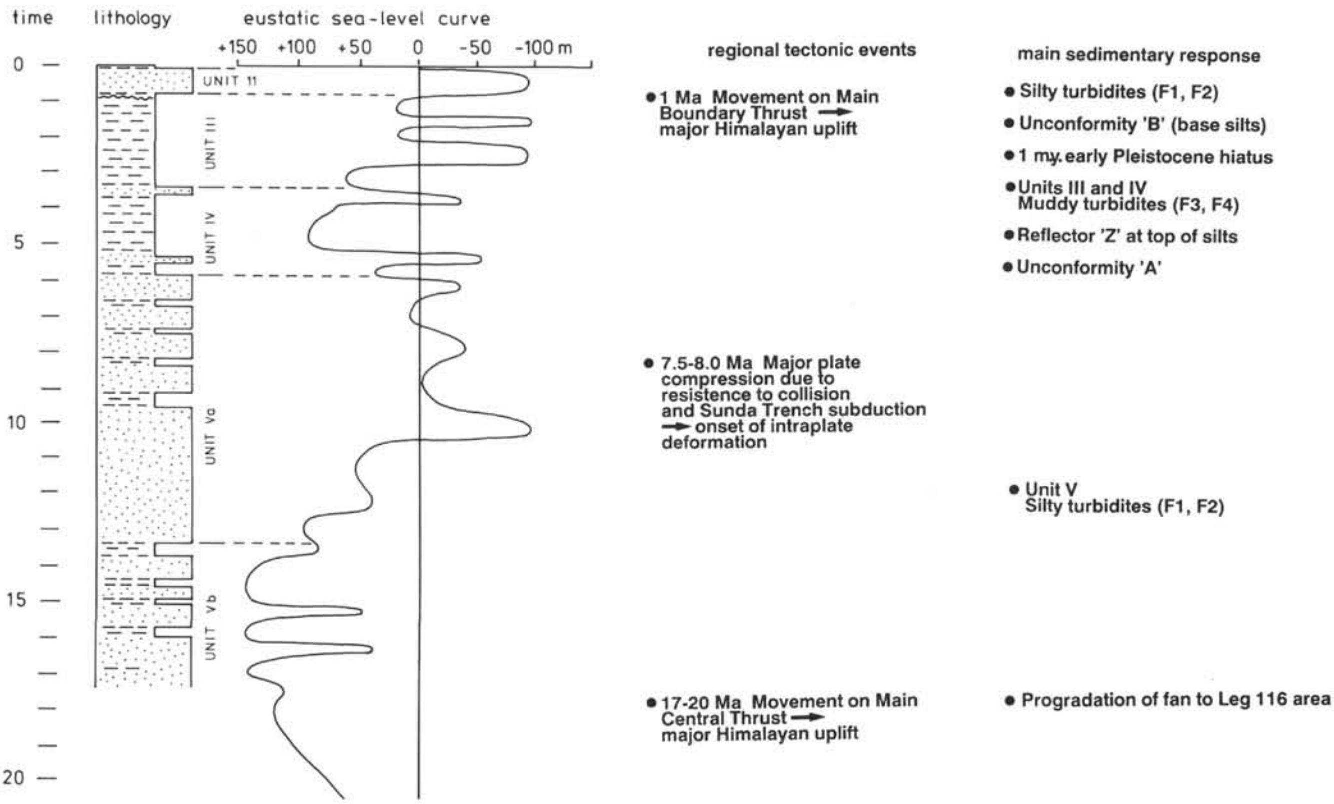

Figure 16. Summary lithostratigraphic section compiled from all three Leg 116 sites, compared with the eustatic sea-level curve (Haq et al., 1987), principal regional tectonic events, and sedimentary response on the distal Bengal Fan. Y-axis: time in Ma.

turbidites from the Ganges delta/shelf, as shown by compositional studies of both coarse and fine fractions (Brass and Raman, Bouquillon et al., Yokoyama et al., all this volume).

The onset of rapid, silt-rich turbidite sedimentation again in the late Pleistocene (Unit II) would certainly have been enhanced by lowered sea level at that time, even if Himalayan uplift were an equally or more important control. However, the mid-Miocene high stand and the many sea-level oscillations through the Pliocene-Pleistocene are not all directly reflected in the sedimentary record. This may be partly because low core recovery in the silty units decreases resolution but may also imply the overprint of a tectonic or other control.

Internal Fan Growth Controls

With a system the size and complexity of the Bengal Fan, there are many other factors that have to be taken into account when assessing the controls on sedimentation. Normal processes of fan growth, including channel avulsion and lobe switching, can markedly affect the pattern of sedimentation in one small area such as the part of the distal fan covered by this study. For example, the intervals of mud-rich deposition within the silty units and of silt-rich turbidites within the muddy units could be related to channel and lobe migration. It is also possible that a greater change in the supply direction of the main active channel or channels, for example directing sediment to the Nicobar rather than to the Bengal Fan, could have very significantly affected sedimentation in the study area. This process could equally well explain the deposition of the mud-rich Units III and IV, or account for the 1-m.y. Pleistocene hiatus encountered at all three sections (Gartner, this volume).

There have also been local effects related to intraplate deformation and motion on the faults. The marked reduction in the thickness of the upper units at Sites 718 and 719 relative to 717 (Fig. 3), is related to their higher position on the fault blocks. The thinning and pinching out of individual turbidites and the consequent microcycles of variation in turbidite thickness observed, can be explained by the existence of slight seafloor relief (say 10 – 50 m) along the protruding edges of fault blocks. The east-west trend of this relief presented an obstacle for the southward-flowing turbidity currents, which were either deflected or thinned and so deposited fewer and thinner turbidites higher up the blocks.

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Annex IN-22

D. K. Rea, "Delivery of Himalayan Sediment to the Northern Indian Ocean and its Relation to Global Climate, Sea Level, Uplift, and Seawater Strontium", in R. A. Duncan *et al.* (eds.), *Synthesis of Results from Scientific Drilling in the Indian Ocean*, 1992, pp. 387-402.

Delivery of Himalayan Sediment to the Northern Indian Ocean and its Relation to Global Climate, Sea Level, Uplift, and Seawater Strontium

DAVID K. REA

Department of Geological Sciences, The University of Michigan, Ann Arbor, MI, 48109-1063, USA

The mass accumulation rate of the terrigenous component of deep sea sediments has been quantified for eleven DSDP and ODP sites in the northern Indian Ocean. Depositional patterns at these sites all show very low input prior to 12 Ma, a five-fold increase in terrigenous flux starting 12 Ma, and distinct flux maxima in the late Miocene and the middle Pliocene. Combining the individual site records into one stacked, averaged and normalized record greatly improves the temporal definition of the overall depositional record. Peaks in sediment delivery clearly do not correspond either with Neogene sea-level changes nor with times of global climate change, implicating Himalayan uplift as the process that controls deposition in the northern Indian Ocean. The late Cenozoic uplift may have occurred in two stages, one in the late Miocene, 9 to 6 Ma, and a later mid-Pliocene phase from 4 to 2 Ma. Comparison of the sediment flux record to the seawater $^{87}Sr/^{86}Sr$ curve shows a distinct lack of correspondence, such that the timing and direction of changes in the slope of the $^{87}Sr/^{86}Sr$ curve do not correspond with the record of clastic input. Other processes influencing the Sr composition of seawater during the past 40 m.y. must be more important than previously considered: variation in sea-floor hydrothermal activity and/or important changes in the $^{87}Sr/^{86}Sr$ ratio of dissolved riverine strontium.

Introduction

The delivery of clastic sediments to the northern Indian Ocean from south-central Asia is, as for all sub-continental regions, controlled by some combination of uplift, changes in sea level, and the changes in global climates. If it is possible to sort out the effects of climate and sea level on this process, then a record of Himalayan uplift may be achievable. The uplift of the Himalayan ranges and Tibetan Plateau is of itself an important question in tectonics. Further, this uplift may have consequences that extend far beyond the mountainous regions of south-central Asia, consequences that may include ocean geochemistry [Raymo et al., 1988; Raymo, 1991; Richter et al., 1992], the initiation of Asian monsoonal atmospheric and oceanic circulation in the earlier part of the late Miocene [Prell and Kutzbach, 1991; Kroon et al., 1991], and even the mid-Pliocene onset of Northern Hemisphere glaciation [Ruddiman and Kutzbach, 1989]. If this tectono-climatic association is valid, then scenarios which call for modest middle Cenozoic uplift and very rapid late Cenozoic uplift are appropriate. Recent work has demonstrated that the rapid northward motion of the Indian subcontinent slowed markedly at about 55 Ma, presumably upon contact with Asia [Klootwijk et al., 1991, 1992], and that turbidite deposition began in the northern Indian Ocean in early Miocene [Cochran, 1990] or perhaps Oligocene [Kolla and Coumes, 1987] time. Many authors suggest relatively rapid uplift since about the middle Miocene [Gansser, 1964, 1981; Zeitler, 1985; Molnar et al., 1987; Searle et al., 1987; Copeland and Harrison, 1990], but there is not yet a consensus on the temporal details of the mid-to late-Cenozoic uplift of the Himalayan Mountains [see above references and Ruddiman et al., 1989; Cochran, Stow et al., 1990; Molnar and England, 1990; Richter et al., 1991; Harrison et al., 1992]. Quantification of the oceanic depositional record permits an overview of the sediment delivery to the northern Indian Ocean that integrates all the controlling influences of uplift, climate, and sea-level.

Determination of mountain uplift history by investigation of the clastics shed therefrom is a time-honored method in geological sciences. The enormous sedimentary deposits of the Indus and Bengal fans are the direct result of Himalayan erosion and the construction of these fans should contain an unambiguous record of sediment supply from the Indian subcontinent [Curray and Moore, 1971; Kolla and Coumes, 1987]. Here I present the geologic history of the flux of clastic sediments to the northern Indian Ocean. The record of sediment delivery thus obtained can be compared to well known records of sea-level change and of climate change in order to discern any apparent relationships between them. The data presented below are appropriate to answering questions on timescales of hundreds of thousands of years and longer. Thus processes like the Plio-Pleistocene sea-level variations associated with orbital-timescale changes in ice volume will not be individually discernable in our results. On a longer timescale, however, such periods of rapid and large sea level changes should result in enhanced sediment supply to the deep sea.

Determination of Sediment Fluxes

The traditional value for sediment deposition rate is the linear sedimentation rate (LSR), commonly given in centimeters per thousand years (cm/ky), or meters per

Synthesis of Results from Scientific Drilling in the Indian Ocean
Geophysical Monograph 70

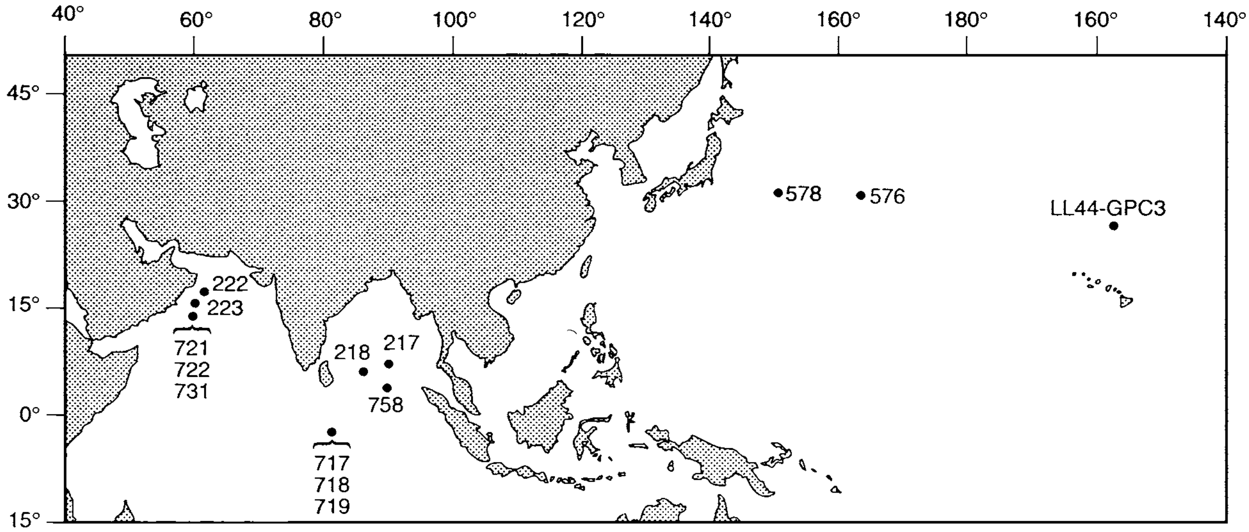

Fig. 1. Index map of the northern Indian Ocean showing locations of drill sites examined for sediment flux data.

million years (m/my). These values, however, have severe limitations and are useful only as a gross descriptor of sedimentation. A much more useful value to describe sedimentation is the mass accumulation rate (MAR). This value is a quantification of the true flux of sediment to the ocean floor measured in mass per unit area and unit time, commonly $g(cm^2{}_*ky)^{-1}$. The MAR is the product of the linear sedimentation rate and dry bulk density (DBD):

$$MAR(g(cm^2{}_*ky)^{-1}) = LSR(cm/ky) \times DBD(g/cm^3) \quad (1)$$

These values have the properties of accounting for downcore compaction via the bulk density values, being comparable from site to site and ocean to ocean, and being useful for any quantitative mass balance calculation. Furthermore, since the relative abundance of any minor sediment component fluctuates in response to and antithetically from the abundance of any major sedimentary component, the only way to examine the true variability of all the sedimentary components in a core is to determine the MAR of each one:

$$MAR_{component} = MAR_{total} \times wt\%_{component} \quad (2)$$

The Deep Sea Drilling Project and its successor the Ocean Drilling Program have recovered cores from eleven drill sites in the northern Indian Ocean (Figure 1; Table 1) which permit quantification of the sediment input into that ocean. MAR values for the terrigenous sediment component in each of these drill sites were determined using the general methodology established by Rea and Thiede [1981]. For each sediment core recovered, nominally 9.5 meters long, the percentage of terrigenous material was taken from the original lithologic, smear-slide descriptions [von der Borch, Sclater et al., 1974; Whitmarsh, Weser, Ross et al., 1974; Cochran, Stow et al., 1989; Prell, Niitsuma et al., 1989]. Wet-bulk density data were taken from the shipboard GRAPE (Gamma Ray Attenuation Porosity Evaluator) measurements [ibid.] and converted to DBD values [Rea and Thiede, 1981]. Linear sedimentation rates were determined from comparison of the nannofossil biostratigraphy from the Leg 22 [von der Borch, Sclater et al., 1974] and 23 [Whitmarsh, Weser, Ross et al., 1974] site chapters with the timescale of Berggren et al. [1985]. For the Leg 116 sites I employed the nannofossil biostratigraphy presented by Gartner [1990] and for the Leg 117 sites I used the nannofossil stratigraphy of Sato et al. (1991). The data for Site 758, Leg 121, are from Hovan and Rea [unpublished manuscript, 1992]. Sedimentation rates are determined on a zone-by-zone basis and are well constrained for the Leg 116, 117 and 121 sites but the discontinuous coring practices of the earlier cruises entails deterioration of this type of data. For the Leg 22 and 23 sites a downcore depth-biostratigraphic zone plot was constructed and used to derive a conservative LSR model that had the fewest slope (rate) changes. Every sediment core was assigned an age based upon linear interpolation within the appropriate nannofossil zone. One terrigenous MAR value was calculated for each core from the average values of DBD, LSR and percent terrigenous component for that 9.5-meter interval. The accuracy estimated for these types of calculations is approximately ±25% with much of that error stemming from the smear-slide abundance estimates. This degree of accuracy is not a problem in interpretation as all sites show many-fold to order of magnitude changes in terrigenous MAR (Figures 2 and 3).

The deeper sites investigated here, those situated directly on the Indus (222, 223) and Bengal (218, 717, 718, 719) fans, are dominated by turbidites and are characterized by silts and sands. The sites on Owen Ridge (721, 722, 731) and Ninetyeast Ridge (217, 758) contain pelagic carbonate with a minor silt/clay component. This minor terrigenous component is the result of Himalayan-derived hemipelagic deposition at the northern Ninetyeast Ridge and of a

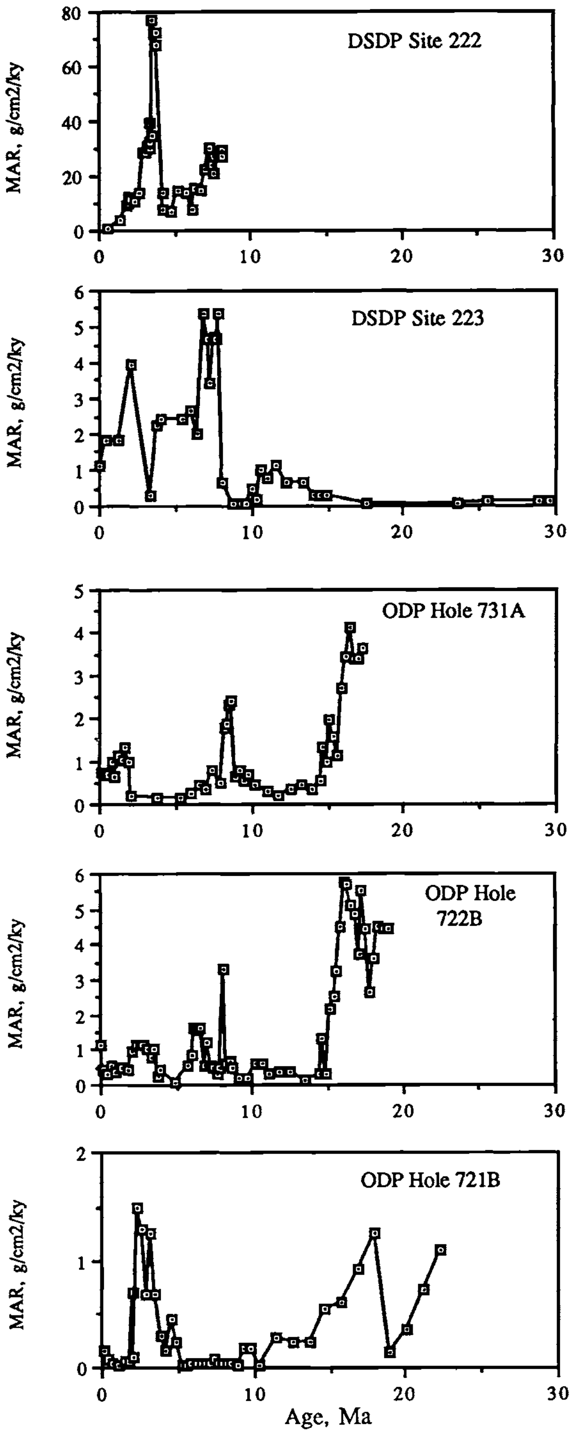

Fig. 2. Mass accumulation rates (MAR) of terrigenous sediments in drill sites on the Indus Fan. Note variable vertical scales.

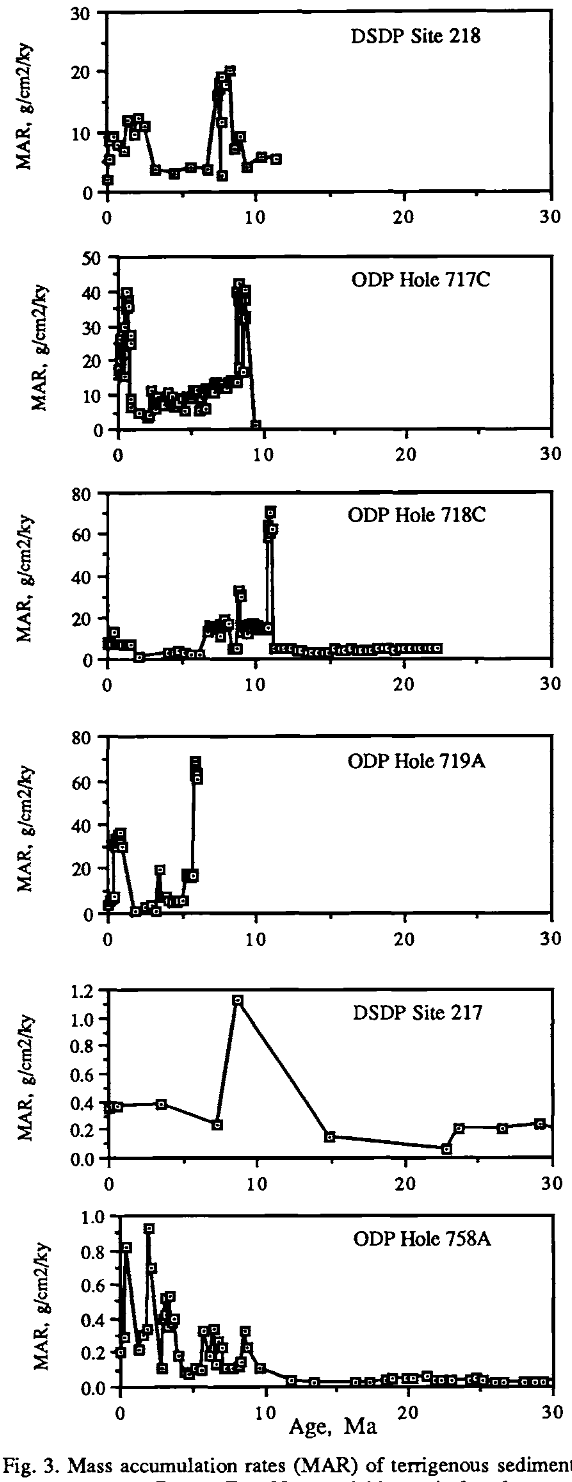

Fig. 3. Mass accumulation rates (MAR) of terrigenous sediments in drill sites on the Bengal Fan. Note variable vertical scales.

combination of hemipelagic and eolian material on Owen Ridge [Peirce, Weissel et al., 1989; Prell, Niitsuma et al., 1989].

The question of a single site on a deep-sea fan, or anywhere, giving a reliable overview of the construction of the entire deposit is relevant. In approaching this question one can make two observations and one additional calculation. The observations are that the three sites drilled within 10 km of each other on the Bengal Fan (717, 718, 719) show similar sedimentation patterns (Figure 3) indicating this problem to be of far smaller magnitude than assumed previously [Cochran, 1990]. Secondly, the

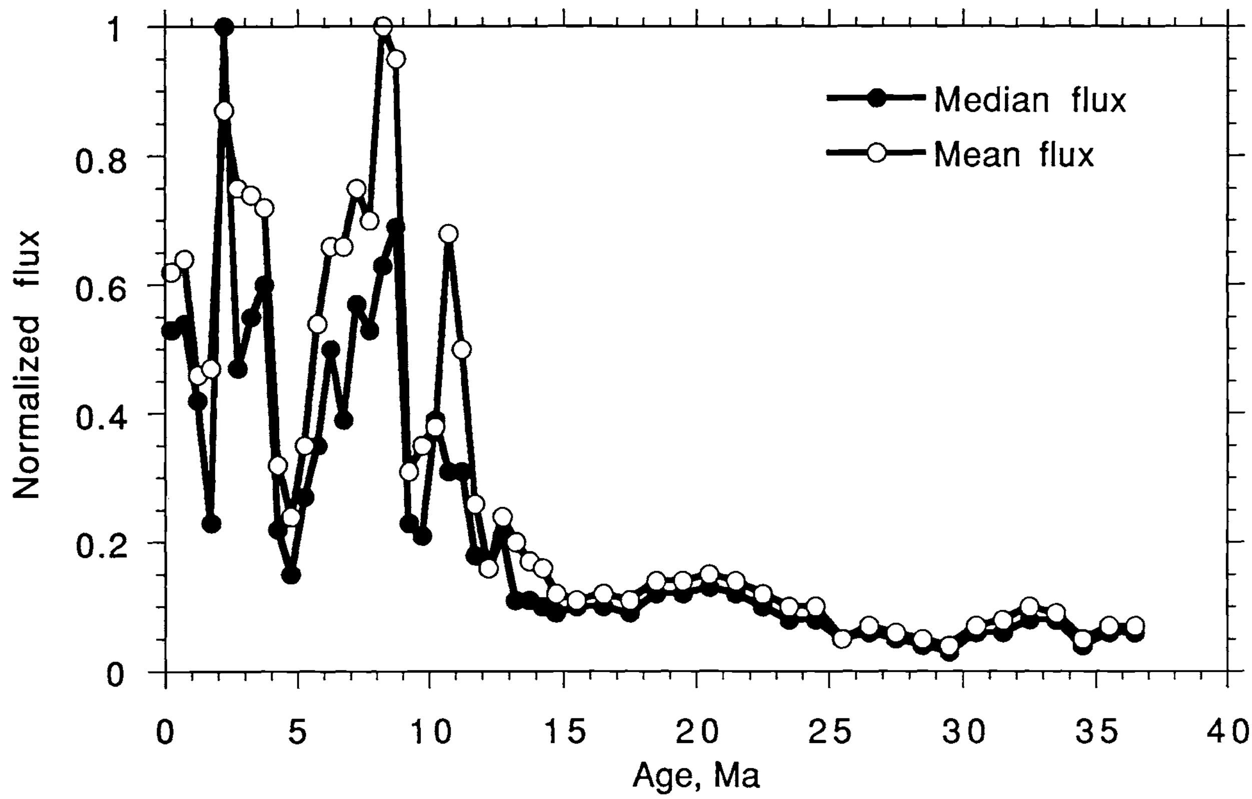

Fig. 4. Normalized, stacked and averaged sediment delivery from the Himalayas to the northern Indian Ocean. Note maxima at 2 to 4 Ma and 6 to 9 Ma.

general pattern of the individual flux records (Figures 2 and 3) are all reasonably similar suggesting similar depositional histories at all sites.

To further elucidate the true temporal pattern of sediment flux to the northern Indian Ocean, I have normalized, stacked and averaged the flux data from all sites. The time interval chosen is 0.5 m.y. for sediments less than 15 m.y. old, and 1.0 m.y. for older sediment. For every site, the flux data for each time interval were averaged and then normalized such that the highest flux at any site has a relative value of 1.0 and all other values are less. The normalized values from all eleven sites are summed for each time interval and divided by the number of sites contributing to the sum. This procedure serves to reduce the noise, often from biostratigraphic inadequacies, and enhance the signal in any data set by a factor equal to the square root of the number of data points included in the average. Commonly 8 or 9 values from the 11 sites were included in every 0.5 m.y. average, enhancing the signal contained therein by a factor of 2.8 to 3.0. Only four sites are useful for times older than 15 Ma. Inherent in this procedure is the assumption that the hemipelagic sites provide equally valid temporal information as the turbidite sites. The final stacked and averaged values were again normalized to a maximum value of 1.0 (Table 2). It is possible to do the same calculations using the median value of each time period. Using the median values has the advantage of excluding extremes that may be included in a mean value, but the result will display somewhat more statistical variability [Dean and Dixon, 1951]. Figure 4shows the results of these determinations. The normalized median flux values display a single-value peak at 2.25 Ma that is 30% greater than the next highest point and thus serves to reduce all other relative values. The normalized mean fluxes have several higher values; these normalized mean fluxes will be the basis for the temporal interpretations that follow.

TERRIGENOUS SEDIMENT FLUX

The flux data (Figures 2 and 3) indicate two ocean-wide periods of enhanced terrigenous sediment flux to the region of the Indus and Bengal fans. During the lower portion of late Miocene time clastic fluxes increased 2.5- (Site 223, Figure 2) to 13-fold (Site 719, Figure 3) over the average values at those sites. This late Miocene pulse occurs in ten of the eleven sites examined. It is missing only from Hole 721B (Figure 2) which is at a depth of 1945 meters on the Owen Ridge and is the shallowest of the sites studied. At Site 718, one of three sites on the distal Bengal Fan, this pulse appears to begin a bit earlier than at any of the other sites, with increased fluxes beginning at about 11 Ma. All eleven sites exhibit a Plio-Pleistocene pulse of terrigenous input, commonly of somewhat lesser magnitude than the late Miocene pulse, with generally a two- to five-fold increase in the MAR of terrigenous sediment (although at Sites 222 and 721 [Figure 2] the increase is more than an

TABLE 1. Drillsites Examined for Terrigenous Flux Information.

Leg	Hole	Latitude	E. Long	Depth (m)	Fan	Record length
117	721B	16°07.8'N	59°51.9'	1945	Indus (h)	22.3 Ma, 424 m
117	722B	16°37.3'N	59°47.8'	2028	Indus (h)	19.0 Ma, 566
117	731A	16°28.2'N	59°42.2'	2366	Indus (h)	17.4 Ma, 409 m
23	222	20°05.5'N	61°30.6'	3546	Indus (t)	8.2 Ma, 1300 m
23	223	18°45.0'N	60°07.8'	3633	Indus (t)	58 Ma, 665 m
22	217	08°55.6'N	90°32.3'	3030	Bengal (h)	62 Ma, 402 m
22	218	08°00.4'N	86°17.0'	3737	Bengal (t)	11.5 Ma, 773 m
116	717C	00°55.8'S	81°23.4'	4735	Bengal (t)	9.4 Ma, 828 m
116	718C	01°01.3'S	81°24.1'	4730	Bengal (t)	22.3 Ma, 940 m
116	719A	00°57.7'S	81°24.0"	4737	Bengal (t)	6.0 Ma, 460 m
121	758A	05°23.4'N	90°21.7'	2924	Bengal (h)	80 Ma, 677 m

Hemipelagic sites designated "h", turbidite sites designated "t".

order of magnitude). Sediments deposited during these two times of enhanced flux contain a mineral suite that corresponds to the eroding rocks of the Higher Himalayas [Brass and Raman, 1990; Yokoyama et al., 1990; Amano and Taira, 1992].

There are several other inferences concerning the depositional processes of this region that can be drawn from the flux information. These data support the conclusion of Cochran [1990] that, when studied on this tectonic timescale, local variability is only a minor concern. The spike at Site 718 to MAR values of about 70 $g(cm^2{}_*ky)^{-1}$ at 11 Ma (Figure 3) is all in one nannofossil zone and may be the consequence of poorly constrained biostratigraphy (and thus an extreme LSR), but the general elevation above background level that occurs about 11 Ma is real for that site. There is not quite enough information at nearby Hole 717C to discount firmly this observation at Site 718. Further, because there are limited data available for this particular time interval, this one high value is the entire reason for the relative maxima at 10.5 to 11.5 Ma on the normalized mean flux curve (Figure 4).

The three sites drilled during Leg 117 on Owen Ridge, Sites 721, 722, and 731, all exhibit much higher clastic fluxes prior to 14 Ma (Figure 2). The Leg 117 Shipboard Scientific Party [1989] recognized that the lowermost sedimentary unit in each of these sites consisted of turbidites of the Indus Fan, and reasoned that the middle Miocene reduction in turbidite input here was the result of tectonic uplift of the Owen Ridge raising the sea floor above the level of turbidite deposition and not an indication of any change in clastic flux to the sea floor. It is important to determine whether these lower and middle Miocene higher flux values represent normal sedimentation on the Indus Fan or whether they may reflect a true pulse of sediment from the Indus drainage basin. The clay mineralogy of this lowermost unit is distinctly different from that of the overlying Owen Ridge units and similar to that of the Indus Fan sites [Debrabant et al., 1991]. Flux values of the Owen Ridge turbidites, a few $g(cm^2{}_*ky)^{-1}$, are similar to the average background flux values at Indus Fan Sites 222 and 223 (see Figure 2) and thus are sedimentologically unremarkable in the fan environment. Further, neither nearby Indus Fan Site 223 nor any of the Bengal Fan sites show any indication of a depositional pulse during the lower or middle Miocene. Thus the interpretation of the Leg 117 Shipboard Scientific Party [1989] regarding the terrigenous sediments at Owen Ridge seems valid, and only the upper hemipelagic portions of those three sites are included in the normalization and averaging procedure. Various Leg 117 authors have suggested an Arabian-eolian source for the clays in the pelagic carbonates above the Owen Ridge turbidites [Clemens and Prell, 1991; deMenocal et al., 1991]. This may be largely correct, but the terrigenous flux maxima in the early portion of the late Miocene and in the Plio-Pleistocene that occur on Owen Ridge are indistinguishable in age from those fan-related maxima seen at all the other sites and probably represent Indus-derived hemipelagic input.

Temporal Pattern of Sediment Flux and Possible Controlling Factors

The normalized, stacked and averaged MAR values exhibit two distinct sedimentary regimes in the northern Indian Ocean during middle and late Cenozoic time (Figure 4). For the past 12 m.y. the region has been characterized by relatively high and variable mass accumulation rates of terrigenous sediment; the earlier record is one of low clastic input. Since 12 Ma, the flux of sediment to the northern Indian Ocean has, on the average, increased five-fold over earlier values. Two periods of relatively high sediment input dominate the late Cenozoic record, at 2 to 4 Ma and 6 to 9 Ma . Lesser peaks are found at 0 to 1 Ma and 10.5 to 11.5 Ma. The peak at about 11 Ma derives from the single very high flux value at Site 718 and is therefore somewhat less reliable than the others.

Other information from both terrestrial and marine settings also point to the main sedimentary pulses occurring in the late Miocene and Plio/Pleistocene, and not earlier. Amano and Taira [1992], in a study of the heavy mineral assemblages of Bengal Fan Sites 717, 718 and 719, associate minerals derived from the erosion of the

TABLE 2. Normalized Median and Mean Sediment Fluxes.

Age interval	Median flux	Mean flux
0.0-0.5	0.532	0.619
0.5-1.0	0.540	0.637
1.0-1.5	0.419	0.462
1.5-2.0	0.226	0.475
2.0-2.5	1.000	0.872
2.5-3.0	0.468	0.747
3.0-3.5	0.548	0.739
3.5-4.0	0.605	0.720
4.0-4.5	0.218	0.323
4.5-5.0	0.145	0.236
5.0-5.5	0.266	0.348
5.5-6.0	0.355	0.543
6.0-6.5	0.500	0.662
6.5-7.0	0.387	0.664
7.0-7.5	0.573	0.749
7.5-8.0	0.532	0.702
8.0-8.5	0.629	1.000
8.5-9.0	0.694	0.949
9.0-9.5	0.226	0.309
9.5-10.0	0.210	0.346
10.0-10.5	0.387	0.380
10.5-11.0	0.306	0.685
11.0-11.5	0.306	0.503
11.5-12.0	0.177	0.262
12.0-12.5	0.161	0.157
12.5-13.0	0.210	0.242
13.0-13.5	0.113	0.198
13.5-14.0	0.113	0.166
14.0-14.5	0.097	0.159
14.5-15.0	0.089	0.122
15.0-16.0	0.097	0.113
16.0-17.0	0.105	0.117
17.0-18.0	0.089	0.107
18.0-19.0	0.121	0.141
19.0-20.0	0.121	0.141
20.0-21.0	0.129	0.147
21.0-22.0	0.121	0.143
22.0-23.0	0.105	0.124
23.0-24.0	0.081	0.096
24.0-25.0	0.081	0.102
25.0-26.0	0.048	0.051
26.0-27.0	0.065	0.068
27.0-28.0	0.048	0.062
28.0-29.0	0.040	0.046
29.0-30.0	0.032	0.040
30.0-31.0	0.056	0.068
31.0-32.0	0.065	0.077
32.0-33.0	0.081	0.102
33.0-34.0	0.081	0.091
34.0-35.0	0.040	0.048
35.0-36.0	0.065	0.068
36.0-37.0	0.056	0.070

Higher Himalayas only with the large late Miocene and Plio/Pleistocene (Figure 3) sedimentary pulses and interpret two stages of uplift. Kolla and Coumes [1987] in a seismic-profile study of the Indus Fan note that turbidite deposition may have been occurring since the Oligocene, but that the two major depositional episodes occurred in late Miocene and Plio/Pleistocene time. In a study of the age and deposition rate of the Siwalik deposits of Pakistan, Johnson et al. [1985] showed continuous deposition since the early Miocene with a pronounced increase in sedimentation rate in the earliest part of the late Miocene. The heavy mineral assemblage of the Siwalik units studied shows a sudden increase in metamorphic-related minerals coincident with the rapid increase in sedimentation rate, suggesting the unroofing of a newly-exposed metamorphic terrane [Johnson et al., 1985]. Together, these studies and the information compiled above and shown on Figure 4 all show a similar depositional history. Terrigenous clastics were being deposited at continental and marine sites by at least late Oligocene time. Major increases or pulses in this process occurred in late Miocene and Plio/Pleistocene time. None of the records of sediment deposition show indications of important depositional pulses at any time earlier than about the middle/late Miocene boundary.

To determine the processes or factors that may play a determining role in causing the flux patterns observed it is appropriate to examine other records of global change. Two such records pertain. The first is the oxygen isotope record of Cenozoic climate change. The $\delta^{18}O$ record shown on Figure 5 is that compiled from the benthic foraminifer *Uvigerina* sp. for ODP Sites 756, 757 and 758 on the Ninetyeast Ridge [Rea et al., 1991; Hovan and Rea, unpublished manuscript, 1992]. This plot shows the increases in $\delta^{18}O$ values associated with important climatic changes at 36, 13.5 and 2.5 Ma. These events are considered to reflect initiation of significant cooling and ice accumulation on Antarctica at the time of the Eocene /Oligocene boundary, an important cooling and/or enhancement of Antarctic ice volume in the middle Miocene, and the onset of Northern Hemisphere glaciation in the late Pliocene [Kennett, 1982].

The Indian Ocean isotope data show the three important changes quite clearly (Figure 5). If these times of important climate change have had an effect on the delivery of sediment from the Himalayas to the Indian Ocean [Molnar and England, 1990] there should be some clear temporal correspondence between plots of sediment delivery and of $\delta^{18}O$. If one compares these patterns for the length of the record (Figure 6) no temporal correspondence is observed. The early Oligocene cooling and increase in Antarctic ice volume appears to have had no effect on the delivery of sediment from the Himalayan region to the ocean. The isotope event at 13.5 Ma precedes the earliest, minor flux event at 11 Ma by more than 2 million years, an awkwardly long time if climate is the determining factor in the erosion of pre-existing highlands. Details of these two records (Figure 7) further emphasize this non-correspondence. The major late Miocene flux peak bears no relation to the

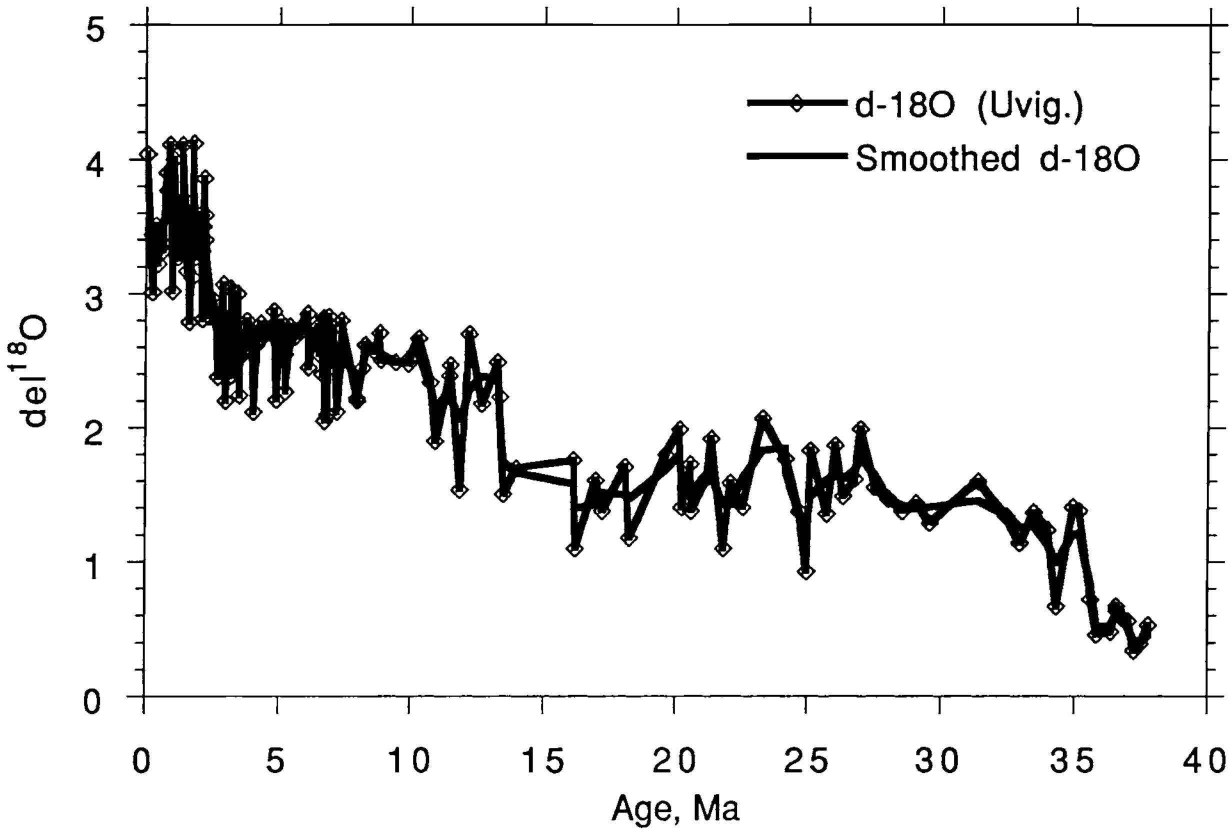

Fig. 5. Oxygen isotopic values of the benthic foraminifer *Uvigerina* sp. from three Indian Ocean drill sites on Ninetyeast Ridge: Sites 756, 757, and 758.

relatively unchanging isotope record at that time and the Pliocene flux maxima occurs before the late Pliocene $\delta^{18}O$ shift that signals the onset of Northern Hemisphere glaciation. These comparisons seem to eliminate global climate changes as a determining factor for erosion of the Himalayas.

Changes in global sea level play an important role in the sediment input to the oceans. Times of rising and high sea level generally correspond with times of reduced sediment delivery to the deep sea, and times of falling, rapidly fluctuating, or low sea level generally correspond with times of enhanced input of sediment to the deep sea [Haq et al., 1987; Greenlee and Moore, 1988]. Sea level fluctuations are probably not important to the record of Indian Ocean sedimentation prior to 12 Ma; the geologic history of sea level for the later Neogene, however, may be quite important. Relative sea level records determined by Haq et al. [1987] and by Greenlee and Moore [1988] are shown on Figure 8. These records show higher sea levels in the middle Miocene and a distinct lowstand at 10 Ma. A broad highstand between 9 and 6 Ma is followed by rapidly fluctuating sea levels between 6.5 and 3.5 Ma. The record of the last 2.5 million years is not shown on these sorts of curves but would be represented by dozens of fluctuations of 50 to 100 meters amplitude. As the Greenlee and Moore [1988] record is a bit more detailed, I use it to compare with the normalized sediment flux pattern for the past 15 m.y. (Figure 9). This comparison shows that the sea-level fall to the 10 Ma lowstand corresponds to the modest flux maximum at about 11 Ma. The highstand at 9 to 6 Ma, however, is exactly coincident with the time of maximum sediment input to the northern Indian Ocean, opposite to the expected relationship. Further, the time of rapidly fluctuating sea levels between 6 and 4 Ma, which should be optimal conditions for sediment delivery to the sea floor, are the time of minimal terrigenous relative fluxes. Relatively high fluxes occur during the following period of reduced sea level change, and the past 2.5 m.y which should be a time of high sediment input is characterized by relative fluxes lower that either of the two major peaks (Figure 9). Since sea level fluctuations and sediment delivery patterns are generally opposite the normal, well-understood, relationship, the conclusion is that sea level does not control the delivery of sediment to the northern Indian Ocean.

Comparison of the sediment flux data to representations of global climate and of sea level indicate that these important aspects of the earth's environmental systems do not control sediment input to the northern Indian Ocean. The dominant pattern of flux maxima at 2 to 4 Ma and 6 to 9 Ma result from another process; the only remaining large scale event that could be responsible for the observed pattern is the late Cenozoic uplift of the Himalayan ranges and Tibetan Plateau. Sediments associated with each of

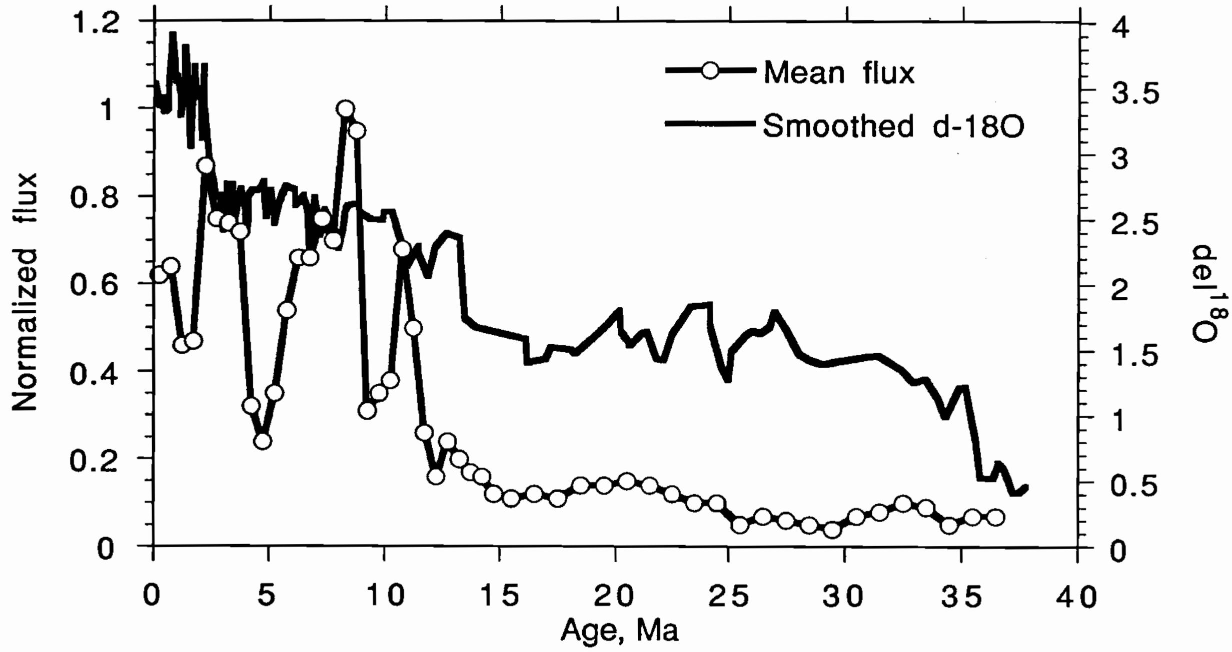

Fig. 6. Comparison of the smoothed oxygen isotope record and the normalized mean sediment flux record in the northern Indian Ocean.

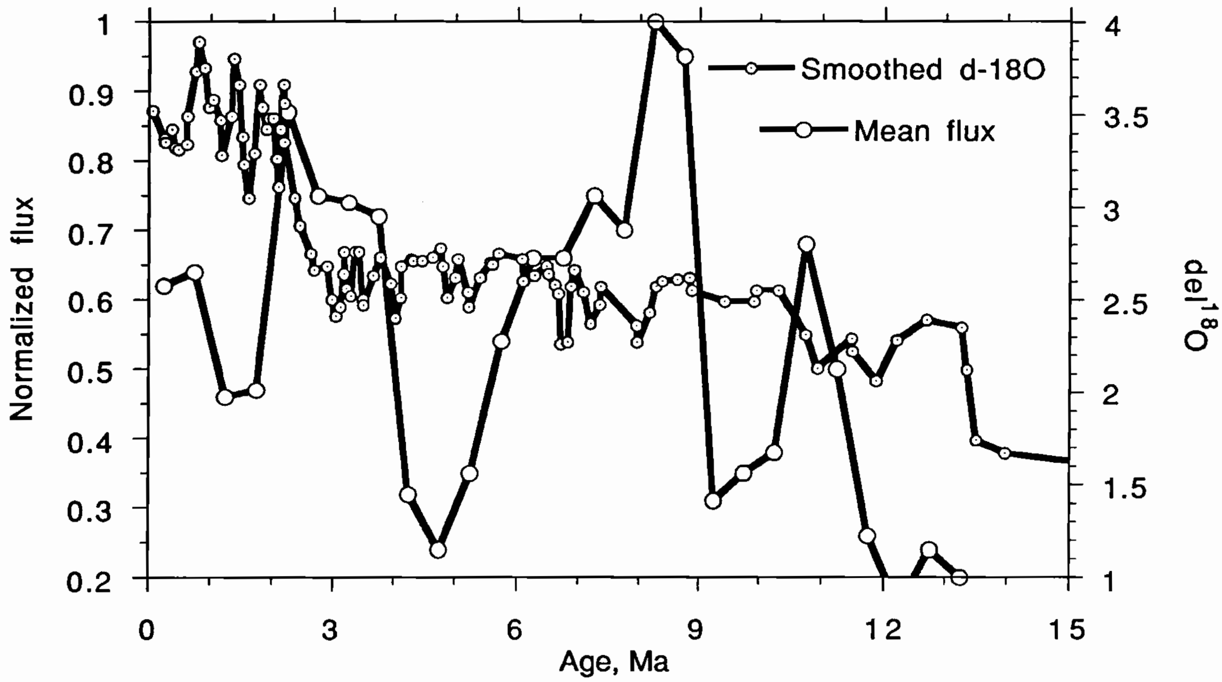

Fig. 7. Details of the Neogene portion of the smoothed oxygen isotope record and the mean sediment flux record. Note that the times of climate change at 13.5 Ma and 2.5 Ma are not associated with any lasting increases in sediment flux.

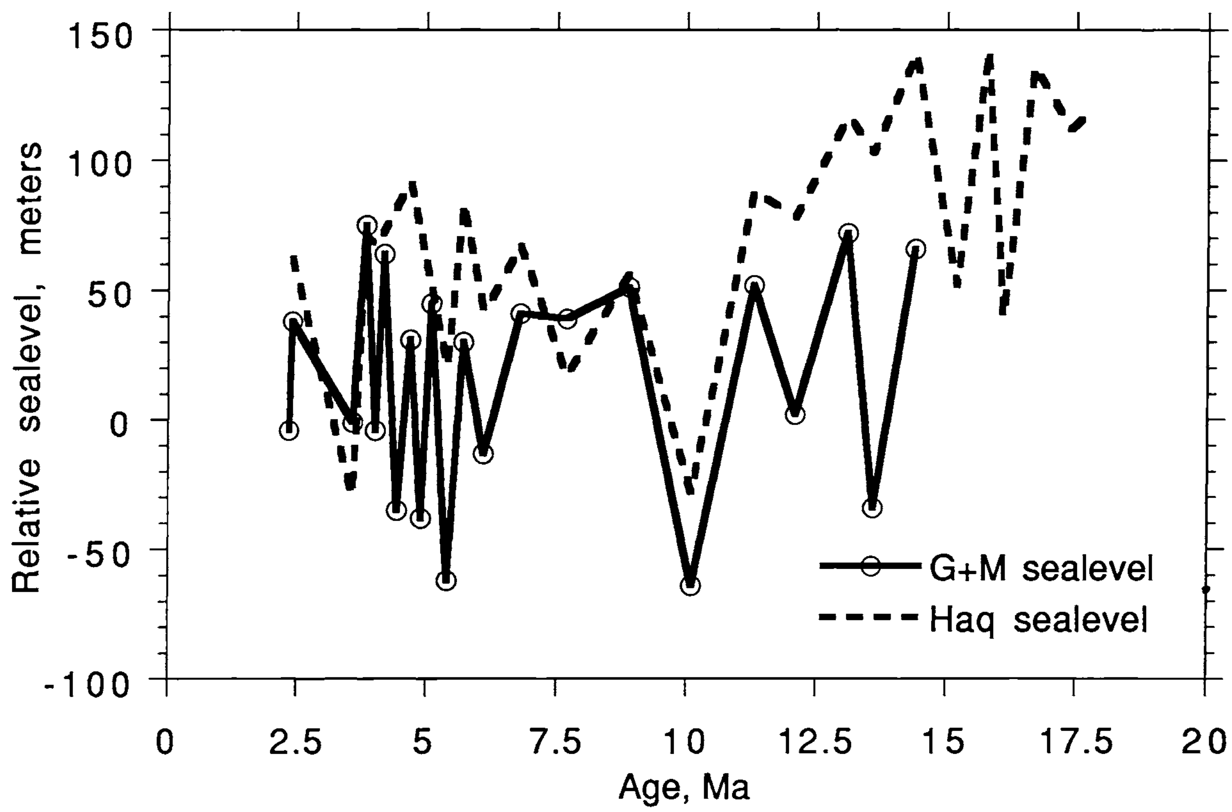

Fig. 8. Neogene relative sea level curves from Haq et al. [1987] and Greenlee and Moore [1988]. Note falling sea level from 11 to 10 Ma and time of stable sea level from 9 to 6 Ma.

these pulses have both clay and heavy mineral assemblages that can be associated with the eroding Himalayas. No evidence of similar sedimentary pulses occur at any time earlier in the Cenozoic.

The mass accumulation rates of terrigenous sediments entering the northern Indian Ocean (Figures 2 and 3) and the overall temporal pattern of their variability (Figure 4) provide strong support for theories of rapid uplift of the Himalayas during the late Cenozoic [Zeitler, 1985; Molnar et al., 1987; Amano and Taira, 1992]. The data do not support suggestions of widespread uplift and erosion beginning in early Miocene time [Copeland et al., 1987; Copeland and Harrison, 1990; Richter et al., 1991, 1992]. The late Cenozoic uplift occurred in two distinctly separate stages, one at about 9 to 6 Ma and a second 4 to 2 Ma. The earlier uplift may have served to enhance land-sea contrast, thus significantly strengthening the intensity of the Asian monsoons in the early part of late Miocene time [Prell and Kutzbach, 1991; Kroon et al., 1991]. The mid-Pliocene uplift began before and ended after the onset of Northern Hemisphere glaciation. Thus a causal relationship [Ruddiman and Kutzbach, 1989] is not clearly demonstrated, although depending on threshold assumptions, such a relationship may not be inconsistent with the information presented.

A Supplementary Section on Seawater Strontium

The strontium isotopic composition of seawater has been getting steadily more radiogenic since the middle Eocene (Figure 10). This curve is the integrated result of three fluxes: the input of relatively light strontium into the ocean from hydrothermal and other basalt-related sources, the input of relatively heavy strontium from continental sources, and the input of Sr with near-seawater isotopic values from the dissolution of marine carbonates [DePaolo, 1986; Palmer and Edmond, 1989]. This increasingly radiogenic nature of the seawater Sr curve has been related to enhanced erosion of and runoff from continents during the later portions of the Cenozoic [DePaolo, 1986; Raymo et al., 1988; Hodell et al., 1990; Raymo, 1991]. Hodell et al. [1990, 1991] and Richter et al. [1992], noting that the runoff from the Himalayan region is much more radiogenic than anywhere else [Palmer and Edmond, 1989; Krishnaswami et al., 1992], suggested that for this reason, and since southern Asia is the predominant sediment source to the world ocean, the record of input of strontium to the ocean from the Himalayan region would be of fundamental importance to the Cenozoic $^{87}Sr/^{86}Sr$ history.

The important changes in the seawater strontium curve occur in the middle Eocene, about 42 Ma, when the curve steepens abruptly, and in the middle Miocene, at about 16 Ma, when the slope becomes more gentle (Figure 10). Another steepening of the gradient may begin about 2.5 Ma. The sundry students of strontium have assumed that the

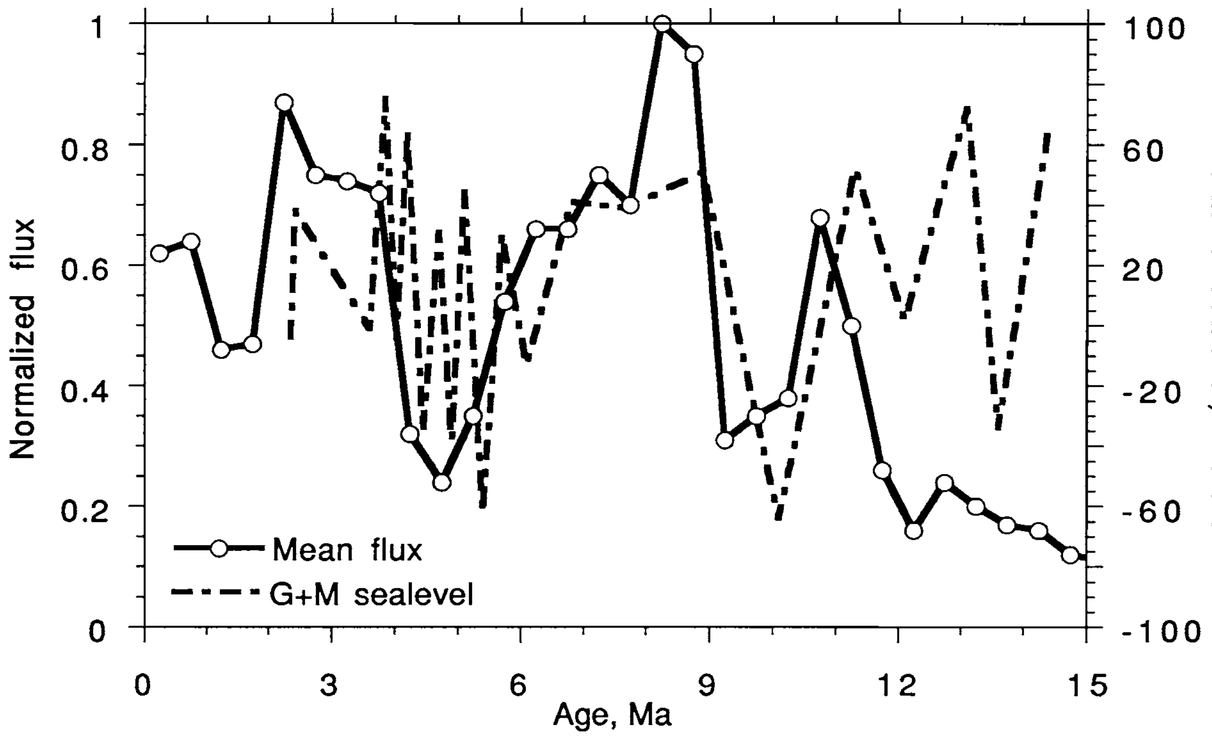

Fig. 9. Comparison of the sea level record of Greenlee and Moore [1988] with the normalized mean sediment flux record in the northern Indian Oce Falling sea level at 10-11 Ma is associated with minor sediment flux peak, but the major flux peak at 6-9 Ma occurs at a time of high sea level and the following flux minima occurs when sea level is lower and highly variable. The last 2.5 Ma is a time of rapid and large variations in sea level but this is not reflected in the sediment delivery curves.

flux of hydrothermal strontium has changed little since the middle Eocene and interpreted the data to represent changing input rates of continentally-derived radiogenic strontium into the ocean. The information gathered and calculated for the study of Himalayan sediment delivery can be compared with the seawater $^{87}Sr/^{86}Sr$ history to observe whether any temporal correspondence occurs (and remembering that the residence time of Sr in the oceans is on the order of 2.5 m.y. [Hodell et al., 1990]).

Comparison of the seawater strontium curve to the record of Himalayan sediment delivery to the Indian Ocean shows a poor correspondence (Figure 11). The most rapid increase in the relative amount of radiogenic strontium in the ocean occurs during times of relatively quite low sediment delivery. The $^{87}Sr/^{86}Sr$ slope decrease at 16 Ma precedes by a few million years the five-fold late Miocene increase in sediment input. Further, this slope change is in the "wrong" sense - towards the less radiogenic end-member at at time when the world-wide continental input of material to the ocean is increasing notably (Raymo et al., 1988). Comparison of the data spanning just the past 15 m.y. (Figure 12) shows that this unanticipated relationship is evident in the details of the data from Miocene and younger sediments. The times of high sediment flux, 9 to 6 and 4 to 2 Ma, are characterized by level or even declining $^{87}Sr/^{86}Sr$ values. Times of relatively reduced sediment delivery are characterized by more steeply rising values (Figure 12). So the expected correlation of the $^{87}Sr/^{86}Sr$ slope with the oceanic flux of continentally derived material is not achieved either in the long or medium time frame.

The highly radiogenic isotopic values of the dissolved Sr in Himalayan rivers derive from outcrops of Precambrian granites and gneisses in the Ganges drainage basin [Krishnaswami et al., 1992]. If the erosion of these rocks is a controlling factor in the shape of the seawater strontium curve then such erosion has been greatly reduced since 16 Ma, in contrast both to the overall sediment delivery information (Figure 11) and to the data of Amano and Taira [1992] which show erosion of these same sorts of rocks to be enhanced during the late Miocene and Plio/Pleistocene depositional pulses. It seems unlikely that the erosion of these granites and gneisses explains the steep portion of the Cenozoic seawater strontium curve; perhaps it may bear on the more modest variability since 16 Ma (Figure 12).

The $\delta^{18}O$ curve of global climate (Figure 5) shows distinct changes which denote times when climate deterioration presumably has enhanced chemical and physical weathering of the continents, resulting in more sediment delivery to the ocean, although we observed above that this correspondence does not work well for the Himalayan region. Comparison of the $^{87}Sr/^{86}Sr$ curve with the oxygen isotope curve (Figure 13) shows apparently similar problems. The slope change in strontium isotope values begins several million years before the important climate change at the end of Eocene time. I note here, however, that

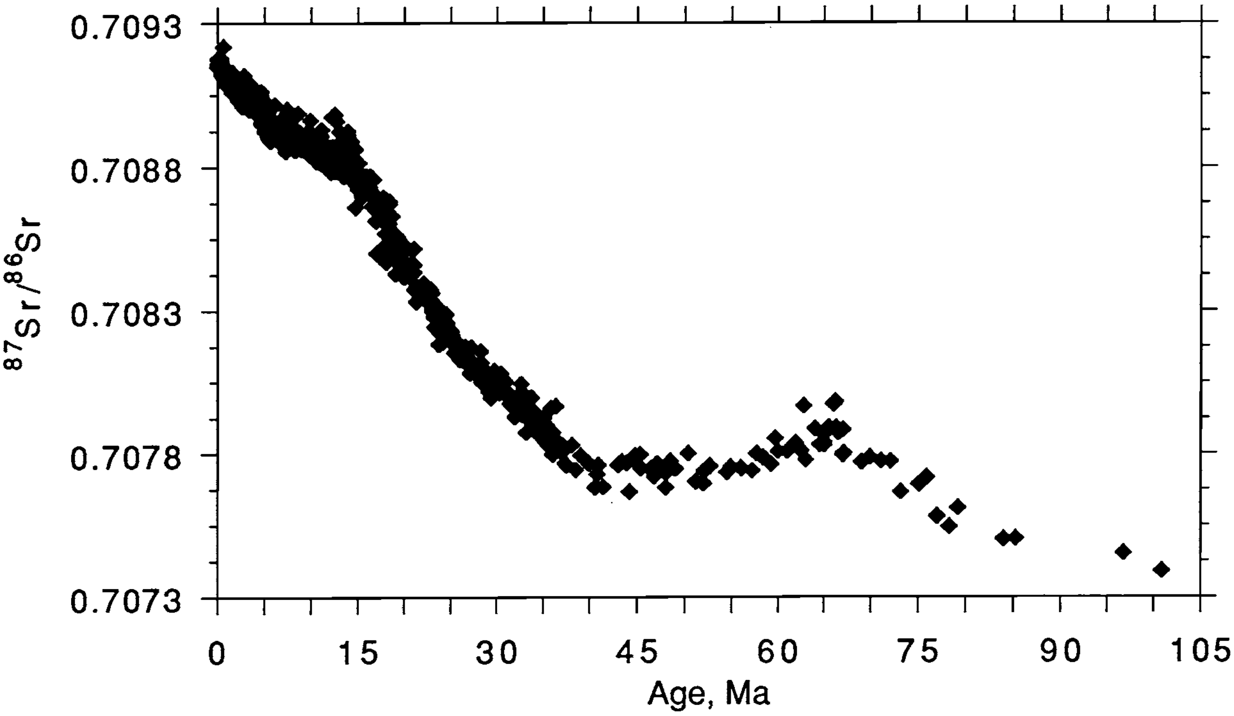

Fig.10. The Late Cretaceous and Cenozoic seawater $^{87}Sr/^{86}Sr$ curve. Data from several sources have been slightly adjusted based on laboratory standards and seawater values reported by each investigator [DePaolo and Ingram, 1985; DePaolo, 1986; Capo and DePaolo, 1990; Hess et al., 1986, 1989; Hodell et al., 1989, 1990, 1991; Miller et al., 1988, 1991]. All data are plotted using the Berggren et al. [1985] timescale.

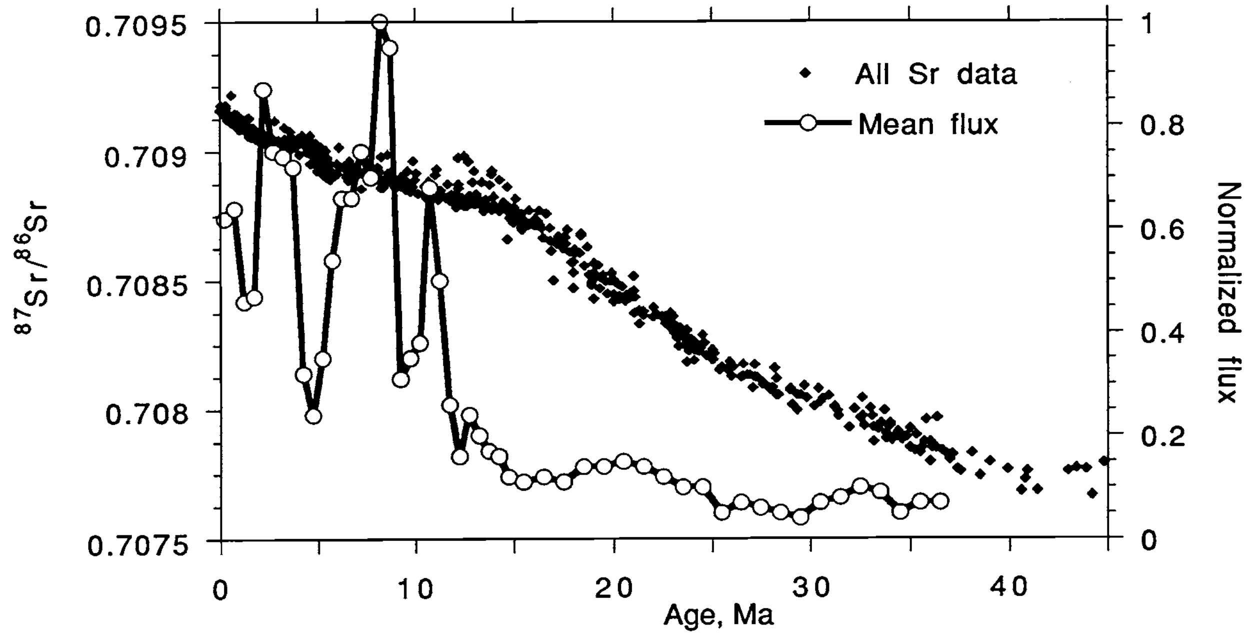

Fig. 11. Comparison of the seawater strontium curve of Figure 10 to the normalized mean sediment flux to the northern Indian Ocean.

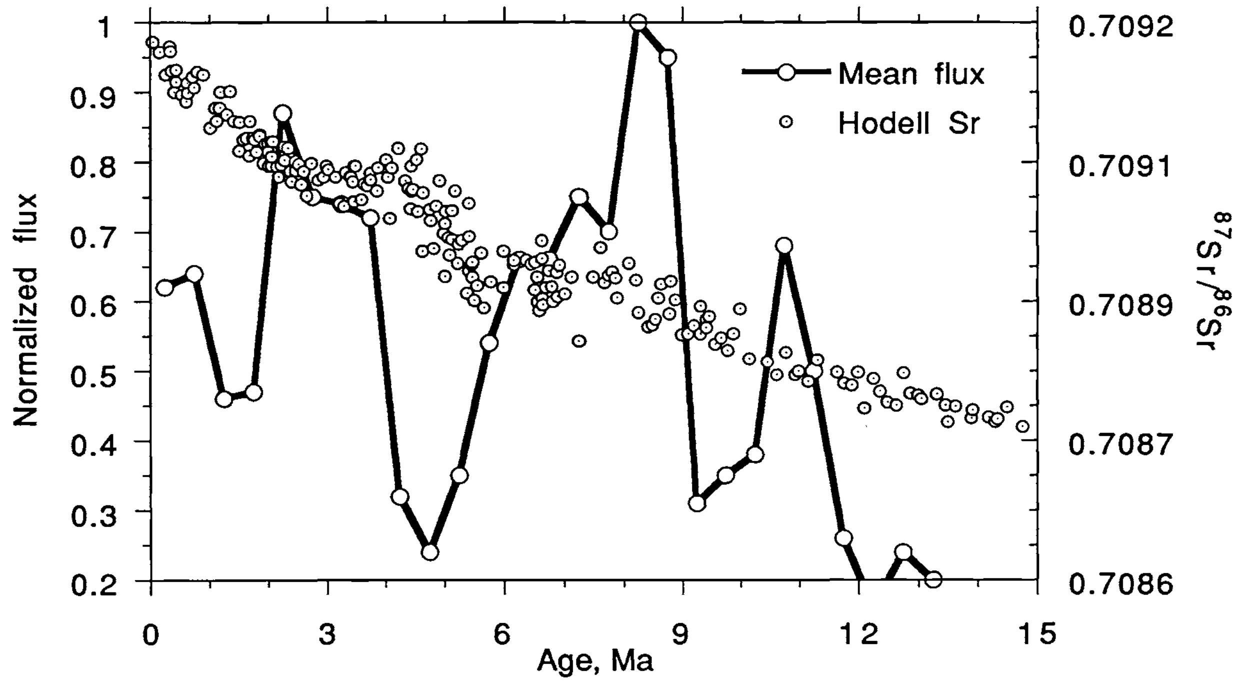

Fig. 12. Details of the past 15 m.y. of Himalayan sediment delivery and the $^{87}Sr/^{86}Sr$ values of seawater [all values from Hodell et al., 1989, 1990, 1991]. Note that the times of reduced sediment flux at 4 to 6 Ma and 0 to 2.5 Ma are the times when the $^{87}Sr/^{86}Sr$ curve is steepest.

recent high-latitude ODP drilling has found evidence of the cooling of and glacial ice upon Antarctica during late Eocene time [Kennett and Barker, 1990; Ehrmann, 1991; Barron et al., 1991]. This earlier cooling of the southern continent might be associated in time with the slope change of the $^{87}Sr/^{86}Sr$ curve [Zachos et al., 1992].

In the middle Miocene, the reduction in slope of the $^{87}Sr/^{86}Sr$ curve precedes the 13.5 Ma change in climate/isotopes by 2.5 m.y. and is in the sense of suggesting reduced, rather than enhanced, importance of input of radiogenic strontium. The steepening of the Sr-isotope curve in the last 2.5 m.y. does correspond to the mid-Pliocene onset of Northern Hemisphere glaciation (and the associated rapid sea-level fluctuations) as indicated by the $\delta^{18}O$ information.

Sea level control appears poorly constrained. The Cenozoic sea level fluctuations (Figure 8) would seem to call for much more sediment delivery into the ocean during the later portion of the Cenozoic, since the middle Miocene, than before. Comparison of the sea level curves to the $^{87}Sr/^{86}Sr$ curve (Figure 14) for the past 20 m.y. may suggest a correlation between flatter portions of the $^{87}Sr/^{86}Sr$ curve at 8 to 6 Ma and 2.5 to 4 Ma and times of higher sea levels. Periods of rapidly fluctuating sea level at 4 to 6 Ma and 0 to 2.5 Ma, presumably times of higher global sediment delivery to the sea floor, correspond to steeper portions of the curve.

All this information leaves us with this conclusion: the Cenozoic strontium isotopic curve for seawater does not reflect the input of continentally derived clastics to the ocean. Therefore the flux of radiogenic Sr, which is in the dissolved load of rivers, may have little to do with the flux of sediment, although a general decoupling of gross overall dissolved and particulate sediment delivery, especially in regions like the Himalayas undergoing very rapid erosion, would be difficult to support. The isotopic ratio of the dissolved riverine strontium may have changed markedly with time, being higher from 42 to 16 Ma and lower since. The non-correspondence of clastic fluxes and slopes of the $^{87}Sr/^{86}Sr$ curve (Figure 13) even suggests that the $^{87}Sr/^{86}Sr$ ratio of the river waters varied in the opposite sense of the particulate fluxes, being significantly higher during times of lower particulate flux. Clearly the knowledge of exactly what is being eroded in the Himalayas and when is very important [Palmer and Edmond, 1989; Krishnaswami et al., 1992; Amano and Taira, 1992]. That information lies in the details of the mineralogy and geochemistry of the sediments of the Indus and Bengal Fans.

There is a final observation to be made. All discussions about the nature of the $^{87}Sr/^{86}Sr$ curve assume that it is the continental/radiogenic aspect that is determining the slope of the curve. The potential role of the hydrothermal component, assumed to have changed little since there has not been much change in crustal generation rates [Delaney and Boyle, 1988; Richter et al., 1992], is not considered. However, it has been shown that reliance upon the presumed association of hydrothermal activity with spreading rate is inappropriate at these time intervals of less than tens of millions of years [Owen and Rea, 1985; Lyle et al., 1987]. To determine directly the amount of sea-floor hydrothermal activity during the past 40 m.y. one must quantify the mass accumulation rate of the

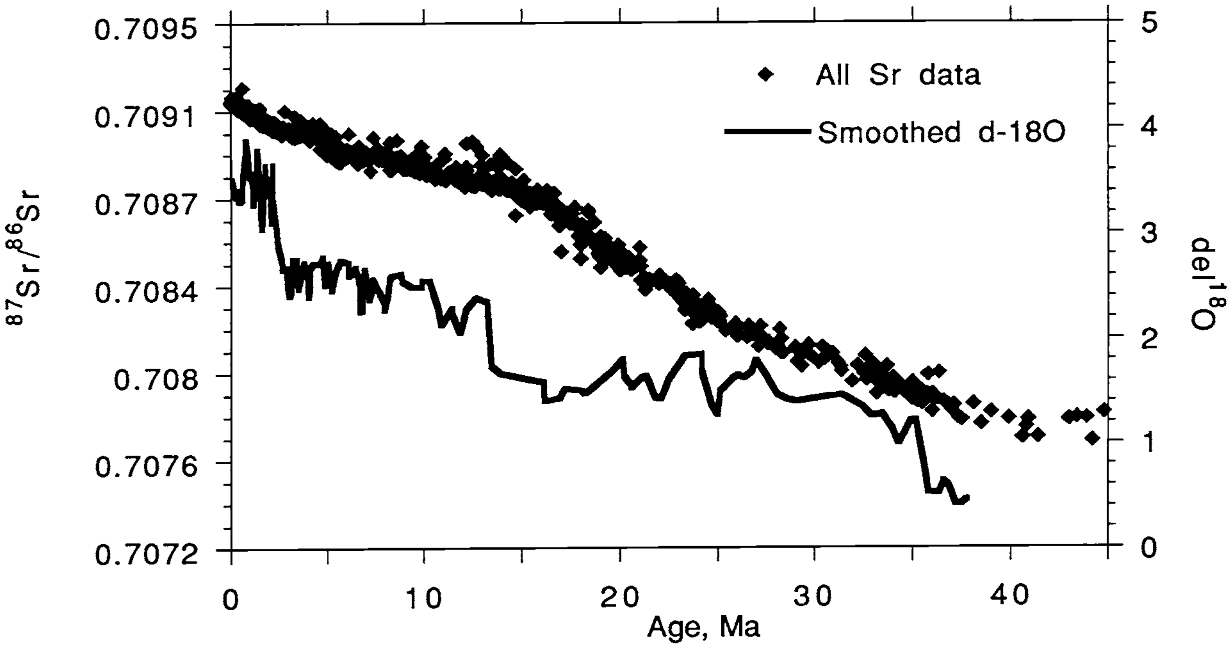

Fig. 13. Comparison of the seawater strontium curve of Figure 10 to the Indian Ocean oxygen isotope record of climate change.

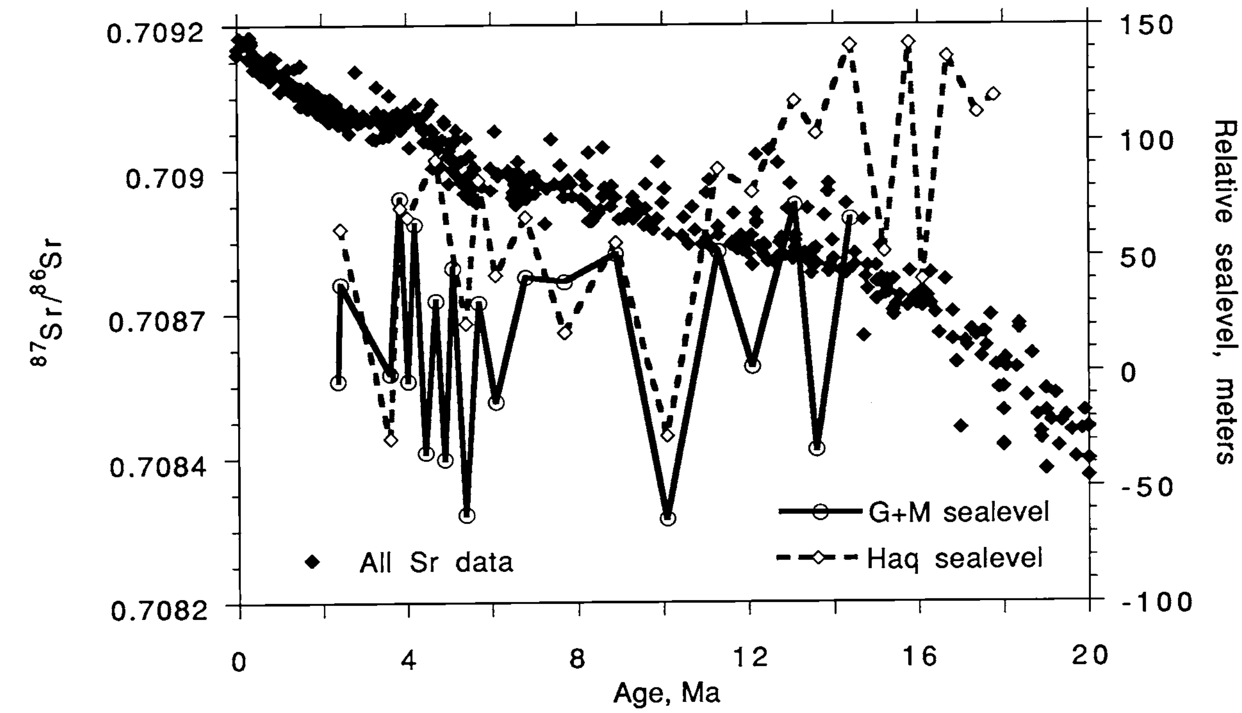

Fig. 14. Details of the past 20 m.y. of sea level changes [from Haq et al., 1987; Greenlee and Moore, 1988] compared to the $^{87}Sr/^{86}Sr$ seawater record.

hydrothermal component in the oceanic sedimentary section. This analysis and calculation has only been done once and in rather rudimentary fashion for the whole Cenozoic but the results may be instructive for considering the strontium data. Leinen [1989] has determined the flux of hydrothermal materials to the central North Pacific pelagic clay core LL44-GPC3 (Figure 1) for the entire Cenozoic. That record shows a five to ten-fold reduction in the flux of hydrothermal materials in sediments younger than late Eocene. Leinen's calculations are in agreement with other indications of Cenozoic hydrothermal activity such as the Indian Ocean hydrothermal flux record [Owen and Zimmerman, 1991] and the age distribution of hydrothermal ore deposits [Olivarez and Owen, 1989].

The rather awkward non-correlation between the increasingly radiogenic strontium composition of seawater and what we presently understand about both climate change and the delivery of continental debris to the oceans suggests that additional processes may be involved in determining the shape of the $^{87}Sr/^{86}Sr$ curve of Figure 10. Based on the work of Leinen [1989], I suggest that one critical additional factor is a marked reduction in the input of the hydrothermal end member, certainly during middle (42 to 16 Ma) and probably during late (16 to 0 Ma) Cenozoic time, thus permitting the seawater strontium curve to trend more rapidly towards a continental-radiogenic signature. Investigations of the Cenozoic fluxes of hydrothermal materials thus hold great potential for increasing our understanding of the Cenozoic record of seawater strontium.

CONCLUSIONS

Temporal patterns of sediment delivery from the Himalayan region to the northern Indian Ocean show higher sediment MAR values since about 12 Ma, with low values for the entire older Cenozoic. Relative flux maxima at 2 to 4 Ma and from 6 to 9 Ma do not correspond to times of either climate change or to times of low or falling sea level. Since the remaining determinant of clastic flux from a continent is the uplift of mountains, the data support hypotheses of rapid late Cenozoic uplift of the Himalayas. The uplift appears to have occurred in two stages in the late Miocene and middle Pliocene and may be ultimately responsible for the origin of Asian monsoons and even of Northern Hemisphere glaciation.

Examination of the seawater strontium isotope curve in light of the record of Himalayan sediment delivery to the ocean shows a distinct non-correspondence between the two. There may also be a question about invoking Cenozoic climate change to explain the increasingly radiogenic nature of seawater strontium. The possibility that other determining factors may have changed in important ways, such as sea-floor hydrothermal activity or the $^{87}Sr/^{86}Sr$ ratio of dissolved Sr in rivers, should be considered more strongly.

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Annex IN-23

A. V. R. Sastry, K. V. Suresh, M. V. Ramesh and S. Kamalakaram, “Sediment Transport from the Outer Shelf into the Lower Bengal Fan”, *Geological Survey of India*, Spl. Pub. No. 29, 1992, pp. 189-195.

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Sediment Transport from the Outer Shelf into the Lower Bengal Fan

A. V. R. SASTRY, K. V. SURESH, M. V. RAMESH and S. KAMALAKARAM
Geology Department. Andhra University, Visakhapatnam

ABSTRACT

Fifty four surface sediment samples collected between 1300 and 3400 m isobaths covering the lower Bengal Fan area bounded by latitudes 13° 30' N and 15° 30' N and longitudes 81° E and 84° E are analysed for grain size distribution and for their Total Foraminiferal Number (TFN) with the objectives of delineating the sediment transport. Sand is concentrated wherever the sea floor slope changes and attains a maximum of 35%. The occurrence of benthonic foraminifera of exclusive shelf habitat and the sand in the deep sea samples are the unequivocal evidences of sediment transport from the adjacent shelf and shelf slope into the northwestern part of the lower Bengal Fan.

To identify the origin of the transported sediments, mineralogical and sedimentological analysis were carried out on 124 grab samples collected between 20 and 500 m isobaths off Visakhapatnam, the Krishna and the Godavari river mouths. The sand fractions from outershelf sediments contain, besides usual minerals, white, yellow, brown, black flakes, slabs and granules whose similarity with those of the sand fractions from the deep sea samples suggests that the sediment is transported from the outershelf area into the middle and the lower Bengal Fan.

INTRODUCTION

The present day distribution of sediments in the lower Bengal Fan area is the result of the interplay of different processes on the sediments once discharged by the rivers, *i.e.*, the Ganges, the Godavari, the Krishna *etc.*, during the low stand of sea level, and subsequent rise in the sea level. The present work deals with the size characteristics, mineralogical studies of the surface sediments collected from different depths ranging between 1300 and 3400 m. With a view to interpret the sediment transport pattern in the Lower Bengal Fan area between Latitudes 13° 30' and 15° N and longitudes 81° and 84° E, total foraminiferal number has also been assessed in the sediments to supplement the nature of the transport pattern. The study was mainly based on fifty four grab samples collected by GSI officers from the northwestern part of the Lower Bengal Fan, along two transects (Fig. 1).

METHODS OF STUDY

The size distribution of sediments is determined following standard procedures. (Carver, 1971; Sastry and Murthy, 1989). Auto-correlation-function is used to optimise the grain size, least square fit to know the ratio of change in wt% to change in grain size diameter, cross correlation to know the similarities in sediment samples (Davis, 1973). Total foraminiferal Number (TFN) is also calculated (Walton, 1952).

RESULTS

Sedimentological studies

The weight percentages of sand, silt and clay in each of the samples are presented in Table I together with the depths. Fig. 1 presents a profile with sedimentological and micropalaeontological results. The profile shows that the gradient of the sea floor is steep at the proximal end of the transect and a gentle gradient is maintained for the rest of the transect (Fig. 1). In the majority of the samples, the sand (0-4ϕ) percentage is about 5%, while it ranges from 11 to 23% in the rest of the samples. Lines of equal weight percentage of sand, silt and silt + sand indicate that the 'V's of the

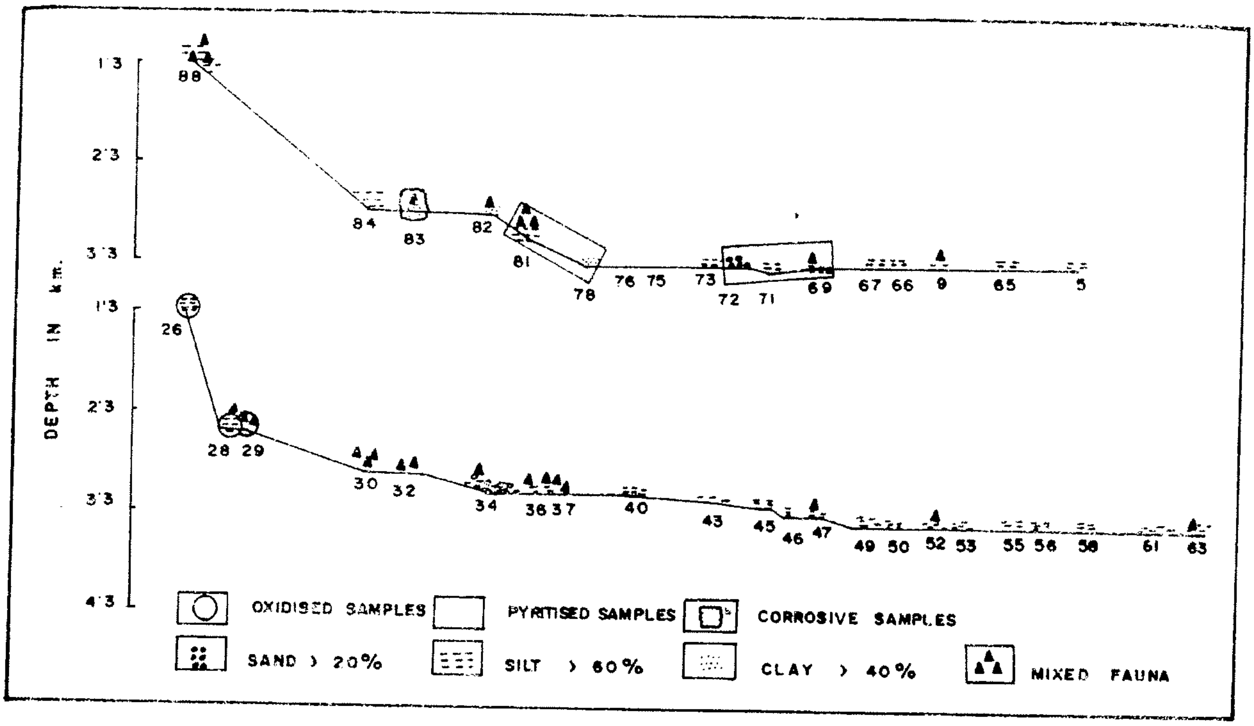


Fig. 1: Profiles showing sediment type and mixed fauna.

lines point towards NE and SW direction for the two transects beyond 2900m depth and they are entirely of different pattern towards the continental shelf slope. From the 'V' of the lines. it is inferred that the sediment distribution is in the NE-SW direction.

Micropalaeontological studies

In surface sediments the total foraminiferal number (TFN) per 10g of dry sediment is generally >3000 upto 3400 m water depth and it is <1000 at shallower depths. The TFN is >2500 in the top and <90 in the bottom of the core of 2.8m length. The planktonic forams are in greater number than the benthonic and account for 50-99% of TFN. The planktonic forams increase from 60% at 3000 m to 90% at 3400 m depth. The unusually large TFN and high planktonic densities in the distal part of the fan area are attributed to lower rates of detrital sedimentation than in the landward part of the fan. Of the 212 species of benthonic forams, 92 species are of shelf habitat (East Coast of India) while 29 species are common to shelf and deep sea. The shallow water benthonic foraminifera of east coast shelf habitat occur along with deep water fauna on the entire 300 km stretch of the two transects and they vary from traces to 8%. Twelve benthonic species of characteristic shelf habitat are found along with deep sea benthonic foraminifers. The percentage of shallow water benthonic foraminifera varies from 3 to 49 (Table 2). The characteristic species of Recent period *i.e.*, *Sphaeroidinella dehiscens. Pulleniatina obliquiloculata* and *Globorotalia truncatulinoides* are identified in the cores which indicates that the core sediment is deposited during the Recent period. From sedimentological and foraminiferal studies it is concluded that the continental shelf sediment has moved into the Bengal Fan. In order to support the surmise that the sediment has moved, mineralogical studies have been carried out on the shelf sediments and statistical and computer techniques have been applied to the granulometric data of the deep sea samples.

Mineralogical Studies

The detrital minerals quartz, smoky quartz, feldspar, pyroxene, amphibole, micas, garnets, magnetite, ilmenite, rutile, tourmaline, zircon, chlorite, kyanite and sillimanite decrease in abundance away from the coast and are not found beyond 170 m isobath off

Visakhapatnam. At water depths 200 m and beyond, biological debris and peloids predominate.

Among the detrital minerals off the Krishna river mouth approximately 95% of the sand fraction is quartz and the rest contain fuchsite quartzite and opaques.

Quartz, smoky quartz, garnet, magnetite, ilmenite, kyanite, sillimanite and rutile occur in the sand fraction of the samples from the northwestern part of the lower Bengal Fan. Besides, very few grains of azurite are present (Plate Ia), slabs, peloids (Plate I b-f) and ooids (Plate-II a) are observed.

White, yellow, brown, grey flakes, slabs and granules (Plate I (a)-(f)) are found in shelf sediments at different depths off Visakhapatnam, the Godavari and the Krishna river mouths.

The sand fractions of the sediments from the deep sea also contain exactly similar flakes and slabs, peloids and granules. In some of the sand and silt fractions, the entire quantity consists of granules and is completely devoid of even quartz grains, while in some others varying proportions of quartz are associated with the granules in sand fractions. Cross sections of the grains reveal a brownish core with a black crust in some while in others brown crust surrounds the white core (Plate II). Some of the ellipsoidal white grains are veneered with dark brown/red and black coating. These appear to be more porous in the shelf sediments than those from the deep sea. They float in bromoform and sink after sometime, and some of them are friable (sp. gr. is 1.6 to 1.8).

Statistical Studies

Computer techniques are applied to granulometric data to establish the transport of sediment. The slope of the line (that is the ratio of change in wt% to change in grain size diameter) in each sample by the least square fit method, auto-correlation to find the optimum grain size in each sample and cross-correlation to understand the similarities of sediment samples are carried out.

From the least square fit for the sand fraction and silt plus clay fractions of all the samples, the slope values are calculated and are plotted in figures to understand the controlling factors of transport and to delineate their directions. Iso-slope lines for sand fraction show a constant value (= 1.5) throughout the transect beyond 2500 m depth, except for samples at the distal end (samples 005, 007, 009). Iso-slope lines for silt plus clay show an increase in the values towards the distal end of the transect. This shows that sorting of the silt plus clay fraction is relatively better towards the distal end than at the proximal end.

Auto-correlation is carried out for all the fifty four samples for sand fractions and for silt plus clay fractions separately to decipher the optimum grain size in both the sand and silt plus clay fractions, so that the behaviouristic pattern of the sediment movement can be visualised. From the iso-optimal values of grain size for sand and silt plus clay fractions, it is observed that optimal grain size distribution for sand fraction does not indicate any discernible pattern anywhere along the transects. On the other hand the iso-optimal lines for silt plus clay fractions show a gradual increase from 5.2 to 5.7 even in regions of no gradient or insignificant change of gradient (Fig. 2). Thus from the iso-slope and iso-optimal values, it is concluded that the sorting has improved towards distal end of the transect and that the bottom currents play a significant role in the redistribution of silt plus clay fractions. This observation is in conformity with earlier workers (Venkatratnam Kolla, 1976). Gross correlation (combination of auto-correlation and linear correlation) is done for all the samples with a view to find the similarities and the dissimilarities in the samples. All the samples are subdivided into groups of positive values.

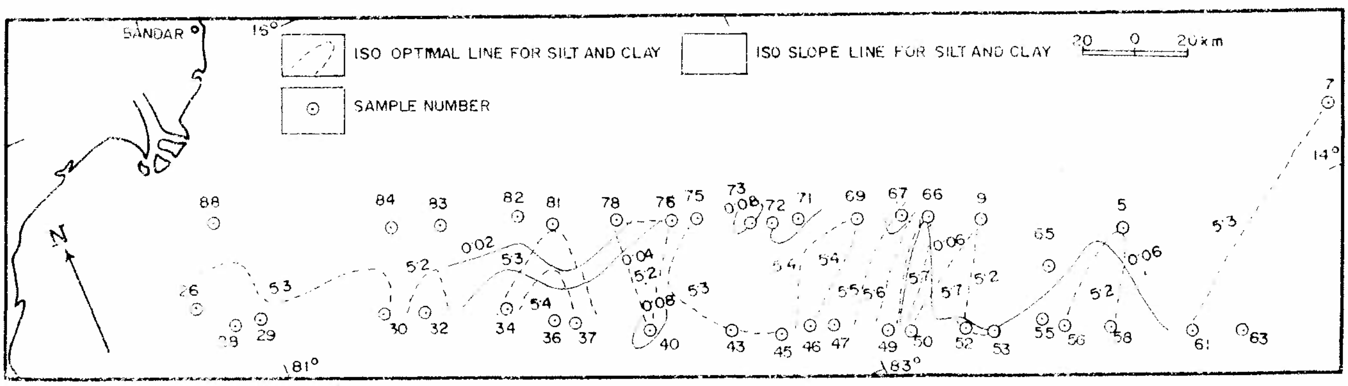


Fig. 2: Iso-slope and Iso-optimal lines for the samples from the Bengal Fan.

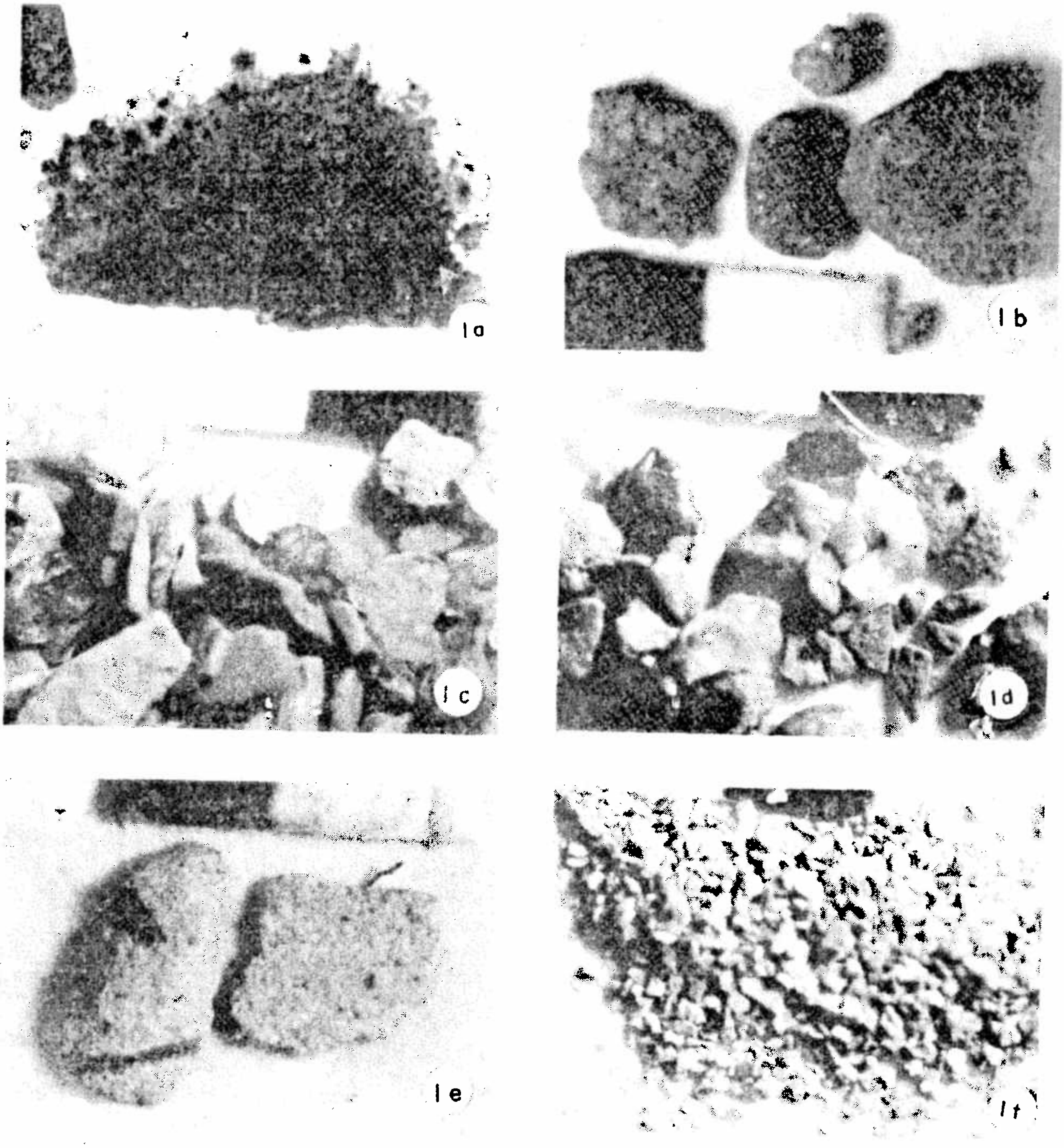
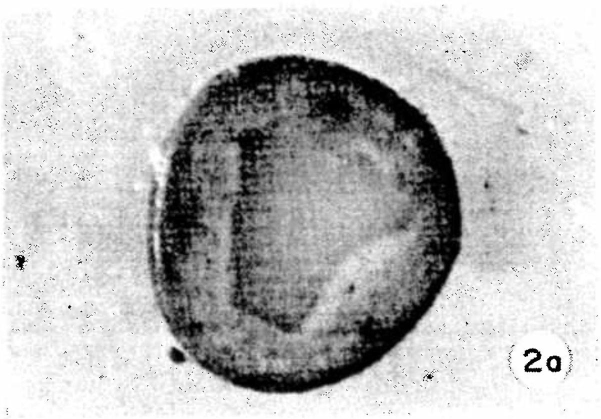


Plate 1: Photographs of sand-sized grains in outer shelf and deep sea. a) Azurite grain from the shelf slope of the transect. b) Pores on the sand sized grains of the deep sea samples at the distal end of the transect. c) Sand sized grey slabs and pitted quartz grains from deep sea (N E part of lower Bengal Fan). d) Sand sized grey slabs, flakes, magnetite, pitted quartz from outer shelf off Visakhapatnam. e) Friable grey slabs from outer shelf off the Godavari river. f) Fine sand sized gray flakes and granules from outer shelf off Visakhapatnam.



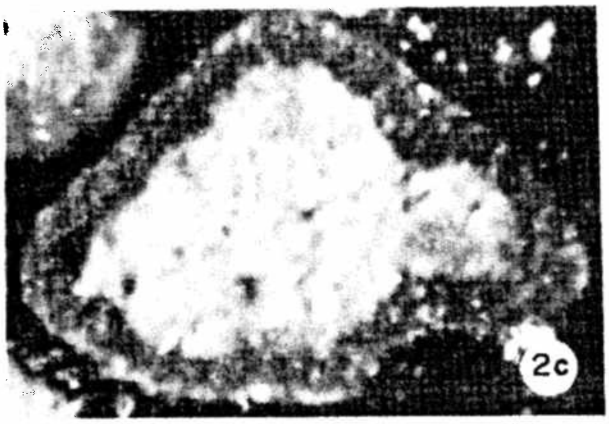


Plate II: Photograph of micronodules and oolites from outer shelf and deep sea. a) Cross section of an oolite showing yellow outer rim enveloping translucent white irregular inner core; outer shelf off Visakhapatnam. b) Micronodule showing dark brown outer rim surrounding light brown inner core from distal end of the transect, c) Cross section of a sand sized slab showing dark brown outer rim with light brown inner core; foot of the shelf slope.

DISCUSSION

Mineralogical studies did not yield any definite clues regarding the transport of sediment. The presence of smoky quartz in the continental shelf sediments and also in the deep sea sediments cannot be cited as an evidence for the sediment movement from a definite source as the smoky quartz grains could have been contributed by any one of the rivers flowing into the Bay of Bengal. The mineral azurite is not as ubiquitous as smoky quartz. The azurite is not found in the continental shelf sediments, but it is found on the shelf slope and deep sea sediments. It can be argued that the mineral must have been transported by any one of the rivers, *viz.*, the Ganges, the Mahanadi or the Godavari. Then it becomes difficult to explain how this mineral can be found on the shelf slope sediment off the Krishna river. It must have been transported either by the nearest adjoining river Krishna or by the movement of the shelf sediments off the river Krishna, or by gravity flow or by turbidity currents.

The slabs, granules, peloids which are observed in the continental shelf sediments at different depths from Visakhapatnam to Nagapatnam must have found their way through the submarine canyons or by gravity flows or turbidity currents into the northwestern part of the Lower Bengal Fan. The shelf sediments which moved into the Bay of Bengal must have been deposited more at the shelf slope which in turn might have been spread along the entire length of 300 km transect by the bottom water currents.

The grains with core and crust may perhaps give some clues regarding the sequence of events. While describing the phosphatic nodules with dark outer rind (DSDP, 102, 168 p.) it was mentioned that they are formed by "hiatus concentrations". It is possible that the core of the grains (micronodule) must have been formed before and the rind is developed after Holocene transgression, which requires further confirmation.

CONCLUSIONS

The cumulative evidences from sedimentological, foraminiferal and mineralogical observations and those from the statistical data permit the following conclusions:

1. The direction of movement is from shelf slope to the deep sea.
2. Gravity plays a role in transportation of sediment at the shelf slope.
3. The bottom water currents are effective in redistribution of silt plus clay in the lower Bengal Fan.
4. The core of the granule (micronodule) (Plates II b and c) must have been formed before and the rind after Holocene transgression which requires further confirmation.

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TABLE 1: WEIGHT PERCENTAGES OF SAND-SILT-CLAY

1	2	3	4	5	6	7	1	2	3	4	5	6	7
034	3100	34.701	60.304	16.583	95.005	76.887	075	3300	17.144	49.713	33.142	66.857	82.855
036	3100	23.112	58.908	24.872	82.02	83.78	073	3300	13.882	68.846	17.372	82.628	86.212
046	3300	14.639	73.668	11.692	88.307	85.36	072	3300	22.445	53.164	24.391	75.609	77.555
049	3300	17.982	58.895	23.122	76.877	82.017	069	3300	13.55	61.229	25.415	74.584	86.644
052	3400	15.391	59.262	25.346	74.653	84.608	071	3350	6.593	54.945	38.461	61.538	93.406
063	4400	11.808	68.177	20.015	79.985	88.192							

Note: 1 = Sample No. 2 = Depth in Meters. 3 = Wt.% Sand. 4 = Wt.% Silt. 5 = Wt.% Clay. 6 = Wt.% Sand + Silt. 7 = Wt.% Silt + Clay.

TABLE 2: MIXING PERCENTAGE OF BENTHIC FORAMINIFERA IN THE LOWER BENGAL FAN

Station No.	Total Benthic Forams	Benthic Forams from Shelf	Mixing (percentage)	Water Depth in m	Station No.	Total Benthic Forams	Benthic Forams from Shelf	Mixing (percentage)	Water Depth in m
026	222	75	33.8	1300	061	44	16	36.4	3400
028	192	52	27.1	2500	063	104	16	15.4	3400
029	308	124	40.3	2500	007	2	—		3300
030	370	206	55.7	2900	088	156	97	62.2	1300
032	99	23	23.2	2900	084	35	50	14.3	2750
034	68	20	29.4	3100	083	181	101	55.8	2800
036	252	86	34.1	3100	083	84	40	47.6	2800
037	58	17	29.3	3100	081	199	87	43.7	2800
040	132	36	27.3	3200	078	63	21	33.3	3200
043	858	236	27.5	3200	076	57	23	40.4	3300
045	919	439	47.8	3300	075	49	9	18.4	3300
046	164	46	28.1	3300	073	152	29	19.1	3300
047	38	8	21.1	3300	072	56	22	39.3	3300
049	128	40	31.3	3400	071	74	34	45.9	3350
050	88	28	31.8	3400	069	188	72	38.3	3300
052	232	100	43.1	3400	067	340	120	35.3	3300
053	88	24	27.3	3400	066	200	124	12.0	3300
055	32	—	—	3400	009	43	22	51.2	3300
056	52	—	—	3400	065	116	52	44.8	3300
058	64	32	50.0	3400	005	73	58	52.1	3300

Annex IN-24

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Land from the Sea: The Mangrove Afforestation Program of Bangladesh

P. Saenger

Centre for Coastal Management, University of New England,
Northern Rivers, East Lismore, NSW 2480, Australia

&

N. A. Siddiqi

Plantation Trials Unit, Bangladesh Forest Research Institute, Barisal, Bangladesh

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ABSTRACT

The coastal areas of Bangladesh have a high cyclone frequency. The protection from cyclone damage afforded by the natural mangrove forests of the Sundarbans, led the Forest Department in 1966 *to initiate a mangrove afforestation programme. These initial plantings proved highly successful in protecting and stabilizing coastal areas, and led to a large-scale mangrove afforestation initiative. To date, approximately* 120 000 *ha of mangroves have been planted. Nursery and planting techniques have been developed for the major species, while additional species are still being investigated. As a result of the extensive monospecific plantations, however, outbreaks of two major insect pest species have been observed. In addition, a number of other problems were also encountered but in terms of coastal protection and stabilization, wood production and land reclamation, large-scale mangrove afforestation appears to be both technically possible and socio-economically beneficial.*

1 INTRODUCTION

The coastal areas of Bangladesh have suffered severe cyclone damage almost annually since cyclone recordings began in 1584. During the period from 1960 to 1970, eight severe cyclones were recorded, with the intense cyclone and associated storm surge of November 1970 reported[1] to have caused the deaths of about 300 000 people; current estimates of the April 1991 cyclone yield a similar figure.

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The protection from cyclone damage afforded by the Bangladesh Sundarbans mangrove forests, a continuous natural mangrove forest of 5800 km^2 in the south-west of Bangladesh, led the Forest Department in 1966 to commence a programme of planting mangroves outside the protective coastal embankments in order to provide greater protection for inhabited coastal areas. These initial mangrove plantings were highly successful and led to the development of a large-scale mangrove afforestation programme. With the interest in mangrove afforestation around the tropics,[2–7] we review the development of the Bangladesh mangrove afforestation programme, its implementation and the benefits and experience gained from it.

2 THE BANGLADESH COASTAL ENVIRONMENT

The coastal area of Bangladesh lies within the tropical zone between 21–23°N and 89–93°E. The mean annual rainfall varies from about 1500 mm in the west to over 3800 mm in the south-eastern region. The heaviest rainfall occurs during the monsoon period (July and August) while there is practically no rainfall during the dry winter months of December to February. Mean coastal temperature during January is 19·5°C while during July, the mean temperature is 27·2 °C. Cyclones are most common during the pre- and post-monsoon period, with May and October having the highest frequency.

Most of the 710 km coastline is dominated by the deltaic deposits of the Ganges–Brahmaputra–Meghna Rivers. Originating in the Himalayas, this river complex carries an estimated annual sediment load of $2{\cdot}4 \times 10^9$ tons.[8] These sediments are transported and sorted by river flow and reworked by tidal and wind action, leading to extensive areas of accretion and erosion in the coastal area. With the fall in mean sea level after the monsoon, these newly formed deltaic deposits–locally known as 'char' lands–become increasingly exposed, often drying completely during the winter months.

Because of the nature of these 'char' lands, their partial submergence during subsequent monsoons, and their high interstitial salinity, these areas are not suitable for agriculture until salts have been leached out and soil ripening has occurred.[9,10] Consequently, this new land remains bare until natural successional changes lead to a grass cover, usually dominated by halophytic uri-grass, *Oryza coarctata.*[11] Protection of these lands from subsequent erosion and acceleration of their vertical accretion are prime objectives of the coastal afforestation programme.

3 BACKGROUND TO THE PROJECT

From its limited beginnings in 1966, annual plantings of approximately 320 ha (800 acres) of mangroves were undertaken on newly accreted land in the Patuakhali, Barisal, Noakhali and Chittagong coastal districts. These plantations were established by the respective district coastal afforestation staff with assistance from the local villagers. Techniques to raise suitable seedlings and to establish the plantations were developed by 'trial and error'.

As the coastal afforestation programme proceeded, it became apparent that the plantations contributed both to the acceleration of land accretion, and to the stabilization of the 'char' lands. These plantations and the sedimentary processes they induced apparently had the ultimate potential of providing land sufficiently raised and stabilized to be used for agricultural purposes–thus, meeting the prime objectives of the afforestation programme.

While the initial objective of the afforestation programme was to create a shelter belt to protect the lives and properties of the coastal communities, the early success of the plantations resulted in the setting of additional objectives for coastal afforestation,[12] including to: (a) provide forest products for a range of uses; (b) develop forest shelter-belts to protect life and property inland from tidal surges; (c) inject urgently needed resources into the national economy (i.e. timber and land); (d) create employment opportunities in rural communities; and (e) create an environment for wildlife, fishes, and other estuarine and marine fauna.

With these additional objectives and the more stable conditions after political independence on 16 December 1971, the afforestation programme was given added impetus in 1973. From July 1980 to December 1985, the World Bank-funded Mangrove Afforestation Project I aimed to plant approximately 8100 ha (20 000 acres) of mangroves annually while the Mangrove Afforestation Project II was designed to create a further 8100 ha (20 000 acres) of new plantations annually from 1986 to 1990. By 1990, 120 000 ha of mangroves had been planted (Fig. 1) although accurate area determinations are still being collated by the Space Research and Remote Sensing Organization (SPARRSO).

In conjunction with the increased funding for, and acceleration of, the planting programme, a more systematic investigation of techniques was initiated to refine the raising of seedlings, determine the optimal planting season, develop an appropriate spacing of seedlings, and determine the optimal harvesting strategy. Responsibility for these investigations was given to the Plantation Trials Unit, established as

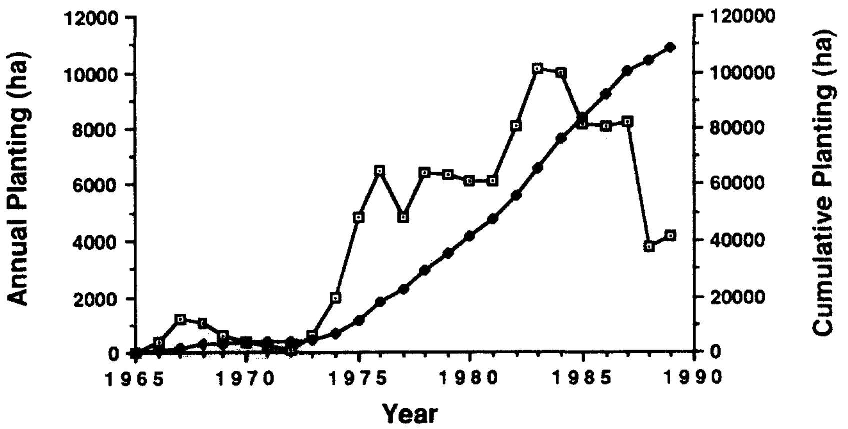

Fig. 1. Cumulative and annual area of coastal mangrove plantations. (Based on data supplied by Ishtiaq Uddin Ahmed, Assistant Conservator of Forests.)

part of the Bangladesh Forest Department in 1980 and transferred to the Forest Research Institute in 1985. As part of the evaluation of the Mangrove Afforestation Project I and II, the need for an intensive management-orientated research programme was also identified in relation to the mangrove plantations. Objectives for such a research programme included, *inter alia,* the improvement of nursery and plantation techniques, and the more effective management of mangrove plantations. For existing plantations, such management included the control of pest outbreaks, the development of thinning schedules and optimal rotation times, underplanting trials, site/species matching studies as well as growth trials for a range of indigenous and exotic species. For future plantations, management capabilities were needed to identify the most favorable locations for plantations and to develop techniques, using additional mangrove species, to establish successful multi-specific plantations.

4 SPECIES SELECTION

Although roughly 27 species of mangroves and a similar number of mangrove associates occur in Bangladesh[13,14] most are rare, or of little economic importance.[11] Only 10 or so species occur frequently enough to sustain silviculture (Table 1).

As a result of the early trial and error approach to plantations, only two species, *Sonneratia apetala* and *Avicennia officinalis,* showed encouraging survival rates, and, as a consequence, these two species

TABLE 1

Mangrove Species Occurring with Sufficient Frequency and/or Producing Sufficiently Valuable Products to Sustain Silviculture, and Major Propagation Techniques

Species	*Propagation techniques*			
	Nursery grown	*Direct seeding*	*Seeding transplant*	*Polybag culture*[a]
Sonneratia apetala	×			
Sonneratia caseolaris	×			
Nypa fruticans	×	×		
Avicennia officinalis	×	×		
Avicennia marina		×		
Avicennia alba		×		
Amoora cucullata		×		
Heritiera fomes		×	×	×
Bruguiera gymnorrhiza		×	×	×
Bruguiera sexangula		×	×	×
Ceriops decandra		×	×	×
Exceocaria agallocha		×	×	×
Xylocarpus mekongensis			×	×
Xylocarpus granatum				×
Cynometra ramiflora				×
Aegiceras corniculatum				×

[a] Currently only used for experimental plantations.

dominate the mangrove plantations generally as monospecific stands.[15] These species are medium quality timbers used for fuel wood, constructions and furniture.[16,17] About 80% by area of the early plantations consisted of monospecific stands of *S. apetala*, about 15% consisted of stands of *A. officinalis* with the remaining areas consisting of *Excoecaria agallocha*, *Bruguiera* spp. and *Ceriops decandra*, more valuable species for timber or paper pulp production. Polybag culture of a range of other mangrove species (Table 1) has been experimentally developed although field assessments of the performance of these species are as yet incomplete.[18,19]

5 NURSERY AND PLANTING TECHNIQUES

Nursery and planting techniques vary considerably among the various species, and a summary of the techniques employed for each of the major species is provided below:

TABLE 2

Mean (and standard error) Survival, Height and Girth, Stemwood Production and Tree Qualities at Different Initial Spacings for a 5-year-old *Sonneratia apetala* Plantation at Barisal from Three Replicated Random Blocks[24]

Spacing (m)	*Survival (%)*	*Height (m)*	*Girth (mm)*	*Volume per plot (m^3)*	*Wood production (m^3/ha/year)*	*% Unforked trees*
0·85 × 0·85	29(14)	9·1(0·8)	275(40)	5·02(1·06)	16·06(2·3)	90(7)
1·2 × 1·2	52(9)	8·7(0·3)	249(10)	5·77(0·71)	18·45(2·7)	90(2)
1·7 × 1·7	42(15)	8·9(0·2)	305(15)	3·69(0·95)	11·80(2·2)	84(2)
2·4 × 2·4	37(21)	7·8(0·5)	413(77)	1·75(0·93)	5·60(1·2)	73(6)
3·4 × 3·4	39(21)	7·9(0·8)	392(97)	1·95(0·98)	6·23(1·5)	38(16)

5.1 Sonneratia apetala

Mature green fruits of keora (*S. apetala*) are generally collected during September and they are heaped for 20 days to allow the pericarps to decay. They are then rubbed and washed in water to separate the small seeds from the rotted fleshy portion of the fruits. About 1 kg of green fruit will yield about 275 g or 7500 seeds.[20] These seeds maintain their viability for about one month. Approximately 7–8 kg of these seeds are broadcast onto intertidal nursery beds 1·2 m wide and 12 m long, slightly raised above the surrounding sediment. The beds are usually encircled by low (15 cm) earthen walls which retain water pumped into the enclosures during unusually dry periods.

Germination onset and success is largely controlled by salinity which needs to be maintained below 20 ppt; above 20 ppt germination performance declines rapidly.[21]

The seedlings are allowed to grow for about 10 months and from each nursery bed about 2350 seedlings of the desired height (30–60 cm) become available for the next suitable planting season, i.e. from July to August. At this time, the seedlings are gently pulled out of the ground and packed for transport to selected afforestation sites. Generally, one such nursery bed provides sufficient seedlings to plant an area of 0·4 ha at the usual spacing of 1·2 × 1·2 m.[20] The uprooted seedlings can be stored in the shade for up to 6 days without any significant losses.[22] As discussed later, this approach results in adequate survival rates for a species that has not been cultivated elsewhere.

5.2 Excoecaria agallocha

Seeds of this species ripen in August. The seeds retain their viability for about one month and can either be sown directly onto sheltered intertidal areas, or may be raised in nurseries. Although nursery raising is not used for large plantings, some polybag seedlings are allowed to grow for about 12 months and seedlings of the desired height (30–50 cm) become available for planting from July to August. At this time, the seedlings are packed for transport to afforestation sites where they are usually planted out at a spacing of $1{\cdot}0 \times 1{\cdot}0$ m. One-year-old seedlings may also be collected from the floor of natural forests of the Sundarbans and rapidly transported to planting sites where they are usually planted on relatively raised lands. Because this species is mostly planted onto more raised lands, survival rates using these planting techniques are around 80% after 12 months.

5.3 Avicennia officinalis

The crypto-viviparous[23] propagules of species of *Avicennia* are usually collected from around the base of mother trees in August to September. When kept in air, these propagules lose their viability within a few days. These propagules may be directly planted into sheltered areas by 'dibbling'–where the propagule is gently pushed into the soft sediment until firmly wedged. 'Dibbling' is usually undertaken during neap tide periods to allow the seedling to develop roots. Pre-treatment of the propagules has also been used to decrease the establishment time. Such treatment consists of placing the propagules in small nets and exposing them to daily tidal inundation to hasten the decay of the pericarp. Removal of the pericarp by pre-treatment reduces the establishment time to 2–3 days compared with the 5–6 days required where no pre-treatment is used. Alternatively, propagules may be raised in nursery beds that are exposed to daily tidal inundation. Seedlings are raised for about 1–2 months after which they are gently pulled out of the ground and packed for transport to afforestation sites where they are usually planted out into holes of 3 cm diameter at a spacing of $1{\cdot}0 \times 1{\cdot}0$ m. Recent experiments using one-year-old seedlings (ranging in height from 70 to 90 cm) raised in nursery beds and planted out at Chittagong and Barisal, showed high survival rates, and may prove to be more suitable for areas where larger seedlings are required.

6 SURVIVAL AND GROWTH OF THE PLANTATIONS

6.1 Survival

Because of the highly dynamic nature of the Bangladesh coastline, survival of mangroves is generally poor and replacement planting often needs to be undertaken for up to 3 years. In sheltered localities, however, survival is usually around 70% (see next section). Long-term survival (i.e. between 5 and 15 years) is also highly variable, but in experimental plots at Barisal,[24] survival in 5-year old *S. apetala* ranged from 29 to 52%. Quantitative data for *A. officinalis* is still being collated but initial analyses suggest approximately 30–60% survival rates after 5 years in the Chittagong coastal district.

6.2 Optimal planting season

Planting during June to August appears to result in maximum survival of newly planted seedlings of *S. apetala* based on replicate plots where fixed numbers of seedlings were planted out from nurseries every month over a 24-month period (Fig. 2). Cyclical regression analysis of these data[25] shows that not only the time of planting but the age of seedlings is a contributing factor, and that seedlings older than 12 months generally result in lower survival rates for equivalent months (e.g. compare July/August in 1988 with July/August in 1989 in Fig. 2).

While quantitative field trials have not yet been carried out with *A. officinalis,* maximal survival of this species also appears to occur during June to August. In some areas such as the Chittagong and Noakhali

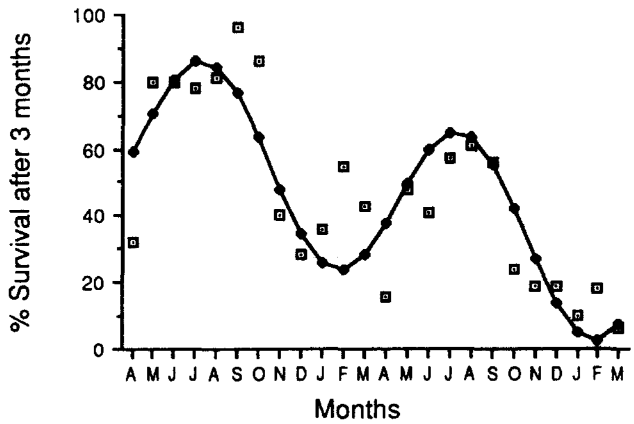

Fig. 2. Percent survival (%S) of seedlings 3 months after planting out from the same nursery stock over a 24-month period from April 1988 to March 1990. Both the seasonal changes in survival, and the declining trend due to increasing age of seedlings, can be recognized in the fitted curve shown, where

$$\%S = 78{\cdot}48 - 18{\cdot}87\cos(2\pi t/T) + 17{\cdot}86\sin(2\pi t/T) - 1{\cdot}72A$$

where t is time in months from t_0 = April 1988; T = wavelength of the cycle, i.e. 12 months; A is age of seedlings in months where $A = t + 7$. ($R^2 = 0{\cdot}7$; $P < 0{\cdot}001$).[25]

Divisions, winter planting is considered to result in higher survival rates but, to date, no experimental data support this view.

6.3 Optimal initial spacing and thinning schedules

At $1{\cdot}2 \times 1{\cdot}2$ m spacing, the trees become congested within 4 or 5 years (Table 2). In such dense *Sonneratia* and *Avicennia* plantations, thinning is carried out after 9–10 years when up to 50% of the stems may be removed.[26] Thinning of these plantations largely consists of removing stunted trees and cutting smaller stems from multi-stemmed trees, and results in slightly reduced natural mortality together with marginal annual increases in height and girth. In more widely spaced plantations, thinning is generally not required because of the relatively slow rate of tree growth and the loss of some trees in plantations due to stem borer attack (see below); the products of thinning yield low economic returns.

6.4 Mean annual increment/height increases

Increases in height and girth, and thus volume, depend on the initial spacing of the particular plantation (Table 2). In 5-year-old plantations of *S. apetala,* maximal heights are attained at a spacing of $0{\cdot}85 \times 0{\cdot}85$ m while maximal girth is found in plantations where the initial spacing was $2{\cdot}4 \times 2{\cdot}4$ m. Maximal wood production for this species of $18{\cdot}5\ m^3$/ha/year occurs at an initial spacing of $1{\cdot}2 \times 1{\cdot}2$ m.[24] The heights, girths and volumes together with their mean annual increments (MAI) for variously aged plantations for all species used in afforestation are summarized in Table 3. These data show that, with an initial spacing of $1{\cdot}2 \times 1{\cdot}2$ m, acceptable volume increments are found in some species throughout the coastal regions. For other genera such as *Bruguiera, Ceriops* and *Xylocarpus,* poor growth performance occurs throughout the coastal regions, and is attributable to poor species-to-site matching, particularly in relation to interstitial salinity and tidal inundation.[10,23]

7 PROBLEMS ENCOUNTERED

The mangrove afforestation project in Bangladesh is being carried out in one of the most dynamic natural environments on earth and as such, some problems associated with land stability must be expected and can never be completely eliminated. Four types of land stability problems have been recognized[27] including: burial of mangrove seedlings when

TABLE 3

Growth Performance of Variously Aged Monospecific Plantations and Means for the Individual Species.[34] Mean Standing Volume and the Mean Annual Increment in Volume Have Been Calculated Using Allometric Functions, Initial Densities and Mean Mortality Rates for the Plantations

Species	*Location*	*Age (years)*	*Ht Mean (m)*	*Ht SD*	*Ht MAI (m)*	*DBH Mean (cm)*	*DBH SD*	*DBH MAI (cm)*	*Volume Mean (m^3/ha)*	*Volume MAI (m^3/ha/year)*
Sonneratia apetala	Char Kashem	10	10·50	1·07	1·05	11·88	2·04	1·19	94·2	13·9
	Patherghata	11	12·00	1·58	1·09	12·99	0·98	1·18	123·9	16·7
	Char Kukri	11	12·71	1·28	1·16	12·74	2·28	1·16	124·3	16·8
	Char Osman	11	10·65	1·65	0·96	11·38	2·62	1·03	87·3	11·6
	Hali Shahar	11	9·47	1·09	0·86	13·57	2·10	1·23	114·5	15·2
	Bogachatter	13	8·34	1·31	0·64	10·08	1·66	0·78	58·1	6·4
	Mean		10·61	1·33	0·96	12·11	1·95	1·10	100·4	13·4
Sonneratia caseolaris	Char Islam	9	5·60	0·97	0·62	15·31	3·09	1·70	105·4	16·4
	Galachipa	11	10·76	1·01	0·97	21·11	3·21	1·92	302·7	40·3
	Mean		8·18	0·99	0·80	18·21	3·15	1·81	204·0	28·3
Avicennia officinalis	Hali Shahar	9	3·70	0·77	0·41	4·16	0·87	0·46	6·3	1·0
	Bogachatter	11	5·30	1·12	0·48	10·59	2·46	0·96	48·9	6·1
	Char Kashem	12	6·89	0·84	0·53	12·22	3·19	0·94	75·7	8·1
	Char Kukri	13	8·42	1·07	0·65	16·09	3·96	1·24	148·9	16·3
	Bandar	13	4·41	1·03	0·34	8·82	2·15	0·68	30·8	3·2
	Char Osman	14	9·30	1·08	0·66	14·99	4·29	1·07	138·0	14·0
	Mean		6·34	0·99	0·51	11·15	2·82	0·89	74·8	8·1
Avicennia marina	Hali Shahar	9	3·21	0·51	0·36	4·02	0·88	0·45	5·5	0·8
	Grokghata	10	5·23	1·02	0·52	7·79	1·95	0·77	26·3	3·6
	Bogachatter	11	5·82	1·31	0·53	13·21	3·73	1·12	80·1	9·5
	Mean		4·75	0·95	0·47	8·34	2·19	0·78	37·3	4·7
Avicennia alba	Grokghata	10	4·67	0·90	0·47	6·68	1·42	0·67	18·2	2·5
	Bandar	13	4·16	1·06	0·32	5·56	0·43	0·80	11·9	2·2
	Mean		4·42	0·98	0·40	6·12	0·93	0·74	15·1	2·3
Bruguiera gymno-rrhiza	Char Hare	10	2·25	0·71	0·23	1·31	1·16	0·13	0·5	0·1
	Char Osman	10	3·54	0·75	0·35	3·12	0·55	0·31	3·5	0·5
	Dhal Char	11	4·19	0·44	0·38	4·50	0·70	0·41	7·8	1·0
	Char Kashem	12	2·76	0·62	0·23	2·82	1·32	0·24	2·6	0·3
	Char Kukri	13	4·07	0·44	0·31	5·83	1·33	0·45	13·0	1·3
	Mean		3·36	0·59	0·30	3·52	1·01	0·31	5·5	0·6
Bruguiera sexangula	Hali Shahar	10	1·42	0·49	0·14	0·78	0·93	0·08	0·2	0·0
	Bogachatter	12	1·76	0·76	0·14	0·70	1·08	0·06	0·1	0·0
	Bandar	13	2·89	0·91	0·22	1·93	1·06	0·15	1·2	0·1
	Mean		2·02	0·72	0·17	1·14	1·02	0·10	0·5	0·1

TABLE 3—*contd.*

Species	*Location*	*Age (years)*	*Ht Mean (m)*	*Ht. SD*	*Ht. MAI (m)*	*DBH Mean (cm)*	*DBH SD*	*DBH MAI (cm)*	*Volume Mean (m^3/ha)*	*Volume MAI (m^3/ha/ year)*
Excoecaria	Dhal Char	11	7·67	1·56	0·70	9·70	3·94	0·88	51·0	6·6
agallocha	Char Kukri	12	7·40	1·22	0·62	11·14	2·91	0·93	65·7	7·8
	Char Osman	14	7·32	1·19	0·52	9·62	2·34	0·50	48·7	3·8
	Bogachatter	14	3·77	0·73	0·27	7·00	2·34	0·50	18·0	1·7
	Mean		6·54	1·18	0·53	9·37	2·88	0·70	45·9	5·0
Ceriops	Dhal Char	9	1·23	0·21	0·13					
decandra	Bogachatter	12	1·38	0·54	0·11					
	Bandar	12	1·41	0·37	0·12					
	Mean		1·34	0·38	0·12					
Xylocarpus	Char Kashem	11	3·75	0·78	0·34	3·32	1·75	0·30	4·0	0·5
mekongensis	Mean		3·75	0·78	0·34	3·32	1·75	0·30	4·0	0·5

and where sediment accretion rates are particularly high; smothering of seedlings by sand in areas where wave action reworks large volumes of sand shorewards; the winnowing of fine sediment (clay and silt) from the plantation site during prolonged stormy periods, leaving a mobile sandy lag deposit; and the erosion of plantation margins through bank slumping by migrating tidal and river channels. All four types of coastal change have caused the loss of mangroves from existing plantations. However, the increasingly systematic identification of areas with land stability problems is being used to avoid planting sites where the risk of crop losses between planting and harvesting is high. In this way, mangrove losses due to adverse coastal changes should be progressively minimized.[28]

Other problems in relation to mangrove plantations have been identified.[29,30] Over and above the generally difficult communication and logistic conditions in the coastal areas, these problems include unauthorised cattle and buffalo grazing and the illegal occupation of newly raised land by the local villagers for cultivation of rice.

In the mangrove nurseries, one of the initial problems encountered was that heavy rains during the early nursery period caused low seedling production, usually because the seeds are light and easily floated away.

In addition, early planting trials of other mangrove species using the technique where seedlings are pulled out of the ground, did not provide acceptable levels of survival, presumably due to root damage during seedling extraction. The high proportion (about 80% by area) of *S.*

apetala in early plantations is partly due to the tolerance which this species shows toward this transplanting procedure. Polybag culture is now used to raise seedlings of at least 10 different mangrove species (Table 1) for growth trials, and these show much better performance in terms of survival and growth after out-planting. Nevertheless, the extent of the early monospecific plantations has led to outbreaks of two major pest organisms:

7.1 Keora stem borers: *Zeuzera conferta* (Cossidae: Lepidoptera)

Stem borer infestations of *S. apetala* plantations have increased markedly over the last five years apparently with the increased area of monospecific stands of this species. In 1988, a mean of 52% of the trees were affected with 22%, 17% and 13%, respectively, showing severe, moderate or slight infestations.[31]

Although stem borer attacks generally do not kill the trees, they reduce their timber value, and the Protection Division of the Forest Research Institute is presently trying to develop control measures. At the same time, the PTU is evaluating the silvicultural control of this insect through multi-specific plantations, particularly mixtures of *Sonneratia* and *Avicennia*.

7.2 Leaf defoliators: *Streblote siva* (Lasiocampidae: Lepidoptera)

The numbers of this insect have also increased in apparent response to large monospecific stands of *S. apetala*. As with the stem borer, this species generally does not kill the trees but severe infestations may cause growth deformities and a marked decline in growth generally and wood production specifically. The silvicultural control of this insect through multi-specific plantations, particularly mixtures of *Sonneratia* and *Avicennia* is currently under investigation by the PTU.

7.3 Economics of thinning

In 1985, the mean yield of wood from 10-year-old plantations was estimated at 200 m^3/ha, providing an MAI of 20 m^3/ha.

Because of purchaser preference, the price of *Sonneratia* as fuel wood is approximately 2 Taka ft^3 while other popular fuelwoods are generally priced at 15 Taka ft^3 even though *Sonneratia* has a slightly higher calorific value (8236 Btu/lb) when compared with mango (7886 Btu/lb) and raintree (8191 Btu/lb).[32] Thus, from a purely economic perspective, while the price of *Sonneratia* as fuel wood remains low, the cost of thinning is barely recoverable.[26] One of the options currently being evaluated is to design the plantations so as to optimize timber productions without the need for thinning.

On the basis of experimental trials it was found[33] that an adjustment of density so that in 5- or 6-year-old plantations, densities of 1100–1600 trees/ha occurred, would result in marginally increased diameter increment, and hence, volume. Such an adjustment of density may be achieved either by thinning when plantations are 5 or 6 years old, or by adjusting the initial spacing so that this density is attained by natural attrition around 5 or 6 years after planting.

If the products of thinning are an important outcome from the coastal plantations, and if these can be harvested economically, then it seems that the current spacing of 1·2 m × 1·2 m should be retained, with thinning carried out when the plantations are 5 or 6 years old. However, as there is some doubt on the economics of thinning,[26] it may be preferable to adjust the initial spacing to achieve the desired density 5 or 6 years after planting out. An initial spacing of 1·75 m × 1·75 m will result in the desired densities after 5 or 6 years through natural losses and, would thus reduce the initial labour involved in establishing the new plantations. On the other hand, such wider initial spacings would require monitoring to ensure that unforeseen physical events, for example, have not caused major departures from the predicted survival rates. In addition, some infilling may also still be required as mortality may occur in patches rather than randomly through newly established plantations.

8 BENEFITS GAINED

On current estimates, there are some 96 000 ha of suitable coastal lands presently available for further plantations. Despite this, it is estimated that a total of 150 000 ha has been reclaimed and stabilized since the inception of this programme. Considerable areas (60 000 ha) have now become raised to the level where they are no longer suitable for further mangrove plantations and these are currently planted with salt-tolerant upland trees (e.g. *Acacia nilotica, Albizia procera, Samanea saman, Casuarina equisetifolia*) or have been transferred from the Forest Department to the local people for grazing cattle, goats and buffalo.

More importantly, the protection and stabilization has provided 60 000 ha of stabilized land which at current land values ($US 800/ha), suggests that the real success of the coastal plantations has been to generate $1{\cdot}44 \times 10^9$ Takas from new agricultural lands.

In addition, it is estimated that the plantations have provided more than 600 000 m^3 of wood (Ishtiaq Uddin Ahmed, Assistant Conservator of Forests, personal communication, 1991) and other forest products, and have provided in excess of 5×10^6 man days employment for local villagers over the last 25 years, considerably adding to the economies of coastal villages.

During the intense cyclone of April 1991, many of the mangrove plantations were damaged. The intensity of damage was higher along the Chittagong coast than in the western part of the coastal belt but none of the mangrove nurseries sustained any significant damage. Young plantations (1–5 years old) seemed to have suffered most damage through wave action, with leaf loss ranging from 10 to 80%. By July 1991, however, most of the plantations showed clear signs of recovery (N. A. Siddiqi, unpublished data, 1991), and it is expected that full recovery will occur with the exception of those areas where excessive silt deposition resulted. Damage to non-mangrove species raised on the coastal embankments (such as *Acacia nilotica*) was significantly higher than that to mangroves, and less developed root systems in non-mangrove species may have contributed to their susceptibility to 'wind-throw'.

Consequently, it may be argued that the most significant benefit provided by the mangrove plantations was the provision of a self-repairing system which facilitated the stabilization and protection of the coast during intense cyclonic conditions.

9 LESSONS LEARNED

While resource decision-making is always easier with the benefit of hindsight, there are several important lessons emanating from this programme which have wider application. From an ecological management perspective, the major lesson to date has been that monospecific mangrove cultures may develop problems which are difficult and costly to remedy. Where the economic conditions are as they are in Bangladesh, then silvicultural control measures need to be investigated rather than to rely on chemical control measures. More importantly, plantations need to be designed as multispecific systems to minimize or avoid some of the identified problems. In that sense, silvicultural research should precede any intensive planting programme.

In some instances, mangrove plantations have had a sacrificial value, i.e. they have caused such rapid accretion that the land no longer supports mangroves. Because using mangrove plantations to accelerate the accretion of new land is not necessarily compatible with optimal timber production, the objectives for afforestation need to be reviewed and clearly prioritized.[27]

Finally, the changing soil salinities as well as soil maturation of the newly accreted lands require an integrated programme of sequential planting of suitable species which are able to adapt to the changing conditions. In contrast to the existing situation, such an integrated programme requires the long-term control and tenure of the land by the Forest Department.

Despite the improvements that could have been made to this programme at its inception, it has nevertheless proved successful in most respects and illustrated that large-scale mangrove afforestation is both technically possible and socio-economically beneficial.

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Annex IN-25

Relevant Abstracts of the Scientific and Technical Guidelines of the Commission on the Limits of the Continental Shelf, Doc. CLCS/11, adopted at its fifth session on 13 May 1999.

INTRODUCTION

[...]

1.3. With these Guidelines, the Commission aims also to clarify its interpretation of scientific, technical and legal terms contained in the Convention. Clarification is required in particular because the Convention makes use of scientific terms in a legal context which at times departs significantly from accepted scientific definitions and terminology. In either cases, clarification is required because various terms in the Convention might be left open to several possible and equally acceptable interpretations. It is also possible that it may not have been felt necessary at the time of the Third United Nations Conference on the Law of the Sea to determine the precise definition of various scientific and technical terms. In still ether cases, the need for clarification arises as a result of the complexity of several provisions and the potential scientific and technical difficulties which might be encountered by States in making a single and unequivocal interpretation of each of them.

[...]

SECTION 2. ENTITLEMENT TO AN EXTENDED CONTINENTAL SHELF AND THE DELINEATION OF ITS OUTER LIMITS

[...]

2.2.1. Bath the basis for entitlement to delineate the outer limits of an extended continental shelf and the methods to be applied in this delineation are embedded in article 76. However, it is clear that the positive proof of the former precedes the implementation of the latter, as stated in article 76, paragraph 4 (a):

> "For the purposes of this Convention, the coastal· State shall establish the outer edge of the continental margin wherever the margin extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured"

2.2.2. The Commission defines the term "test of appurtenance" as the process by means of which the above provision is examined. The test of appurtenance is designed to determine the legal entitlement of a coastal State to delineate the outer limits of the continental shelf throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance.

[...]

2.2.5. The Commission finds that the proof of entitlement over the continental shelf and the method of delineation of the outer limits of the continental shelf are two distinct but complementary questions. The basis for delineation cannot be ether than pertinent to that of entitlement itself.

2.2.6. The Commission shall use at all times: the provisions contained in paragraph 4 (a) (i) and (ii), defined as the formulae lines, and paragraph 4 (b), to determine whether a coastal State is entitled to delineate the outer limits of the continental shelf beyond 200 nautical miles. The Commission shall accept that a State is entitled to use all the ether provisions contained in paragraphs 4 to 10 provided that the application of either of the two formulae produces a line beyond 200 nautical miles.

[...]

2.2.8. The formulation of the test of appurtenance can be described as follows: If either the line delineated at a distance of 60 nautical miles from the foot of the continental slope, or the line delineated at a distance where the thickness of sedimentary rocks is at least 1 per cent of the shortest distance from such point to the foot of the slope, or both, extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, then a coastal State is entitled to delineate the outer limits of the continental shelf as prescribed by the provisions contained in article 76, paragraphs 4 to 10.

[...]

SECTION 5. FOOT OF THE CONTINENTAL SLOPE DETERMINED AS THE POINT OF MAXIMUM CHANGE IN THE GRADIENT AT ITS BASE

[...]

5. 4.5. The Commission defines the base of the continental slope as a region where the lower part of the slope merges into the top of the continental rise, or into the top of the deep ocean

floor where a continental rise does not exist. The Commission recommends that the search for the base of the continental slope be carried out by means of a two-step approach. First, the search for its seaward edge should start from the rise, or from the deep ocean floor where a rise is not developed, in a direction towards the continental slope. Secondly, the search for its landward edge should-start from the lower part of the slope in the direction of the continental rise, or the deep ocean floor where a rise is not developed.

5.4.6. As a general rule, whenever the base of the continental slope can be clearly determined on the basis of morphological and bathymetric evidence, the Commission recommends the application of that evidence. Geological and geophysical data can also be submitted by coastal States to supplement proof that the base of the continental slope is found at that location.

[...]

SECTION 6. FOOT OF THE CONTINENTAL SLOPE DETERMINED BY MEANS OF EVIDENCE TO THE CONTRARY TO THE GENERAL RULE

[...]

6.1.10. The Convention does not prescribe the application of a specific scientific methodology to define the location of the foot of the continental slope when evidence to the contrary to the general rule is invoked. The Commission interprets this provision as an opportunity for coastal States to use the best geological and geophysical evidence available to them to locate the foot of the continental slope at its base when the geomorphological evidence given by the maximum change in the gradient as a general rule does not or cannot locate reliably the foot of the continental slope.

[...]

6.2.3. The shelf and the continental slope have characteristics typical of continental crust, often including thick layers of sediments. The foot and the base of the continental slope are inseparable, and commonly lie close to the outer edge of the continent, that is, near the place where the crust changes from continental to oceanic.

[...]

SECTION 8. DELIMITATION OF THE OUTER LIMITS OF THE CONTINENTAL SHELF BASED ON SEDIMENT THICKNESS

[...]

8.1.8. The sediment thickness at any location on the continental margin is the vertical distance from the sea floor to the top of the basement at the base of the sediments, regardless of the slope of the sea floor or the slope of the top basement surface.

[...]

Annex IN-26

N. P. C. Reddy and K. Mohano Rao, “Heavy Sediment Influx during Early Holocene: Inference from Clay Mineral Studies in a Core from the Western Bay of Bengal”, *Current Science*, Vol. 81, 2001, pp. 1361-1364.

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Heavy sediment influx during early Holocene: Inference from clay mineral studies in a core from the Western Bay of Bengal

N. P. C. Reddy* and K. Mohana Rao

Regional Centre, National Institute of Oceanography, 176, Lawson's Bay, Visakhapatnam 530 017, India

Clay mineral studies were carried out in a 650 cm long sediment core collected at a depth of 2200 m from the north-western Bay of Bengal. Illite is the predominant mineral, followed by montmorillonite and chlorite. Illite concentration varies from 49 to 65% from the core top to 380 cm and further down, increases to 85%. Montmorillonite content ranges from 22 to 36% above 380 cm, with a maximum in the upper 20 cm. Lowest values of montmorillonite (3–8%) are observed below 380 cm. Chlorite values range from 12.8 to 29%. Kaolinite is present in traces.

The changes in mineral composition at 380 cm in the core are interpreted to be a transitional period of Pleistocene–Holocene. This is substantiated by the lithological, foraminiferal and geochemical studies of the core. Very high content of illite below 380 cm of the core reflects glacial weathering products of crystalline metamorphic/sedimentary rocks of Himalayas carried by Ganges–Brahmaputra rivers during the late Pleistocene, when the sea level was low. Increase of montmorillonite and kaolinite during the Holocene indicates that the Ganges–Brahmaputra province sediments were diluted with sediments from the peninsular rivers draining metamorphic gneisses, schists, Deccan Traps and Quaternary sediments. This distribution can be explained by circulation pattern and tectonics in the Ganges delta during early Holocene.

The top 380-cm thick sediment deposition during Holocene is attributed to heavy sediment influx during Mid Termination (MT) (12,500–10,000 years BP), due to increased precipitation and run-off resulting from high intensity monsoonal regime.

CLAY minerals are a powerful source for the interpretation of marine depositional processes and their study also reflects weathering conditions imparted on the rock particles that were found in the source terrain[1,2]. For example, well-crystallized smectite and kaolinite were used to elucidate depositional origin on the eastern Nile cone[3]. Chlorite and kaolinite also have been used as valuable indicators of continental sources and differential depositional sites in the eastern Atlantic sediments off North America[4]. The Bay of Bengal covers about 2.2 million sq km and is one of the highest terrigenous input sites of the world ocean. The fan is reported to be about 2800–3000 km long, 830–1430 km wide and 16 km thick, beneath the northern Bay of Bengal. Though the shelf sediments on the east coast of India were studied in detail for clay minerals, very few studies[5–9] were carried out in the deeper Bay of Bengal especially in the Bengal Fan. Chauhan *et al.*[6] reported clay minerals in a core from the eastern Bay of Bengal and suggested peninsular river source to the Holocene sediments. Chaudhri[7] has encountered only Holocene sediments derived from the Himalayas, in cores of 303 cm length from the middle Bengal fan region. Chowdary *et al.*[8] ruled out the peninsular river source to the middle fan during mid-Holocene. In contrast, Shastri *et al.*[9] concluded that the transportation of sediments is from shelf to slope to deeper western Bengal Fan. In view of the above, we plan to address to the provenance of the sediments in a sediment core from the western Bengal Fan. In this paper, we report clay mineralogy and provide an explanation for the heavy sediment deposition during the Holocene.

A sediment core of 650 cm length was collected during the 42nd cruise of *ORV Sagar Kanya* at a water depth of 2200 m (lat. 16°00'N and long. 87°05'E) (Figure 1). Subsampling of the core was done on-board, mainly at 10 cm interval and also wherever a change in colour was observed. For clay mineral analysis in all 14 subsamples were selected. Less than 2 μm fractions of the sediment were separated[10] and rendered free of $CaCO_3$ and organic matter, by treating with acetic acid and hydrogen peroxide, respectively. Oriented clay slides were prepared and scanned from 3 to 30° 2θ at 2° 2θ min^{-1} with a Philips X-ray diffractometer, using nickel filtered CuKα radiation. These samples were again rescanned after treatment with ethylene glycol for 1 h at 100°C for confirmation of montmorillonite[11]. The

*For correspondence. (e-mail: npcreddy@Kadali.nio.org)

principal peak areas of the clay mineral kaolinite + chlorite, illite and montmorillonite were multiplied by the weighting factors 2, 4 and 1, respectively. Semi-quantitative evaluation of clay minerals was done following Biscaye[12]. The samples were also scanned from 24 to 26° 2θ at 1/2° 2θ min^{-1}, for the resolution of kaolinite and chlorite[13].

Percentage of clay minerals, and montmorillonite (M) to illite (I) and kaolinite (K) to chlorite (C) ratios are shown in Table 1. Illite is the predominant mineral followed by montmorillonite and chlorite (Figure 2). On the basis of clay mineral distribution and M/I ratio the core is divided into two units, each with distinct clay mineral assemblages and source. The demarcation of the boundary at 380 cm also gets support from the grain size, organic carbon, calcium carbonate and foraminiferal studies[14] (Figure 3). Unit II sediments represent the region from 650 to 380 cm and unit I sediments from 380 cm to the core top. The sediments of unit II are blackish-grey silts and are relatively coarser. The sediments of unit I are dark yellowish-brown at the surface and light-to-dark olive-grey downwards, up to 380 cm. They are dominated by clay/clayey silt. The $CaCO_3$ content is low (4 to 6%) in unit II and high (12 to 19%) in unit I. The total organic carbon content varies from 0.04 to 1.4%, with a decreasing tendency from unit II to

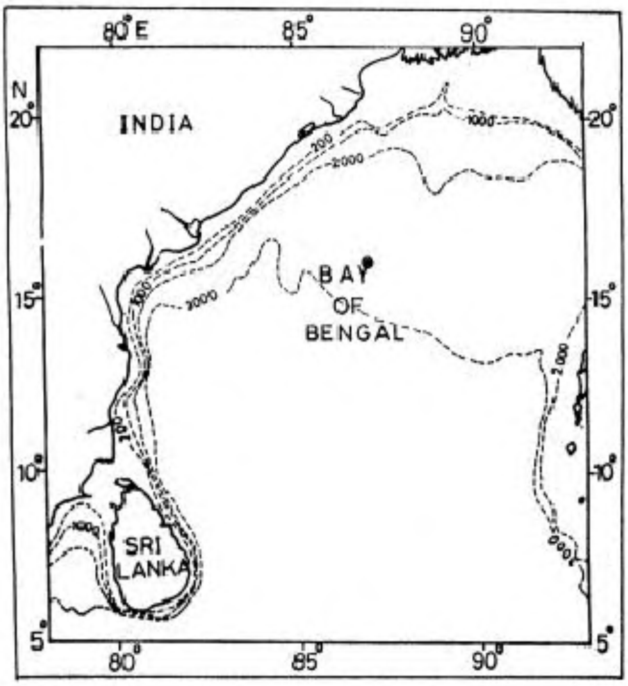

Figure 1. Location map showing position of the core.

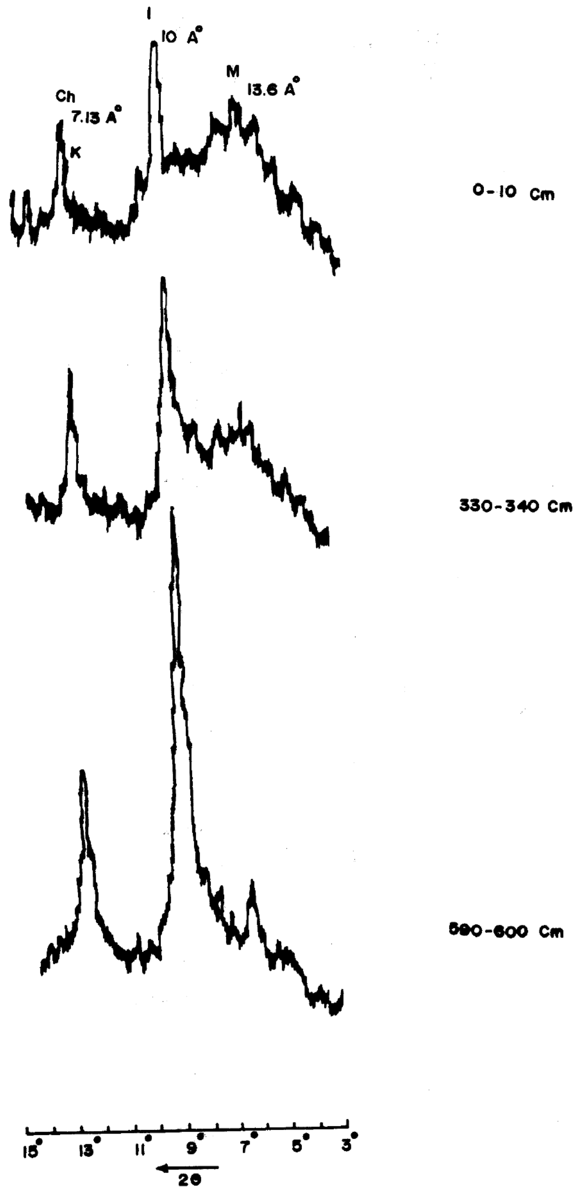

Figure 2. X-ray diffractograms of selected subsamples.

Table 1. Percentage of clay minerals and M/I, K/C ratios

Core depth (mm)	Clay mineral (%) K + C	I	M	M/I	K/C
0–10	14.0	49.2	36.8	0.74	0.89
10–20	13.4	50.0	36.6	0.73	
30–40	17.9	57.9	22.2	0.37	
50–60	12.9	60.6	26.5	0.43	
149–160	14.7	65.3	20.0	0.30	
170–182	15.3	67.0	17.7	0.26	0.47
227–280	14.7	54.0	51.3	0.58	
330–340	14.2	58.3	27.5	0.47	
375–380	29.0	53.0	18.0	0.33	0.33
390–400	28.3	57.3	14.4	0.25	
450–455	13.7	84.5	1.8	0.02	
460–462	13.8	82.2	4.0	0.04	
590–600	15.5	82.5	2.0	0.02	0.13
612–617	12.8	85.2	2.0	0.02	

K + C, Kaolinite + Chlorite; I, Illite; M, Montmorillonite.

unit I. The demarcation at 380 cm between unit II and unit I represents the Pleistocene–Holocene boundary[14].

Illite content in unit II increases to a maximum of 85%, while montmorillonite values are as low as 3 to 8%. Chlorite content varies from 12.8 to 29.0%, with traces of kaolinite. The M/I ratio is < 0.04 and reveals the total predominance of illite during late Pleistocene. The K/C ratio is as low as 0.13.

In unit I, illite content varies from 49 to 65% and montmorillonite content varies from 22 to 36%, with a maximum in the upper 20 cm. Chlorite ranges between 13 and 17%. The M/I ratio increases from 0.30 to 0.75 up core from the boundary, indicating steady increase in montmorillonite since the beginning of the Holocene. The K/C ratio increased from 0.33 to 0.89 since the Holocene.

The sediments of unit II comprise high illite, low montmorillonite and low M/I and K/C ratios. This reflects the glacial weathering products of crystalline metamorphic/sedimentary rocks of the Himalayas carried by Ganges–Brahmaputra rivers. It appears that the large quantity of sediments must have been transported and deposited by turbidity currents during late Pleistocene, when the sea-level was 120 cm lower[15] than present.

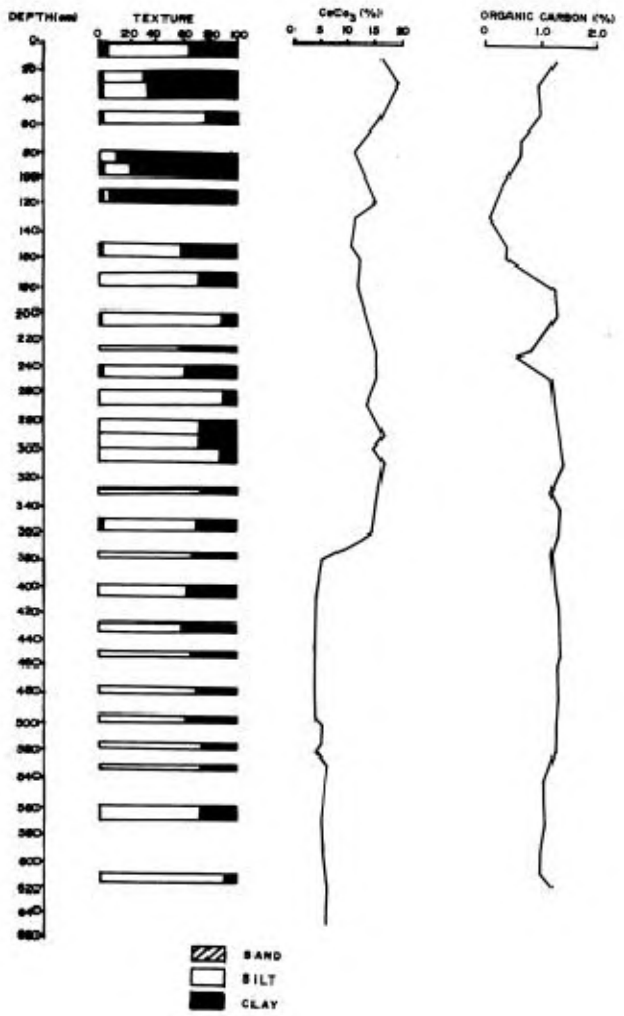

Figure 3. Lithological, textural and geochemical log of the core.

The sediments of unit I consist of relatively low illite, high montmorillonite, high M/I and K/C ratios. These are most probably derived from the peninsular rivers like Mahanadi, Godavari and Krishna. Mahanadi drains metamorphic rocks (gneisses and schists with local acid and basic igneous bodies) and Quaternary sediments[16] under humid tropical conditions. This results in enhanced chemical weathering products such as kaolinite and montmorillonite. The Godavari and Krishna drain through Deccan Traps covered by black cotton soils in the upper reaches and Precambrian formations in the lower reaches. Therefore, montmorillonite followed by kaolinite are the dominant weathering products. The increase in the K/C ratio in the Holocene sediments also supports this inference. The cumulative effect of the peninsular river sediment contribution is therefore visible in the clay mineral assemblage of the core in unit I. The change in clay mineral assemblage from unit II to unit I indicates that the sediments derived from the peninsular rivers are transported abundantly to the site than that of Ganges-derived sediments during the Holocene. The high sedimentation rate at the core site during Holocene may be related to the SW monsoon, when river sediment discharge from Ganges–Brahmaputra and peninsular rivers was at its peak. The possible reasons for these changes are circulation pattern, and tectonics in the Ganges delta during Holocene.

Though the circulation patterns[17] clearly indicate that transport mechanism of montmorillonite to the core site is possible, the exact path of these river sediments to the deep sea is yet to be established. Earlier studies on clay mineralogy of the shelf sediments of the east coast of India[18,19] indicated that the sediments derived from the Krishna–Godavari province are transported northwards, under the influence of NE-flowing currents associated with SW monsoon winds. But the present study indicates that the entire sediment input is not shifted towards the extreme north, but some material is invariably transported across the shelf to get deposited in the deep-sea fan. The NE-flowing currents during the SW monsoon also direct the Ganges-derived sediments towards the east. As the present core is located towards the west, less sediment might have got deposited at the site. Reduction of sediment supply from the Ganges–Brahmaputra rivers can also be explained by tectonic activity in the Ganges delta[20]. Due to the subsidence of the delta during early Holocene[20], large sediment flux was deposited in the deltaic region and therefore, relatively low sediment flux was transported to the Bengal Fan. This is evident by accumulation of a thick (to 40 m) highstand sediment sequence in the lower flood plains[20].

On the basis of oxygen isotope stratigraphy[21], the LGM level (18,000 BP) was reported at 80 cm core depth. According to Cullen[5], the LGM level varied between 60 and 100 cm in the cores of the central Bay of Bengal. The sedimentation rate of 2–4 cm/ky was reported for the Bay of Bengal by various authors[22,23]. Suresh and Bagati[24] reported low concentration of calcium carbonate in the upper part of the cores in the middle Bengal Fan and suggested high influx of clastic material derived from the Godavari, during the post-glacial period. The present study indicates a deposition of 380 cm since the beginning of Holocene to the present. This high sediment influx might have resulted due to the high-intensity monsoonal regime during MT 12,500–10,000 yrs BP. According to Cullen[5], the increased precipitation and run-off is due to the increased eastward advection of equatorial surface waters by the SW monsoon current. Goodbred and Kuehl[25] explained that after ca. 11,000 years BP, there was a drop in fan sedimentation[28] as a result of rising sea level and tectonic trapping of the Ganges–Brahmaputra sediment on the flooded Bengal Basin. The high discharge in the early Holocene suggests its relation to a stronger SW monsoon in South Asia. Similar patterns of high monsoon-related sediment discharge have been noted throughout the tropics and subtropics, suggesting a widespread fluviosedimentary response[25].

Unit II sediments correspond to Pleistocene and illite is the predominant mineral. The glacial weathering products of the Himalayas carried by the Ganges–Brahmaputra are a major source for these sediments. The increase in montmorillonite proportion during Holocene (unit I) supports the fact that the Ganges-derived sediments are diluted by supply from the peninsular rivers as a result of circulation pattern and tectonics in the Ganges delta during the early Holocene. Heavy sediment influx during the early Holocene may be due to high-intensity monsoonal regime during MT.

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Annex IN-27

S. J. Sangode, N. Suresh and T. N. Bagati, "Godavari Source in the Bengal Fan Sediments: Results from Magnetic Susceptibility Dispersal Pattern", *Current Science*, Vol. 80, 2001, pp. 660-664.

Godavari source in the Bengal fan sediments: Results from magnetic susceptibility dispersal pattern

S. J. Sangode*, N. Suresh and T. N. Bagati

Sedimentology Group, Wadia Institute of Himalayan Geology, 33 General Mahadeo Singh Road, Dehra Dun 248 001, India

The Bay of Bengal has been receiving erosional products dominantly from the Himalaya since Mid-Eocene time through the Ganges–Brahmaputra river system, with minor contribution from peninsular rivers. Spatial distribution of magnetic susceptibility in 13 cores from the western part of the Bengal submarine fan indicates predominance of Godavari river source (peninsular India) during the Late Quaternary. Sequential down-core analysis of magnetic susceptibility-dispersal patterns suggests that the Godavari source dominated the top ~ 100 cm of the Bengal fan sedimentation. This changeover is attributed to weakening of the Himalayan source (Ganges–Brahmaputra) after the Last Glacial Maxima (23–14 Ka BP).

THE Bengal fan (20°N to 8°S) in the Bay of Bengal covering an area of about 3×10^6 km^2 and a volume of $7–8 \times 10^6$ km^3 is the product of extensive denudation of Himalaya (youngest orogeny of the world)[1–4]. Sedimentation in this fan is mainly governed by gravity flows and turbidity currents[1]. A Mid-Eocene age was assigned to the onset of sedimentation in the Bengal fan[2]. Relatively more continuous sequence is available since Lower Miocene to present (ODP Leg 116)[5]. Yokoyama *et al.*[5] inferred that the Lower Miocene sediments in the Bengal fan are derived from Precambrian and Palaeozoic sedimentary rocks of the Lesser Himalaya. Further, they noted a dominant metamorphic source at 15 Ma and un-roofing as well as successive erosion of the Central Himalayan rocks between 3.5 and 0.5 Ma. Thus the Ganges–Brahmaputra river system of Himalaya was the single largest source of detritus to the Bengal fan at least till 0.5 Ma (refs 2, 5). However, magnetic properties on black mud turbidites in the distal part of the Bengal fan suggested that titanomagnetite, and to some extent hematite of the Deccan basalt affinity (peninsular India) dominate the magnetic mineral assemblage[6]. Clay minerals in the surface sediments of the fan indicate predominance of smectite derived from the Deccan basalt[7]. The isopach contours of Curray[8] also depict a significant curvature for the Godavari source in the Bay of Bengal. Thus, it is widely accepted that the river Godavari, which flows largely through the Deccan province in peninsular India has also made an important contribution to sedimentation over the Bengal fan. However, the timing of predominant weakening/strengthening of Godavari vs Himalayan source is not yet resolved for the Late Quaternary.

Between-the-hole correlation of cored samples is useful for sedimentologic and climatic investigations in marine sediments. Magnetic susceptibility measurements provide a quantifiable, non-destructive and most economic method for inter-core correlation[9,10]. Pattern matching of magnetic susceptibility profiles enables continuous correlation with an added advantage for identification of irregularities[9]. The magnetic susceptibility of sediments responds not only to the majority of iron-bearing ferri- and anti-ferromagnetic minerals, but also to the variation in diamagnetic and paramagnetic components such as quartz, feldspar, calcium carbonate and clay minerals. The primary cause of variation of magnetic susceptibility in deep-sea sediments is the change in the amount and nature of terrigenous inputs, grain size associated with sorting by various agencies, depositional and post-depositional conditions and climate fluctuations[10]. The magnetic susceptibility variation of deep marine sediments indirectly reflects the proportion of biogenic (carbonates and silica) to lithogenic (clay and detrital) components[9]. Although there are a few reports of whole core magnetic susceptibility logging in the Indian ocean[11–13], there is no attempt on sediment provenance studies based on magnetic susceptibility, particularly for the economically important Middle and Lower Bengal fan regions.

Geological Survey of India Research Vessel (*Samudra Manthan* Cruise: 43) provided deep-sea sediment cores (each 50 to 300 cm) from the western Bay of Bengal. Previously Suresh[14] and Suresh and Bagati[15] performed detailed textural and grain-size analysis, calcium carbonate and clay mineral determinations using the same split cores of the present investigation. Suresh and Bagati[16] used magnetic susceptibility of two cores and distinguished two intervals of ooid turbidites in cores SM 43/15 and 43/17. During the present investigation we attempted to precisely determine the source influx in the Middle and

*For correspondence. (e-mail: bswihg@nde.vsnl.net.in)

Lower fan region using magnetic susceptibility inter-core-correlation on 13 cores in the western Bay of Bengal (14° to 18°N lat. and 83° to 87°E long., Figure 1). Of these, five cores are from the Lower fan (SM 43/76, 77, 83, 87 and 94), four from the Middle fan (SM 43/15, 17, 22 and 26) and two each from the continental rise (SM 43/42 and 96) and continental slope (SM 43/9 and 100) off the Vishakhapatnam coast.

Materials and methods

Magnetic susceptibility samples were taken at 5 cm interval by pressing standard non-magnetic cubes into the split-cores. Susceptibility measurements were carried out on a Bartington MS-2 system. The instrument uses a sharply-tuned oscillator circuit to detect the change in frequency of an AC waveform after insertion of the sample into the field. The change in frequency of AC is directly proportional to the magnetic susceptibility (X_{lf}%) of sample. A peak alternating field of 80 A/m rms is applied at low (0.465 kHz) and high (4.65 kHz) frequency. After calibration of the instrument (using pure $MnCO_3$ and distilled water), each sample was measured three times at both frequencies to calculate the average frequency dependence of susceptibility (X_{fd}%). Corrections for air and the diamagnetism of plastic containers were made for each set of readings and the volumetric magnetic susceptibilities calculated (units of 10 E–11 m^3).

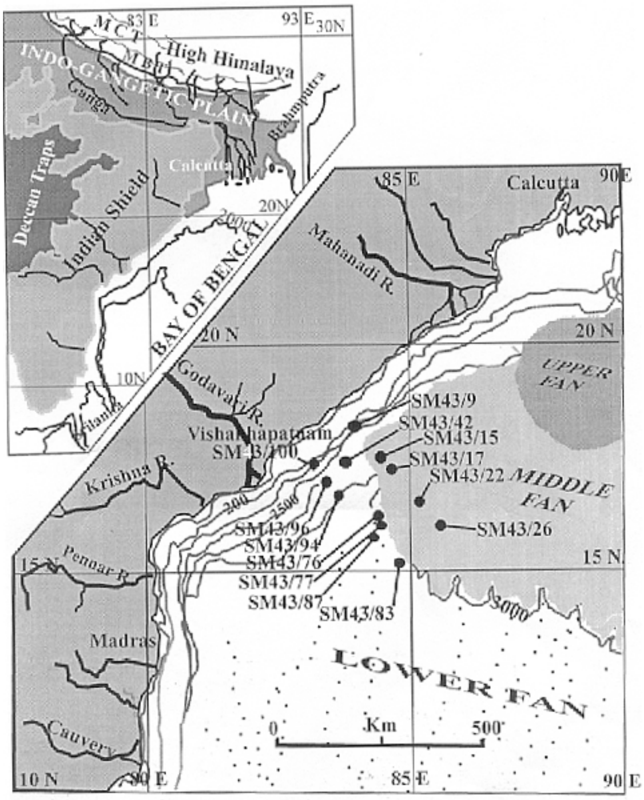

Figure 1. Geographic locations of the studied cores from the Bay of Bengal. Dotted lines mark the position of palaeochannels and the continuous parallel lines mark the contours. MCT, Main Central Thrust; MBT, Main Boundary Thrust.

Core correlation

Figure 2 *a–c* shows the spatial and temporal distributions of sediment texture and magnetic susceptibility in the

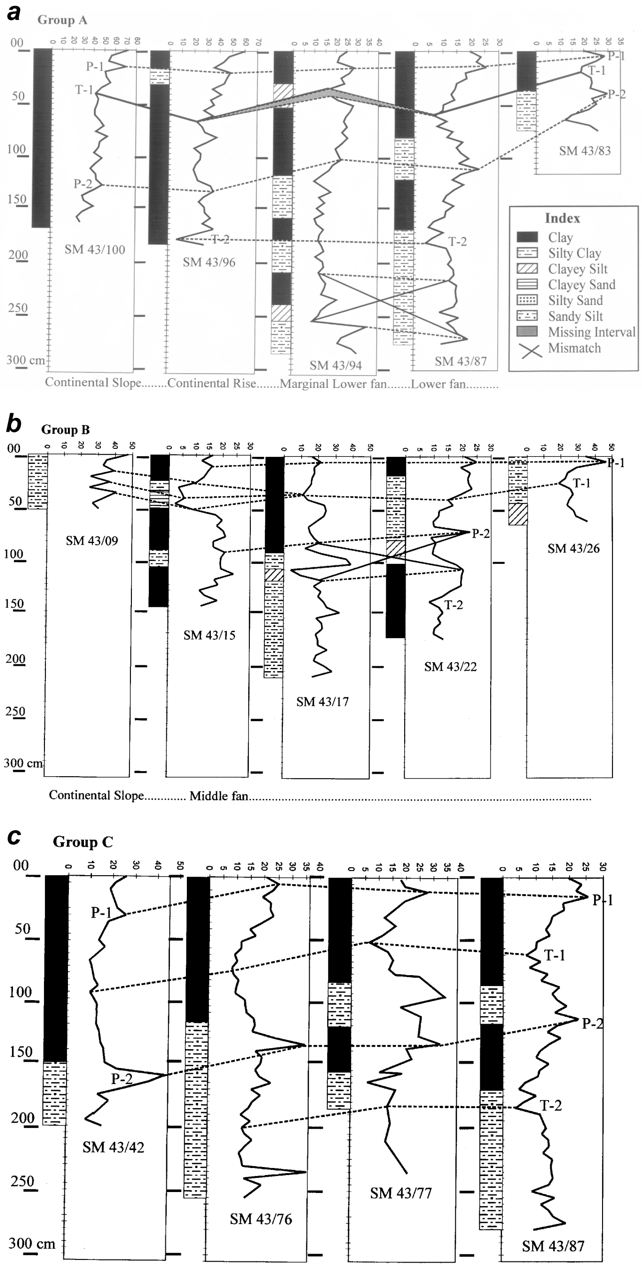

Figure 2. Inter-core correlation using low frequency (0.465 kHz) magnetic susceptibility (units of 10E-11 m^3 SI) among (***a***), Group A cores; (***b***), Group B cores; and (***c***), Group C cores. Plotted on the vertical scale are the lithofacies variation with core depths in cm. Dashed lines indicate major peak-to-peak and trough-to-trough correlations. Major peak and troughs are P-1 and P-2, and T-1 and T-2 respectively (as described in text).

studied cores. Texturally, the sediments are mainly composed of clay and silty-clay with occasional influx of clayey-silt, clayey-sand, silty-sand and sandy-silt. The topmost part of all the cores is dominated by clay (except SM 43/09 and 26) while the lower part is dominated by silty-clay (except SM 43/100, 96, 15 and 22). Broadly the clay and silty-clay belong to pelagic/hemipelagic facies and the rest are gravity flow/turbidites depositional facies (more details in refs 14–16). The spatial textural pattern displays some notable lateral facies variation, even amongst the adjacent cores. A mud turbidite observed at 40 cm in SM 43/94 is absent in adjacent cores. Similarly an interval at 250 cm in SM 43/94 showing calcareous turbidite is represented by the interval of mud turbidite in SM 43/87. An ooid turbidite at 40 cm in SM 43/15 is not present at this level in its nearest core SM 43/17 (details in ref. 16). These intervals are expressed by mismatch in the magnetic susceptibility pattern of the respective cores.

Magnetic susceptibility core-correlation was performed by plotting 'tie lines' based upon the visual best-fit pattern match and relative amplitudes of the magnetic susceptibility curves. Five distinct types of patterns were observed common in all the cores, viz. (1) acute 'W', (2) tilted 'W', (3) flattened 'W', (4) tilted 'Z', and (5) combination of 'Z and W'. Based on the general trend of magnetic susceptibility profiles, bathymetric location of the cores, textural and CaCO3 variation; the inter-core correlation has been categorized into three groups; Group A, SM 43/100, 43/96, 43/94, 43/87, 43/83 (Figure 2 *a*); Group B, SM 43/09, 43/15, 43/17, 43/22, 43/26 (Figure 2 *b*); Group C, SM 43/42, 43/76, 43/77, 43/87 (Figure 2 *c*).

Group A yielded the best correlation amongst all the groups, with a good within-group correlation between the two distant cores SM 43/94 and SM 43/87. The cores in this group are arranged in the order: Continental slope (SM 43/100), Continental rise (SM 43/96), Marginal lower fan (SM 43/94) and Lower fan region (SM 43/87 and SM43/83). Decrease in the intensity of magnetic susceptibility towards the deeper part of the ocean suggests a general preponderance of source-controlled nature of magnetic mineral distribution. Convergence of tie lines towards the deeper part indicates decreasing rate of sedimentation towards the deep ocean. Four major tie lines in Group A indicate primarily the two peaks (P-1, P-2) and two troughs (T-1, T-2). There is no apparent correlation between plots of X_{fd}% (Figure 3) and the magnetic susceptibility (Figure 2 *a*) suggesting its control by detrital as well as authigenic components at different levels and depositional conditions. The X_{fd}% for P-2 in Group A suggests an inverse relation to susceptibility and is in the range of authigenic Single Domain grains (SD, X_{fd}% ~ 0–5%)[17], except for the continental slope core (SM 43/100). This level (P-2) for the cores in the deeper part of the ocean (SM 43/87 and 83) also corresponds to a prominent peak in $CaCO_3$ (Figure 4). Suresh and Bagati[15] reported significant occurrence of *in situ* calcareous fossils at this level for the same cores, resulting in the higher carbonate

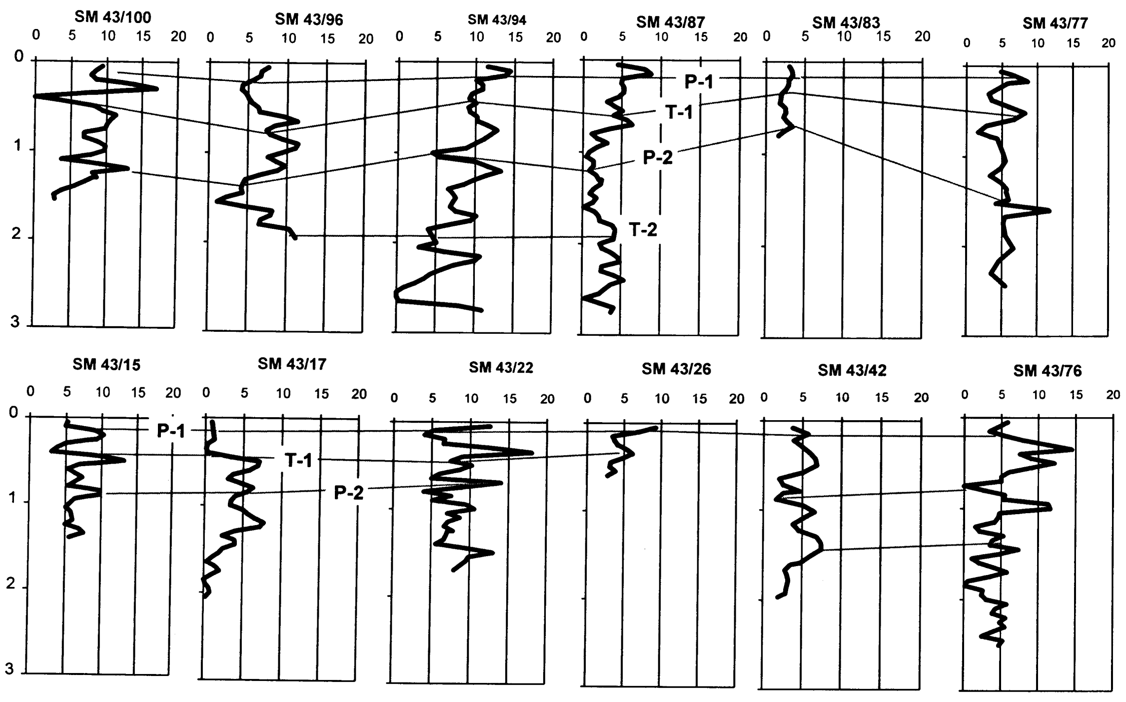

Figure 3. Coefficient of frequency dependence of susceptibility (X_{fd}%) plots with vertical scale of depth of cores (in m). Tie lines correspond to P-1, P-2, T-1 and T-2 for the respective cores in Figure 2 *a–c* of magnetic susceptibility inter-core correlation.

content. Hence the SD fraction at this level may be of authigenic origin similar to biogenic magnetites reported elsewhere in deep marine environments[18]. There is a significant mismatch from 200 to 250 cm level of SM 43/94 and 87. This is also pronounced in the $CaCO_3$ curves (Figure 4) and lithologic and textural parameters[15]. The X_{fd} and X_{lf} for the peak P-1 in the deeper part cores show a direct correlation and fall in the range of superparamagnetic (SP) fraction (0 to 0.3 μm), which probably suggests anthropogenic input (widely discussed by Thompson and Oldfield[18]).

Group B cores document three levels of mismatch; at 30–40 cm and ~ 100 cm, respectively between SM 43/15 and 17, and at ~ 80–120 cm between SM 43/17 and 22. These intervals amongst the magnetic susceptibility patterns of SM 43/22, 43/17 and 43/15 remarkably correspond to the different turbidity events described in ref. 16. A mismatch noted at ~ 100 cm between SM 43/22 and 17 corresponds to a sharp decline in $CaCO_3$ near 100 cm interval of the core SM 43/22, in contrast to its increase in the adjacent core SM/17 (see Figure 2 *b* and 4). This interval is marked by a sandy turbidite[15] in SM 43/22, which is absent in SM 43/17. The intervals from 104 cm to 112.5 cm in SM 43/17 and from 27 to 49.5 cm in SM 43/15 are ooid turbidites. Such mismatch between adjacent cores is due to different lithofacies associated with independent turbidity events and/or gravity flows.

Group C cores show good correlation amongst SM 43/76, 77 and 87, which agrees well with the earlier reported[15] good correlation between $CaCO_3$ and sandy fractions for the same cores. An interval of 100–150 cm of the cores SM 43/42 and 43/76 does not correlate ideally to SM 43/77. The detailed textural and mineralogical data suggest difference in lithology during the same interval. The peak at this interval (P-2) in SM 43/76 is co-relatable to the peak in SM 43/77, which can further be correlated with P-2 of SM 43/87.

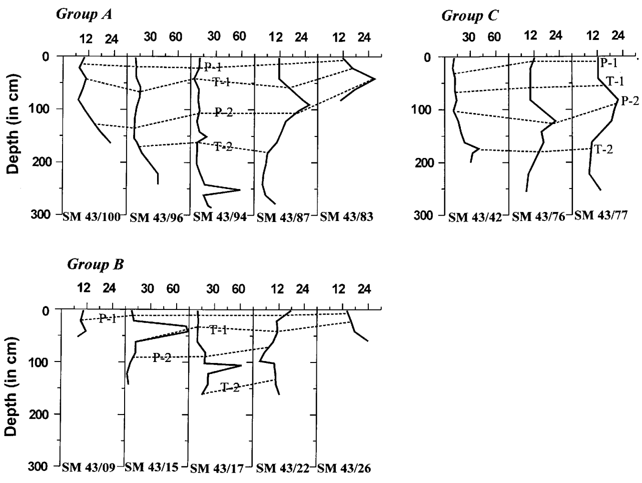

Figure 4. Percentage calcium carbonate variation in the studied cores for Groups A–C using loss on ignition method (details in ref. 15).

Magnetic susceptibility dispersal patterns

Relative core positions were plotted using latitude/longitudes for respective cores creating a grid in a Microsoft Windows-based graphics software. The surface of the three-dimensional projection was elevated on a vertical scale of magnetic susceptibility for the respective core positions. Thus four subsequent intervals are plotted assigning the magnetic susceptibility values of correlated peaks/troughs (P-1, T-1, P-2 and T-2) to depict the magnetic susceptibility dispersal with time and space. SM 43/87 is the longest core in the deeper part of the ocean. The magnetic susceptibility curve as well as textural and lithologic parameters are less affected by irregularities in this core. Further, detailed pollen analysis was conducted by Phadtare and Thakur[19] on the same core. Therefore, the reference depth levels assigned for the different stages in the 3D susceptibility dispersal pattern (P-1 at 15 ± 5 cm, T-1 at 55 ± 5 cm, P-2 at 110 ± 5 cm and T-2 at 180 ± 5 cm in Figure 5) are with reference to SM 43/87 and the error (± 5 cm) due to sampling interval. The respective magnetic susceptibility values for correlated

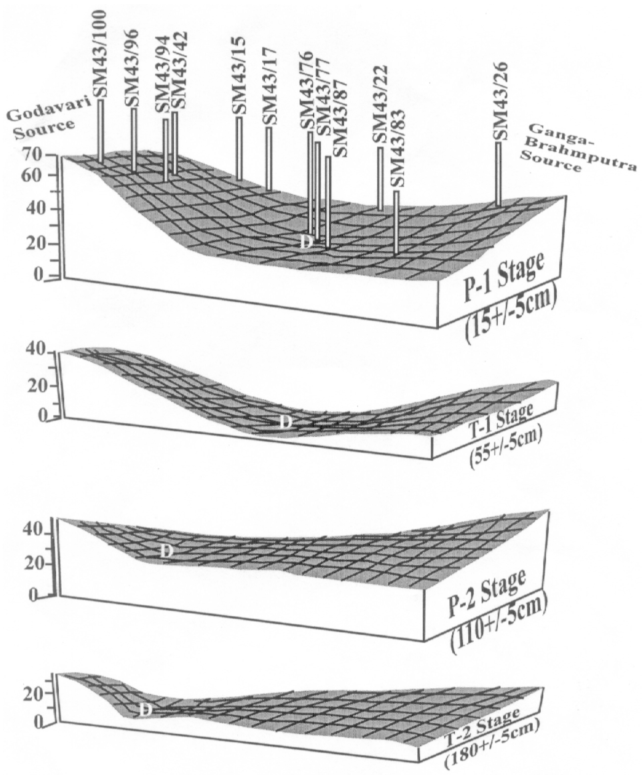

Figure 5. Cartoon depicting three-dimensional magnetic susceptibility dispersal patterns for the subsequently correlated stages T-2, P-2, T-1 and P-1 (described in text). The grid has been elevated on vertical axes using the correlated peak or trough values of magnetic susceptibility (10E-11 m^3 SI units) for the respective stages on the relative cores locations. *D* denotes the depression in the dispersal pattern.

peaks and troughs of the individual cores are plotted on the vertical scale.

The magnetic susceptibility dispersal pattern (Figure 5) suggests a downward slope off the Vishakhapatnam coast. Correlation of peaks (and troughs) by tie lines displays a decreasing trend in rate of sedimentation after P-2 towards the deeper part (see the converging tie lines in Figure 2 *a–c*) in contrast to diverging tie lines below P-2. This pronounces the effect of increased influx from Godavari after P-2 level. From the dispersal diagrams it can be noted that the depression (*D* in Figure 5) marks the elevation towards Godavari source and is migrated away towards the deeper part of ocean with younger stages of respective levels, i.e. T-2 to T-1 and P-2 to P-1. Hence this depression in dispersal pattern is taken as a reference to denote the source fluctuations. Stage T-2 (180 ± 5 cm) shows the minimum intensity of magnetic susceptibility during which Godavari source was weak and confined mostly to the continental slope region. The depression started migrating away from the Godavari source (off Vishakhapatnam coast) during stage P-2 (110 ± 5 cm). Further, upwards from the next stage (T-1) the depression migrated more effectively away from the Vishakhapatnam coast (see Figure 5). The P-2 interval precisely coincides with the decreased continentality as inferred by Phadtare and Thakur[19] from pollen analysis and high *in situ* carbonate reported by Suresh and Bagati[15] based on SM 43/87.

Discussion and conclusion

The prominent peak at P-2 corresponds to the less continentality, which may occur during the Last Glacial Maximum (LGM). The LGM in the Bengal fan is marked by decreased input from Himalayan source relative to the Deccan source (peninsular India) due to weak SW monsoon, corresponding to the decreased discharge from Ganges–Brahmaputra rivers[20–22]. Although no dating was available for the studied cores, based on the previous work[20–22] in a nearby area, LGM was reported at 60 to 100 cm level of core depth.

The susceptibility peak P-2 shows direct relation to calcium carbonate for majority of cores (Figures 2 and 4) instead of an inverse relation that can be expected from the diamagnetic nature of carbonates. Earlier Suresh and Bagati[15] reported the *in situ* biogenic nature of the carbonates at this level. Therefore, such a direct relation favours authigenic SD magnetite of biogenic nature that may be evident from the X_{fd}% values at this interval (discussed earlier in the article). The increasing trend in calcium carbonate away from the shore and its biogenic nature suggests that the low continentality (terrigenous influx) during this interval (LGM) weakened the Himalayan source relative to the peninsular source. Subsequently the stages T-1 and P-1 too mark to continue the predominance of the Godavari (peninsular) source. Prior to the interval T-2, the more detrital inputs from the Ganges–Brahmaputra were diluting the magnetic inputs off the Vishakhapatnam coast/Godavary source, that is characteristic of higher magnetic susceptibility due to weathering products of Deccan basalt in the peninsula. Therefore, the decreased input from Ganges–Brahmaputra subsequently after P-2 (i.e. 110 ± 5 cm) gave rise to increased amplitudes of susceptibility peak in the younger stages (see the amplitudes of P-1 with respect to P-2 and T-1 with respect to T-2). Hence, it can be concluded that a changeover from Ganges–Brahmaputra to Godavari source took place after LGM during the Late Quaternary sedimentation history of the Bengal fan.

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Annex IN-28

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Mangroves along the coastal stretch of the Bay of Bengal: Present status

*F. Blasco & M. Aizpuru

Laboratoire d'Ecologie Terrestre (UMR 5552) - Université Paul Sabatier/CNRS
13, av. du Colonel Roche - BP 4072 - 31029 Toulouse cedex 4, France
[*E-mail: Francois.Blasco@cict.fr]

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With the help of high resolution satellite data (SPOT products), it has been possible to portray on maps the present distribution of main mangrove types and sub-types of the Bay of Bengal coastline. New figures have been given for the mangroves of each concerned country especially for Myanmar. The present ecological status of mangrove ecosystems in the three major deltas, the Godavari, the Ganges and the Irrawaddy are totally distinct. In the Godavari delta (India) mangroves are receding in area and biomass; in the Ganges, the Sunderbans (India and Bangladesh) are evolving very slowly in size but an important species substitution is in progress; in the Irrawaddy (Myanmar) mangroves are in continuous decline. The present distribution and status of each mangrove type is the result of direct and indirect anthropic factors. Conversion to agriculture, reafforestation, fishponds constructions, forest exploitation are now easily detected from space. Conversely, indirect impacts, such as freshwater diversion or chemical pollution, cannot be monitored with sensors operating in the visible part of the electromagnetic spectrum.

[**Key words** : Mangroves, mapping, remote sensing, Bay of Bengal]

Although the present distribution of each mangrove type, along a given coastal stretch, and the present relative abundance of individual mangrove species are not always fully explained, it appears that the main cause of mangrove change is the anthropic destruction of these ecosystems following policy decisions relating to economic development by Governments or private sectors. In protected areas such as the Sunderbans (India and Bangladesh) or in the Andamans, changes in mangrove ecosystems are obviously much slower than elsewhere. The main objective of this paper is to produce a new assessment of the mangroves located along the coasts of the Bay of Bengal. The study area is unique in many ways. It has the world's largest mangroves in a single block (the Sunderbans, 5700 km^2), one of the world's largest coastal afforestation programmes (Bangladesh), one of the rare remaining genuine, almost untouched mangroves in Andaman Islands and, probably, the least scientifically explored coastal ecosystems, in Myanmar. For the first time a cartographic assessment of these mangroves, using remote sensing data, has been achieved.

Materials and Methods

The coasts of the Bay of Bengal belong to four important countries, the east coast of India, Bangladesh, Myanmar and the west coast of Thailand (Fig. 1). Recent satellite data are now available. Since the publication of our Classification and evolution of the mangroves of India[1] and the World Mangrove Atlas[2] we have been trying to produce a cartographic inventory of remaining mangrove stands all over Asia, especially in the Bay of Bengal, in order to quantify the changing status of these mangroves.

From a methodological point of view a complete wall-to-wall coverage with high resolution satellite data has been collected. The concerned satellite data are the following:

— A full coverage with SPOT quicklook products provided by Spot Image Company, Toulouse, France. Most of them have been acquired between 1996 and 1999.
— RESURS satellite data cover the entire Irrawaddy delta (Myanmar). They were provided by EEC Joint Research Center, Ispra, Italy. In addition SPOT3 HRV 251/318 (7 March 1996 and 17 March 1999) was provided by Spot Image Company.
— Moreover, for India and Bangladesh, the Sunderbans were covered by several SPOT images (KJ 234/306), the latest being acquired on the 11th March 1999.
— For Thailand, the satellite data are those analysed by the IDRC/NRCT/RFD in 1991.

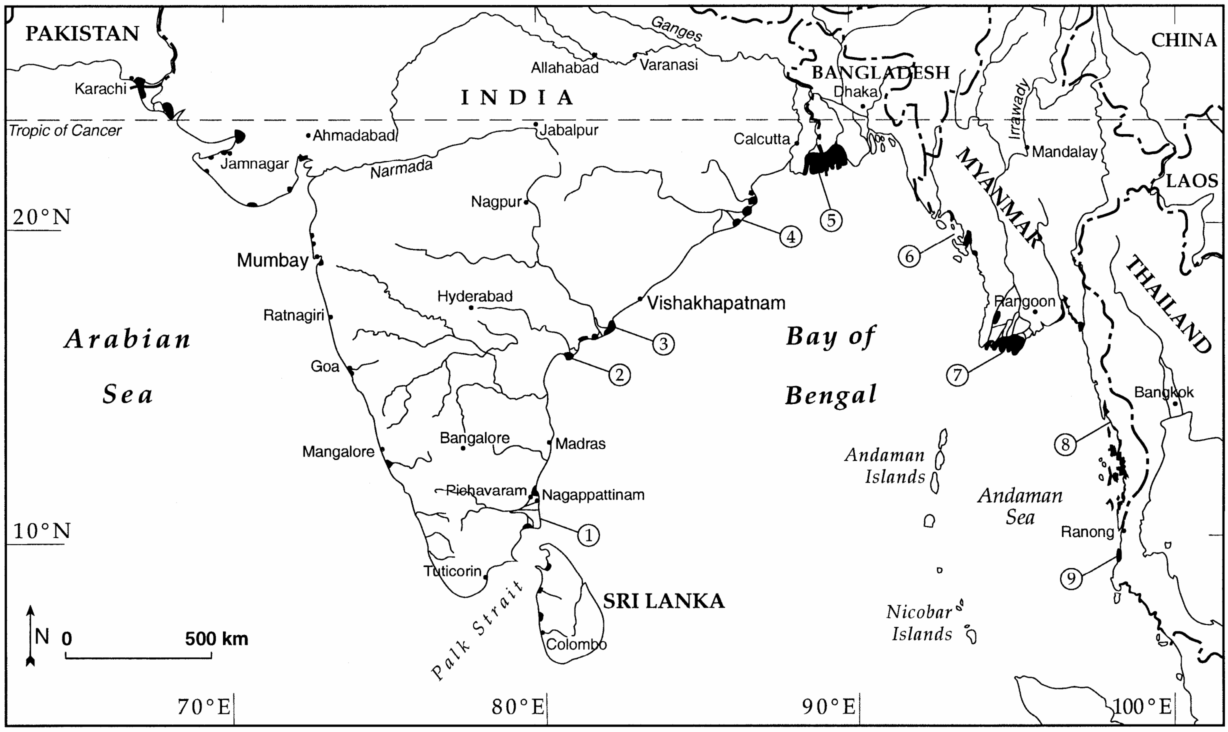


Fig. 1—Location of main mangrove stands in the region, including the Bay of Bengal coastal stretch [1—Cauvery delta (Pichavaram), 2—Krishna delta, 3—Godavary delta, 4—Mahanadi delta, 5—Ganges delta (Sunderbans), 6—Arakan coast (Myanmar), 7—Irrawady delta, 8—Tenasserin coast (Myanmar), 9—West coast of Thailand (Ranong and Khan Pha Bay)]

Table 1—Main mangrove types in India and probably in Asia[1]

Average height	Average ground coverage or density		
(m)	70-100%	25-70%	<25%
> 5	1-Tall dense mangrove forest	5-Tall open mangrove forest	9-Mangrove woodland
2-5	2-Low dense mangrove forest	6-Low open mangrove forest	10-Low mangrove woodland
0.5 to 2	3-Dense mangrove thicket	7-Open mangrove thicket	11-Scattered mangrove shrub
< 0.5	4-Low dense mangrove thicket	8-Low discontinuous mangrove thicket	12-Scattered mangrove under-shrub

A detailed description of image enhancement, software, GIS types etc. is reported earlier[3]. They do not differ fundamentally from those classical supervised automated classifications already described[4-6].

All figures provided in this paper concerning the actual extent of the mangroves in major deltas of the east coast of India (Mahanadi, Khrishna and Godavari, Cauvery), the successful afforestation programme in Bangladesh, the magnitude of deforestation activities in Myanmar (Burma) etc. are new and are supported by satellite products. However they need additional surveys and cross-checking with ISRO's and IDRC's remote sensing inventories[7,8]. It may be noted that mangroves of the Arabian Sea and those of the Andaman and Nicobar Islands were not studied here.

One of the main difficulties encountered is the discrimination of mangrove sub-classes from space. It is well known that in natural ecosystems or in phenomena, exact boundaries are difficult to define, and limits can only be approximated. We decided to produce a general code to represent the real-world entities normally found in mangrove areas. We subsequently adopted a practical classification system based on the predefined concepts given in Table 1. Such a subdivision of mangrove ecosystems into smaller and smaller sub-classes is unavoidable for any multi-scale inventory.

In theory, each of these mangrove sub-classes has a characteristic spectral response induced by its chlorophyll content (density and structure of the ecosystem) which is mainly integrated by the red bands (strongly absorbed by green plants) and by the humidity gradients in soils (related to tidal levels) that are easily detected from the near infra-red bands.

To produce some statistics at a continent or a subcontinent level (*i.e.* at a relatively small scale), the classification system had to be simplified, hence the priority was to discriminate from space and to delineate the following classes:

Dense (tall or low) mangroves (including unexplained top dying)
Degraded mangrove or young stands
Very degraded mangrove or young stages
Mangrove afforestation areas
Active deforestation activities (hot spots)
Mangrove areas converted to other uses

Dense mangroves—The canopy is dense and evergreen; such an ecosystem or group of ecosystems (sub-classes 1 to 4 in Table 1) is hardly subject to visible degradation processes, from space. This class includes, in the Gangetic delta, an area which corresponds to an unexplained mortality of some mangrove trees (*Heritiera fomes*).

Degraded and very degraded mangrove stages—This is a broad class in which most degraded stages (mainly 7 to 12 in Table 1) are grouped, although at a local or a national levels, additional distinctions would be needed.

Mangrove afforestation areas—They have been discriminated and mapped. This extremely ambitious coastal management activity is commented in the section related to the Gangetic delta.

Active deforestation activity (or hot spots)—Deforestation and wood extraction are major causes, yet poorly documented, of mangrove depletion in many parts of the world. Monitoring activities are to be focused mainly on those areas where active deforestation practices were observed and should be considered as ‘hot spots’ for the survival of rare plant communities. In this specific topic satellite technology provides capability which hitherto were unavailable.

Mangrove areas converted to other uses—This comprises a class which is not fully reliable. However, what has been mapped in this class represents the minimum coastal areas where the soils have a reflectance similar to that of mangrove soils but where mangroves no longer exist. This class gives an idea of the magnitude of mangrove losses in the concerned areas during this century. In countries like India and Bangladesh mangroves were mainly converted to agriculture. In Thailand and Viet Nam, recent mangrove conversions during the last 25-30 years were mainly due to aquaculture. Conversely, old non productive shrimp ponds are now being replanted with mangrove species especially in Viet Nam (*Rhizophora apiculata*) and in Bali (*R. mucronata* and *Bruguiera gymnorrhiza*).

Results

Mangrove ecosystems along the Bay of Bengal coast (excluding islands) can be considered as relatively well known except for those of the coastal zone of Myanmar. Several recent works have been devoted to local or national mangrove studies. This is the case in India, where the specialized literature is abundant[9,10] and in Bangladesh where mangrove play a vital role[11]. In Thailand also[12] where several important researches have been recently carried out either locally, especially in Ranong, Klung areas and Phuket island, or with the analysis of a full remote sensing coverage[13-15]. On the other hand the Andaman and Nicobar Islands which are not analysed in this paper were abundantly studied[16-20]. In these islands of the Bay of Bengal the present status of main mangroves stands seem to be satisfactory with several sites having been given legal protection especially in the framework of the great Andaman Biosphere Reserve.

The location of main mangrove stands is given in Fig. 1. This coastal stretch about 5000 km long, is located in a tropical region characterised by moist tropical coastlands in its northern and eastern parts (more than 1500 mm of rain per year, 5-6 dry months: December to May), a much dryer coastal part (800-1200 mm of rain per year, 6-8 dry months: January to August) is found near Chennai (Madras,

Table 2—Characteristics of the three major tropical rivers and their deltas of the Bay of Bengal

	Mean tidal amplitude (m)	Average flow (m^3/s)	Annual sediment discharge (tons/years)	Catchment area (km^2)	Deltaic area (km^2)
Ganges/ Brahmaputra	5	35,000	2.5 billion	2 million	100,000
Irrawaddy	3	12,000	300 million	320,000	20,000
Godavari	1.5	3,000	?	133,000	8,200

India) and in Sri Lanka. One of the most spectacular climatic peculiarity is the high frequency of cyclonic storms which affect the eastern coasts, especially in India, and the northern Bay of Bengal[21]. Three major tropical rivers and their deltas are found in the Bay of Bengal (Table 2). In theory, this broad climatic, geomorphological and hydrological context is, globally, extremely favourable for the development of luxuriant mangroves in the above deltas as well as in creeks and bays of the region. In practice they are receding at an alarming rate.

East coast of India

At least 85% of India's mangroves are found in the east coast where rivers and estuaries are more extensive than on the coast of the Arabian Sea. The largest areas of mangroves are found in the Sunderbans (mouth of the Ganges) and in Andaman and Nicobar Islands (interesting ecological, conservation and restoration data on the mangroves of the west coast of India and Sri Lanka are available[22-26]).

The average figures available in 1975 for the east coast of India[27] are as follows:

Cauvery delta	15 km^2
Krishna and Godavari deltas	100 km^2
Mahanadi delta	50 km^2
Sunderbans (West Bengal-Ganges)	2000 km^2
Total	2165 km^2

However no accurate mapping was available at that time and these figures needed confirmation. Today only relict stands of mangroves are found along the east coast of India, each one in almost complete isolation. All these mangroves are within the reach of virtually everyone.

In the South of the Indian Peninsula some isolated patchy mangroves are found. They are rare and mainly composed with stunted populations of *Avicennia marina* Vierh. These little remnants of the Palk Strait mangroves are poorly known; they receive a very limited amount of fresh water and have dense human communities close by. All are overgrazed and suffer from an uncontrolled fire-wood extraction[28].

Best preserved stands are found near Chidambaram (Pichavaram mangroves) in the delta of Cauvery river. They correspond to 'low open mangrove forest' (Fig. 2) with *Avicennia marina* Vierh., *A. officinalis* L., *Excoecaria agallocha* L. of our classification[1]. Rhizophoraceae members [*R. apiculata* Bl., *Bruguiera cylindrica* (L.) Bl.)] are also present in Pichavaram. They are becoming rare elsewhere on the east coast of India. In summary the general ecological conditions prevailing in this part of Asia, South of the 14^{th} parallel are:

— Exceedingly long dry season (7 or 8 consecutive months without rain, from January to July or August) inducing high salt concentrations in soils and tidal water.
— Short irregular rainy season (Oct. to December) accompanied by cyclonic storms.
— Most of the remaining mangroves are found in almost closed coastal lagoons in which tidal influence is very reduced (< 0.50 m) and the risk of long lasting floods during cyclonic periods is high (as in Muttupet).
— Strong anthropic interference including fuel wood extraction, fresh water diversion for agriculture, over grazing etc.

All these precarious ecological conditions are not in favour of mangrove development, which are under

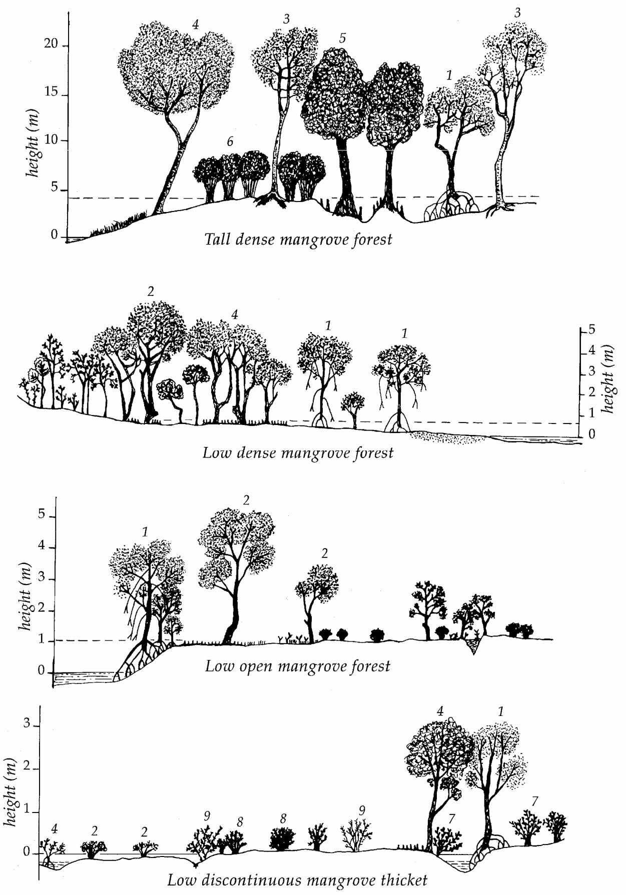


Fig. 2 — Some physiognomic mangrove types commonly found in the study area (see Table 1). [1. *Rhizophora* sp., 2. *Avicennia* sp., 3. *Excoecaria agallocha*, 4. *Sonneratia* sp., 5. *Bruguiera gymnorhiza*, 6. *Ceriops* sp., 7. *Acanthus ilicifolius*, 8. *Acrostichum aureum*, 9. *Suaeda* spp.]

threat[29]. Nevertheless it has been shown that even extremely poor mangrove stands, surviving in hostile environmental conditions, play a positive role in the production of postlarval stages and juvenile shrimps[30-32]. The present extent of mangrove stands in Cauvery delta could be about 6 km^2 of degraded mangrove.

The mangroves of the deltas of the Krishna and the Godavari rivers

Here, mangroves (Fig. 3) are about 750 km^2 from the nearest mangroves located northwards in Orissa (Mahanadi delta) or southwards in Tamilnadu (Cauvery delta). This great discontinuity in the distribution of halophytes has certainly played a role in their present floristic composition. Some striking and unexplained features have to be recalled, including:

— The high natural abundance of *Sonneratia apetala* Buch. Ham in these deltas although it has totally disappeared southwards.
— In contrast, *Nypa fructicans* Wurms. which is found northwards (Mahanadi and Gangetic deltas) is unknown southwards in India.

Other floristic peculiarities have been recorded in these deltas where the remaining mangroves are undergoing serious hydrological, geomorphological and anthropic alterations. The largest mangrove stands are found at the mouths of the Coringa. Elsewhere, low

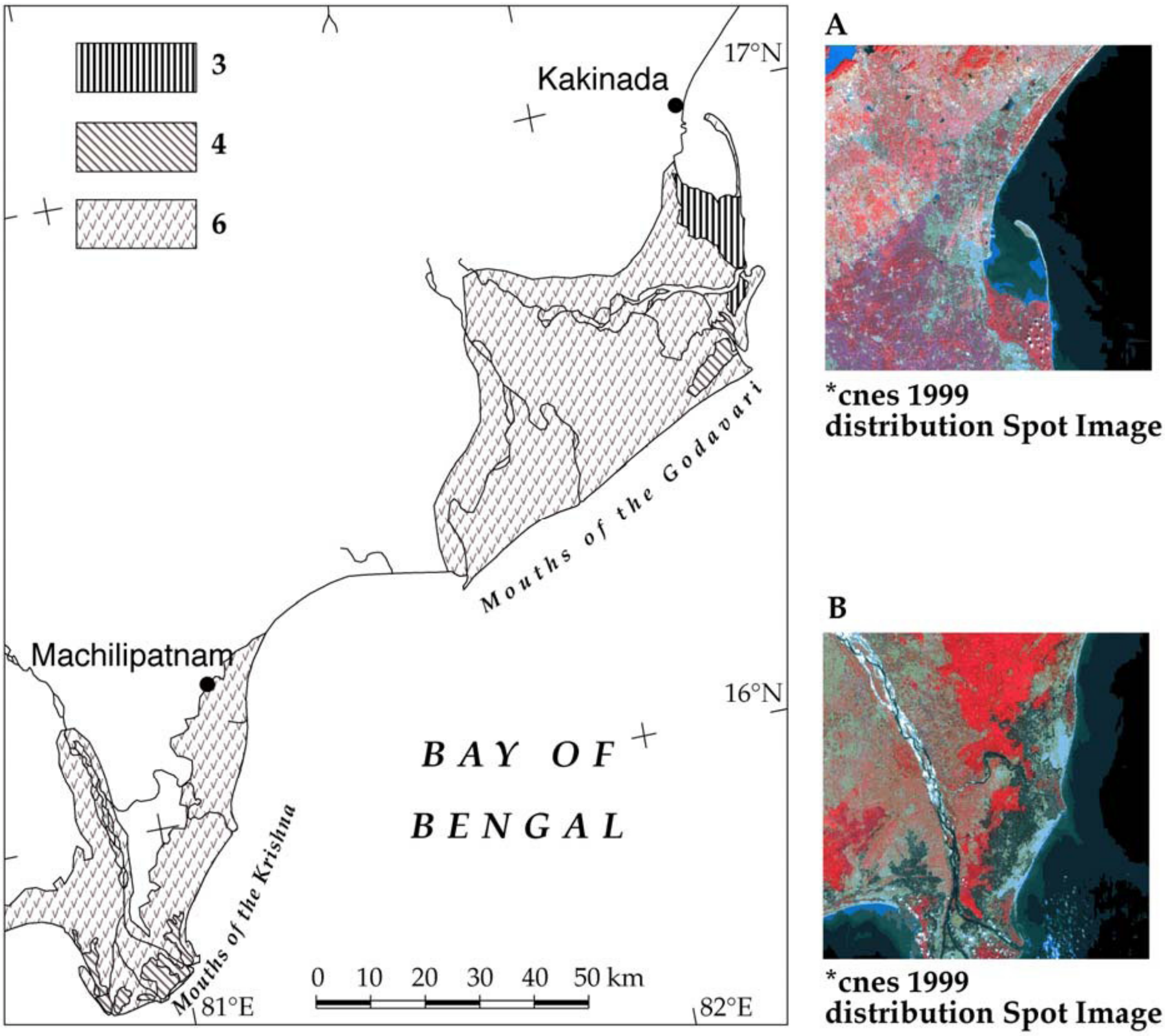


Fig. 3 — The mangroves of the Krishna and the Godavari deltas: an illustration of satellite data (A. SPOT4 quicklook, KJ 223/316, 10 Jan. 99; B. SPOT2 quicklook, KJ 221/318, 22 Feb. 99) and resulting map. [Legend of map: 1. Dense mangrove forest (silviculture or natural); 2. Unexplained top dying; 3. Degraded mangrove (or young stands); 4. Very degraded mangrove (or young stages); 5. Mangrove afforestation areas; 6. Mangrove areas converted to other uses, 7. Intensive mangrove deforestation]

open mangrove forests, open mangrove thickets and low degraded riverine mangroves are progressively declining in spite of their importance as habitats for juvenile shrimps feeding grounds and production of post larval stages[1,33-35]. In the Krishna delta conspicuous halophytic communities were observed from space (*Suaeda*, *Salicornia*, *Arthrocnemum*). The present extent of mangrove stands in Krishna and Godavari deltas seems to be about 130 km^2 of dense, secondary mangroves and 150 km^2 of very degraded mangroves intermingled with conspicuous halophytic communities with Chenopodiaceae. These figures need confirmation.

The Mahanadi delta

In contrast with the Ganges delta, the little known Mahanadi delta has attracted little attention of the scientific community. Interestingly the flora of Mahanadi mangroves (Fig. 4) is extremely diverse and seems to be one of the richest of the world, similar to the flora of the Ganges, except perhaps that *Nypa fruticans,* which is common in the Ganges, is almost extinct in the Mahanadi delta.

One of the most striking floristic features of the Maipara estuary, according to the list of plants recorded by Banerjee & Rao[36,37] is the abundance of phanerogams which is presumably higher than that of the Ganges with the presence of such species as *Sonneratia griffithii* Kurz and *Aegilitis rotundifolia* Roxb. This point needs confirmation as these species have not previously been reported from India. *Heritiera fomes* Buch-Ham and allied species such as *H. littoralis*

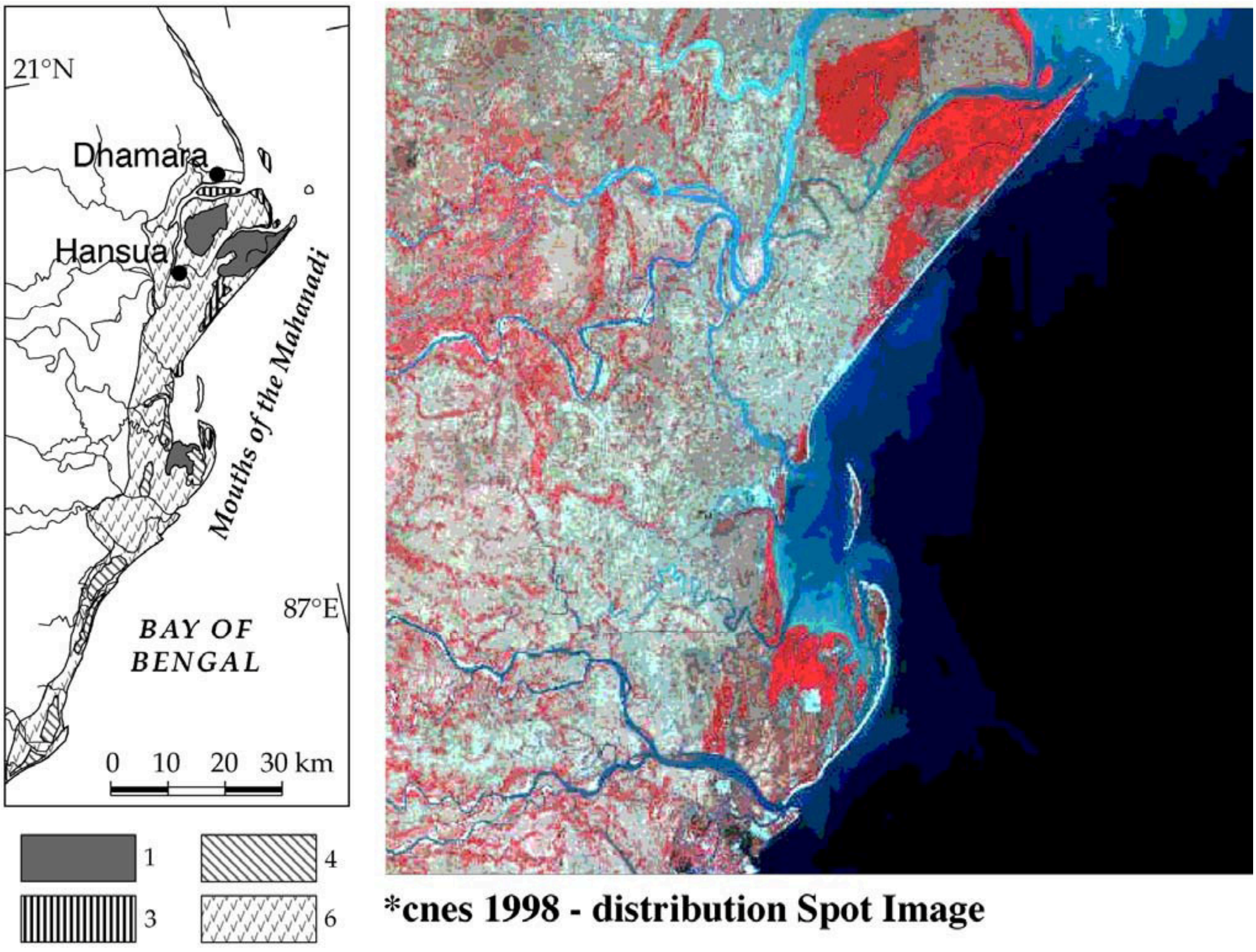


Fig. 4 — Main mangroves of the Mahanadi delta: an illustration of satellite data (SPOT4 quicklook, KJ 231/309, 16 Dec. 98) and resulting map [Legend of map: see Fig. 3]

Aiton and *H. globosa* Kosterm. (the latest species being reported only from Borneo as far as we know), are also reported by Banerjee & Rao[36,37]. No explanation has yet been given to such an exceptional floristic richness concentrated in such a tiny mangrove area endowed with a highly diversified physiographic context.

The factors influencing biodiversity and floristic richness in each deltaic region is not fully understood[38]. The assumption here is that the propagules originated in the Sunderbans are water-buoyant and dispersed to the nearest deltaic area which is the mouth of the Mahanadi river. This could explain the high degrees of relationship between the floras of the Ganges and of the Mahanadi. However, each species has its own past history and its own biological properties depending on the time its propagules remain buoyant and viable, its capacity to establish in each geomorphological, pedological and tidal context. Today, in about 250 km^2 of mangroves, one of the highest biodiversity of halophytic phanerogams is concentrated. It could be interesting to extend the study to the faunal diversity (Polychaetes, Gasteropods, Brachyurans etc.).

The ecological conditions are rather similar to those of the Sunderbans with frequent severe cyclonic storms, mean annual rainfalls fluctuating between 1500 and 2000 mm (May to November) and a tidal amplitude much higher than in the South (3 to 5 m). Several physiognomic types can be found in the Mahanadi delta including: ‘tall dense mangrove forest’ with *Heritiera fomes*; ‘open mangrove thickets’ with palms (*Phoenix paludosa* Roxb.); ‘scattered mangrove undershrubs’ with grassy halophytes (*Suaeda, Salicornia* etc.). The present extent of mangrove stands in the Mahanadi delta (Fig. 4) seems to be about 120 km^2 of dense mangroves, 50 km^2 of degraded mangroves and 90 km^2 of very degraded mangroves.

The Gangetic delta (India and Bangladesh)

The Gangetic delta (the Sunderbans), is formed at the confluence of two big rivers, the Ganges and the

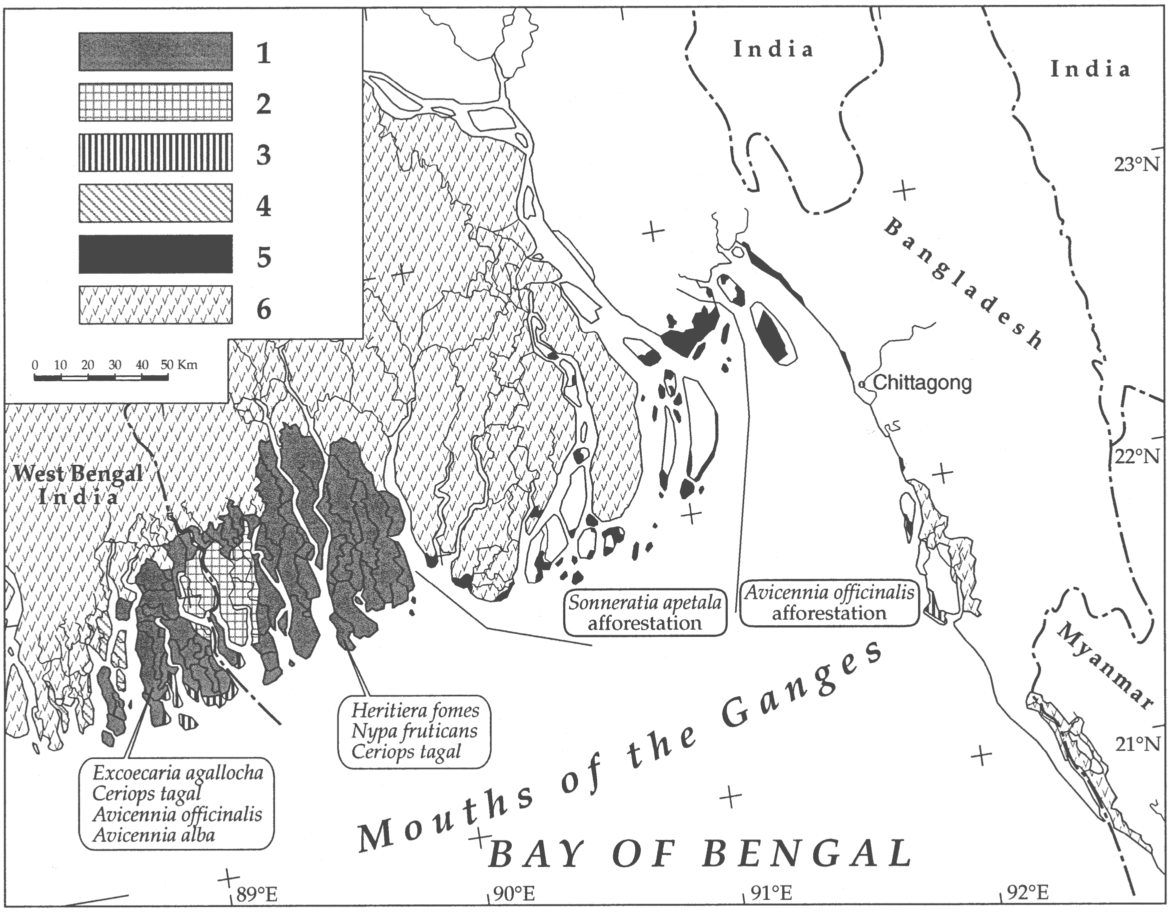


Fig. 5 — The mangroves of West Bengal (India) and Bangladesh [Legend of map: see Fig. 3]

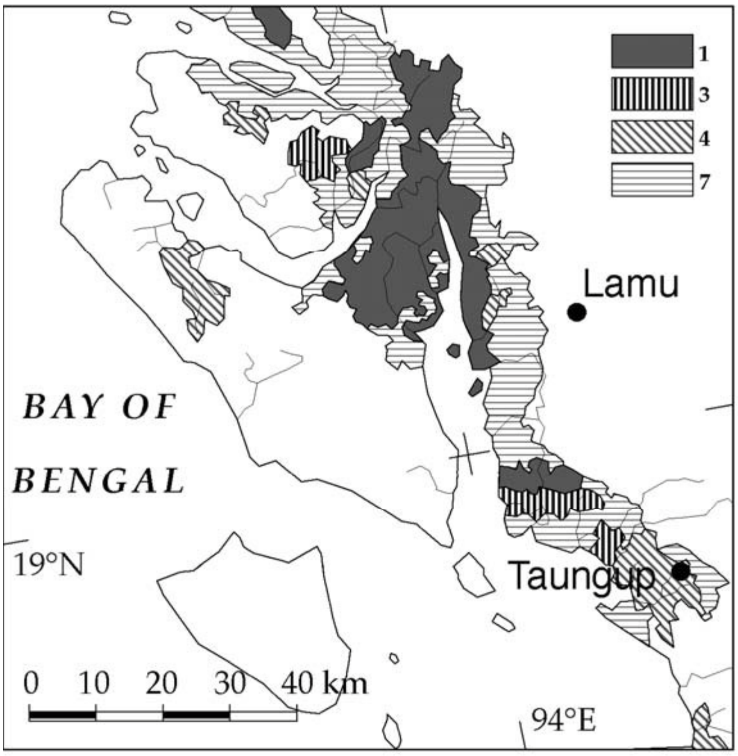
Brahmaputra, where the world's most extensive mangrove forests in a single block are found today, covering about 2000 km^2 in the Indian territory and about 3700 km^2 in Bangladesh (Fig. 5). Key ecological parameters which strongly influence the biology of these communities are: high tidal amplitudes exceeding 6 m, high frequency of cyclonic storms (1 to 4 every year), high demographic pressure (> 800 inhabitants/km^2). The entire region is cut by a dense network of rivers and canals in which the islands are densely covered with mangroves. The densely inhabited northern parts of the delta are protected by tall embankments (8-10 m above the water level at low tide).

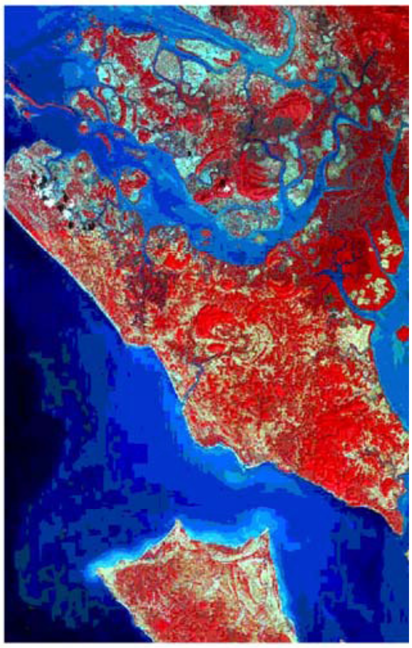
Practically all mangrove types described on Indian shorelines can be found in the Sunderbans. 'Tall dense mangrove forests' with *Heritiera fomes* (in Bangladesh) or with *Avicennia officinalis* L. (in West Bengal, India) are common. But the assemblage of species varies from one place to another. *Excoecaria agallocha* (gewa) is abundant and heavily exploited. *Ceriops decandra* (Griff.) Ding Hou also forms 'low dense forests', whereas *Nypa fruticans* (golpatta) forms narrow fringes at the edge of the mangrove in Bangladesh, close to the principal water course. Until now we have not been able to discriminate these floristic and physiognomic types from space.

The scientific literature available today is abundant and covers an imposing array of topics such as ecology[39], phytochemistry, remote sensing and soils[21,35,40], aquatic and terrestrial mammals such as dolphins, deers and tigers[41-43], microfungi[44], afforestation practices[45-47], productivity[48-50], biodiversity[51] etc.

In spite of a large amount of literature available today on the Sunderbans, our ecological knowledge remains meagre and scattered. Almost all management practices that are applied in these mangroves, like in most mangroves of the world, are primarily the result of empirical expertise often provided by foresters. Such fields as primary productivity, plant animal interactions, micro-organisms and nutrient cycling in mangrove soils and waters etc. which constitute essential knowledge for management practices on a long term sustained yield basis, are practically unexplored[52].

This very valuable resource called as 'Sunderbans' is protected and managed in India and Bangladesh since more than 70 years. The most valuable timber (furnitures, constructions, ships etc.) is *Heritiera fomes* (local name *sundri*). Trees of 60 cm diameter and about 30 m tall were recorded at the beginning of this





***cnes 1998 and 1999 distribution Spot Image**

Fig. 6 — Active deforestation in the mangroves of Myanmar (Arakan coast): an illustration of satellite data (Assemblage of SPOT1 quicklook, KJ 246/311, 9 Dec. 98 and SPOT4 quicklook, KJ 246/312, 1 Jan. 99) and resulting map [Legend of map see Fig. 3]

century[53] 'but owing to heavy fellings and the difficulties experienced in controlling them, trees over 3 feet in girth are now by no means common'. This progressive degradation in the standing biomass of the Sunderbans is continuing. Some serious changes are occurring since 1980. SPOT satellite observations[3] show an abnormal decline in the absorption of band XS2 (red band 0.61-0.68 μm) indicating a tendency towards deciduousness or leaf-shedding which is often the signal of unhealthy situations and a probable ecological disturbance. This abnormal spectral response is due to the so called '*Heritiera* top dying' which opens the canopies. This alteration which affects a dominant species has probably deep consequences in ecosystem processes, in stand structure, in socio economic impacts etc. The Sunderbans are probably entering a transitional phase to a closed canopy mangrove of unknown components. Such species as *Excoecaria agallocha* which shows a natural tendency to spread all over the mangroves in this part of the world could become the leading species if the global ecological conditions affecting the dying areas remain suitable.

As the matter of fact the dieback of *Heritiera fomes* (Fig. 5), raises obvious economic and ecological issues particularly related to its causes and to the development of new successional stages. The mortality which affects one species does not create here important gaps in the ecosystems. This means that light demanding species often found on higher mangrove soils are able to settle soon after the felling of *sundri*. According to known auto-ecological behaviours *Excoecaria agallocha* and some Rhizophoraceae members (*Ceriops* or *Bruguiera*) are likely to be the first pioneers in open stations. The Department of Botany of the University of Chittagong (Bangladesh) has set up a monitoring programme for the detection of the evolutionary trends in the mangrove areas affected by the dieback disorder of *Heritiera fomes*. Recently Siddiqi[54] has given an overview of this important issue.

In addition to this variety of natural mangrove types, the Ganges delta now has important coastal afforested areas in several islands located offshore from Bangladesh, that can be observed and mapped with high resolution satellite data. Their density in the field some times does not exceed 30%. Two main species used are: *Sonneratia apetala* Buch.-Ham (80% of mangrove plantation, especially in islands where the salinity is lower - about 20 ‰ *i.e.* Rangabali and Kukri islands) and *Avicennia officinalis* L. which is planted in the eastern coastal belt where the salinity of the water is higher - about 25 ‰.

According to our satellite observations, the rate of survival and growth seem to be different from one place to another. If the afforestation programme in Bangladesh which began in 1966 has involved about 160,000 ha, the global apparent rate of success is about 50 % (80,000 ha). Additional data on the mangroves of Bangladesh are available elsewhere[11].

The present extent of mangrove stands in the Gangetic delta is probably as follows:

In India:	Dense mangrove	1330 km^2
	Unexplained top dying	220 km^2
	Degraded mangrove or young stands	140 km^2
	Very degraded mangrove or young stages	230 km^2
In Bangladesh:	Dense mangrove	3570 km^2
	Unexplained top dying	510 km^2
	Degraded mangrove or young stands	50 km^2
	Mangrove afforestation areas	790 km^2

The mangroves of Myanmar

Aug Myint & Kyaw Sae[55] and Han[56] have given noteworthy ecological and botanical description for local areas which complements the technical notes provided by British botanists and foresters[55,57]. According to Troup[53] (p. 153) 'on the Arakan and Bassein (Irrawaddy) coasts, there are extensive *Sundri* (*Heritiera fomes*) forests which have hitherto been little worked, while in Tenasserim there are belts of *Sundri* along many of the tidal creeks and round islands especially in the Mergui district...'. As illustrating the gregarious nature of the tree, eleven sample plots of *Sundri* forest in the Arakan showed the following average stock:

Seedlings	357 per acre
Trees 1-2 ft in girth	104 per acre
Trees 2-3 ft in girth	52 per acre
Trees 3-4 ft in girth	23 per acre
Trees 4-5 ft in girth	8 per acre
Trees 5 ft and over in girth	2-7 per acre

This very valuable timber is exploited and easily transported by sea although the shipping routes remain unknown. According to Han[56] the average annual mangrove depletion in Myanmar was 6700 ha in

1992, whereas rehabilitation and restoration of these ecosystems were negligible.

The present satellite survey clearly shows the critical situation of the mangroves of Myanmar, with extensive and uncontrolled clear cutting in many places along the Arakan coast, presumably with the ultimate objective of extracting *Heritiera fomes* boles and converting the mangrove land to agriculture (Fig. 6). The present extent of mangrove stands in Myanmar is presumably about 2325 km^2 of dense mangroves, 2200 km^2 of degraded mangroves and 2425 km^2 of very degraded mangroves. According to satellite data, at least 1700 km^2 of mangroves have been clear felled recently in the Arakan Coast which is most affected by deforestation practices. These results are surprisingly high and need confirmation. Apparently the evaluation carried out to date in this country have underestimated the actual extent of degraded mangroves along the Tenasserim coast.

West coast of Thailand

The present areal extent of the mangroves of Thailand is reduced to about 1900 km^2. According the survey carried out in 1961 by the Royal Forest Department[58], Thailand mangroves covered about 3600 km^2, about 40 years ago. This is the result of a huge conversion to other uses mainly for the expansion of shrimp ponds[8,13,59]. However the generalization of mangrove destruction in Thailand has affected most by the coasts of the Gulf of Thailand, form Chantaburi, near the border with Cambodia, to Pattani near the border with Pensinular Malaysia.

The west coast of Thailand from Ranong to Turutao has so far been spared from large scale human impacts. The mangrove stands of Ranong[15] and of Khan Pha Bay near Phuket are good examples of almost natural ecosystems with diverse and as yet unexplained types of zonations[60] with a rich woody flora. *Sonneratia griffithii* Kurz (endemic to the Bay of Bengal) seems to be rare at present.

Although we do not have a recent satellite control covering the whole mangroves in Thailand, the present assumption leads to the following figures[61].

Thai mangroves of the Gulf of Thailand:

Total	450 km^2

(patchy remnants scattered over 16 provinces)

Thai mangroves of the Andaman Sea:

Ranong Province	210 km^2
Phang-nga	360 km^2
Phuket	18 km^2
Krabi	300 km^2
Trang	260 km^2
Satul	310 km^2
Total	1458 km^2

So far reafforestation achievement of mangrove land in Thailand is modest compared with the average annual rate of deforestation (probably about 50 km^2/year, since 1961). According to Aksornkoae[61] interesting mangrove reafforestation attempts are nevertheless carried out in Pattani province, mainly with *Rhizophora apiculata* (approx. 7 km^2). No significant mangrove replanting is reported from the west coast of Thailand (Andaman Sea).

Discussion

The status of the mangroves of tropical Asia especially in the countries located around the Bay of Bengal is different from one country to another. In the densely populated east coast of India most mangrove forests have been degraded for decades and are still continuing to be degraded (loss of biomass, species composition simplification mainly due to overgrazing and fuel wood extraction). In the Sunderbans (West Bengal in India and Bangladesh) the silvicultural practices conducted for nearly one century and a rather rigorous protection have led to artificial mangrove ecosystems conceived for forestry production on sustainable basis. Their acreage remained almost constant since a few decades but some abnormalities have been recently noticed on their spectral responses. Apparently the low reflectance in the near infra-red channel (0.79 µm to 0.89 µm) could be related to the so called 'top dying' which has affected the populations of *Sundri* (*Heritiera fomes* Buch. Ham) since 1980. To date, no one knows the exact ecological and biological mechanisms involved in this dieback nor its potential spread out.

The huge tidal afforestation programme conducted by Bangladesh since 1966 concerns mainly the islands located in the eastern part of the delta and some coastal areas north of Chittagong. The results provided by a satellite survey[3] confirm the success (800 km^2) of this large scale intertidal planting (mainly with *Sonneratia apetala*). It is obvious that some replanted areas have disappeared either because the islands have been washed away (by cyclones and surges) or have been converted to new croplands after the consolidation of sediments by mangrove trees.

In the poorly surveyed Myanmar for the first time the magnitude of large scale coastal deforestation activities have been observed. Some rare populations of *Heritiera fomes*, which is the most valuable species, could shortly be endangered.

This study illustrates the approach towards monitoring of the evolution of mangrove ecosystems on a global scale. A complete satellite coverage is being gathered and further analyses are in progress.

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Annex IN-29

A. A. Allen, "Volte-Face in the Punjab", *Nature*, Vol. 438, 2005, pp. 925-926.

microglia come from? What signalling pathway leads to the release of BDNF from microglia? How does BDNF–TrkB signalling alter E_{anion} in lamina I neurons — could it perhaps lead to reduced synthesis of the KCC2 chloride transporter in the same neurons, or are TrkB receptors activated on other spinal cells that then influence lamina I neurons? Finally, what is the underlying circuitry that mediates the sensation of neuropathic pain when the actions of GABA and glycine are disrupted in the lamina I pain pathway?

Coull and colleagues' results provide an optimistic outlook for the treatment of neuropathic pain, because disrupting BDNF signalling was able to reverse established allodynia in the rat model. This suggests that continuous microglial–neuronal signalling is required to maintain allodynia, and that it may be possible to treat the condition even after the neuropathic pain state is established. ■

Carole Torsney and Amy B. MacDermott are in the Department of Physiology and Cellular Biophysics, Center for Neurobiology and Behavior, Columbia University, New York, New York 10032, USA.
e-mail: abm1@columbia.edu

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EARTH SCIENCE

Volte-face in the Punjab

Philip A. Allen

Rivers are the great conveyor belts that carry sediment from mountains to the sea. In the Punjab — the Land of Five Rivers — a wholesale shift occurred in the past that re-routed sediment to different oceans.

Rivers don't come much bigger than the Ganges and the Indus, both of which drain the mighty Himalaya. However, as Clift and Blusztajn[1] show in this issue (page 1001), size does not mean permanence. Around five million years ago, the rivers of the Punjab evidently shifted from flowing into the Ganges system and the Bay of Bengal to flowing via the Indus system into the Arabian Sea. This major diversion of continental drainage has been deciphered from the isotopic signature of minerals collected from the Indus fan, a vast undersea cone of sediment stretching for more than 1,000 kilometres from the mouth of the Indus River.

It is well known that rivers shift their courses — switching of the position of the main channel within a river valley is historically well documented, and typically takes place at intervals of decades to thousands of years. Many of the lowland tracts of the world's major rivers, which flow through some of the most densely populated parts of the Earth's surface, and which were the sites of long-since-disappeared civilizations, contain a remarkable record of such switches. The Po of northern Italy and the Huang He (Yellow River) of eastern China are excellent examples. But what is less well understood is the wholesale shifting of river courses at the longer timescales described by Clift and Blusztajn.

The total amount of sediment discharged into the world's ocean is about 20 billion tonnes per year[2–4], and a high proportion of this global annual budget comes from the river systems of southeast Asia, from the Indus to the Huang He[5]. The sediment dumped onto the sea bed of the Indian and western Pacific oceans over the past tens of millions of years has created a vast apron, a few kilometres thick near the mouths of the major rivers, which gradually thins seawards over distances of several thousand kilometres. Scientists are increasingly piecing together the record of past climatic and tectonic events sealed in these deep-sea sediments. On the one hand, measurements of the volumes of these deposits allow variations in the erosion rates of the Asian mountain belts over time to be estimated. On the other, distinctive chemical fingerprints in the sediment permit an evaluation of where the sediment came from in the first place. A combination of the two methods yields a picture of a highly dynamic hinterland in terms of tectonics, evolving topography and river discharge.

Clift and Blusztajn[1] reconstruct the discharge of particulate sediment of the ancient Indus River over the past 30 million years using data obtained from seismic surveys of the sediment on the floor of the Arabian Sea. During this time, the collision of India with Eurasia has formed the mountains of the Himalaya, a bountiful source of sediment for the rivers draining into the ocean. The chemical fingerprint of the sediments of the Indus fan is the rare-earth element neodymium[6]. This is expressed as ϵ_{Nd}, which is related to the ratio $^{143}Nd/^{144}Nd$ compared with a standard for the Earth, and is sensitive to the type of source rocks.

The currently low values of ϵ_{Nd} in modern Indus River sands appear to be part of a trend that started after five million years ago. Strongly negative ϵ_{Nd} values, typical of the sediments of the Bengal fan, are thought to be supplied by sources in the Himalayan mountain ranges marking the frontal zone of crumpling between India and Asia. More positive ϵ_{Nd} values are associated with source areas located behind the Himalaya, particularly in the Karakoram Range of northeast Pakistan, which is drained by the headwaters of the Indus. So Clift and Blusztajn make the intriguing connection that

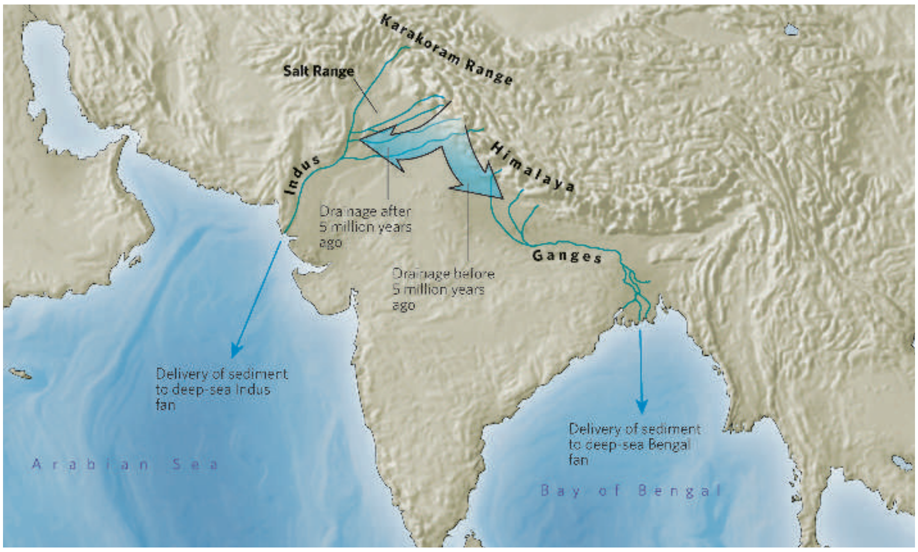


Figure 1 | Drainage of the Himalaya. The map shows the configuration of rivers as it is today, with the rivers of the Punjab flowing into the Indus and delivering sediment into the Indus fan in the Arabian Sea. According to Clift and Blusztajn's[1] analysis of neodymium isotopes in sediments, however, before about five million years ago the Punjabi rivers instead flowed southeast (see Fig. 1b of the paper[1] on page 1002), delivering sediment into the Ganges and the Bengal fan. The growth of the Salt Range is one possible contributory factor to this diversion. Others are flexing of the Indian tectonic plate in response to mountain building and erosion, and the effects of climate change on river discharge.

MICROBIOLOGY

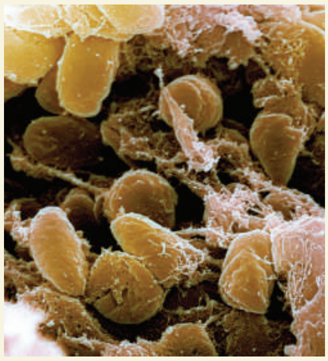
Perspectives on plague

The bacterium *Yersinia pestis* (pictured) is notorious as the cause of bubonic plague. When it is breathed in, however, it also causes the rarer but deadlier pneumonic plague. The pathology of this disease in humans and animals is fairly well understood, but much less is known about the earliest stages. Wyndham W. Lathem and colleagues (*Proc. Natl Acad. Sci. USA* **102,** 17786–17791; 2005) have developed a mouse model of pneumonic plague that gives perspectives on these stages as experienced by the host and by the bacterium.

The team infected mice with *Y. pestis* through the nose, and the animals developed a disease that closely resembled pneumonic plague in humans. Bacterial numbers in the animals' lungs increased massively in the first 24 hours after infection. Yet when the authors studied the levels of inflammatory molecules normally produced during an immune response, there was little change during this period.

So the bacteria must have a potent anti-inflammatory activity that allows them to become established before the host immune system detects them. After 48 hours, the levels of inflammatory molecules escalated, showing that the mouse immune response does eventually kick in; but it would seem to be too little, too late.

And what happens in *Y. pestis*? A microarray analysis showed that there is a change in the expression of about 10% of the bacterium's genes after it infects its host. Notably, many of these genes are associated with virulence, and in particular with the so-called type III secretion system. This system was already known as a potential means for the bacterium to subvert its host's immune system by altering the types and amounts of inflammatory molecules. That the expression of genes for the system



NIAID/CDC/SPL

is increased in the mice confirms this animal model as biologically valid. Moreover, a comparison with *in vitro* studies showed that the regulation of this system is more complex *in vivo* — suggesting that the model will provide greater insight into this devastating infection. **Helen Dell**

before five million years ago the rivers of the Punjab flowed eastwards as part of the Ganges system to feed the Bengal fan (Fig. 1).

This explanation of the former drainage of the Land of Five Rivers makes sense in the light of the sediments deposited at the foot of the Himalaya, known as the Siwalik Group sediments. These were deposited by ancient river systems that cut into the rising Himalayan mountains, and indeed it was previously suggested[7,8] that there was a continental-scale flip-flop of drainage between the Bengal and Indus sinks. The real value of these new results[1] is therefore not the idea that drainage diversion can occur on a continental scale, but that the isotopic data from the deep-sea Indus fan provide such striking support for that view.

We are now developing a more dynamic impression of the way in which sediment is routed from mountains to the sea. Such routing is strongly influenced at a relatively local scale by the emergence of new mountain ranges in response to continuing continental convergence. For example, the growth of the Salt Range of northern Pakistan may have triggered the diversion of the main tributaries of the ancient Indus to the Arabian Sea. But at the larger scale there are the subtle changes in regional floodplain slopes caused by the flexing of the Indian tectonic plate in response to the growth and erosion of the adjacent mountain belt, whose great mass acts downwards — like a swimmer on the end of a diving board. The longitudinal sediment-filled troughs produced by such flexural downbending[9], known as foreland basins, are particularly prone to major diversion of river systems flowing along the axis of the basin. Unlike steep rivers in tectonically uplifting mountain areas, which cut down into bedrock like cheese wires, low-gradient rivers in foreland basins are easily deflected. Continental-scale diversion might also result from the effects of climate change on river discharge, which may allow one river to dominate its neighbours and capture their drainage systems.

Clearly, investigators attempting to interpret the sedimentary record of the deep sea must be careful to disentangle the effects of climate change, variations in tectonically driven erosion, and continental-scale switches of river drainage. The use of a range of isotopic signatures in river and deep-sea sediments will help in this challenging undertaking. ■

Philip A. Allen is in the Department of Earth Science and Engineering, Imperial College London, South Kensington Campus, London SW7 2AZ, UK.
e-mail: philip.allen@imperial.ac.uk

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DEVELOPMENTAL BIOLOGY

A message to the back side

Wolfgang Driever

Vertebrate embryos from fish to mammals seem to use different routes to work out which way is up and which side is front. Yet a novel system involved in defining the dorsal side of fish might be conserved in mammals.

Vertebrates have many developmental processes in common; but so far, no unifying mechanism that specifies the dorsal–ventral (back-to-belly) axis in the vertebrate early embryo has been found. Egg cells, or oocytes, are in general roughly spherical and have only one axis: animal–vegetal, often characterized by the cell nucleus being in the 'animal' portion and away from the 'vegetal' yolk-rich pole. In amphibians and fish, after fertilization certain protein signals are physically transported from the vegetal region to the future dorsal side, contributing to the specification of dorsal. By contrast, the mechanisms of axis formation in mammals are not understood.

On page 1030 of this issue, Gore and colleagues[1] present evidence from zebrafish that *nodal* messenger RNAs, which encode the dorsal signal protein Nodal, are progressively localized to the cells that go on to form the dorsal side. Surprisingly, this dorsal localization also occurs if sequence elements from human *nodal* mRNA are used instead of the zebrafish ones, indicating an evolutionarily conserved mechanism.

The zebrafish version of Nodal is formally called Ndr1 (for Nodal-related 1) and, like the Nodal proteins found in all other vertebrates investigated, it is involved in specifying dorsal structures and two of the major embryonic

Annex IN-30

P. D. Clift and J. Blustajn, “Reorganization of the Western Himalayan River System After Five Million Years Ago”, *Nature*, Vol. 438, 2005, pp. 1001-1003.

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LETTERS

Reorganization of the western Himalayan river system after five million years ago

Peter D. Clift[1] & Jerzy Blusztajn[2]

Uplift of mountains driven by tectonic forces can influence regional climate[1,2] as well as regional drainage patterns, which in turn control the discharge of eroded sediment to the ocean[3,4]. But the nature of the interactions between tectonic forces, climate and drainage evolution remains contested[5–7]. Here we reconstruct the erosional discharge from the Indus river over the past 30 million years using seismic reflection data obtained from drill core samples from the Arabian Sea and neodymium isotope data. We find that the source of the Indus sediments was dominated by erosion within and north of the Indus suture zone until five million years ago; after that, the river began to receive more erosional products from Himalayan sources. We propose that this change in the erosional pattern is caused by a rerouting of the major rivers of the Punjab into the Indus, which flowed east into the Ganges river before that time. Seismic reflection profiles from the Indus fan suggest high mass accumulation rates during the Pleistocene epoch partly driven by increased drainage to the Indus river after five million years ago and partly by faster erosion linked to a stronger monsoon over the past four million years[1]. Our isotope stratigraphy for the Indus fan provides strong evidence for a significant change in the geometry of western Himalayan river systems in the recent geologic past.

Tectonic forces in continental collision zones are widely recognized to drive rock and surface uplift that in turn affects climate locally, and even globally[1,8]. Changing topography and climate also affects regional drainage patterns, which in turn control the discharge of eroded sediment to the ocean. Thus, mountain uplift and associated orographic rainfall might be expected to accelerate continental erosion and increase mass accumulation rates on continental margins. However, in practice the sediment discharge to the ocean may also be controlled by the loss or gain of drainage to the main river course. South and East Asia are the global type areas for studies of how tectonic forces have influenced climate and drainage evolution. In East Asia, Clark *et al.*[3] analysed drainage patterns in eastern Tibet and suggested that the Red River had originally been the ancestral river of East Asia, suffering progressive loss of drainage to neighbouring systems, caused by the long-term change in regional topography. Unfortunately, the timing of capture events cannot be reconstructed from the terrestrial evidence alone.

Marine sediments can provide temporal control to drainage development models through the biostratigraphy that defines their depositional age. Capture events must affect the composition and rate of delivery of sediment to the ocean. In this study, we chose to study drainage evolution in the Indus river because the exhumation history of the source mountains is relatively well constrained[9] and the palaeoceanography and palaeoclimatology of the Arabian Sea itself has been documented back to ~14 Myr ago, allowing ready comparison with the sediment record of erosion[10,11].

We reconstructed the long-term erosional discharge from the Indus river using new and previously published seismic reflection data (Supplementary Fig. 1) to estimate accumulation rates of clastic material as a proxy for continental erosion rates. Although some sediment is preserved onshore, around two-thirds of the total volume is preserved offshore[12]. Although the profiles used to generate this budget only extend ~400 km from the coast they provide representative coverage of the sub-seafloor structure over the thickest parts of the fan. They are dated by ties to industrial well Indus Marine A-1 (ref. 13). The budget calculation process is described in the Supplementary Methods. In addition, we studied sediment samples from a series of scientific and industrial boreholes across the Arabian Sea to characterize the changing composition of Indus discharge during mountain uplift (Fig. 1). Because no single borehole penetrates the entire sequence we used a series of wells to construct a composite section (Supplementary Table 1). The provenance of the sediment was constrained through Nd isotope analysis of bulk samples. This method is based on the age and compositional differences between rocks across the India–Asia collision zone[14–17].

The Nd isotope data show a coherent temporal development, with ε_{Nd} values[18] rising gradually from around -11 at 30 Myr ago to -9.5 at 5 Myr ago (Fig. 2), implying a relatively stable provenance. This is surprising given the major tectonic events that occurred in the Himalayas during that interval, not least the exhumation of the Greater Himalayas, probably during the Early Miocene[19]. ε_{Nd} values of -10 to -11 are consistent with a relatively stable sediment provenance dominated by erosion from the Karakoram[12,14], and contrasting with the more negative (that is, Himalayan) values of the Bengal fan[20]. Erosion from the Greater Himalayas is calculated to comprise ~25% of the total Indus discharge for ε_{Nd} values of -10. However, these values are less negative than those measured from sands in the modern delta (ε_{Nd} around -15)[14]. Our new results show that the low modern ε_{Nd} values represent a trend to more negative values that started after 5 Myr ago, reaching very low values no later than the Late Pleistocene (~300 kyr ago). This shift can only be achieved by greatly increasing the input from Himalayan sources at the relative expense of the Karakoram or arc rocks of the Indus suture zone. Although the difference between the modern river and the Pleistocene may partially reflect damming of the Indus river in the past 30 years, this first-order shift from the Oligo-Miocene values must be a response to natural processes.

The bulk of the Himalayan material now contributing to the Indus river is delivered by the four large rivers of the Punjab (the Sutlej, Ravi, Chennab and Jellum rivers; Fig. 1). Although erosion of the Nanga Parbat massif contributes material of very negative ε_{Nd} values (-22 to -30)[21], the Indus river immediately downstream of Nanga Parbat has an ε_{Nd} value of around -11, which is far short of the -15 seen at the delta, or even in the Pleistocene fan sediments[12,14]. The only way to shift the net Indus sediment budget from the pre-5-Myr levels to those seen today is by an increase in the relative discharge

[1]Department of Geology and Petroleum Geology, University of Aberdeen, Aberdeen AB24 3UE, UK. [2]Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543, USA.

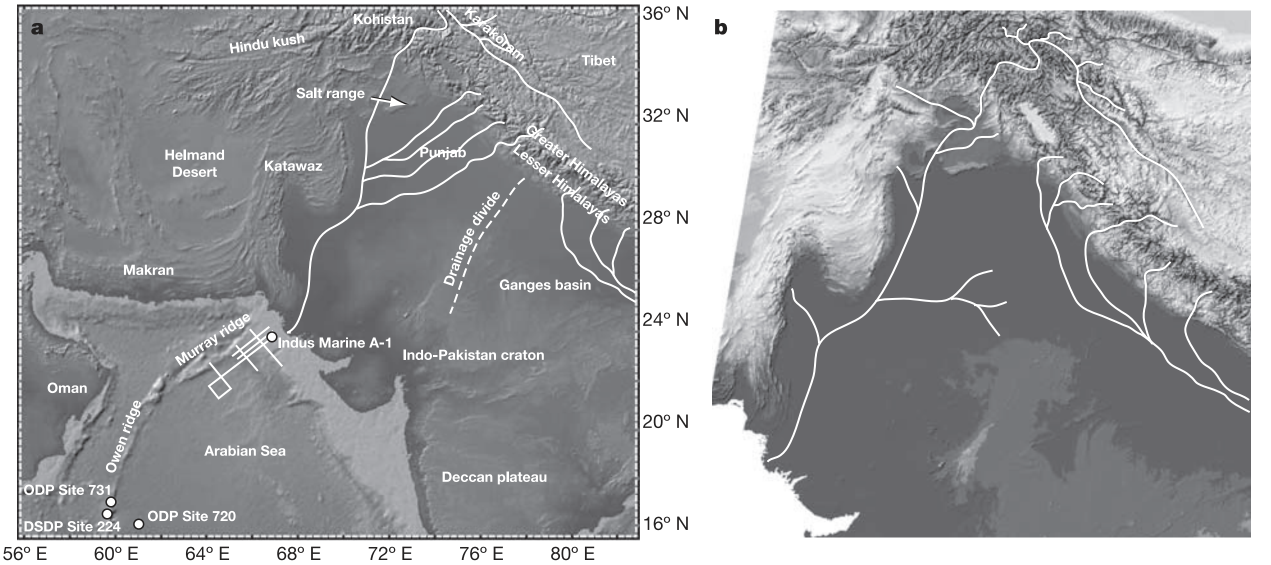

Figure 1 | Topographic maps showing post- and pre-capture Indus drainage, together with locations of drill and seismic data. a, Shaded relief map of the Arabian Sea and surrounding land masses, showing the location of the drill sites and seismic profiles considered in this study. Major tributaries of the Indus river are shown. **b**, Proposed drainage geometry in the Indus river drainage before ~5 Myr ago.

from the Himalayas. This implies that input from the Punjabi rivers before 5 Myr must have been largely non-existent.

This seems odd, because reconstruction of the exhumation histories for the western Greater Himalayas shows that these mountains were in existence before 20 Myr ago[9,21] and foreland sediments demonstrate that these ranges were being rapidly eroded during the Early to Mid-Miocene[22,23]. Nonetheless, this erosion does not seem to be communicated to the Arabian Sea until after 5 Myr ago. We suggest that the simplest explanation for this pattern is that the ancestral Punjabi rivers were connected to the Ganges and not the Indus drainage. Support for this model comes from the palaeocurrent measurements of Burbank *et al.*[23], who showed eastward flow in the foreland basin of northeast Pakistan, in the region now occupied by the Punjabi tributaries, during much of the Miocene.

The dramatic switch in isotopic character after 5 Myr ago must be driven by capture of these Punjabi tributaries to the Indus river. Why this capture occurred is not certain. This period was one of tectonic rejuvenation of the Main Central Thrust[24,25], which would be predicted to have increased the erosional contribution into the basin. In addition, early Pliocene uplift of the Salt range[26] may have been crucial in diverting rivers from their original southeastward flow into the Indus system. Alternatively, drainage capture may have occurred by a simple northeastward advance of tributaries of the Indus that short-circuited the older drainage pattern into the Ganges to provide a more direct route to the ocean.

The effect of the proposed capture on sediment accumulation rates can be seen in Fig. 2. Unfortunately the low resolution of the provenance and erosion histories makes a convincing link between the two impossible to establish at present. However, there is a clear increase in sedimentation rates from Pliocene to Pleistocene as the provenance was changing, consistent with drainage capture into the Indus system. Nd isotope character starts to change by 3.6 Myr ago when sedimentation rates were still low. However, the shift in isotope value is small, suggesting limited capture. The greatest change in provenance correlates at the first-order level with the increase in accumulation rates during the Pleistocene. However, increases in marine sedimentation rate are known from throughout Asia during the Pleistocene[27]. Average sedimentation rates approximately doubled between the Pliocene and the Pleistocene in the Indus Fan, but how much of this increase reflects drainage capture is unclear.

The Nd isotope data allow us to generate a rough estimate of how much extra Himalayan discharge would be required to produce a shift in average $\varepsilon_{\mathrm{Nd}}$ values from −10 to −13, assuming the discharge from the upper reaches of the Indus remained constant over the past 5 Myr. If the pre-capture Indus comprised ~25% Himalayan material (with an average $\varepsilon_{\mathrm{Nd}}$ value of −17 compared to −11 for the Karakoram and +8 for Kohistan[14]) to produce an average $\varepsilon_{\mathrm{Nd}}$ value of −10, then the post-5-Myr-ago shift to values of −13 would require the proportion of Himalayan material to rise to ~70% of the total, approximately a threefold increase. Total sediment discharge would thus increase by around 45%. However, because mean

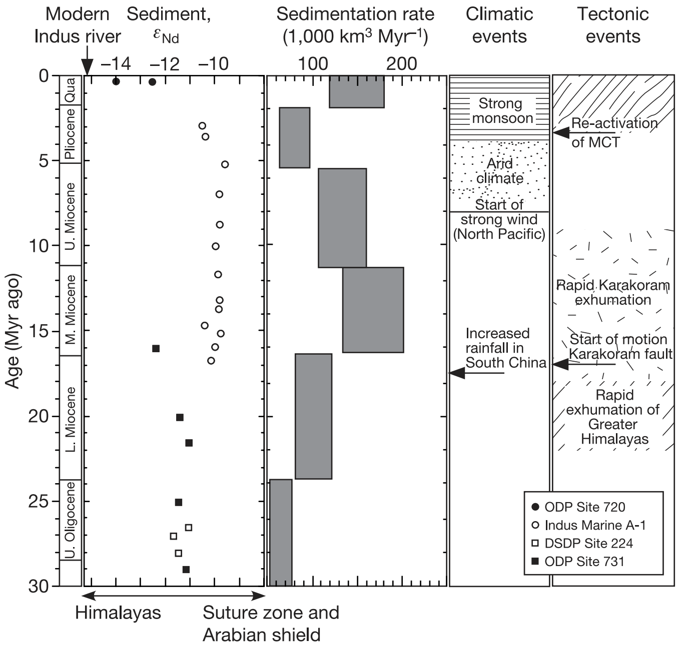

Figure 2 | The evolving Nd isotope composition and sedimentation rates on the Indus fan in relation to climatic and tectonic events known from onshore in Asia. MCT, Main Central Thrust. U., Upper; L., Lower; M., Middle; Qua, Quaternary.

accumulation rates approximately doubled after 5 Myr ago it follows that an additional volume of sediment, similar in size to that contributed from the Punjabi tributaries, must have been supplied to the Indus as a result of enhanced erosion throughout the catchment.

This study presents evidence for the nature and timing of a major drainage capture event in the western Himalayas. Faster sediment accumulation in the Pleistocene after a low in the Pliocene is estimated partly to reflect capture to the Indus after 5 Myr ago, but also seems to require faster erosion, probably driven by a stronger, wetter summer monsoon after 4 Myr ago[1]. We note that fast erosion is not unique to the cyclical glacial–interglacial climate of the Plio-Pleistocene[7], but must be controlled by other factors, at least during in the middle Miocene. Although the exact timing of drainage capture has yet to be established, the new isotope stratigraphy for the Indus fan provides strong evidence for a major change in the geometry of western Himalayan river systems in the relatively recent geologic past, probably caused by compressional deformation in the mountains. This study highlights the need to account for such capture events when trying to interpret marine erosional records, where changes in sediment composition and accumulation rates need not be directly linked to either source uplift or climate change, but simply to drainage reorganization.

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Supplementary Information is linked to the online version of the paper at www.nature.com/nature.

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Annex IN-31

G. Prasetya, "The Role of Coastal Forests and Trees in Protecting against Coastal Erosion", in S. Braatz, S. Fortuna, J. Broadhead and R. Leslie (eds.), *Coastal Protection in the Aftermath of the Indian Ocean Tsunami: What Role for Forests and Trees?, Proceedings of the Regional Technical Workshop, KhaoLak, Thailand, 28–31 August 2006*, FAO, 2007, pp. 103-130.

CHAPTER 4
PROTECTION FROM COASTAL EROSION

Thematic paper: The role of coastal forests and trees in protecting against coastal erosion

Gegar Prasetya[1]

1 Introduction

Shoreline changes induced by erosion and accretion are natural processes that take place over a range of time scales. They may occur in response to smaller-scale (short-term) events, such as storms, regular wave action, tides and winds, or in response to large-scale (long-term) events such as glaciation or orogenic cycles that may significantly alter sea levels (rise/fall) and tectonic activities that cause coastal land subsidence or emergence. Hence, most coastlines are naturally dynamic, and cycles of erosion are often an important feature of their ecological character. Wind, waves and currents are natural forces that easily move the unconsolidated sand and soils in the coastal area, resulting in rapid changes in the position of the shoreline.

Excluding the impact of human activity, these processes are simply natural evolutionary phenonema. Human activities along the coast (land reclamation, port development, shrimp farming), within river catchments and watersheds (river damming and diversion) and offshore (dredging, sand mining) in combination with these natural forces often exacerbate coastal erosion in many places and jeopardize opportunities for coasts to fulfill their socio-economic and ecological roles in the long term at a reasonable societal cost.

Development within coastal areas has increased interest in erosion problems; it has led to major efforts to manage coastal erosion problems and to restore coastal capacity to accommodate short- and long-term changes induced by human activities, extreme events and sea level rise. The erosion problem becomes worse whenever the countermeasures (i.e. hard or soft structural options) applied are inappropriate, improperly designed, built, or maintained and if the effects on adjacent shores are not carefully evaluated. Often erosion is addressed locally at specific places or at regional or jurisdictional boundaries instead of at system boundaries that reflect natural processes. This anomaly is mostly attributable to insufficient knowledge of coastal processes and the protective function of coastal systems.

The costs of installing hard structures for coastal protection are very high; strong negative public reaction to rock emplacements along the coast often aggravate the problem (Bray *et al.*, 1995; Black, 1999; Clark, 1995; van der Weide, 2001). This has led to uncertainty among managers and local government authorities on how to treat shoreline erosion. It has become an issue for serious debate for politicians, coastal managers, land- and property owners, lawyers, bankers, insurers and fisherfolk, especially in areas of intensive use and rapidly rising coastal land value. Many of these stakeholders are resorting to planned retreat where houses or hotels are simply removed and the coast is left to erode. However, planned retreat can be expensive, unnecessary and sometimes impossible, especially in highly modified environments.

Increased interest in soft structures for coastal protection (including increased forest cover) and a combination of hard and soft structures is predominating and is consonant with advanced knowledge on coastal processes and natural protective functions. There is evidence that coastal

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[1] Agency for the Assessment and Application of Technology, Indonesia.

forests and trees provide some coastal protection and that the clearing of coastal forests and trees has increased the vulnerability of coasts to erosion (Figure 4.1) — such as in Viet Nam (Mazda *et al.*, 1997; Cat *et al.*, 2006), Malaysia (Othman, 1994), Indonesia (Bird and Ongkosongo, 1980; Nurkin, 1994; Tjardana, 1995), Sri Lanka (Samarayanke, 2003), India (Malini and Rao, 2004; Gopinath and Seralathan, 2005) China (Bilan, 1993) and Thailand (Thampanya *et al.*, 2006). This paper will elaborate on and discuss the causes of coastal erosion induced by human activities; erosion management options; and the role of coastal forests and trees in protecting coastal areas against coastal erosion, as well as their socio-economic and environmental considerations.

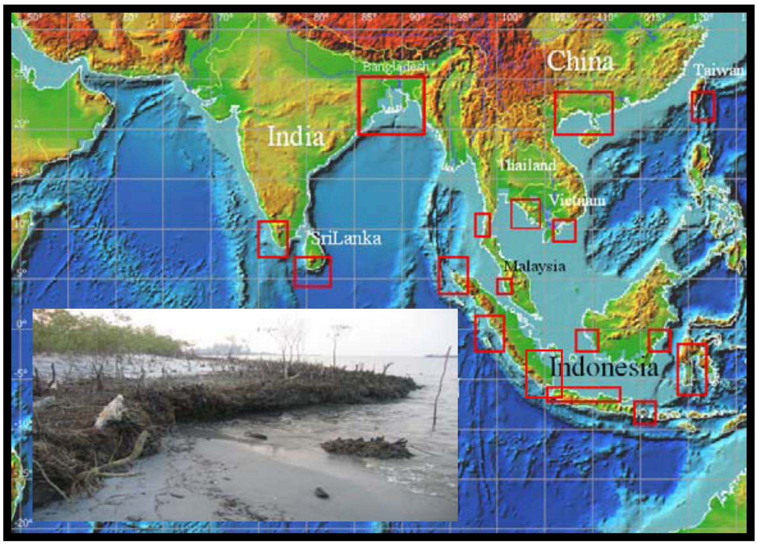


Figure 4.1 Coastal erosion sites reported in Asian and Indian Ocean countries; the inset indicates how clearing of coastal forest such as mangroves has increased the vulnerability of coasts to erosion (base map source from ITDB, 2004)

2 Coastal erosion: Extent and causes

Coastal erosion and accretion are natural processes; however, they have become anomalous and widespread in the coastal zone of Asia and other countries in the Indian Ocean owing to combinations of various natural forces, population growth and unmanaged economic development along the coast, within river catchments and offshore. This type of erosion has been reported in China, Japan, India, Indonesia, Viet Nam, Sri Lanka, Thailand, Bangladesh and Malaysia.

2.1 The extent of the coastal erosion problem in Asia

Bilan (1993) reported that the erosion rate in the northern part of Jiangsu Province in China is serious and as high as 85 metres/year; in Hangzhou Bay the rate is 40 metres/year, while in Tianjin it is 16–56 metres/year. Erosion persists even where preventive measures such as sea dykes are constructed. Beach scour has been found along coasts with sea-dyke protection. This erosion is attributable to many factors such as river damming and diversion, that leads to less sediment supply to the coast, and the clearing of mangrove forests, which makes coastal areas more susceptible to the hazard. Juxtaposing these phenomena, the intensification of typhoons and storm surges during the 42-year period between 1949 and 1990 has meant that storm surges with increasing tidal levels exceeding one and two metres have occurred 260 and 48 times respectively, thus exacerbating the erosion problem. Most of the sediment taken offshore by the storm waves has been returned in minimal quantities to the coast during normal conditions owing to the frequent storm intensity.

According to Othman (1994), nearly 30 percent of the Malaysian coastline is undergoing erosion. Many of these areas are coastal mudflats, fringed by mangroves. Behind the mangroves there are usually agricultural fields protected from tidal inundation by bunds (dykes). Locally, mangroves are known to reduce wave energy as waves travel through them; thus, the Department of Irrigation and Drainage has ruled that at least 200 metres of mangrove belts must be kept between the bunds and the sea to protect the bunds from eroding. However, the mangroves themselves are susceptible to erosion when the soil under their root systems is undermined by wave action that mostly occurs during periods of lower water level or low tide. The value of intact mangrove swamps for storm protection and flood control alone in Malaysia is approximately US$300 000/kilometre (http://ramsar.org).

In Viet Nam, most of the coastline in the south that is located in a wide and flat alluvial fan and bordered by tidal rivers fringed by wide mangrove swamps, has been eroded continuously at a rate of approximately 50 metres/year since the early twentieth century (Mazda *et al.*, 1997; Cat *et al.*, 2006). This massive erosion — mostly due to wave and current action — and vanishing mangrove vegetation is attributable to the long-term impacts of human activities since the late nineteenth century and also human-induced change within watersheds (dam construction that has reduced the sediment supply to the shore). Erosion still occurs in the central coastal zone of Viet Nam and preventive measures such as sea dykes, revetments, and tree plantations have been implemented in many coastal areas; however, in the southern coastal zone, mangrove plantations have mitigated wave action and prevented further erosion (Cat *et al.*, 2006).

The rapid erosion of the coast of Sagar Island in West Bengal, India, is caused by several processes that act in concert; these are natural processes that occur frequently (cyclones, waves and tides that can reach six metres in height) and anthropogenic activities such as human settlement and aquaculture that remove mangroves and other coastal vegetation. The erosion rate from 1996 to 1999 was calculated to be 5.47 square kilometres/year (Gopinath and Seralathan, 2005). The areas that are severely affected by erosion are the northeastern, southwestern and southeastern faces of the island. Malini and Rao (2004) reported coastal erosion and habitat loss along the Godavari Delta front owing to the combination of the dam construction across the Godavari and its tributaries that diminishes sediment supply to the coast and continued coastal land subsidence.

Sri Lanka's experience with coastal erosion dates back to 1920 (Swan, 1974; 1984). It has become more serious because mangroves are being eradicated by encroachment (human settlement), fuelwood cutting and the clearing of coastal areas for intensive shrimp culture. Mangrove forest cover was estimated to be approximately 12 000 hectares in 1986; this dwindled to 8 687 hectares in 1993 and was estimated to be only 6 000 hectares in 2000 (Samrayangke, 2003). Approximately US$30 million has already been spent on breakwaters and other construction to combat coastal erosion on southern and western coasts (UNEP, 2006); however, coastal erosion still persists in some coastal areas.

In Indonesia, coastal erosion started in the northern coast of Java Island in the 1970s when most of the mangrove forest had been converted to shrimp ponds and other aquaculture activities, and the area was also subjected to unmanaged coastal development, diversion of upland freshwater and river damming. Coastal erosion is prevalent throughout many provinces (Bird and Ongkosongo, 1980; Syamsudin *et al.*, 2000; Tjardana, 1995) such as Lampung, Northeast Sumatra, Kalimantan, West Sumatra (Padang), Nusa Tenggara, Papua, South Sulawesi (Nurkin, 1994) and Bali (Prasetya and Black, 2003). US$79.667 million was provided by the Indonesian Government to combat coastal erosion from 1996 to 2004, but only for Bali Island in order to protect this valuable coastal tourism base (Indonesia water resource donor database:http://donorair.bappenas.go.id). A combination of hard structures and engineering approaches (breakwaters/jetties/revetments) of different shapes that fused functional design and aesthetic values, and soft structures and engineering approaches (beach nourishment) was used. They succeeded in stopping coastal erosion on Sanur, Nusa Dua and Tanjong Benoa beaches, but were neither cost effective nor efficient, because during low tide all of the coastal area was exposed up to 300 metres offshore; thus, these huge structures were revealed and became eyesores.

In Thailand, intensification of coastal erosion came to notice during the past decade (Thampanya *et al.*, 2006). Overall, the net erosion is approximately 1.3 to 1.7 metres/year along the southern Thailand coastline. Total area losses amount to 0.91 square kilometres/year for the Gulf coast and 0.25 square kilometres/year for the western coast. Most of the eroded areas increase with larger areas of shrimp farms, less mangrove forest area, and when dams reduce riverine inputs and coastal land subsidence transpires. In areas where erosion has prevailed, the presence of mangroves has reduced erosion rates. Mangroves dominating coastal locations exhibit less erosion than areas with non-vegetated land or former mangrove areas.

Such examples indicate that there is a strong relation between major coastal erosion problems throughout the region and degradation of the protective function of coastal systems such as coastal forest and trees – particularly mangrove forest. Artificial and natural agents that induce mangrove loss and make coastal areas more susceptible to coastal erosion include anthropogenic factors such as excessive logging, direct land reclamation for agriculture, aquaculture, salt ponds, urban development and settlement, and to a lesser extent fires, storms, hurricanes, tidal waves and erosion cycles owing to changing sea levels (Kovacs, 2000). More scientific investigation and quantification of the physical processes and dynamic interaction of the system is needed to understand how and under what circumstances mangrove forests and other coastal vegetation effectively protect the shoreline from erosion. A number of efforts have focused on field observations, laboratory and numerical model experiments and theoretical analysis (Wolanski 1992; Mazda *et al.*, 1997; Massel *et al.*, 1999).

Plate 4.1 Different types of coastal protection structures in Tanjong Benoa and Sanur Bali for protecting the valuable tourism base. Clockwise: Satellite images of the offshore breakwater and artificial headland, groynes and beach nourishment (Google maps); headland and beach nourishment with coconuts; loc cit *waru* trees; revetment protection using limestone in combination with *waru trees* (note the dangerous placing of the boats)

2.2 The causes of coastal erosion

Coastal erosion and accretion are complex processes that need to be investigated from the angles of sediment motion under wind, wave and tidal current action; beach dynamics within a sediment/littoral cell; and human activities along the coast, within river catchments and watersheds and offshore, both at spatial and temporal scales. In terms of temporal scales, the issue of sea-level rise is complex and produces a range of environmental problems. As the sea level rises, the water depth increases and the wave base becomes deeper; waves reaching the coast have more energy and therefore can erode and transport greater quantities of sediment. Thus, the coast starts to adjust to the new sea level to maintain a dynamic equilibrium. Figure 4.2 lists the processes of coastal erosion and accretion, as well as natural factors and human activities.

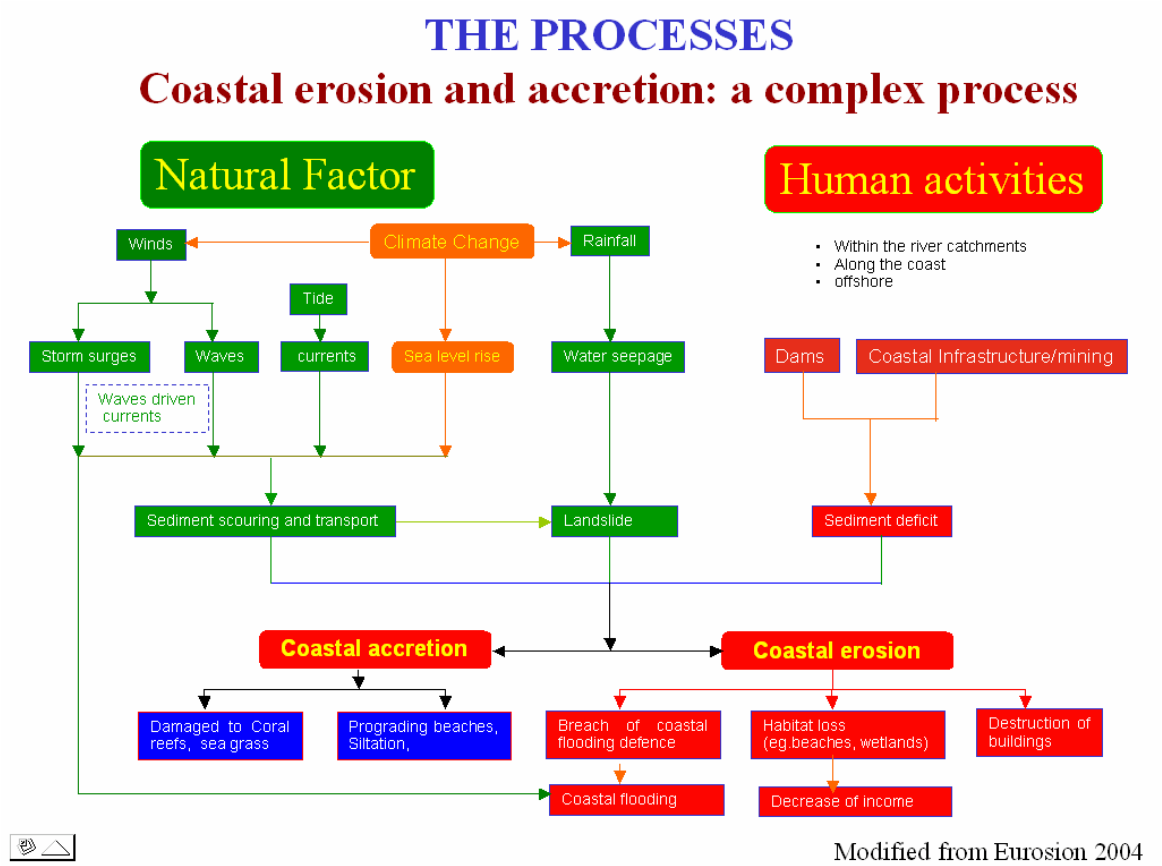


Figure 4.2 The complex processes of coastal erosion and accretion

The key physical parameters that need to be understood to identify coastal erosion as a problem in the coastal zone are:

- Coastal geomorphology: Coastline type and sensitivity to coastal processes.
- Wind: The main force in wave generation; under the right environmental conditions, wind may transfer sediment from the beach environment landward on all open coastlines.
- Waves: They are the most important forces for sediment erosion and transport to the coastal zone. They introduce energy to the coast and also a series of currents that move sediment along the shore (longshore drift) and normal to the shore (cross-shore transport). It is important to understand the movement of wave forms as well as water particles and their interaction with seabed material; also how the waves determine whether the coasts are erosive or accretional.
- Tides: They are influential in beach morphodynamics. They modulate wave action, controlling energy arriving on the coast and drive groundwater fluctuation and tidal currents.

The interaction of groundwater with tides in the coastal forest environment is crucial in understanding why coastal forest clearance causes intensive coastal erosion in particular environments.

- Vegetation: Important for improving slope stability, consolidating sediments and providing some shoreline protection.

Equally significant human activities that must be considered over the range of spatial and time scales are:

- Activities along the coast: Building houses via land reclamation or within sand dune areas and port/harbour development has a long-term impact on shoreline change; protective seawalls lead to erosion at the end of the structures, generate beach scouring at the toe of seawall and shorten the beach face. This can occur in the short term (less than five years) or the long term (more than five years). Other structures such as groynes and jetties typically cause erosion down-drift of the structure within a short period of time (between five and ten years). Removal of dune vegetation and mangroves will expose low energy shorelines to increased energy and reduced sediment stability, causing erosion within five to ten years
- Activities within river catchments/watersheds: Dam construction and river diversion cause reduction of sediment supply to the coast that contributes to coastal erosion. The effects of dam and river diversion in terms of coastal erosion are not straightforward, but there are mid- to long-term impacts (20 to 100 years) with spatial scales approximately from one to 100 kilometres.
- Onshore and offshore activities: Sand and coral mining and dredging may affect coastal processes in various ways such as contributing to sediment deficit in the coastal system and modifying water depth that leads to altered wave refraction and longshore drift. The impact of these activities will be obvious within a short period of time (one to ten years).

Understanding the key processes of coastal dynamics and how the coasts function both in spatial and temporal time scales (short and long term), as well as human activities along the coast, within the river watershed and offshore is essential for managing coastal erosion because it may occur without reason. A quantitative understanding of changes in spatial and short- and long-term time scales is indispensable for the establishment of rational policies to regulate development in the coastal zone (NRC, 1990). Table 4.1 summarizes possible natural factors and human activities that affect shoreline change over a range of time scales, leading to coastal erosion.

Table 4.1 Possible natural factors and human activities that affect shoreline change

Factor	Effects	Time scale									
		sec's	hours	days	months	years	10 years	50 years	100 years	1000 years	10.000 years
Natural Factors											
Short wave period	Erosion										
Waves of small stepnees	Accretion										
Large wave height	Erosion										
Storm surge	Erosion										
Alongshore currents	Accretion, no change or erosion										
Rip currents	Erosion										
Underflow	Erosion										
Overwash	Erosion										
Wind	Erosion										
Sediment supply (source and sink)	Accretion or Erosion										
Inlet presence	Net erosion; hig instability										
Sea level rise	Erosion										
Land subsidence (tectonic)	Accretion or Erosion										
Human activities											
Dredging	Erosion or Accretion										
Coastal defence	Erosion or Accretion										
Vegetation clearing	Erosion										
Harbour development	Erosion or accretion										
River damming	Erosion										
Land reclamation	Erosion										

3 The coastal type and protective function of the coastal system

Coastlines comprise the natural boundary zone between the land and the ocean. Their natural features depend on the type of rocks exposed along the coastline, the action of natural processes and the work of vegetation and animals. The intensity of natural processes formed their origin — either as erosional or depositional features. The geological composition of a coastal region determines the stability of the soil, as well as the degree of rocky materials and their breakdown and removal.

3.1 Coastal types

3.1.1 Cliff coast

Cliff coast can be classified as "hard" coast as it was formed from resistant materials such as sedimentary or volcanic rocks. This type of coast typically has a short shore platform that is usually exposed during low tide. Natural erosion is attributable to slope instability, weathering and wave action and leads to regression of the shoreline. As illustrated in Figure 4.3, extreme wave conditions such as storm waves and tsunamis will have a less erosive effect on this type of coast; traces of tsunami wave height can be found on cliffs as a trim line where trees or shrubs on the cliff had been erased.

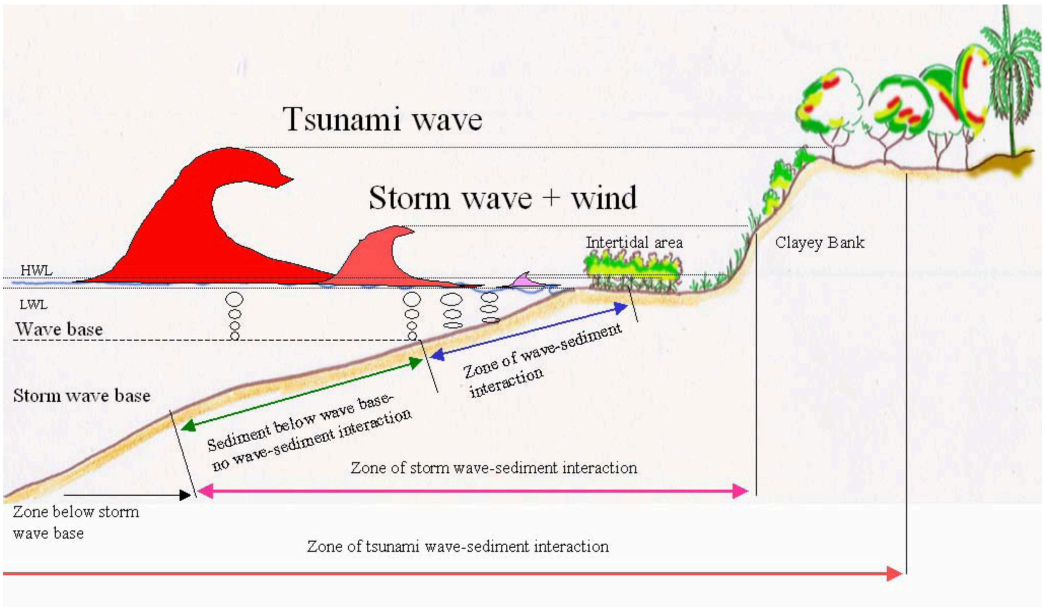


Figure 4.3 Cliff coast (modified from ARC [2000] and French [2001])

3.1.2 Clayey bank coast

This type of coast can be classified as a "semi-hard" coast, consisting of cohesive soils; it is common on estuarine coastlines and often has nearly vertical banks ranging from one to five metres in height. The rate of erosion is relatively high compared to the hard coast because it is composed of weaker and less resistant material. Erosion is mostly due to coastal processes, weathering and loss of vegetation cover (ARC, 2000). For extreme events such storms and tsunami, as illustrated in Figure 4.4, vegetation cover plays a significant role in protecting the coast from flooding and inundation by reducing wave height and energy and decelerating tsunami flow speed; hence, erosive forces and inundation distance are decreased.

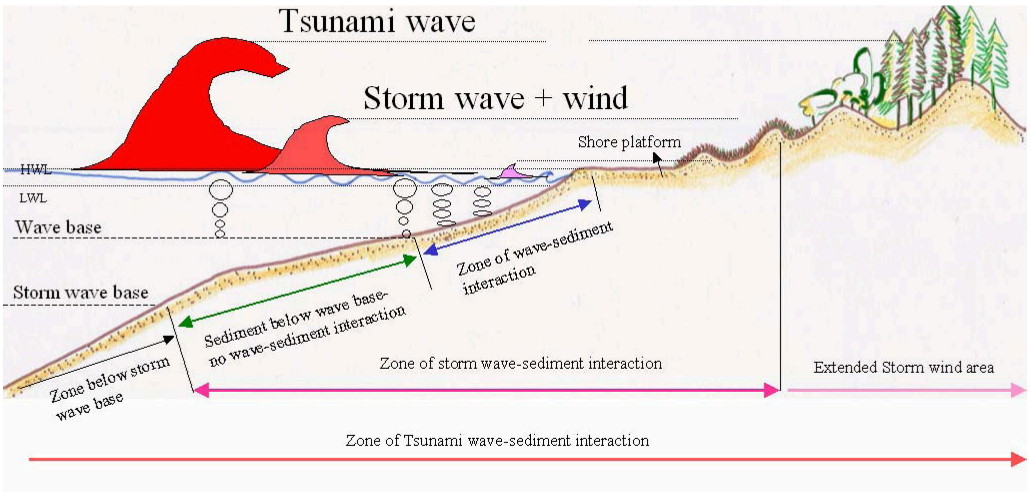


Figure 4.4 Clayey bank type coast (modified from ARC [2000] and French [2001])

3.1.3 Intertidal/muddy coast

This type of coast is characterized by fine-grained sedimentary deposits, predominantly silt and clay that come from rivers; it can be classified as a “soft” coast. It has a broad gentle seaward slope, known as an intertidal mud flat where mangrove forest, saltmarshes, shrubs and other trees are found. Most erosion is generated by river damming that reduces sediment supply, diminishes vegetation cover (usually mangroves and saltmarshes) and exposes vegetation roots by lowering the mud flat (Figure 4.5) that leads to their final collapse. During storms, healthy and dense vegetation/coastal forest and trees can serve as barriers and reduce storm wave height, as well as affording some protection to the area behind them. In the case of a tsunami, coastal forest and trees can decrease wave height and tsunami flow speed to some extent if the forest is dense and wide enough. Both extreme events can cause severe erosion and scouring on the coast and at the river mouth.

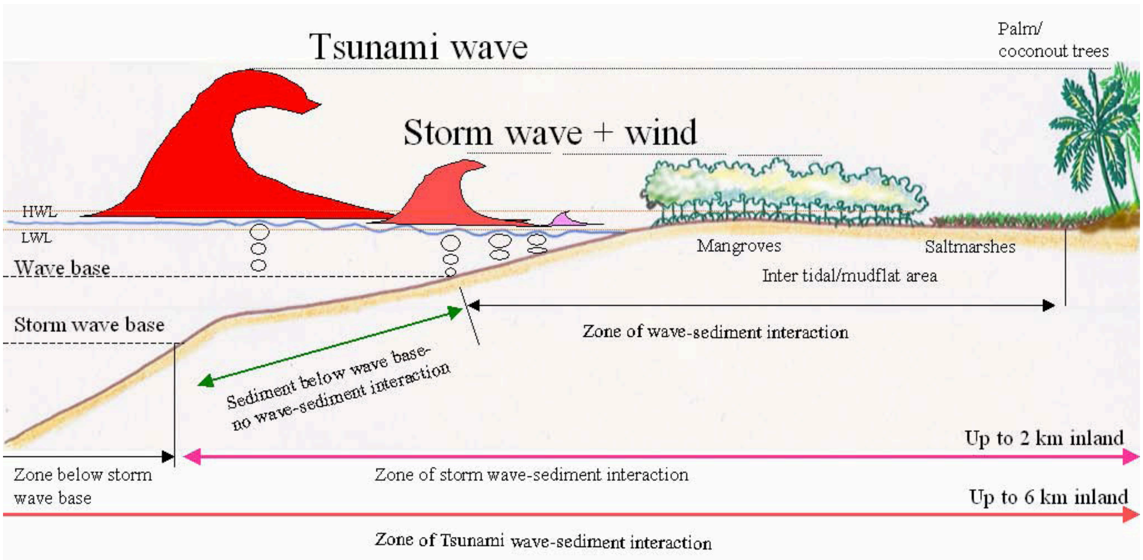


Figure 4.5 Intertidal/muddy coast (modified from ARC [2000] and French [2001])

3.1.4 Sand dune coast

This type of coast consists of unconsolidated material, mainly sand, some pebbles and shells; it can be classified as a soft coast. It has a gentle seaward slope — known as dissipative beaches that have broad fine sand and gradually steep slopes at the backshore/foredunes. Its profile depends on wave form and energy and wind direction; hence, profiles can be adjusted to provide the most efficient means of dissipating incoming wave energy. This type of coast experiences short-term fluctuation or cyclic erosion — accretion and long-term assessment is needed to identify erosion as a problem here. Often accretion and dune rebuilding take much longer than erosional events and the beach has insufficient time to rebuild before the next erosive event occurs. Erosional features are a lowered beach face slope and the absence of a nearshore bar, berm and erosional scarps along the foredune. Generally, erosion is a problem when the sand dunes completely lose their vegetation cover that traps wind-borne sediment during rebuilding, improves slope stability and consolidates the sand. During extreme events such as storms and tsunamis (Figure 4.6), this type of coast can act as a barrier for the area behind the dunes. Sand dunes and their vegetation cover are the best natural protective measures against coastal flooding and tsunami inundation.

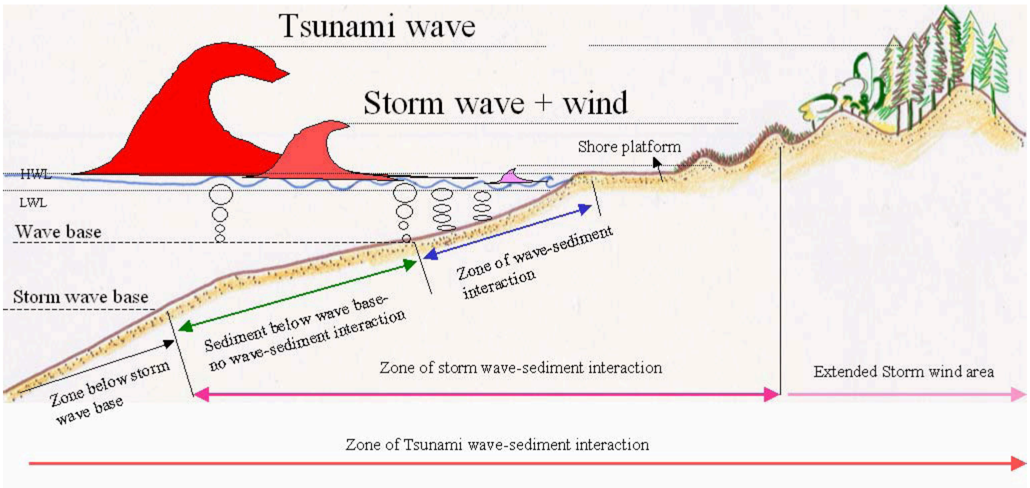


Figure 4.6 Sand dune coast (modified from ARC [2000] and French [2001])

3.1.5 Sandy coast

This type of coast consists of unconsolidated material — mainly sand from rivers and eroded headlands, broken coral branches (coralline sand) and shells from the fringing reefs. It can be classified as a soft coast with reef protection offshore. The beach slope varies from gentle to steep slopes depending on the intensity of natural forces (mainly waves) acting on them. Coconut trees, *waru* (*Hibiscus tiliaceus*), *Casuarina catappa*, pandanus, pine trees and other beach woodland trees are common here. Most erosion is caused by loss of (1) the protective function of the coastal habitat, especially coral reefs (where they are found) that protect the coast from wave action; and (2) coastal trees that protect the coast from strong winds. During extreme events (Figure 4.7), healthy coral reefs and trees protect coasts to some extent by reducing wave height and energy as well as severe coastal erosion.

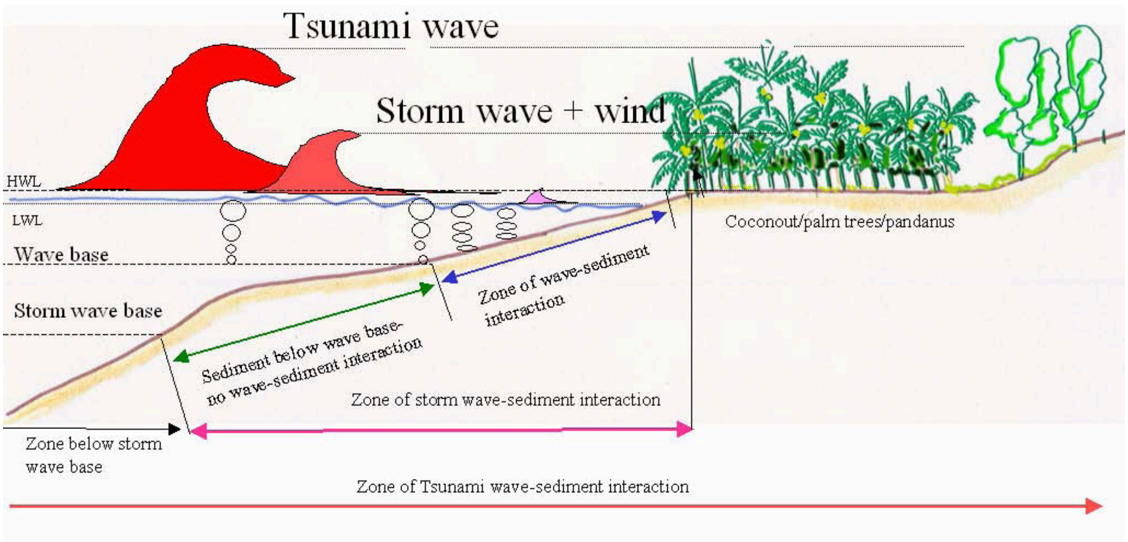


Figure 4.7 Sandy coast (modified from ARC [2000] and French [2001])

3.2 The protective function of coastal systems

Coastal areas with natural protective features can reestablish themselves after natural traumas or long-term changes such as sea-level rise. The protective features of the coastal system vary (Figure 4.8). The role of coral reefs in coastal protection has been studied for some time and recent efforts have focused on the role of coastal vegetation, especially mangrove forest and saltmarshes in this context.

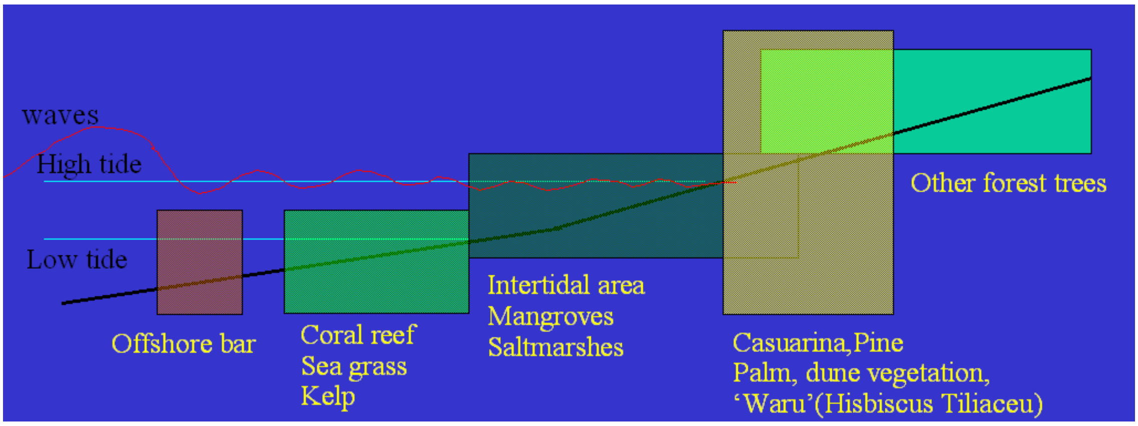


Figure 4.8 The natural protective features of coastal systems

3.3 Scientific findings on the protective functions of coastal forests and trees

Scientific investigations on how coastal vegetation provides a measure of shoreline protection have been conducted (Sale, 1985; Kobayashi *et al.*, 1993; Mazda *et al.*, 1997; Massel *et al.*, 1999; French, 2001; Blasco *et al.*, 1994; Moller *et al.* 1999; Wu *et al.* 2001; Baas 2002; Jarvela 2002; Mendez and Losada 2004; Lee, 2005; Dean and Bender, 2006; Daidu *et al.*, 2006; Moller, 2006; Turker *et al.*, 2006). These field, laboratory and numerical studies show that mangrove forest and other coastal vegetation of certain density can reduce wave height considerably and protect the coast from erosion, as well as effectively prevent coastal sand dune movement during strong winds. Healthy coastal forests such as mangroves and saltmarshes can serve as a coastal defence system where they grow in equilibrium with erosion and accretion processes generated by waves, winds and other natural actions.

3.4 Field studies

The coastal areas around the Bay of Bengal are vulnerable to strong winds, storm surges, tectonic movement, oversedimentation, rapid coastal erosion, fluctuating water and soil salinity and long periods of constant flooding. Based on their scientific investigations in the Bay of Bengal, Blasco *et al.* (1994) reported that the mangrove areas in India and Bangladesh, especially at the mouth of the Ganges (known as the Sunderbans — the largest natural mangrove area of the region found in one block) were able to heal cyclonic wounds and maintain the extent of their total area through natural succession without human interference. Mangroves in these regions have withstood highly adverse environmental conditions such as muddy soils with high salt and water content, destructive tidal effects and strong winds over the flat areas where they have grown in geological terms since the Tertiary (lower Miocene) Period. Via their root systems, mangroves can stabilize the substrate where they occur. According to studies, most erosion is caused by diversion of river flow to coastal areas and mangrove regression due to human activities that convert them for agriculture or aquaculture purposes.

Fan *et al.* (2006) analysed cross-shore variations in the morphodynamic processes of an open coast mudflat in Changjiang Delta, where waves play a dominant role in shaping the tidal-flat profile during typhoons. Each year, roughly seven out of 16 typhoons directly strike China's coast with a 95 percent probability of hitting southwards and the coast of the Chanjiang Delta; they generate waves up to 6.2 metres in height. One-third of the mudflat is colonized by *Spartina alterniflora*, followed by scirpus (*Scirpus mariquete* and *Scirpus triquiter*), and then gradually transits into a less-vegetated pioneer zone behind the bar mudflat. The boundary between the mature marsh and the pioneer marsh is located near the mean neap high water mark and single *Scirpus* stems can survive near the neap lower water elevation. The site-specific erosion rate is related to the local water depth, sediment properties, vegetation and exposure time per semi-diurnal tidal cycle. The area below mean sea level (MSL) at the intertidal mudflat is characterized by dynamic changes in erosion and accretion phases; meanwhile, the higher section is dominated by continuous accretion due to the abundant sediment supply. The area where the *Spartina*-dominated marshes are found has continuous accretion without significant erosion owing to the protection afforded by high and dense vegetation.

Moller *et al.* (1999) studied wave transformation over saltmarshes through field and numerical modelling studies. There is quantitative evidence of the effectiveness of a meso- to macrotidal open coast saltmarsh in attenuating incoming waves over a range of tidal and meteorological conditions. Field measurements indicated that wave energy dissipation rates over the saltmarshes were significantly higher (an average of 82 percent) than over the sand flat (an average of 29 percent); this is due to the saltmarshes having greater surface friction compared to the sand flat. Based on the numerical model, the surface friction factors are of the order ≤0.4. The results of this study provide empirical support to maintaining saltmarshes in front of existing coastal defence structures and for creating new saltmarshes as part of coastal set-back/shoreline re-alignment schemes, as well as reduction of design criteria for flood defence embankments that are fronted by saltmarshes.

Mazda *et al.* (1997) observed the physical processes in fringe forest in coastal areas of Thuy Hai and Thuy Truong in Thai Thuy District, Thai Binh Province, Viet Nam, in a delta of the Gulf of Tonkin. This study elaborated the characteristics of water elevation and water flow in these areas and demonstrated wave reduction by mangroves in the tidal flat off the coast of Thuy Hai where *Kandelia candel* has been planted for several years. Based on these field studies, the wave and current characteristics of propagation through the mangrove forest area are as follows:

- Tidal elevation rises faster at the early stage of flood tide and falls more slowly at the later stage of ebb tide owing to the effects of flow resistance by mangrove vegetation and the bottom mud. In comparison with changes in mangrove swamps dominated by *Rhizophora* spp. and *Bruguiera* spp., changes effected by *Kandelia candel* are considerably smaller because *Rhizopora* spp. and *Bruguiera* spp. have intricate and large prop roots or numerous pneumatophores compared to *Kandelia candel*. These facts suggest that the effect of the drag force on *Kandelia candel* on long-period waves, such as tidal waves, is weak compared to those of *Rhizophora* spp. and *Bruguiera* spp.

- The wave height of the swell increases with increasing tidal level, and decreases with increasing proximity to the coast, which suggests wave energy loss caused by bottom friction and resistance to flow by the mangrove vegetation.

- Wave size decreases considerably through denser mangrove areas; therefore, in well-grown and healthy mangrove areas, the effects on wave reduction do not decrease with increasing water depth, which has important practical implications.

- According to the research, the effectiveness of mangroves with *Kandelia candel* of sufficient height (three to four years old) in reducing wave height per 100 metres was as high as 20 percent and increased to 95 percent when the trees were six years old. At this age, one metre wave height on the open coast will be reduced to 0.05 metre at the coast compared to 0.75 metre without mangroves. Vegetation height and density and the width of the area to be planted are important factors in reducing wave height and protecting the coast from erosion. The effect of wave reduction was considerable even when water depth increased due to the high density of vegetation.

Mazda *et al.* (2002) also analysed coastal erosion caused by tidal forces at Loang Hoa, South Viet Nam, which is located in a wide, flat alluvial fan and lies between two major tidal rivers – the Mui Nai River and the Nga Bay River. Based on field and numerical studies, they found that degradation of mangroves along the tidal rivers led to intensification of tidal currents at the mouths of the rivers and erosion on the coast. This study reached the same conclusion as a study carried out by Wu *et al.* (2001) for Merbok Estuary, Malaysia.

Othman (1994) observed that nearly 30 percent of the coastline of Malaysia is undergoing erosion. Many of these areas are coastal mudflats, fringed by mangroves. He found that instead of erosion due to clearing of the mangrove area for development projects, conditions in the west coast of Peninsular Malaysia suggest that mudflats undergo a cycle of accretion and erosion such as found in Sungai Burong, Pulau Pinang, where this cycle is about 20 years. Based on his observations in Sungai Besar Selangor, a 50-metre-wide belt of *Avicennia* is sufficient to reduce waves of one metre to a height less than 0.3 metre. However, these mangroves are also susceptible to erosion generated by the lowering of mudflats in front of the mangroves that leads to waves agitating the mud base below the root system and causing trees to collapse. *Avicennia* is a pioneer species that decelerates currents via its root system, and together with its trunk, attenuates wave height. The closer the trees are to each other, the greater the wave energy will be reduced. A five-year new growth of *Avicennia* can serve as an efficient wave attenuator. In the studied area behind the *Avicennia* zone, *Rhizophora* and *Bruguiera* zones were found, which contribute to reduced wave height and velocity.

3.5 Laboratory model experiments

Among the different coastal protection techniques and procedures, the protective capacity of coastal vegetation has yet to be investigated and analysed in detail (Turker *et al.*, 2006). Knowledge on the interaction between vegetation and incident waves creates a better understanding of ecological and geomorphological processes in coastal waters, with particular respect to coastal defence management by vegetation. Important developments in understanding the effects of vegetation on coastal bed morphology and the interaction between waves, sediment transport and the vegetated area can be achieved through extensive studies in controlled laboratory conditions. The controlled laboratory environment will allow measurement of wave parameters that are not easily measurable in natural conditions. Coops *et al.* (1996) conducted an experimental study in a wave tank to assess the interaction between waves, bank erosion and emergent vegetation. They used two helophyte species, *Phragmites australis* (Cav.) Trin. ex Steudel and *Scirpus lacustris* L., and two types of sediment (sand and silty sand) in a wave tank. Their findings showed that emergent vegetation influenced the erosive impact of waves by both sediment re-inforcement and wave attenuation. A smaller amount of net erosion was measured in the wave-exposed area covered by vegetation than in the area where there was no vegetation. Most of the erosion of the soil occurred due to the uprooting of rhizome parts, and in this case it happened to *Scirpus lacustris* but not to *Phragmites australis*. The greatest wave attenuation was measured in fully developed vegetation of both species.

Struve *et al.* (2003) combined laboratory experiments (in wave flume) and a two-dimensional (2-D) numerical model to investigate additional roughness owing to vegetation as an important factor for influencing water velocities and levels in a mangrove estuary. The effect of varying stem diameter and density was tested and staggered and linear models of tree distribution were also analysed. The smallest dowels used in some experiments were fitted with bent extensions similar to the stilt roots of *Rhizophora*. The results of the study showed that the effect of stilt roots was similar to stems, despite their different shape, and the change in velocity along the flume was related to the surface area of the model trees. A comparison between staggered and linear model tree distribution indicated that hydraulics shading had an effect based on the size and interference of the wave.

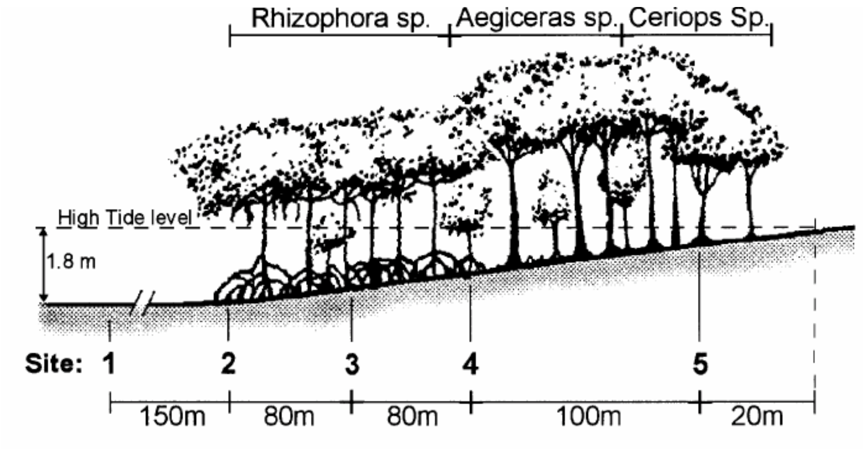
Turker *et al.* (2006) examined a changing beach profile under the protection of emergent vegetation (*Phragmites australis* without foliage) through various wave conditions in a laboratory; the most important governing parameters of coastal erosion in term of waves and sand properties under the protection of emergent vegetation were evaluated and defined. The findings showed that emergent vegetation is a relevant element for beach protection that tends to minimize erosion and even leads to zero erosion (Turker *et al.*, 2006). The vegetated area absorbs substantial wave energy due to friction and drag force; the experimental analysis showed that the amount of erosion is directly proportional to wave height and inversely proportional to sediment particles and the density of vegetation.

3.6 Numerical model and analytical studies

Massel *et al.* (1999) used a theoretical approach to predict the attenuation of wind-induced random surface waves in mangrove forest. The geometry of mangrove trunks and their locations were taken into account and the interaction between mangrove trunks and roots was introduced through the modifications of the drag coefficients. Examples of numerical calculations based on observations of wave attenuation through mangrove forest at Townsville, Australia, and Iriomote Island, Japan, showed that the resulting rate of wave energy attenuation depends strongly on the density of the mangrove forest, the diameter of mangrove roots and trunks, and on the spectral characteristic of the incident waves. Computation results for very dense mangrove forest (width unfortunately not defined), indicated that waves attenuate very quickly with distance from the mangrove front, and in the area behind the mangroves they are negligible. With very low density of mangrove forest and the same wave characteristics, wave energy is transmitted relatively easily through the mangrove forest; however, approximately 86 percent of the energy is still dissipated by the mangroves. The field observations (Figure 4.9) show almost the same results on how the mangrove forest can attenuate waves significantly over a relatively short distance. Wave energy is reduced by 75 percent in the wave passage through 250 metres of mangroves.

An interesting result recently revealed by Dean and Bender (2006) in relation to the effects of wave damping by vegetation and bottom friction on the static wave set-up during a severe storm is in line with studies to establish hazard zones associated with 100-year storm events along the shoreline of the United States; it can be used to explain the phenomena investigated by Blasco *et al.* (1994) for the Bay of Bengal area. Based on these studies, using various wave characteristics, the effect of vegetation and bed friction on both internal and bottom energy losses, and associated forces, resulted in a net wave set-down rather than wave set-up, which decreased wave impact on the shoreline behind the vegetated/coastal forest area.

More research is still needed for other coastal forests and trees such as *Pandanus*, *Casuarina* and pine, which do not directly interact with waves during normal conditions, but do so during extreme events such as major storms and tsunamis. Current knowledge is adequate to derive a general guideline on the protective role of the coastal forest in combating coastal erosion. However, it should be borne in mind that the effectiveness of each species in protecting the coast from erosion is very site-specific.



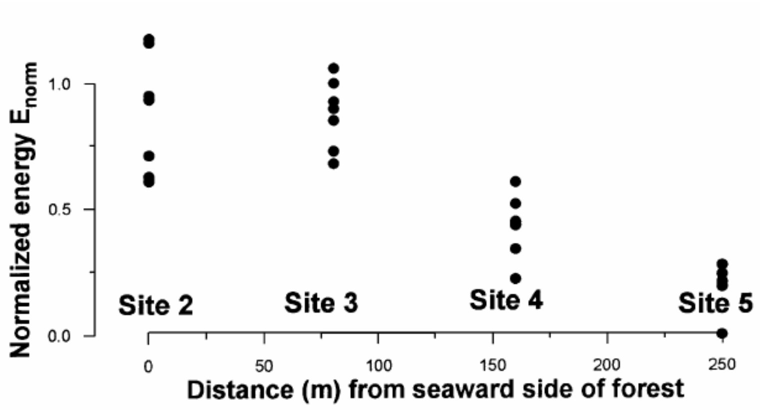


Figure 4.9 Wave attenuation by mangrove forest (*Rhizophora* sp., *Aegiceras* sp., *Ceriops* sp.) at Cocoa Creek, Australia is obvious; measurements at sites 2–5 show the decline in wave energy transmission through the mangrove forest. The incoming wave was measured at site 1 (Massel *et al.*,1999)

4 Managing the coastal erosion problem: Options for coastal protection

Assessing coastal erosion can be done by visual observation and through discussions with inhabitants to ascertain its degree and when it started. Common visual indicators to identify erosion problems are summarized in Table 4.2. However, determining the causes of coastal erosion and which coastal protection options should be used requires a comprehensive study of coastal processes that work on a regional scale (not only on sites) through every season.

Options for combating coastal erosion are traditionally twofold, namely hard structural/engineering options and soft structural/engineering options. These solutions have at least two hydraulic functions to control waves and littoral sediment transport (Kawata, 1989); in applying the solutions, their underlying principles should be well-understood, otherwise they will fail. A combination of hard and soft options has become more popular recently for optimum results because they have weaknesses when used singly. Many schemes have failed and resulted in environmental and socio-economic problems owing to improper design, construction and maintenance, and were often only implemented locally in specific places or at regional or jurisdictional boundaries, rather than at system boundaries that reflect natural processes (Kamphuis, 2002).

Table 4.2 Common visual indicators for identifying erosion problems

All coastlines	Cliff and platform (hard coast)	Clayey banks and muddy coast (semi-hard coast)	Sandy coast (soft coast)
Object (e.g. fence, shed or tree) which falls into the sea	Very steep cliff faces	Tree angle	Stable backdune vegetation in the active zone
Presence of existing coastal erosion management works (particularly poor condition of structures)	Shore platforms	Non-vegetated clayey banks	Damaged vegetation in the active zone (exposed roots)
	Sea caves, notches, stacks	Slumping slopes	Erosion scarps
	Debris at toe of cliff	Dislodged vegetation in the coastal area	Discontinuous vegetation cover on foredunes
	Tree angle at the top of the cliff	Erosion scarps	Irregular foredune crest, blow outs
			Very steep dune formation

4.1 Hard structural/engineering options

Hard structural/engineering options use structures constructed on the beach (seawalls, groynes, breakwaters/artificial headlands) or further offshore (offshore breakwaters). These options influence coastal processes to stop or reduce the rate of coastal erosion.

4.1.1 Groyne

A coastal structure constructed perpendicular to the coastline from the shore into the sea to trap longshore sediment transport or control longshore currents. This type of structure is easy to construct from a variety of materials such as wood, rock or bamboo and is normally used on sandy coasts. It has the following disadvantages:

- Induces local scour at the toes of the structures.
- Causes erosion downdrift; requires regular maintenance.
- Typically more than one structure is required.

4.1.2 Seawall

A seawall is a structure constructed parallel to the coastline that shelters the shore from wave action. This structure has many different designs; it can be used to protect a cliff from wave attack and improve slope stability and it can also dissipate wave energy on sandy coasts. The disadvantages of this structure are:

- It creates wave reflections and promotes sediment transport offshore.
- Scour occurs at the toes of eroded beaches.
- It does not promote beach stability.
- It should be constructed along the whole coastline; if not, erosion will occur on the adjacent coastline.

4.1.3 Offshore breakwater

An offshore breakwater is a structure that parallels the shore (in the nearshore zone) and serves as a wave absorber. It reduces wave energy in its lee and creates a salient or tombolo behind the structure that influences longshore transport of sediment. More recently, most offshore breakwaters have been of the submerged type; they become multipurpose artificial reefs where fish habitats develop and enhance surf breaking for water sport activities. These structures are appropriate for all coastlines. Their disadvantages are:

- They are large structures and relatively difficult to build.
- They need special design.
- The structure is vulnerable to strong wave action.

4.1.4 Artificial headland

This structure is constructed to promote natural beaches because it acts as an artificial headland. It is relatively easy to construct and little maintenance is required. The disadvantages are:

- It is a relatively large structure.
- It can cause erosion downdrift of the protected length of coastline.
- Has poor stability against large waves.

4.2 Soft structural/engineering options

Soft structural/engineering options aim to dissipate wave energy by mirroring natural forces and maintaining the natural topography of the coast. They include beach nourishment/feeding, dune building, revegetation and other non-structural management options.

4.2.1 Beach nourishment

The aim of beach nourishment is to create a wider beach by artificially increasing the quantity of sediment on a beach experiencing sediment loss, improving the amenity and recreational value of the coast and replicating the way that natural beaches dissipate wave energy. Offshore sediment can be sourced and is typically obtained from dredging operations; landward sources are an alternative, but are not as effective as their marine equivalents because the sediment has not been subject to marine sorting.

This method requires regular maintenance with a constant source of sediment and is unlikely to be economical in severe wave climates or where sediment transport is rapid.

It has been used in conjunction with hard structural/engineering options, i.e. offshore breakwaters, headlands and groynes to improve efficiency.

4.2.2 Dune building/reconstruction

Sand dunes are unique among other coastal landforms as they are formed by wind rather than moving waters; they represent a store of sand above the landward limits of normal high tides where their vegetation is not dependent on the inundation of seawater for stability (French, 2001). They provide an ideal coastal defence system; vegetation is vital for the survival of dunes because their root systems bind sediment and facilitate the build-up of dune sediment via wind baffle. During a storm, waves can reach the dune front and draw the sand onto the beach to form a storm beach profile; in normal seasons the wind blows the sand back to the dunes. In dune building or reconstruction, sand fences and mesh matting in combination with vegetation planting have successfully rgenerated dunes via sediment entrapment and vegetation colonization. The vegetation used should be governed by species already present, such as marram, sand couch grass and lyme grass.

4.2.3 Coastal revegetation

Based on studies and scientific results, the presence of vegetation in coastal areas improves slope stability, consolidates sediment and reduces wave energy moving onshore; therefore, it protects the shoreline from erosion. However, its site-specificity means that it may be successful in estuarine conditions (low energy environment), but not on the open coast (high energy environment). In some cases, revegetation fails because environmental conditions do not favour the growth of species at the particular site or there is ignorance as to how to plant properly given the same conditions. It is also possible that anthropogenic influences have completely altered the natural processes in the area. The most obvious indicator of site suitability is the presence of vegetation already growing. This can be extended by other factors such as the slope, elevation, tidal range, salinity, substrate and hydrology (Clark, 1995; French, 2001).

4.2.3.1 Coastal revegetation in muddy coastline environments (tidal zones of estuaries)

In muddy coastal environments or within the tidal zones of estuaries, mangrove forest and other indigenous shrub species are commonly found. Most erosion in these zones is attributable to the removal of the mangroves and other trees. To overcome this problem, replanting is necessary because these trees can regenerate and serve as coastal defence structures.

Planting vegetation species relative to their correct elevation in mudflat environments is important. At low- and subtidal deltas below the high water mark, saltmarsh species are recommended. Saltmarshes are typically zoned according to elevation, the zones being controlled by the frequency and duration of tidal inundation. Within this zone, *Spartina* as a pioneer species is tolerant of more frequent inundation than higher marsh species, and as such, is often used because it can be planted well down the intertidal zone (French, 2001). Other saltmarsh species that can be used are helophyte species such as *Phragmites australis* (Cav.) Trin. ex Steudel and *Scirpus lacustris* L. Within this area, mangroves are also recommended and can be planted easily. If the area already has a serious erosion problem, then special seeding techniques are needed.

A combination of species is suggested to reduce pest damage; however, the choice should be well planned in order to avoid competition. A number of publications provide planting/replanting guidelines, for example Hanley (2006). The mangrove forest should have a minimal width of 300 metres, densities of at least 0.5 metre and be planted in staggered alignment.

4.2.3.2 Coastal revegetation on other coastal types

Sandy coast

Beaches composed of fine sand are usually broad and have a gentle seaward slope representing a low energy environment; beaches with coarse sand, gravel, shells, or broken coral branches have relatively steep slopes representing a high energy environment. Short-term fluctuations on these coasts (if there is no human intervention) do not mean that an erosion problem exists; variations on the beach face are the natural response of the beach to wave form and energy and also strong winds. After extreme conditions, a naturally eroded beach, with features such as a lowered beach face slope, the absence of berms and erosional scarps along the backshore/foredune will return to normal during lower wave energy seasons when waves return sand to the beach and wind transports it landwards to rebuild the upper beach and foredune. Therefore, long-term observations are needed before deciding that the beach is being seriously eroded.

Severe erosion problems on these types of beaches are usually due to human activities such as dam building that decreases the river sediment supply to the coast, vegetation clearance on dunes and in beach woodlands, offshore mining, and building inappropriate coastal structures. In terms of erosion generated by vegetation clearance, revegetation of the area using indigenous vegetation is the only option. Other coastal protection options should be considered in combination with revegetation if the erosion problem is attributable to multiple factors.

Cliff and platform structures

Erosion of cliff and platform structures where there is no beach during high tide is due to complex processes and no single process predominates. These include gradual changes to cliff morphology owing to weathering and wave action at the base of the cliff, and slope instability due to episodic failure of the cliff. Planting shrubs and trees will improve slope stability, for example with *belukar* (dense thickets possibly dominated by isolated trees tangled with lianas); however, other coastal protection options should be considered in combination with revegetation.

4.3 Combinations of options

As mentioned already, combining hard and soft solutions is sometimes necessary to improve the efficiency of the options and provide an environmentally and economically acceptable coastal protection system. Hard solutions are known to:

- cause erosion and unnecessary accretion;
- be expensive and often further aggravate the problem; and
- spoil the aesthetic aspect of the beaches or coastlines they seek to protect, hence decreasing their economic value, especially for tourism purposes.

Meanwhile, many soft solutions can:

- take time to become effective (not overnight or quick-fix solutions), which generates negative public response; and
- be effective solutions only in medium- to long-term perspectives (five to ten years).

A planned retreat where the coast is left to erode can be expensive, unnecessary and sometimes impossible, especially in highly modified environments such as tourism areas and waterfront cities. To optimize the long-term positive impact of soft solutions, many combinations with hard solutions can be selected; combining beach nourishment and artificial headlands/groynes and revegetation and temporary offshore breakwaters/artificial reefs that act as interim hard structures is the most common approach.

4.3.1 Beach nourishment and artificial headlands/groynes

To reduce the frequency of renourishment and downdrift erosion in beach nourishment options, artificial headlands or groynes are often used as they can trap the downdrift movement of sediment.

4.3.2 Revegetation and temporary offshore breakwaters/artificial reefs

In some cases, revegetation in a low energy environment is required because deforestation of the coastal forest has led to direct exposure to wave action. There is also a need to establish offshore breakwaters/artificial reefs as temporary wave protection structures for mangroves and saltmarshes; otherwise, seawalls/revetments for vegetation that grows above the highest water mark such as *waru*, *Casuarina*, pine and palm trees can be built. Once the plants have established themselves, the structures may be removed.

5 Social and environmental implications

Social and environmental problems caused by coastal erosion are relevant and easy to observe. Losses in aquaculture (fish or shrimp ponds) due to erosion diminish fishery productivity and increase the number of unemployed people. Erosion has the same impact on tourism and urban areas where decreasing property values are a major problem. The problem is exacerbated when coastal protection measures have been improperly designed, constructed and maintained, or when they stop locally at specific places such as in front of hotels or properties that can afford to protect their own beaches, but the adjacent coast is left to erode (Plate 4.2). Or they may stop based on ownership (high public vs. private values) or at jurisdictional or administrative boundaries rather than at system boundaries that reflect natural processes. These "solutions" create more problems than answers. Coastal erosion cannot be resolved in a piecemeal fashion; protective measures should be integrated, consider socio-economic conditions and reflect the natural processes that work in the region.

Plate 4.2 Coastal protection efforts to protect a valuable tourism base; meanwhile, the adjacent shore with less economic value has minimal and improper protection. Even revegetation with *waru* to replicate planting at the neighbouring resort failed; the coast was then abandoned and left to erode

Hard and soft options have positive and negative aspects. Most hard options are effective solutions in the short term but create domino effects. They stop local erosion in order to protect the asset, but then contribute to erosion in adjacent areas. In the long term their effectiveness is mostly unsatisfactory. Meanwhile, soft options are effective solutions in medium- to long-term perspectives, but the main issue (French, 2001; Eurosion, 2004) is raising awareness among the public so that they provide effective protection for their homes and businesses; the public perception of security is critical. During the planning process, it is quite common for many people to admit feeling much more secure behind a concrete wall than behind a beach and forest. In this context, a combination of hard and soft structures is advisable.

Public or community involvement in using coastal forest and trees as coastal protection measures is very important during planning, implementation and monitoring; it will raise awareness on these solutions and the concomitant benefits for the ecosystem and all stakeholders. A good example comes from Bangladesh (Clark, 1995). The coastal green belt that had been incorporated with coastal embankments used a variety of trees that afforded not only protection from hazards, but also offered various benefits from the output of the green belt such as fruits, nuts, thatch, coconuts, fuel and poles.

Nature has not only demonstrated how to erode, but also how to protect, and there is probably no protective measure initiated by human beings that has not been originally developed by nature (Bruun, 1972; Bache and MacaSkill, 1981).

6 General guidelines on managing coastal erosion and their options

Understanding the key processes of coastal dynamics and how coasts developed in the past and present, as well as over the short and long term, is very important for managing coastal erosion problems because coastal erosion may occur without cause for concern. This can be very complex and possibly controversial where many conflicts of interests exist within the coastal environment. The main underlying principles for coastal erosion management are as follows (NRC, 1990; ARC, 2000):

- Identify and confirm coastal erosion as a problem.

- Identify, confirm and quantify the cause of the problem and ensure that any management option is well thought out before implementing coastal erosion measures.
- Understand the key processes and characteristics of coastal dynamics and system boundaries that reflect the natural processes of the erosion problem.
- Determine the coastal erosion measure options and implement them using proper design, construction and maintenance with careful evaluation of the effects on adjacent shores.
- Consider the balance of the options' costs and their associated benefits.

A flowchart of this general guideline is given in Figure 4.10.

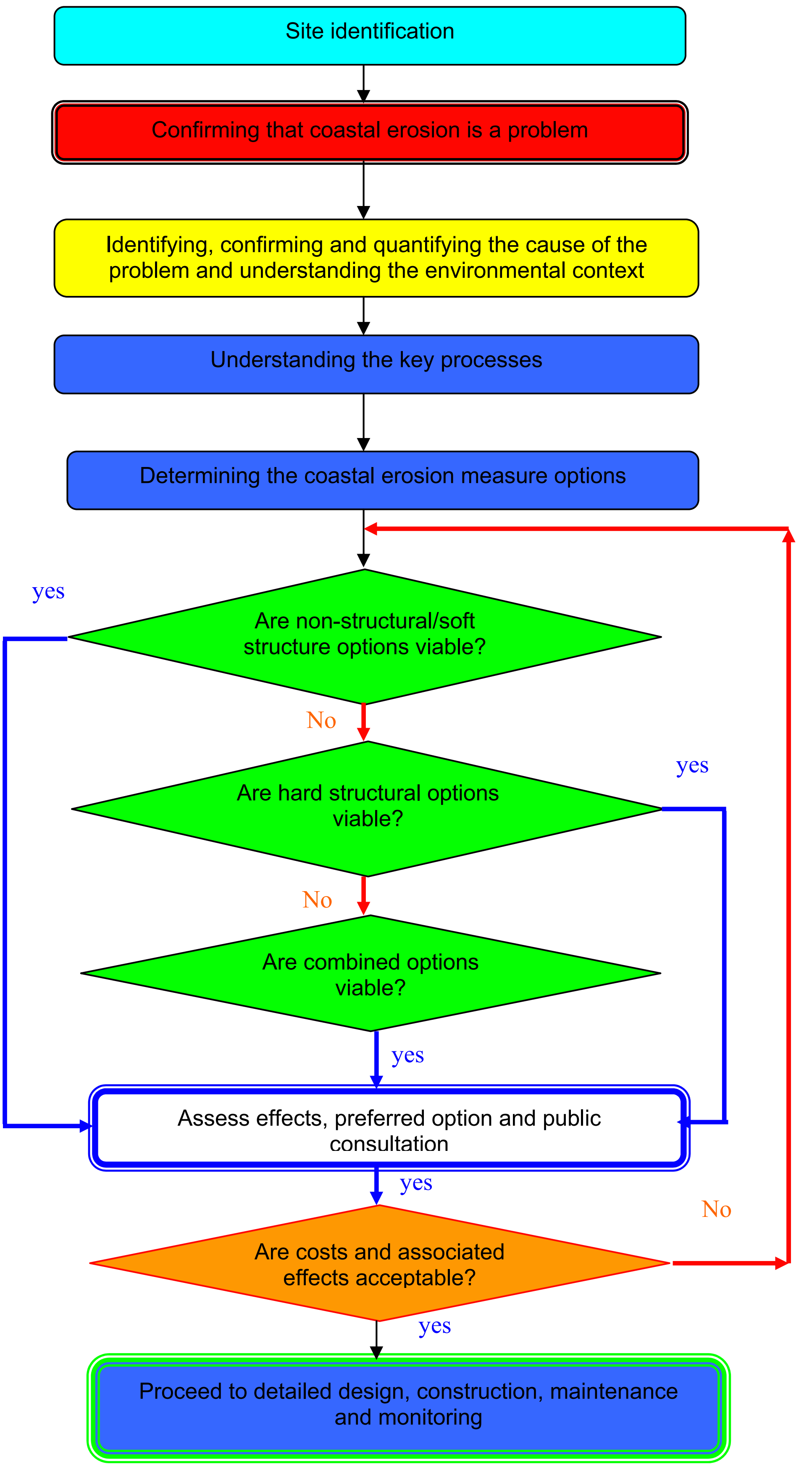


Figure 4.10 Flowchart of the guidelines for managing coastal erosion (modified from ARC, 2000)

Site identification: Simple site identification of coastal erosion can be done visually and through discussion with local inhabitants to give an indication of what is happening on the coast and when it started.

Confirming coastal erosion is a problem: As the coast has transient features, it is natural for it to erode or accrete sediment in response to changing forces; therefore, confirming that coastal erosion is a problem is very fundamental. Generally, coastal erosion is problematic in tourism areas, waterfront cities/residential blocks and aquaculture sites (shrimp ponds). Any legal issues pertinent to coastal management and development should be considered and discussed.

Identifying, confirming and quantifying the cause of the problem: Identifying the cause of the problem requires analysis that should consider any possible sources — both natural and anthropogenic — confirm them, and quantify the scale and intensity of the source and impact in the past, present and possibly in the future. Field observations and data collection of not only physical, but also socio-economic (including historical if available) data of the region are required and crucial at this stage. This will give an idea of what kind of options could be implemented, related to any legal or policy framework on coastal erosion management for the region.

Understanding the key processes: Understanding the key processes of coastal dynamics and how the coasts are functioning in areas where coastal erosion is a problem is essential to determine the system boundary that reflects natural processes. Many mathematical/numerical and physical models of coastal systems have been developed as tools to understand the behaviour of coastal systems. These tools can predict coastline evolution and interaction with the source of the problem and possible options to be implemented in the short and long term. These tools thus contribute to countermeasure planning and design as well as coastal erosion management.

Determining options for addressing coastal erosion: Choosing the optimum option must involve the public or community affected by the erosion. Discuss the available options and provide technical information such as design of the options, materials to be used, construction methods and maintenance and cost–benefit analysis in a wider context to consider the balance of the cost and associated benefits.

6.1 Set up a green belt/buffer zone

The purposes of setting up coastal green belts must not be solely for preventing coastal erosion and mitigating other natural hazards, but also for addressing the socio-economic status of the local communities as well as ecological sustainability.

The purposes of coastal green belts/buffer zones must serve to:

- control and stabilize the shoreline by holding and trapping sediments and consolidate land for areas such as intertidal mudflats with mangrove green belts and sandy coasts with *Casuarina*, pine trees or coconuts and palm trees;
- attenuate the force of devastating storm surges and waves that accompany cyclones and tsunamis;
- provide an amenity and a source of food, materials and income for local communities; and
- benefit biodiversity and create habitat corridors for wildlife that can be used for conservation activities and ecotourism development.

In general, the underlying concepts of setting up green belt/buffer zones (Clark, 1996) are:

- Social forestry: This should not be considered as a source of government or private sector revenue, but to support sustainable livelihood development among the coastal community.

- Ecodevelopment: This is beneficial for conservation activities, educational and recreational opportunities.
- Participatory planning, implementation and monitoring: The indigenous knowledge of local communities should be used in decision-making so they receive benefits directly.

Selection of the vegetation for setting up the green belt/buffer zone should take into account the natural protective function of the coastal system as illustrated in Figure 4.11:

- Start with vegetation at the water's edge and gradually proceed to hydric species inland.
- Select water-edge vegetation that is found locally on each type of coast. In most cases the width of the buffer zone for the intertidal delta ranges between 300 and 500 metres, depending on the slope of the region.
- Select beach vegetation that is found locally on each type of coast. The width of the buffer zone should be a minimum of 100 metres for the flat area, even with sand dunes or coastal embankments.

7 Conclusions

Coastal erosion and accretion are natural processes; however, they may become a problem when exacerbated by human activities or natural disasters. They are widespread in the coastal zone of Asia and other countries in the Indian Ocean owing to a combination of various natural forces, population growth and unmanaged economic development along the coast, within river catchments and offshore. This has led to major efforts to manage the situation and to restore the ability of the coast to accommodate short- and long-term changes induced by human activities, extreme events and sea-level rise. Understanding the key processes of coastal dynamics and how coasts are functioning both in spatial and temporal time scales (short and long term), in juxtaposition with human activities along the coast, within river watersheds and offshore is crucial for managing coastal erosion problems. Three main conclusions can be drawn on the roles that coastal forest and trees can play in combating coastal erosion:

1) There is evidence that they provide some coastal protection and their clearance has increased the vulnerability of coasts to erosion. Based on scientific findings, the presence of vegetation in coastal areas will improve slope stability, consolidate sediment and diminish the amount of wave energy moving onshore, therefore protecting the shoreline from erosion.
2) Increased interest in soft options (in this case the use of coastal forest and trees) for coastal protection is becoming predominant and is in line with advanced knowledge on coastal processes and the natural protective function of the coastal system. This is because hard options are mostly satisfactory in the short term, while soft options are effective in medium to long-term perspectives (five to ten years).
3) A combination of hard and soft solutions is sometimes necessary to improve the efficiency of the options and to provide an environmentally and economically acceptable coastal protection system.

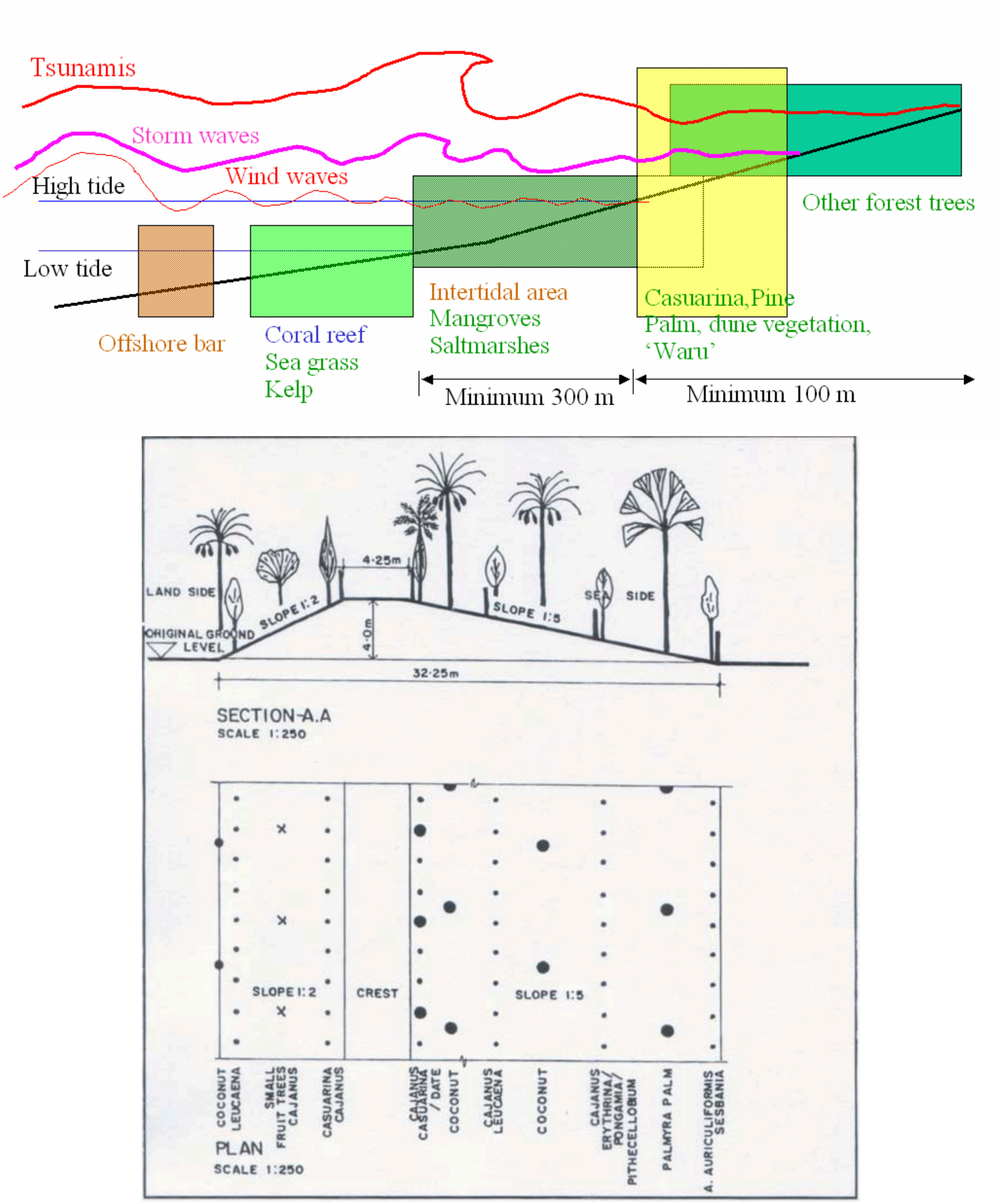


Figure 4.11 The natural protective functions of coastal forest and trees, starting with water-edge vegetation on intertidal deltas, rising to hydric species on higher soils or land. The green belt model below with coastal embankments (in Bangladesh) combines different type of trees, including fruit trees, which benefit local communities (Clark, 1995)

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Annex IN-32

Energy and Mineral Resources Division of the Ministry of Power, Energy and Mineral Resources of the Government of The People's Republic of Bangladesh and Bangladesh Oil, Gas And Mineral Corporation (Petrobangla), Notice Inviting Bids for Exploration of Oil and Natural Gas under Bangladesh Offshore Bidding Round 2008 (with map), February 2008.

NOTICE INVITING BIDS

FOR

EXPLORATION OF OIL AND NATURAL GAS

UNDER

BANGLADESH OFFSHORE BIDDING ROUND 2008

ENERGY AND MINERAL RESOURCES DIVISION
MINISTRY OF POWER, ENERGY AND MINERAL RESOURCES
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

AND

BANGLADESH OIL, GAS AND MINERAL CORPORATION
(PETROBANGLA)

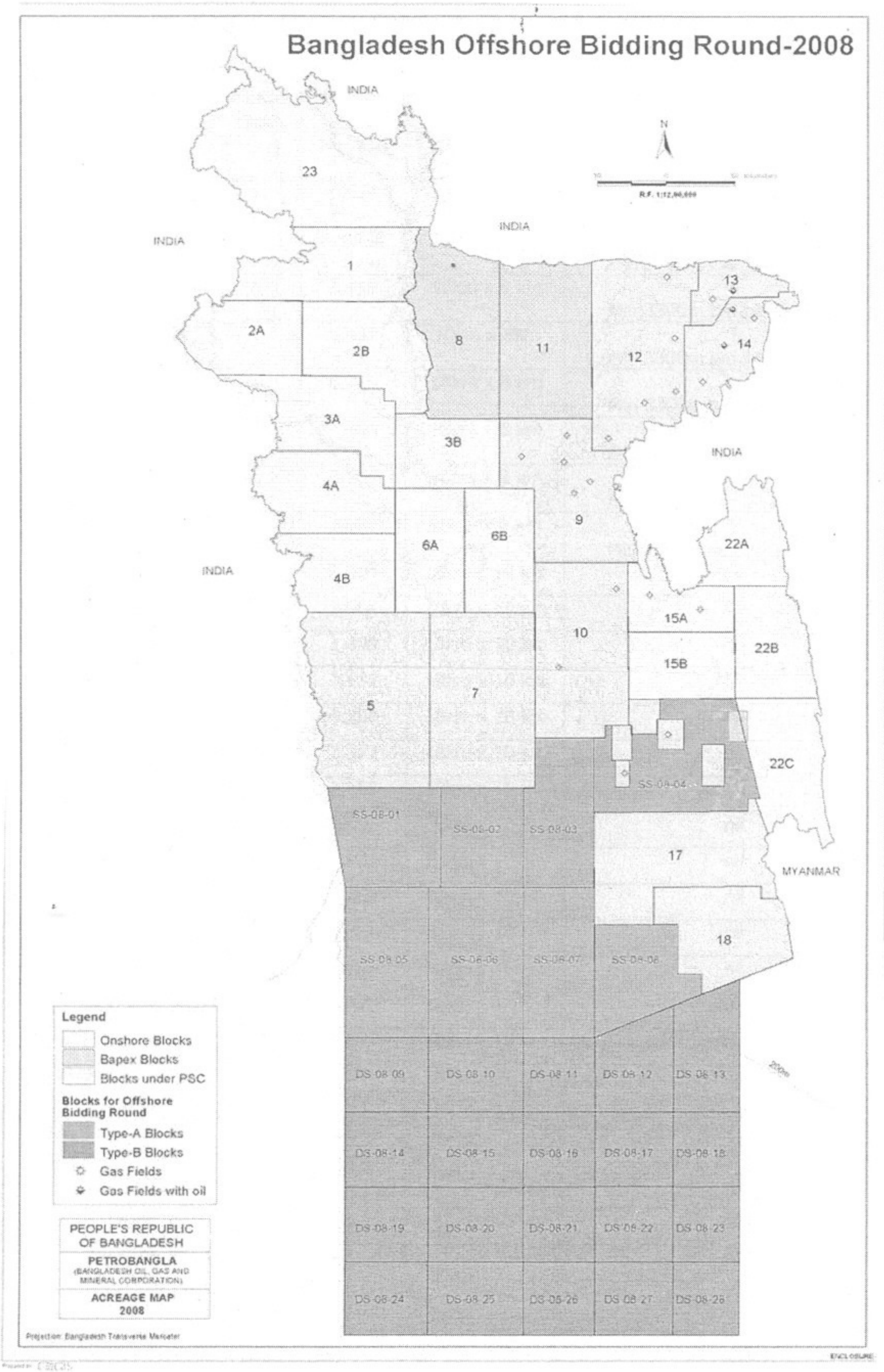
FEBRUARY 2008

Companies are required to purchase the Promotional Package in order to qualify for bidding. The purchase price of Promotional Package is US$ 7,500 (US Dollar seven thousand five hundred) or BDT 525,000 (five hundred twenty five thousand). Purchase of Data Sales Package is optional. Several Data Sales Packages are available at different prices. Companies interested in bidding and purchase of Promotional and Data Packages may contact:

Director, Production Sharing Contract
Bangladesh Oil, Gas & Mineral Corporation (Petrobangla)
Petrocentre (Level 4)
3 Kawran Bazar Commercial Area, Dhaka-1215, Bangladesh.
Telephone 88-02-8114953, Fax: 88-02-9127400
web site: www. petrobangla.org.bd,
E-mail: dpscpb@petrobangla.org.bd

Bids in triplicate should be submitted in sealed envelopes superscribed ***"Confidential" "Offshore Bidding Round-2008"*** and ***"Proposal for Block #........"*** not later than at 1.00 PM BST on 07 May. 2008, to:

Chairman
Bangladesh Oil, Gas & Mineral Corporation (Petrobangla)
Petrocentre (Level 4)
3 Kawran Bazar Commercial Area,
Dhaka-1215,
Bangladesh.


Bangladesh Offshore Bidding Round-2008
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Type-A Blocks
Type-B Blocks
Gas Fields
Gas Fields with oil
PEOPLE'S REPUBLIC OF BANGLADESH
PETROBANGLA
(BANGLADESH OIL, GAS AND MINERAL CORPORATION)
ACREAGE MAP
2008
Projection: Bangladesh Transverse Mercator
ENCLOSURE

Annex IN-33

Y. Tanaka, "Reflections on Maritime Delimitation in the *Nicaragua /Honduras* Case", *Zeitschrift für ausländisches öffentliches Recht und Völkerrecht*, Vol. 68, 2009, pp. 903-937.

Reflections on Maritime Delimitation in the *Nicaragua/Honduras* Case

*Yoshifumi Tanaka**

I. Introduction

A. Nature of the Problem

In 2007, two decisions were newly rendered in relation to maritime delimitations: the *Guyana/Suriname* Arbitration of 17 September 2007[1] and the *Case Con-*

* PhD, DES (Graduate Institute of International Studies and Development, Geneva), LL.M. (Hitotsubashi University, Tokyo), Assistant Professor, Faculty of Law, University of Copenhagen, Denmark. This article is based on my presentation given at the International Law Association British Branch on 5 March 2008. The author wishes to thank Dr Michael Johnston for proofreading the draft.

cerning Territorial and Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea of 8 October 2007 (hereafter the *Nicaragua/Honduras* case).[2] These two cases include some commonalities, for example:

(i) The two cases relate to maritime delimitation between States with adjacent coasts.

(ii) These cases concern the delimitation of a single maritime boundary relating to the territorial sea, the exclusive economic zone (EEZ) and the continental shelf.

(iii) Parties in these cases have ratified the 1982 United Nations Convention on the Law of the Sea (hereafter the LOSC), and consequently, the delimitation of the territorial sea, the EEZ and the continental shelf is governed by Articles 15, 74 (1) and 83 (1) of the LOSC, respectively.

(iv) In each case, one of the Parties of the litigations – Suriname and Nicaragua respectively – urged the international courts to apply the so-called bisector method.

On the other hand, the *Nicaragua/Honduras* judgment sharply contrasts with the *Guyana/Suriname* award on an important point, namely the application of the equidistance method in the process of maritime delimitation. While the Arbitral Tribunal in the *Guyana/Suriname* case applied the equidistance method by rejecting the use of the bisector method, the ICJ, in one part of the *Nicaragua/Honduras* case, refused to apply the equidistance method and applied the bisector method.

As explained elsewhere, the essence of the law of maritime delimitation concerns the question how it is possible to ensure predictability, while taking into account a diversity of factors in order to achieve an equitable result.[3] As with all types of law, the law of maritime delimitation should have a certain degree of predictability. At the same time, as each maritime delimitation case differs, flexible consideration of relevant factors is also required with a view to achieving equitable results. Hence the quest for a well-balanced legal framework reconciling predictability and flexibility should be the essential issue in the law of maritime delimitation. The equidistance method is the only objective method for ensuring predictability of results in the sense that, once the base-points are fixed, the delimitation line is mathemati-

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[1] The Award is available at the homepage of the Permanent Court of Arbitration <http://www.pca-cpa.org/>. For a commentary on the award, see Y. Tanaka, The *Guyana/Suriname* Arbitration: A Commentary, 2 Hague Justice Journal (2007), 28-33.

[2] The text of the judgment is available at the homepage of the ICJ <http://www.icj-cij.org>. The analysis of this study relies on the electronic version of the judgment. The page numbers quoted in this study are the numbers of the electronic text. For an overview of this judgment, see M. Pratt, Commentary: Case Concerning Territorial and Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea (*Nicaragua v. Honduras*), 2 Hague Justice Journal (2007), 34-38; Y. Tanaka, Case Concerning the Territorial and Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea (8 October 2007), 23 International Journal of Marine and Coastal Law (2008), 327-346; P. Bekker/A. Stanic, The ICJ Awards Sovereignty over Four Caribbean Sea Islands to Honduras and Fixes a Single Maritime Boundary between Nicaragua and Honduras, 11 (Issue 26) ASIL Insight (2007); E.A. Kirk, Case Concerning the Territorial and Maritime Dispute between Nicaagua and Honduras in the Caribbean Sea (*Nicaragua v. Honduras*), 57 ICLQ (2008), 701-709; and R. Churchill, Dispute Settlement under the UN Convention on the Law of the Sea: Survey for 2007, 23 International Journal of Marine and Coastal Law (2008), 615-624.

[3] Y. Tanaka, Predictability and Flexibility in the Law of Maritime Delimitation, Oxford 2006, 4-5.

cally determined.[4] In this sense, the equidistance method is an essential element for ensuring predictability in the law of maritime delimitation. Hence, the Court's view concerning the applicability of the equidistance method in the law deserves serious consideration.

Against that background, this study will examine the *Nicaragua/Honduras* judgment focusing particularly on the application of the equidistance method in the law of maritime delimitation. Following the introduction, including the background of the *Nicaragua/Honduras* dispute in Part I, Part II will address the process of maritime delimitation in this case. Part III will review the legal position of the equidistance method in previous case law relating to maritime delimitations. On the basis of the analysis in Part III, Part IV will examine the validity of the *Nicaragua/Honduras* judgment concerning the equidistance method. Part V will then discuss the validity of the bisector method in the current case. Finally a general conclusion is presented in Part VI.

B. Background

Nicaragua and Honduras – which had been under the rule of Spain, and achieved their independence in 1821 – are located in the south-western part of the Caribbean Sea.[5] The coastlines of Nicaragua and Honduras roughly form a right angle that juts out to sea. The convexity of the coast is compounded by the cape formed at the mouth of the River Coco.[6] The delta of the River Coco and even the coastline north and south of it shows a very active morpho-dynamism, and the river mouth is constantly changing its shape.[7] Since the end of Spanish colonial rule, the two States have attempted to resolve their territorial disputes with third-party assistance, such as the Mixed Boundary Commission set up by Article II of the 1894 Gámez-Bonilla Treaty, the Arbitration by the King of Spain, and the Mixed Commission established by the Inter-American Peace Committee. The Mixed Commission of the Inter-American Peace Committee determined that the land boundary would begin at the mouth of the River Coco at 14° 59.8' N latitude and 83° 08.9' W longitude.[8]

From 1963 to 1979, Honduras and Nicaragua generally enjoyed friendly relations. On 21 September 1979, however, Honduras sent a diplomatic Note to Nicaragua stating that a Honduran fishing vessel had been attacked by Nicaragua 8 miles north of the 15th parallel which, according to Honduras, served as the boundary line between Honduras and Nicaragua. Subsequently, numerous incidents in-

[4] H.W.A. Thirlway, The Law and Procedure of the International Court of Justice Part Five, 64 BYIL (1994), 41.

[5] The *Nicaragua/Honduras* case, op. cit., note 2, 11, para. 23.

[6] Ibid., 13, para. 26.

[7] Ibid., 14, para. 32. See also Argument by Mr Colson, Verbatim Record, CR 2007/9, 45, para. 25.

[8] Judgment, op. cit., note 2, 18, para. 47.

volving the capture and/or attack by each State of fishing vessels belonging to the other State in the vicinity of the 15th parallel were recorded in a series of diplomatic exchanges.[9] Nicaragua and Honduras attempted in vain to settle the boundary issues through bilateral negotiations. Thus, on 8 December 1999, Nicaragua instituted proceedings against Honduras concerning a dispute relating to the delimitation of the maritime areas appertaining to each of those States in the Caribbean Sea on the basis of Article XXXI of the Pact of Bogotá as well as Article 36 (2) of the Statute of the ICJ.[10] As the Court included on the Bench no judge of the nationality of either of the Parties, Nicaragua chose Mr. Giorgio Gaja and Honduras chose Mr. Santiago Torres Bernárdez as a judge *ad hoc* to sit in the present case.[11]

In its Application and written pleadings, Nicaragua asked the Court to determine the course of the single maritime boundary between the areas of territorial sea, continental shelf and exclusive economic zone (EEZ) appertaining to Nicaragua and Honduras in the Caribbean Sea. Nicaragua claimed that its maritime boundary with Honduras in the Caribbean Sea had not been delimited. During the oral proceedings, Nicaragua further requested that the Court pronounce on sovereignty over islands located in the disputed area to the north of the boundary line claimed by Honduras and running along 14° 59.8' North latitude.[12] On the other hand, Honduras maintained that in the Caribbean Sea, there was already a traditionally recognized maritime boundary between Honduras and Nicaragua which had its origins in the principle of *uti possidetis juris*. During the oral proceedings, Honduras also asked the Court to adjudicate that the islands Bobel Cay, South Cay, Savanna Cay and Port Royal Cay, together with all other islands, cays, rocks, banks and reefs claimed by Nicaragua which lie north of the 15th parallel, were under the sovereignty of the Republic of Honduras.[13]

It follows that the *Nicaragua/Honduras* case concerns the territorial disputes over the islands and the delimitation of a single maritime boundary in the disputed area at the same time. With respect to the dispute relating to territorial sovereignty over the islands, the Court unanimously found that Honduras has sovereignty over the islands of Bobel Cay, Savanna Cay, Port Royal Cay and South Cay on the basis of the post-colonial *effectivités*.[14] Thus the Court turned to the maritime delimitation of the disputed area.

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9 Ibid., 18-20, paras. 49-58.

10 Ibid., 4, para. 1.

11 Ibid., 5, para. 5.

12 Ibid., 38, para. 127. For the sake of simplicity, the Court generally referred to this as the 15th parallel. Ibid., 24, para. 72.

13 Ibid., 24, para. 73.

14 Ibid., 93, para. 321; 62, para. 227. For an outline of the Court's argument on this issue, see Tanaka, op. cit., note 2, 330-332. In addition, the Court's argument relating to the maritime delimitation has already been summarized by ibid., 333-338.

II. Delimitation of Maritime Areas

A. The Traditional Maritime Boundary Line Claimed by Honduras

1. Application of the Principle of *uti possidetis juris* to Maritime Boundaries

The first issue relating to maritime delimitation was whether or not there was a traditional maritime boundary line as claimed by Honduras. According to Honduras, the line of the 15th parallel constituted the maritime delimitation line on the basis of the *uti possidetis juris* principle referred to in the Gámez-Bonilla Treaty and the 1906 Award of the King of Spain. Honduras claimed that Cape Gracias a Dios separated the jurisdictional areas of the different colonial authorities which exercised authority over the maritime areas off the coasts of present-day Nicaragua and Honduras.[15] In this regard, the Court observed that this principle "might in certain circumstances, such as in connection with historic bays and territorial seas, play a role in a maritime delimitation".[16] According to the Court, however, no persuasive case had been made by Honduras as to why the maritime boundary should extend from the Cape along the 15th parallel. The Court had already denied the relevance of the principle of *uti possidetis juris* in relation to sovereignty over the disputed islands in the present case. Nor had it been shown that Spanish Crown divided its maritime jurisdiction between the colonial provinces of Nicaragua and Honduras even within the limits of the territorial sea. Further to this, the 1906 Award did not deal with the maritime delimitation between Nicaragua and Honduras. Accordingly, the Court concluded that the *uti possidetis juris* principle cannot be said to have provided a basis for a maritime delimitation along the 15th parallel.[17]

It is of particular interest to note that in certain circumstances, the Court accepted the applicability of the principle of *uti possidetis juris* to maritime boundaries.[18] Yet, as in the *Nicaragua/Honduras* case, it appears that the role of this principle remains modest in this field. In the *Land, Island and Maritime Frontier* case between El Salvador and Honduras, for instance, the Chamber of the ICJ stated that the principle of *uti possidetis juris* should apply to the waters of the Gulf of Fonseca as well as to the land. However, the Chamber concluded that there was no

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[15] Judgment, op. cit., note 2, 62, paras. 229-230; Counter-Memorial submitted by Honduras, Vol. I, 25-27, paras. 2.25-2.28; 144-146, paras. 7.38-7.45; Argument by Mr Sands, Verbatim Record, CR 2007/9, 10-39, paras. 1-57.

[16] Judgment, op. cit., note 2, 63, para. 232.

[17] Ibid., 62-64, paras. 229-236. However, Judge *ad hoc* Torres Bernárdez considered that on the basis of the principle of *uti possidetis juris,* the 15th parallel constituted the boundary of the territorial sea with a breadth of six nautical miles. According to Judge Torres Bernárdez, the Court's standard in the application of this principle is too strict. Dissenting Opinion of Judge Torres Bernárdez, ibid., 18-20, paras. 75-83; 25-26, paras. 102-110.

[18] Concerning the application of the principle of *uti possidetis juris* in maritime delimitations, see G. Nesi, *Uti possidetis juris* e delimitazioni maritime, 74 Rivista di Diritto Internazionale (1991), 534-570; M.G. Kohen, Possession contestée et souveraineté territoriale, Paris 1997, 461-464.

attempt to delimit the waters of the Gulf according to the principle of *uti possidetis juris*.[19] Although the applicability of the principle of *uti possidetis juris* was discussed by the Parties in the *Guinea/Guinea-Bissau* case,[20] the Court of Arbitration did not investigate this issue, because it decided that the Convention of 12 May 1886 between France and Portugal did not determine a maritime boundary between the respective possessions of those two States in West Africa.[21] In addition to this, the Arbitral Tribunal, in the *Guinea-Bissau/Senegal* case, ruled that the exchange of letters on 26 April 1960 between France and Portugal established a maritime boundary for the territorial sea, the contiguous zone, and the continental shelf. Nonetheless, the Arbitral Tribunal held that the boundary did not comprise the EEZ because the concept of the EEZ was unknown at that time.[22] While the Arbitral Tribunal appeared to admit the application of the principle of *uti possidetis juris* to maritime boundaries,[23] this award did seem to concern the succession of a boundary agreement in reality. Concerning the application of the principle of *uti possidetis juris* to maritime delimitations within the context of colonization, two points should be noted.

First, intertemporal law should be considered in the application of the principle of *uti possidetis juris* to maritime delimitations.[24] It is conceivable that the principle is not applicable to marine spaces which were unknown in the colonial period. Accordingly, the principle will have no role to play in the delimitation of the EEZ, which was crystallised in the post-colonial period.[25]

Secondly, it should be noted that there was no agreement on the maximum breadth of the territorial sea in the colonial period. Thus even where the principle of *uti possidetis juris* can be applied to the delimitation of the territorial sea, a question arises with respect to the extension of the delimitation line. Currently the maximum breadth of the territorial sea is 12 nautical miles under Article 3 of the LOSC. Yet this does not mean that the delimitation line on the basis of the principle of *uti possidetis juris* will automatically extend until 12 nautical miles.

In this respect, it is notable that the Arbitral Tribunal, in the *Guyana/Suriname* case, addressed the question of whether and how a delimitation should extend from the previous limit of the territorial sea (3 nautical miles) to a newly established limit (12 nautical miles). On this issue, the Arbitral Tribunal did not support automatic extension of the territorial sea from the previously accepted limit of 3

[19] ICJ Reports 1992, 589, para. 386; 601, para. 405. See also 598-600, paras. 400-401.

[20] The *Guinea/Guinea-Bissau* case, 25 ILM (1986), 271, para. 40.

[21] Ibid., 288, para. 85; 304, para. 130.

[22] The *Guinea-Bissau/Senegal* arbitration, 94 RGDIP (1990), 274, para. 88.

[23] R. Kolb, Case Law on Equitable Maritime Delimitation, The Hague *et al.* 2003, 203; S. Lalonde, Uti Possidetis: Its Colonial Past Revisited, RBDI (2001), 84.

[24] Ibid., 85.

[25] Yet Judge Jiménez de Aréchaga was supportive of the application of the principle *uti possidetis juris* to the colonial delimitation of sponge fisheries. Separate Opinion of Judge Jiménez de Aréchaga in the *Tunisia/Libya* case, ICJ Reports 1982, 131-132, paras. 100-102.

nautical miles to the current limit of 12 nautical miles.[26] According to the Arbitral Tribunal, the automatic extension of the existing delimitation line, namely, the N10°E Line, would allow Guyana's territorial sea to cut across the approaches to the river and thus defeat the purpose of that line to protect Suriname's navigational interests. In light of this special circumstance, the Arbitral Tribunal concluded that the territorial sea delimitation must be drawn from the point at which the N10°E line intersects the 3 nautical miles limit to the point at which the equidistance line drawn by the Tribunal of the Award intersects the 12 nautical miles.[27]

2. The Existence of a *de facto* Maritime Boundary

Honduras also contended that there was a "*de facto* boundary based on the tacit agreement of the Parties" at the 15th parallel. According to Honduras, ever since the 1906 Award was rendered, the Parties' oil concession practice concerning the 15th parallel has coincided and has even been co-ordinated along that parallel. Honduras further argued that the existence of a tacit agreement between the Parties on the 15th parallel as the maritime boundary could be suggested by fishing activities in the disputed area, the regional practice of third Parties, and statements of many fishermen.[28] On this issue, the Court generally stated that:

> The establishment of a permanent maritime boundary is a matter of grave importance and agreement is not easily to be presumed. [...] Even if there had been a provisional line found convenient for a period of time, this is to be distinguished from an international boundary.[29]

The Court has noted that from 1961 to1977, the 15th parallel appeared to have had some relevance in the conduct of the Parties. Specifically the Court observed that during this period, several oil concessions were granted by the Parties indicating the 15th parallel as their northern and southern limits, that the 15th parallel divided the respective fishing areas of the two States, and that the 15th parallel was also perceived by some fishermen as a line dividing maritime areas under the jurisdiction of the Parties. According to the Court, however, "these events, spanning a short period of time, are not sufficient for the Court to conclude that there was a legally established international maritime boundary between the two States".[30] The Court further pointed to the fact that in the Note of the Honduran Minister for Foreign Affairs dated 3 May 1982, Honduras concurred with the Nicaraguan Foreign Ministry that "the maritime border between Honduras and Nicaragua has not been legally delimited" and proposed that the Parties at least come to a "temporary" arrangement about the boundary so as to avoid further boundary incidents.[31]

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[26] The *Guyana/Suriname* Award, op. cit., note 1, 99, para. 311.
[27] Ibid., 103, paras. 322-325.
[28] Judgment, op. cit., note 2, 64-69, paras. 237-252.
[29] Ibid., 69, para. 253.
[30] Ibid., 70, para. 256.
[31] Ibid., para. 257. See also 20, para. 56.

In conclusion, the Court held that there was no tacit agreement in effect between the Parties in 1982 – nor *a fortiori* at any subsequent date – of a nature to establish a legally binding maritime boundary.[32]

The jurisprudence relating to maritime delimitations demonstrated that normally the international courts and tribunals were reluctant to accept the existence of a *de facto* maritime boundary on the basis of the conduct of the Parties. Apart from the *Tunisia/Libya* judgment,[33] the conduct of the Parties plays but a modest role in the *Gulf of Maine, St. Pierre and Miquelon, Greenland/Jan Mayen, Eritrea/Yemen, Qatar/Bahrain*, *Cameroon/Nigeria* and *Barbados/Trinidad and Tobago* cases.[34] In particular, the ICJ in the *Cameroon/Nigeria* case explicitly stated that:

> Overall, it follows from the jurisprudence that, although the existence of an express or tacit agreement between the parties on the sitting of their respective oil concessions may indicate a consensus on the maritime areas to which they are entitled, oil concessions and oil wells are not in themselves to be considered as relevant circumstances justifying the adjustment or shifting of the provisional delimitation line. Only if they are based on express or tacit agreement between the parties may they be taken into account. In the present case there is no agreement between the parties regarding oil concessions.[35]

This view was echoed by the *Guyana/Suriname* award, which held that: "The [previous] cases reveal a marked reluctance of international courts and tribunals to accord significance to the oil practice of the parties in the determination of the delimitation line."[36] Accordingly, it may be said that the *Nicaragua/Honduras* judgment is in the line with the existing case law in this field. It appears that the international courts' approach is valid, because giving too much weight to the conduct of the Parties entails the risk of introducing the idea of effectiveness of occupation – which would be incompatible with the fundamental character of the legal title over marine spaces – into the law of maritime delimitation.

B. Delimitation of the Single Maritime Boundary

1. Establishment of a Bisector Line

The jurisprudence of the Court on various occasions makes it clear that the equidistance method is widely used in the practice of maritime delimitation.[37] Nonetheless, Nicaragua asserted that the instability of the mouth of the River

[32] Ibid., paras. 257-258.

[33] The ICJ in the *Tunisia/Libya* case attached great importance to a *de facto* line drawn from Ras Ajdir at an angle of some 26° east of north, which resulted from concessions for the offshore exploration and exploitation of oil and gas granted by the Parties. ICJ Reports 1982, 71, para. 96.

[34] On this issue, Tanaka, op. cit., note 3, 288-299.

[35] Judgment, ICJ Reports 2002, 447-448, para. 304.

[36] The *Guyana/Suriname* arbitration, op. cit., note 1, 125, para. 390.

[37] Judgment, op. cit., note 2, 73-74, paras. 267-272.

Coco at the Nicaragua-Honduras land boundary terminus would make fixing base points and using them to construct a provisional equidistance line unduly problematic. Thus Nicaragua urged the Court to apply the bisector method which constructs the entire single maritime boundary from the bisector of two lines representing the entire coastal front of both States, which would then run along a line of constant bearing 52° 45'21''.[38] On the other hand, Honduras's principal argument was that there was a tacit agreement on the 15th parallel as the single maritime boundary. During the oral proceedings, however, Honduras claimed that if the Court rejected its submission on a tacit agreement, then an adjusted equidistance line would provide the basis for an alternative boundary. Honduras therefore referred to a provisional equidistance line drawn from a single pair of purported mainland base points without using any of the islands as base points.[39]

On this issue, the Court observed that because of the very active morphodynamism of the relevant area, "continued accretion at the Cape might render any equidistance line so constructed today arbitrary and unreasonable in the near future".[40] Furthermore, there were no viable base points claimed or accepted by the Parties themselves at Cape Gracias a Dios. According to the Court, whatever base points would be used for the drawing of an equidistance line, the configuration and unstable nature of the relevant coasts would make these base points uncertain within a short period of time. Given the set of circumstances, the Court considered that in the current case, it was impossible to identify base points and construct a provisional equidistance line for the single maritime boundary delimiting maritime areas off the Parties' mainland coasts. Hence the Court found itself within the exception provided for in Article 15 of the LOSC, namely facing special circumstances in which it cannot apply the equidistance principle.[41]

It followed that the Court must consider the applicability of the alternative methods claimed by the Parties. According to the Court,

> In instances where, as in the present case, any base points that could be determined by the Court are inherently unstable, the bisector method may be seen as an approximation of the equidistance method.[42]

In so stating, the Court found that the bisector method was to be applied in the present case. Unlike the equidistance method, this method relies on the macrogeography of a coastline as represented by a line drawn between two points on the coast. In the Court's view, a Honduran coastal front running to Punta Patuca and a Nicaraguan coastal front running to Wouhnta are the relevant coasts for the pur-

[38] Ibid., 74, para. 273. Concerning the bisector method, see in particular, Memorial submitted by Nicaragua, Vol. I, 95-144, paras. 20-43; Reply of Nicaragua, Vol. I, 180-187, paras. 9.6-9.34; Argument by Mr Brownlie, Verbatim Record, CR 2007/2, 10-43, paras. 1-147.

[39] Judgment, op. cit., note 2, 78, para. 286.

[40] Ibid., 75, para. 277.

[41] Ibid., 75-77, paras. 277-281.

[42] Ibid., 78, para. 287.

poses of drawing the bisector. It follows that the bisector line is an azimuth of 70° 14'41.25".[43]

2. Delimitation Around the Islands

The next issue concerns the delimitation around the islands in the disputed area. Nicaragua argued that these islands should be enclaved within only a 3 nautical mile territorial sea, since a full 12 nautical mile territorial sea would result in giving a disproportionate amount of the maritime areas in dispute to Honduras.[44] By rejecting this argument, the Court ruled that the Honduran islands of Bobel Cay, Savanna Cay, Port Royal Cay and South Cay shall be accorded a territorial sea of 12 nautical miles.[45] It follows that the territorial seas attributed to the Honduran islands and the Nicaraguan island of Edinburgh Cay would lead to an overlap in the territorial seas of the Parties.

Concerning the delimitation method applicable to the overlapped area, the Court referred to the *Qatar/Bahrain* case, which stated that:

> The most logical and widely practised approach is first to draw provisionally an equidistance line and then to consider whether that line must be adjusted in the light of the existence of special circumstances.[46]

Following the precedent, the Court applied the equidistance method in the delimitation of the territorial seas between the Parties. According to the Court,

> Delimiting of this relatively small area can be satisfactorily accomplished by drawing a provisional equidistance line, using co-ordinates for the above islands as the base points for their territorial seas […]. The Court does not consider there to be any legally relevant "special circumstances" in this area that would warrant adjusting this provisional line.[47]

Hence, as illustrated in Figure 2, the equidistance line became the delimitation line in this area.

3. Starting Point and Endpoint of the Maritime Boundary

The last issue related to the starting point and endpoint of the maritime boundary. Both Parties agreed that the appropriate starting point should be located 3 nautical miles seaward from the "mouth" of the River Coco; and that for the first 3 nautical miles a negotiated solution should be found. Yet there was no agreement from where on the River Coco these 3 nautical miles should be measured and in

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[43] Ibid., 81, para. 298. See Figure 1. The validity of the bisector method will be discussed in Part V.

[44] Judgment, op. cit., note 2, 83, para. 300. This is a response to the question posed by Judge Simma during the oral proceedings. Judge Simma's question was: "What are the reasons for the indication by Nicaragua of 3-mile territorial seas around these cays while both Parties to the present dispute in general claim 12-mile territorial seas?", Verbatim Record, CR 2007/12, 54.

[45] Judgment, op. cit., note 2, paras. 300-302.

[46] ICJ Reports 2001, 94, para. 176.

[47] Judgment, op. cit., note 2, para. 304.

what direction.[48] In this respect, the Court set, by fifteen votes to two, the starting-point 3 miles out to sea (15° 00' 52"N and 83° 05'58"W) from the point already identified by the 1962 Mixed Commission along the azimuth of the bisector.[49] The Court found, by sixteen votes to one, that the Parties must negotiate in good faith with a view to agreeing on the course of the delimitation line which links the end of the land boundary as fixed by the 1906 Award and the point of departure of the maritime delimitation in accordance with this judgment.[50]

By contrast, the Court did not specify the precise location of the endpoint, and merely stated that it extends beyond the 82nd meridian without affecting third-state rights.[51] Unlike the earlier case law in this field, no mention was made of the proportionality test, although Nicaragua argued this point.[52] Yet the Court did not clarify the reason for this omission. In conclusion, by fourteen votes to three, the Court drew the single maritime boundary as illustrated in Figure 3.[53]

III. The Applicability of the Equidistance Method in the Law of Maritime Delimitation: Analysis of the Previous Case Law

On the basis of the above description, the following Parts will examine the validity of the Court's argument with regard to the applicability of the equidistance method at the first stage of maritime delimitations in the *Nicaragua/Honduras* judgment. This issue should be addressed from the perspective of the development of jurisprudence relating to maritime delimitations. Thus, it will be appropriate to review the development of case law in this field.[54] There is no doubt that the equi-

[48] Ibid., 84, para. 307. On this issue, see Memorial submitted by Nicaragua, Vol. I, 75-86, paras. 1-30; Counter-Memorial submitted by Honduras, Vol. I, 136-137, paras. 7.9-7.14; 144-146, paras. 7.38-7.45; Reply of Nicaragua, Vol. I, 195-206, paras. 10.1-10.30; Rejoinder of Honduras, Vol. I, 125-127, paras. 8.02-8.06.

[49] Judgment, op. cit., note 2, 87, para. 311; 93, para. 321 (2).

[50] Ibid., 87, para. 311 and 94, para. 321 (4).

[51] Ibid., 90, para. 319.

[52] Reply of Nicaragua, Vol. I, 193, paras. 9.53-9.54; Argument by Mr Brownlie, Verbatim Record, CR 2007/5, 39-40, paras. 64-66; Argument by Mr Brownlie, Verbatim Record, CR 2007/12, 51-52, paras. 63-66. Concerning the concept of proportionality in the law of maritime delimitation, see Tanaka, op. cit., note 3, 161-183.

[53] Judgment, op. cit., note 2, 93, para. 321 (3). Yet the Court failed to specify a reference datum for the coordinates defining the single maritime boundary, although the illustrative maps annexed to the judgment are referred to WGS84. On this issue, see Pratt, op. cit., note 2, 38.

[54] On this issue, see Tanaka, op. cit., note 3, 51-126; L. Lucchini, La délimitation des frontières maritimes dans la jurisprudence internationale: vue d'ensemble, in: R. Lagoni/D. Vignes (eds.), Maritime Delimitation, Leiden/Boston 2006, 1-18; M.D. Evans, Maritime Boundary Delimitation: Where Do We Go From Here?, in: D. Freestone *et al.*, The Law of the Sea: Progress and Prospects, Oxford 2006, 137-160; D. Anderson, Developments in Maritime Boundary Law and Practice, in: D.A. Colson/R.W. Smith (eds.), International Maritime Boundaries, Vol. V, Leiden/Boston 2005, 3205-3209.

table principles as customary law are at the heart of the law of maritime delimitation. Nevertheless, the existing case law demonstrates that the approach to the principles is changing with the passage of time; and that the applicability of the equidistance method at the first stage of maritime delimitations is a fundamental issue underlying the change in approach. The development of the law of maritime delimitation can be divided into two phases: the first phase (1969-1992) and the second phase (1993-present).

A. The First Phase: Case Law relating to Maritime Delimitations between 1969 and 1992

1. Genesis of the Two Approaches to the Equitable Principles

It is common knowledge that the ICJ, in the *North Sea Continental Shelf* cases of 1969, did not admit the mandatory character of the equidistance method. The Court rejected the existence of any obligatory method of continental shelf delimitation, asserting that "there [is] no other single method of delimitation the use of which is in all circumstances obligatory".[55] According to the Court, "it is necessary to seek not one method of delimitation, but one goal".[56] Thus, the Court indicated solely the factors to be taken into account in a negotiation, without specifying a concrete method.[57] In the Court's view, it is the goal which should be stressed, and the law of maritime delimitation should be defined only by this goal, i.e., the achievement of equitable results. In this sense, one could speak of a result-oriented-equity approach.[58]

On the other hand, the Arbitral Tribunal, in the *Anglo-French Continental Shelf* case of 1997, followed a line of argument different from that adopted in the *North Sea Continental Shelf* judgment. First, unlike ICJ in the *North Sea Continental Shelf* cases, the Court of Arbitration equated Article 6 of the 1958 Geneva Convention on the Continental Shelf, as a single combined equidistance-special circumstances rule, to the customary law of equitable principles.[59] On the basis of this interpretation, secondly, the Court of Arbitration applied the equidistance method with modification. Specifically, in the Atlantic region, where Article 6 was applica-

[55] ICJ Reports 1969, 53, para. 101. See also, 49, para. 90.

[56] Ibid., 50, para. 92.

[57] Such factors are the general configuration of the coasts of the Parties, the physical and geological structure, the natural resources, the unity of deposits, and a reasonable degree of proportionality. Ibid., 53-54, para. 101.

[58] However, it must be remembered that several judges harboured misgivings about the Court's approach to the equitable principles because of the lack of any specific method of delimitation. See Dissenting Opinion of Judge Tanaka, ibid., 195-196; Separate Opinion of Judge Ammoun, ibid., 145, para. 45; 132, para. 32.

[59] The *Anglo-French Continental Shelf* case, 18 United Nations, Reports of International Arbitral Awards, 45, para. 70.

ble, the Court of Arbitration considered that a strict application of the equidistance method would tend to produce inequitable results.[60] However, the Court did not consider that the existence of a special circumstance gave it "carte blanche to employ any method that it [chose] in order to effect an equitable delimitation of the continental shelf".[61] It said that:

> The Court notes that in a large proportion of the delimitations known to it, where a particular geographical feature has influenced the course of a continental shelf boundary, the method of delimitation adopted has been some modification or variant of the equidistance principle rather than its total rejection. […] [I]t seems to the Court to be in accord not only with the legal rules governing the continental shelf but also with State practice to seek the solution in a method modifying or varying the equidistance method rather than to have recourse to a wholly different criterion of delimitation.[62]

Thus, the Court of Arbitration accepted the applicability of the equidistance method as a starting point, even where a particular geographical element exists in a situation of lateral delimitation.[63] In so doing, the Court of Arbitration considered equity to be a corrective element. One may call this the corrective-equity approach. According to this approach, the equidistance method is applied at the first stage of delimitation, and then a shift of the equidistance line may be envisaged if relevant circumstances warrant it. It could thus be contended that the arbitral award set another starting point for the case law in this field. In summary, based on the equitable principles, two different approaches appeared in the 1969 and 1977 decisions.

2. Predominance of the Result-Oriented Equity Approach

Later on, the result-oriented equity approach was strongly supported by the 1982 *Tunisia/Libya* judgment. The essence of the ICJ's approach can be seen in the following passage of this judgment:

> The result of the application of equitable principles must be equitable. [...] It is, however, the result which is predominant; the principles are subordinate to the goal. The equitableness of a principle must be assessed in the light of its usefulness for the purpose of arriving at an equitable result.[64]

Thus the Court accepted neither the mandatory character of equidistance, nor some privileged status of equidistance in relation to other methods.[65] According to the Court's approach, the application of the equitable principles would be broken

[60] In this region, the Scilly Isles constituted a special circumstance, ibid., 114, paras. 244-245.

[61] Ibid., para. 245.

[62] Ibid., 116, para. 249.

[63] The Court took into account the fact that, in the Atlantic region, Article 6 was applicable. Yet, as Article 6 is the particular expression of a customary law of equitable principles, the result would be the same as if customary law had been applied.

[64] ICJ Reports 1982, 59, para. 70.

[65] Ibid., 79, para. 110.

down into relevant circumstances in specific situations, ruling out any predetermined method.[66]

The result-oriented-equity approach was echoed by the Chamber of the ICJ in the *Gulf of Maine* case relating to the delimitation of a single maritime boundary (1984). In this case, the Chamber pronounced a "fundamental norm" applicable to every maritime delimitation between neighbouring States. The first norm is that maritime delimitation must be sought and effected by means of an agreement in good faith. The second norm is:

> (2) In either case, delimitation is to be effected by the application of equitable criteria and by the use of practical methods capable of ensuring, with regard to the geographic configuration of the area and other relevant circumstances, an equitable result.[67]

The second part of the fundamental norm includes three elements: (i) equitable criteria; (ii) a practical method; (iii) an equitable result. In this formulation, "an equitable result" should be achieved by resort to "equitable criteria" and a "practical method". According to the Chamber, there has been no systematic definition of equitable criteria because of their highly variable adaptability to different concrete situations.[68] Thus "equitable criteria" are excluded from the legal domain. According to the Chamber,

> [T]he criteria in question are not themselves rules of law and therefore mandatory in the different situations, but 'equitable', or even 'reasonable', criteria, and that what international law requires is that recourse be had in each case to the criterion, or the balance of different criteria, appearing to be most appropriate to the concrete situation.[69]

The same is true regarding the "practical method," since the latter would be selected on a case-by-case basis, relying on actual situations.[70] It follows that according to the Chamber, the law defines neither the equitable criteria nor the practical method, simply advancing the idea of "an equitable result".[71]

The full Court, in the *Libya/Malta* case of 1985, also stressed the result to be achieved, not the means to be applied, by stating that: "[i]t is however the goal – the equitable result – and not the means used to achieve it, that must be the primary element in this duality of characterization."[72] At the stage of establishing the

[66] Judge Jiménez de Aréchaga clearly advocated this view. Separate Opinion of Judge Jiménez de Aréchaga, ibid., 106, para 24. By contrast, several judges criticized the Court's approach, because this approach would blur the distinction between decisions based on equitable principles as law and those taken *ex aequo et bono*. See Dissenting Opinion of Judge Evensen, ibid., 294, para. 14; 291, para. 12. Thus Judge Evensen was supportive of the corrective-equity approach. Ibid., 296, para. 15. See also Dissenting Opinion of Judge Gros, ibid., 149, para. 12; Dissenting Opinion of Judge Oda, ibid., 270-271, paras. 182-184.

[67] ICJ Reports 1984, 299-300, para. 112.

[68] Ibid., 312, para. 157.

[69] Ibid., 313, para. 158.

[70] Ibid., 315, paras. 162-163.

[71] However, Judge Gros criticized the Chamber's approach, by stating that "this [was] closer to subjectivism than to the application of law to the facts with a view to the delimitation of maritime areas". Dissenting Opinion of Judge Gros, ibid., 377, para. 26.

[72] ICJ Reports 1985, 38-39, para. 45.

continental shelf boundary, however, the Court accepted the application of the equidistance method.[73] Thus the Court applied the equidistance method as a first provisional step, and the equidistance line was adjusted in a second stage on account of relevant circumstances. In so doing, the Court adopted the corrective-equity approach for the delimitation of opposite coasts at the operational stage. This shows a clear contrast to the *Tunisia/Libya* case, in which the equidistance method was completely discarded. It may be said that the *Libya/Malta* judgment has a hybrid character in the sense that two approaches were used.

The result-oriented approach was echoed by the two arbitral awards. In fact, the Arbitral Tribunal, in the *Guinea/Guinea-Bissau* case of 1985, ruled that: "They [the factors and methods] are not restricted in number and none of them is obligatory for the Tribunal, since each case of delimitation is a unicum, as has been emphasised by the International Court of Justice."[74] Similarly, the Court of Arbitration, in the *St. Pierre and Miquelon* case (1992), held that the delimitation should "be effected in accordance with equitable principles, or equitable criteria, taking account of all the relevant circumstances, in order to achieve an equitable result. The underlying premise of this fundamental norm is the emphasis on equity and the rejection of any obligatory method."[75] Overall it can be observed that between 1969 and 1992, international courts and tribunals basically took the result-oriented-equity approach.

B. The Second Phase: Case Law relating to Maritime Delimitation between 1993 and 2007

1. The *Greenland/Jan Mayen* Case as a Turning Point

Nonetheless, the law of maritime delimitation was to change radically toward the corrective-equity approach. A turning point was the *Greenland/Jan Mayen* judgment of 1993. In the *Greenland/Jan Mayen* dispute, there was no agreement on a single maritime boundary, and, thus, the Court was "not empowered – or constrained – by any such agreement for a single dual-purpose boundary".[76] Accordingly, the law applicable to the continental shelf and to the Fishery Zone must be examined separately.

Concerning the continental shelf, the applicable law was Article 6 of the 1958 Convention on the Continental Shelf which both Parties had ratified. The Court equated Article 6 with customary law by relying on a passage of the 1977 award of

[73] Ibid., 47, para. 62.

[74] 25 ILM (1986), 251-307, 289-90, para. 89. Underline in the original. The French text is the authentic one. See Award of 14 February 1985, 89 RGDIP (1985), 484-537.

[75] The *St. Pierre and Miquelon* case, 31 ILM (1992), 1163, para. 38.

[76] The *Greenland/Jan Mayen* case, ICJ Reports 1993, 57, para. 43; 42-43, para. 9.

the Court of Arbitration in the *Anglo-French Continental Shelf* case.[77] For the Court,

> [I]n respect of the continental shelf boundary in the present case, even if it were appropriate to apply, not Article 6 of the 1958 Convention, but customary law concerning the continental shelf as developed in the decided cases, it is in accord with precedents to begin with the median line as a provisional line and then to ask whether "special circumstances" require any adjustment or shifting of the line.[78]

Considering the fact that the Court had rejected Article 6 as customary law, this represents a turning point in terms of the relationship between treaty law and customary law. According to this interpretation, the equidistance method is incorporated into customary law.

With respect to law applicable to the Fishery Zone, the Court equated the customary law applicable to the FZ with that governing the EEZ on the basis of the agreement of the Parties.[79] The next issue is the relation between the law applicable to the FZ and that governing the continental shelf. The Court, referring to the *Gulf of Maine* and the *Libya/Malta* cases, ruled that:

> It thus appears that, both for the continental shelf and for the fishery zones in this case, it is proper to begin the process of delimitation by a median line provisionally drawn.[80]

Furthermore, quoting the *Anglo-French* arbitral award, the Court held that:

> It cannot be surprising if an equidistance-special circumstances rule produces much the same result as an equitable principles-relevant circumstances rule in the case of opposite coasts, whether in the case of a delimitation of continental shelf, of fishery zone, or of an all-purpose single boundary.[81]

Thus the Court assimilated the law of continental shelf delimitation with that of the FZ at the customary law level.

In summary, the Court attempted to achieve assimilation at three levels: (i) the assimilation of Article 6 of the Convention on the Continental Shelf to customary law; (ii) assimilation between the law applicable to the EEZ delimitation and that governing the FZ delimitation in customary law; and (iii) the assimilation of customary law for the continental shelf delimitation and for an EEZ/FZ delimitation. The Court's view is significant in the sense that so far as the coasts face each other, the law of maritime delimitation is to be unified under a triple rule of "agreement-equidistance-special circumstances". Consequently, the equidistant (median) line is to be drawn at a first stage, and relevant circumstances are to be considered at a second stage. Thus, for the first time in the case law of the ICJ, the corrective-equity approach was adopted as customary law. On the basis of this approach,

[77] Ibid.

[78] Ibid., 61, para. 51.

[79] Ibid., 59, para. 47.

[80] Ibid., 62, para. 53.

[81] Ibid., para. 56.

the Court drew a coincident maritime boundary for the continental shelf and the FZ.

2. Development of the Corrective-Equity Approach

The Court's approach in the *Greenland/Jan Mayen* case was echoed by the *Eritrea/Yemen* arbitration (the Second Phase) of 1999.[82] The view of the Tribunal is worth quoting in full:

> It is a generally accepted view, as is evidenced in both the writings of commentators and in the jurisprudence, that between coasts that are opposite to each other the median or equidistance line normally provides an equitable boundary in accordance with the requirements of the Convention, and in particular those of its Articles 74 and 83 which respectively provide for the equitable delimitation of the EEZ and of the continental shelf between States with opposite or adjacent coasts.[83]

Thus the Tribunal decided that:

> [T]he international boundary shall be a single all-purpose boundary which is a median line and that it should, as far as practicable, be a median line between the opposite mainland coastlines. This solution is not only in accord with practice and precedent in the like situations but is also one that is already familiar to both Parties.[84]

Hence the Tribunal expressly ruled that, so far as the maritime delimitation between States with opposite coasts was concerned, a median or an equidistance line would provide an equitable maritime boundary under Articles 74 and 83 of the LOSC. At the same time, it should be stressed that the Tribunal did not consider a median line as the end product. Indeed, the Tribunal applied a proportionality test to examine the equitableness of the median line drawn by it. This means that if there is disproportionality, such a line should be modified, which will lead to the corrective-equity approach.

The corrective-approach was further promoted by the ICJ in the *Qatar/Bahrain* dispute of 2001. This dispute simultaneously included the delimitation of both territorial sea and single maritime boundaries. Neither Bahrain nor Qatar was a party to the 1958 Geneva Conventions on the Law of the Sea. While Bahrain had ratified the 1982 LOSC, Qatar was only a signatory to it. Thus, it was customary law which was applicable to this case.[85] Concerning the law applicable to territorial sea delimitation, the Court held that Article 15 of the LOSC was to be regarded as having a customary character. In this respect, the Court clearly adopted the corrective-equity approach for a territorial sea delimitation.[86] Concerning the law appli-

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[82] For the text of the *Eritrea/Yemen* arbitration (the Second Phase), 40 ILM (2001), 983-1013. Concerning the commentary on this arbitration, see Y. Tanaka, Reflections on the *Eritrea/Yemen* Arbitration of 17 December 1999 (Second Phase: Maritime Delimitation), 48 NILR (2001), 197-225.

[83] The *Eritrea/Yemen* arbitration (the Second Phase), op. cit., note 82, 1005, para. 131.

[84] Ibid., para. 132.

[85] ICJ Reports 2001, 91, para. 167. It should be noted that both Parties agree that most of the provisions of the 1982 Convention which are relevant for the present case reflect customary law. Ibid.

[86] Ibid., 94, para. 176.

cable to a single maritime boundary, it should be recalled that customary law was applicable in the northern sector. Referring to the approach taken by the *Greenland/Jan Mayen* case, i.e., the corrective-equity approach, the Court in the *Qatar/Bahrain* case clearly stated that it would follow the same approach in the present case.[87] In this regard, it is important to note that in the area where a single maritime boundary was to be drawn, "the coasts of the two States [were] rather comparable to adjacent coasts".[88] Accordingly, the ICJ explicitly accepted, for the first time in the case law of the Court, the applicability of the corrective-equity approach as customary law in the delimitation between States with adjacent coasts.[89] Moreover, the Court noted that:

> [T]he equidistance/special circumstances rule, which is applicable in particular to the delimitation of the territorial sea, and the equitable principles/relevant circumstances rule, as it has been developed since 1958 in case law and State practice with regard to the delimitation of the continental shelf and the exclusive economic zone, are closely interrelated.[90]

This appears to suggest assimilation between the law applicable to a territorial sea delimitation and a single maritime boundary delimitation.

The ICJ, in the *Cameroon/Nigeria* case, broke new ground by applying the corrective-equity approach under Articles 74 and 83 of the LOSC. With respect to the law applicable to the maritime delimitation, both Cameroon and Nigeria were Parties to the LOSC.[91] Accordingly, the relevant provision, in particular Articles 74 and 83 of the Convention, was applicable to the maritime delimitation.[92] In this regard, the Court took the following interpretation:

> They are expressed in the so-called equitable principles/relevant circumstances method. This method, which is very similar to the equidistance/special circumstances method applicable in delimitation of the territorial sea, involves first drawing an equidistance line, then considering whether there are factors calling for the adjustment or shifting of that line in order to achieve an "equitable result".[93]

On the basis of the *Greenland/Jan Mayen* and *Qatar/Bahrain* cases where the corrective-equity approach was applied, the Court explicitly stated that it would "apply the same method in the present case".[94] Hence, the corrective-equity approach was applied in the *Cameroon/Nigeria* case. It is worth noting that the

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87 Ibid., 111, para. 230. In this regard, the Court held that "it will first provisionally draw an equidistance line and then consider whether there are circumstances which must lead to an adjustment of that line". Ibid.

88 Ibid., 91, para. 170.

89 Y. Tanaka, Reflections on Maritime Delimitation in the *Qatar/Bahrain* Case, 52 ICLQ (2003), 76-77.

90 ICJ Reports 2001, 111, para. 231.

91 Cameroon ratified the UN Convention on the Law of the Sea on 19 November 1985 and Nigeria ratified the Convention on 14 August 1986.

92 Judgment, ICJ Reports 2002, 440, para. 285. See also Memorial of Cameroon, 533-34, para. 5.75-5.78; argument by Mr Kamto, Verbatim Record, CR 2002/22, 43, para. 24.

93 The Judgment, ICJ Reports 2002, 441, para. 288.

94 Ibid., 442, para. 290.

Court applied the corrective-equity approach under Articles 74 and 83 of the LOSC.[95] According to the Court's interpretation, a specific method, i.e. the equidistance method, should be incorporated into Articles 74 and 83.

3. Two Arbitral Awards in 2006 and 2007

The corrective-equity approach was also applied by the *Barbados/Trinidad and Tobago* arbitration of 2006 and the *Guyana/Suriname* arbitration of 2007. In the *Barbados/Trinidad and Tobago* arbitration, the Arbitral Tribunal ruled:

> The determination of the line of delimitation thus normally follows a two-step approach. First, a provisional line of equidistance is posited as a hypothesis and a practical starting point. While a convenient starting point, equidistance alone will in many circumstances not ensure an equitable result in the light of the peculiarities of each specific case. The second step accordingly requires the examination of this provisional line in the light of relevant circumstances, which are case specific, so as to determine whether it is necessary to adjust the provisional equidistance line in order to achieve an equitable result.[96]

In relation to this, the Arbitral Tribunal stated that: "While no method of delimitation can be considered of and by itself compulsory, and no court or tribunal has so held, the need to avoid subjective determinations requires that the method used start with a measure of certainty that equidistance positively ensures, subject to its subsequent correction if justified."[97] The first part of this sentence does not coincide with the previous case law because the ICJ confirmed the application of the equidistance method at the first stage of the delimitation process under Articles 74 and 83 of the LOSC as well as customary law. To this extent, it would appear that the *Barbados/Trinidad and Tobago* award was still affected by the result-oriented-equity approach advocated in case law at the early stage. Even so, it is worth noting that the Arbitral Tribunal adopted the corrective-equity approach in the operation of maritime delimitation.

The *Guyana/Suriname* arbitration of 2007 reflected the corrective-equity approach more clearly. With respect to the law applicable to the delimitation of the territorial seas, the Tribunal ruled that Article 15 of the Convention places primacy on the median line as the delimitation line between the territorial seas between opposite or adjacent States.[98] The Tribunal then examined special circumstances

[95] Y. T a n a k a, Reflections on Maritime Delimitation in the *Cameroon/Nigeria* Case, 53 ICLQ (2004), 388-390.

[96] The *Barbados/Trinidad and Tobago* arbitration, para. 242. The text of the Award is available at the home page of the Permanent Court of Arbitration. <http://www/pca-cpa.org>. For an overview of this award, see Y. T a n a k a, Award of the Arbitral Tribunal Constituted Pursuant to Article 287, and in Accordance with Annex VII, of the UN Convention on the Law of the Sea: the Barbados and the Trinidad and Tobago Case (11 April 2006), 21 IJMCL (2006), 523-534; B. K w i a t k o w s k a, The 2006 Barbados/Trinidad and Tobago Award: a Landmark in Compulsory Jurisdiction and Equitable Maritime Boundary Delimitation, 22 IJMCL (2007), 7-60.

[97] The *Barbados/Trinidad and Tobago* arbitration, op. cit., note 96, para. 306.

[98] The *Guyana/Suriname* arbitration, op. cit., note 1, 93, para. 296.

which might require the adjustment of the equidistance line, and ruled that special circumstances of navigation may justify deviation from the median (equidistance) line. The delimitation of the continental shelf and EEZ in the present case is governed by Articles 74 and 83 of the LOSC. In this respect, the Tribunal ruled that:

> In the course of the last two decades international courts and tribunals dealing with disputes concerning the delimitation of the continental shelf and the exclusive economic zone have come to embrace a clear role for equidistance.[99]

The Tribunal further stated that in addition to maritime delimitation between opposite coasts, the presumption in favour of equidistance applied in maritime delimitations between States with adjacent coasts.[100] Thus the Tribunal took the corrective-equity approach, by stating that:

> The case law of the International Court of Justice and arbitral jurisprudence as well as State practice are at one in holding that the delimitation process should, in appropriate cases, begin by positing a provisional equidistance line which may be adjusted in the light of relevant circumstances in order to achieve an equitable solution. The Tribunal will follow this method in the present case.[101]

Having examined whether there were relevant circumstances which might justify departure from the provisional equidistance line, the Arbitral Tribunal held that there were no such circumstances. The Tribunal therefore concluded that the equidistance line should be the delimitation line of the continental shelf and the EEZ between the Parties.[102]

4. Summary

In summary, it may be observed that in broad perspective, the law of maritime delimitation has developed from the co-existence of the two approaches toward the unification of the corrective-equity approach. The unification of the law can be seen at four levels:[103]

(i) The interpretation of treaties: the unification of the interpretation of Article 6 of the 1958 Geneva Convention on the Continental Shelf and that of Article 83 of the 1982 LOSC;

(ii) Sources of the law: the unification between customary law and treaty law in the field of maritime delimitation;

(iii) Maritime spaces: the unification of the law applicable to the delimitation of the territorial sea, the continental shelf and the EEZ.

(iv) The configuration of the coast: the unification of the law applicable to delimitation between States with adjacent coasts, and those with opposite coasts.

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99 Ibid., 108, para. 335.

100 Ibid., 109, para. 338.

101 Ibid., 110, para. 342.

102 Ibid., 127, para. 392.

103 Y. Tanaka, Quelques observations sur deux approches jurisprudentielles en droit de la délimitation maritime: l'affrontement entre prévisibilité et flexibilité, Revue Belge de Droit International (2004), 454. See also Anderson, op. cit., note 54, 3209.

The unification of the law of maritime delimitation under the corrective-equity approach would be significant with a view to enhancing the normative level of the law of maritime delimitation. Indeed, from a normative viewpoint, the result-oriented-equity approach is problematic for three main reasons.[104]

The first problem is its excessive subjectivity. Without any objective criteria for judging equitableness, the result-oriented equity approach runs the risk of producing legal impressionism. An unlimited discretion for the Court would lead not only to a fragmentation of the law of maritime delimitation, but would also equate the result of its application with a decision *ex aequo et bono*.

The second problem is unpredictability. With the result-oriented approach, it is the specific factors characterising any given individual situation which define the equitable result. Consequently, the appreciation of equity is defined by each of the factors of any given case and this makes it difficult to form predictable rules of maritime delimitation. This is contrary to an essential requirement of law: certainty and predictability. As an essential condition, the law of maritime delimitation should have a degree of predictability beyond the reliance on the particular circumstances of each case. Over-individualisation prevents this by undermining the certainty and predictability of law.[105]

Third, the result-oriented equity approach is nothing but a truism.[106] The problem is that of determining which rules of international law should be applied in order to achieve an equitable result.[107] In fact, the point disputed between the Parties is the concrete method to be applied for maritime delimitations. According to the result-oriented equity approach, however, such criteria and methods are considered as outside the realm of law. In sum, because of its excessive subjectivity and unpredictability, the result-oriented equity approach carries the danger of undermining the normativity of the law of maritime delimitation.[108]

By contrast, the important advantage of the corrective-equity approach is that it has a certain degree of predictability by incorporating a specific method of delimitation, i.e., the equidistance method, into the legal domain. According to the corrective-equity approach, a consideration of equity may come into play at a second stage, but only in cases in which equidistance lines provisionally drawn produce

[104] T a n a k a , op. cit., note 3, 123-125.

[105] It is of particular interest to note that in the *Libya/Malta* case, Malta argued that "an excessive individualisation of the rule of law, which changes from one case to another, would be incompatible with the very concept of law". Pleadings, Vol. II, 293, para. 111.

[106] According to Judge O d a , the equitable principles under this approach are merely "the principle of non-principle", Dissenting Opinion of Judge O d a in the *Tunisia/Libya* case, ICJ Reports 1982, 157, para. 1.

[107] Ibid., 255, para. 155.

[108] P. W e i l , Perspective du droit de la délimitation maritime, Paris 1988, 174-75. See also by the same author, Le droit international en quête de son identité, Cours général de droit international public, 237 RCADI (1992), 245-60; and L'équité dans la jurisprudence de la Cour internationale de Justice: Un mystère en voie de dissipation?, in: V. Lowe/M. Fitzmaurice (eds.), Fifty Years of the International Court of Justice, Essays in Honour of Sir Robert Jennings, Cambridge 1996, 121-44.

inequitable results. To this extent, the corrective-equity approach makes it possible to reduce the subjectivity and unpredictability of equitable principles.

IV. Questions Concerning the Court's View on the Equidistance Method in the *Nicaragua/Honduras* Case

A. The Court's View Concerning Instability of Basepoints

Although the ICJ, in the *Nicaragua/Honduras* dispute, applied the equidistance method to delimitation around the islands in the disputed area, the Court precluded the application of this method in delimitation of the other overlapping area. In so doing, the Court took the view that the application of the equidistance method at the first stage of maritime delimitations is not obligatory, even though "equidistance remains the general rule".[109] As explained earlier, an essential reason for rejecting the use of the equidistance method in the *Nicaragua/Honduras* judgment related to the instability of the basepoints. Accordingly, a question arises whether or not this can be a decisive reason to exclude the equidistance method in the process of maritime delimitation. In this regard, it would appear that the majority opinion is not free from controversy.

First, as suggested by Judge Ranjeva and Judge *ad hoc* Torres Bernárdez, it would appear that the difficulty in the instability of basepoints is not insurmountable.[110] In fact, during the oral proceedings, Honduras showed its provisional equidistance line.[111] Similarly, in relation to the seaward starting point, Nicaragua argued that: "The proposed starting line would be located at a point along that median line direction situated 3 nautical miles out to sea from the mouth of the Coco River."[112] In its Reply, Nicaragua further explained that: "This point [...] represents an approximate median line and the sector produced by this method is coincident with the alignment resulting from the bisector method [...]."[113] It would seem to follow that the seaward fixed starting-point proposed by Nicaragua arose from the application of the equidistance method. In fact, Nicaragua attached an il-

[109] Judgment, op. cit., note 2, 77, para. 281.

[110] Separate Opinion of Judge Ranjeva in the *Nicaragua/Honduras* case, ibid., 3, para. 10 (electronic text); Dissenting Opinion of Judge Torres Bernárdez, ibid., 30, para. 128.

[111] Argument by Mr Colson, Verbatim Record, CR 2007/10, 24-28, paras. 123-141. The equidistance line proposed by Honduras was constructed on the basis of Bobel Cay, Port Royal Cay and South Cay on the Honduran side, and Edinburgh Cay and Edinburgh Reef on the Nicaraguan side. The first segment of the provisional equidistance line extends in an east-south-east direction from the mainland to a point which is a trijunction point that is equally distant from Bobel Cay, Edinburgh Cay and the point fixed by the 1962 Mixed Commission, ibid., 25, para. 127 and 26, para. 132. See also Judgment, op. cit., note 2, 75, para. 276; 78, para. 285.

[112] Memorial submitted by Nicaragua, Vol. I, 83, para. 23.

[113] Reply of Nicaragua, 197, para. 10.5.

lustration identifying an approximate median line in its Memorial.[114] During the oral proceedings, Nicaragua also showed its provisional median line dividing Nicaraguan and Honduran waters.[115] Hence it appeared to be possible to draw a provisional equidistance line in the *Nicaragua/Honduras* case.

Second, it must be noted that Article 7 (2) of the LOSC does envisage the problem of shifting coastlines:[116]

> Where because of the presence of a delta and other natural conditions the coastline is highly unstable, the appropriate points may be selected along the furthest seaward extent of the low-water line and, notwithstanding subsequent regression of the low-water line, the straight baselines shall remain effective until changed by the coastal State in accordance with this Convention.

Where, as the Court stated, the configuration of the coastlines of Nicaragua and Honduras is highly unstable, it appears that Article 7 (2) would have provided a solution for identifying reliable basepoints.[117] This provision explicitly recognizes that the straight baselines remain effective notwithstanding changes in the coastline. It would follow that a delimitation line on the basis of the baselines shall also remain effective.

Third, the impact of changes in coastline upon maritime boundaries should not be exaggerated. In reality, the configuration of coastlines is more or less changeable owing to erosion, accretion, and sea-level rise resulting from global warming. Considering the requirement for stability of maritime boundaries, however, it is arguable that in principle, changes in basepoints or baselines resulting from natural causes will not affect maritime boundaries already established between States concerned, unless those States agree otherwise.[118] It must also be remembered that un-

[114] Memorial submitted by Nicaragua, 197.

[115] Argument by Mr Brownlie, Verbatim Record, CR 2007/12, 45, paras. 28-30.

[116] Separate Opinion of Judge Ranjeva in the *Nicaragua/Honduras* case, op. cit., note 2, 2, para. 7. See also Dissenting Opinion of Judge Torres Bernárdez, ibid., 30, para. 131. With respect to Article 7 (2) of the LOSC, see S. McDonald/V. Prescott, Baselines along Unstable Coasts: An Interpretation of Article 7 (2), 8 Ocean Yearbook (1990), 70-89; V. Prescott/E. Bird, The Influence of Rising Sea Levels on Baselines from Which National Maritime Claims are Measured and an Assessment of the Possibility of Applying Article 7 (2) of the 1982 Convention on the Law of the Sea to Offset Any Retreat of the Baseline, International Boundaries and Boundary Conflict Resolution, Proceedings of the IBRU Conference held at the University of Durham 14-17 September 1989 (International Boundaries Research Unit, University of Durham, 1989), 279-300.

[117] Dissenting Opinion of Judge Torres Bernárdez in the *Nicaragua/Honduras* case, op. cit., note 2, 30, para. 131; 36, para. 161.

[118] Professor Soons has examined the question whether changes in basepoints or baselines resulting from sea level rise may affect existing maritime boundaries, and answered in the negative. A.H.A. Soons, The Effects of a Rising Sea Level on Maritime Limits and Boundaries, 37 NILR (1990), 226-229. The answer will be the same with respect to changes in basepoints resulting from erosion or accretion. In practice, for instance, Article 3 (3) of the 2000 Agreement on the Delimitation of the Territorial Sea, Exclusive Economic Zone and Continental Shelf in the Beibu Gulf (Gulf of Tonkin) between the People's Republic of China and the Socialist Republic of Vietnam makes clear that no topographical change shall change the demarcation line for the territorial seas of the two countries unless otherwise agreed by the Parties. For the text of the Agreement, see Colson/Smith, op. cit., note 54, 3755-3758.

der Article 62 (2) of the Vienna Convention on the Law of Treaties, treaties establishing a boundary – which must be deemed to include treaties establishing maritime boundaries – are excluded from invocation of a fundamental change of circumstances.[119] For the same reasons, boundaries established through international adjudication will not be affected by subsequent changes in the configuration of the coasts.[120]

Fourth, the Court appeared to consider that an equidistance line may automatically become "arbitrary and unreasonable" if the location of the basepoints was changed because of the shift of coastlines. If this is the case, the equitableness of an equidistance line will rely solely on the choice of the basepoints. However, it should be noted that the equitableness of a provisional equidistance line must be envisaged by taking all relevant circumstances into account. Having constructed a provisional equidistance line, the international courts and tribunals are required to examine whether there are any circumstances which necessitate its adjustment. Where an equidistance line was established as a maritime boundary by international courts and tribunals, the line was considered as equitable in relation to all relevant circumstances. Should an equidistance line today be equitable with regard to all relevant circumstances, it is arguable that the shift of coastlines alone will not automatically make the equidistance line inequitable.[121]

Fifth, the Court stated that "the pair of base points to be identified on either bank of the River Coco at the tip of the Cape would assume a considerable dominance in constructing an equidistance line".[122] However, as Judges Ranjeva and Torres Bernárdez pointed out, it is inconceivable that the use of a single pair of base points would become an obstacle requiring a complete rejection of the application of the equidistance line.[123] In fact, the Court, in the *Cameroon/Nigeria* case, constructed the equidistance line on the basis of only two points of the mouth of the Akwayafe and Cross Rivers, West Point and East Point, as determined on the 1994 edition of British Admiralty Chart 3433.[124] Accordingly, it may be argued that the limited number of base points cannot be a decisive factor for one to discard the application of the equidistance line at the first stage of maritime delimitation.

[119] Soons, op. cit., note 118, 228.
[120] Ibid., 229.
[121] I am obliged to Professor Hugh Thirlway for drawing my attention to this point.
[122] Judgment, op. cit., note 2, 75, para. 277.
[123] Separate Opinion of Judge Ranjeva in the *Nicaragua/Honduras* case, ibid., 3-4, para. 10; Dissenting Opinion of Judge Torres Bernárdez, ibid., 30, para. 132. See also Argument by Mr Quéneudec, Verbatim Record, CR 2007/14, 24-29, paras. 1-25.
[124] ICJ Reports 2002, 443, para. 292.

B. Inter-Linkage between Legal Title and the Delimitation Method

The next issue relates to whether the equidistance method should be applied at the first stage of maritime delimitations as a legal obligation. In this respect, the Court, in the *Nicaragua/Honduras* case, ruled that:

> [T]he equidistance method does not automatically have priority over other methods of delimitation and, in particular circumstances, there may be factors which make the application of the equidistance method inappropriate.[125]

However, it would appear that this view is not free from controversy. The issue should be examined in connection with the legal title over marine spaces. The *Libya/Malta* case concerning the delimitation of the continental shelf provides an important insight into this. In this case, the full Court made two important points.

First, the Court accepted that the distance criterion constitutes the common legal title for both the continental shelf and the EEZ. In the Court's view,

> [T]he institution of the exclusive economic zone, with its rule on entitlement by reason of distance, is shown by the practice of States to have become a part of customary law. […] Although there can be a continental shelf where there is no exclusive economic zone, there cannot be an exclusive economic zone without a corresponding continental shelf. It follows that for juridical and practical reasons, the distance criterion must now apply to the continental shelf as well as the exclusive economic zone.[126]

Accordingly, "at least in so far as those areas are situated at a distance of under 200 miles from the coasts in question, title depends solely on the distance from the coasts of the claimant States of any areas of sea-bed claimed by way of continental shelf".[127]

Second, the Court supported the existence of a link between the legal title and a method of delimitation by saying that:

> The criterion is linked with the law relating to a State's legal title to the continental shelf. [...] It therefore seems logical to the Court that the choice of the criterion and the method which it is to employ in the first place to arrive at a provisional result should be made in a manner consistent with the concepts underlying the attribution of legal title.[128]

For the Court,

> [T]he legal basis of that which is to be delimited cannot be other than pertinent to the delimitation.[129]

Having examined the equities of the distance criterion and of the results of its application, the Court affirmed the validity of the approach consisting in tracing a median line at the provisional stage.[130]

125 Judgment, op. cit., note 2, 74, para. 272.
126 ICJ Reports 1985, 33, para. 34.
127 Ibid., 35, para. 39.
128 Ibid., 46-47, para. 61.
129 Ibid., 34, para. 34.
130 Ibid., 47, para. 62.

In the present writer's view, as the Court itself ruled, there seems to be a general sense that the method of delimitation should be connected to the legal title. For instance, Weil explicitly advanced the view, by saying that:

> [I]l est tout aussi évident, faut-il le rappeler, que la délimitation est étroitement liée à la base juridique du titre. La délimitation ne peut pas être comprise en dehors du titre; elle est fille du titre.[131]

Lucchini and Voelckel echoed this view, by stating that:

> Le titre est, en effet, l'élément fondamental de base. La délimitation ne peut avoir lieu qu'à partir de lui et en s'appuyant sur lui.[132]

Since the legal title over maritime spaces is attributed by virtue of distance, it is logical that the method of delimitation should reflect this element. The criterion of distance is spatial in nature. Equidistance is the only method which reflects the spatial nature of the distance criterion, for it comes nearest to an equal division of overlapping area by relying on the distance from the coasts.[133] Should a method of delimitation be combined with the distance criterion, it is arguable that the equidistance method should logically be singled out. Currently, as the Court ruled in the *Libya/Malta* case, there is no doubt that the distance criterion as the common legal title for the continental shelf and the EEZ has become customary law. Where the legal title based on the distance criterion reflects customary law, the method derived from the legal title would also have a customary nature. Hence, in the present writer's opinion, much can be said for the view that the equidistance method should be regarded as an obligatory method at the first stage of maritime delimitations.

V. Questions Concerning the Validity of the Bisector Method

The next issue which needs to be discussed is the validity of the bisector method adopted in the *Honduras/Nicaragua* case. In this regard, three questions should be highlighted.

A. Consistency with the Previous Case Law

The first question pertains to a consistency with the previous case law concerning the use of the bisector method. The Court stated that in instances where any

[131] Weil, op. cit., note 108, 53. The translation by MacGlashan, which differs slightly from the original text, is as follows: "[I]t must be remembered that delimitation is nonetheless closely linked with the legal basis of title. Delimitation cannot be understood without title, which lies at its very heart." P. Weil, The Law of Maritime Delimitation – Reflections, translated by M. MacGlashan, Cambridge 1989, 48-49.

[132] L. Lucchini/M. Voelkel, Droit de la mer, Tome 2, Délimitation, Navigation et Pêche, Vol. I, Délimitation, Paris 1996, 211.

[133] Weil, op. cit., note 108, 53, 86.

basepoints that could be determined by the Court are inherently unstable, the bisector method may be seen as an approximation of the equidistance method. According to the Court,

> This was the situation in the case concerning the *Continental Shelf (Tunisia/Libyan Arab Jamahiriya)*, where equidistance could not be used for the second segment of the delimitation because the segment was to begin at a point not on any possible equidistance line. The Court there used a bisector to approximate the northerly change in direction of the Tunisian coast beginning in the Gulf of Gabes (ICJ Reports 1982, 94, para. 133 C (3)). The Chamber of the Court in the *Gulf of Maine* case also used a bisector of the Gulf-facing mainland because it deemed the small islands in the Gulf unsuitable for use as base points and because the first segment of the delimitation was to begin at "Point A", which was also off any equidistance line. The Arbitral Tribunal in the 1985 *Delimitation of the maritime boundary between Guinea and Guinea-Bissau* case drew a perpendicular (the bisector of a 180° angle) to a line drawn from Almadies Point (Senegal) to Cape Shilling (Sierra Leone) to approximate the general direction of the coast of "the whole of West Africa". The Tribunal considered this approach, rather than equidistance, necessary in order to effect an equitable delimitation that had to be "integrated into the present or future delimitations of the region as a whole" (International Law Reports, Vol. 77, 683-684, para. 108).[134]

Nonetheless it appears questionable whether these cases quoted in the above paragraph could provide proper precedents with respect to the bisector method.

First, in the *Tunisia/Libya* case, the Court drew a line bisecting the angle between the line of the Tunisian coast (42°) and the line along the seaward coast of the Tunisian Islands of Kerkennah (62°). Consequently, the line of delimitation in the second sector runs at an angle of 52° to the meridian. In so doing, however, the Court purported to give the Kerkennah Islands a "half-effect". The Court's view in this matter is worth quoting:

> The Court would recall however that a number of examples are to be found in State practice of delimitations in which only partial effect has been given to islands situated close to the coast. [...] One possible technique for this purpose, in the context of a geometrical method of delimitation, is that of the "half-effect" or "half-angle". Briefly, the technique involves drawing two delimitation lines, one giving to the island the full effect attributed to it by the delimitation method in use and the other disregarding the island totally, as though it did not exist. The delimitation line actually adopted is then drawn between the first two lines, either in such a way as to divide equally the area between them, or as bisector of the angle which they make with each other, or possibly by treating the island as displaced toward the mainland by half its actual distance therefrom. Taking into account the position of the Kerkennah Islands, and the low-tide elevations around them, the Court considers that it should go so far as to attribute to the Island a "half-effect" of a similar kind.[135]

Thus the purpose of drawing a bisecting line in the *Tunisia/Libya* case totally differs from the aim of the bisector line in the *Nicaragua/Honduras* case. In rela-

[134] Judgment, op. cit., note 2, 78-79, para. 288.
[135] ICJ Reports 1982, 89, para. 129.

tion to this, it has to be stressed that in the *Tunisia/Libya* case, the bisecting line was drawn between two lines along the seaward coasts of the same State, i.e. Tunisia,[136] while the bisector method in the *Nicaragua/Honduras* case concerns the coastlines of two States. It must also be noted that the *Tunisia/Libya* case is not an instance where any basepoints that could be determined by the Court are inherently unstable. Accordingly, it may be said that the *Tunisia/Libya* case does not provide a proper precedent in this matter.

Second, in the *Gulf of Maine* case between the United States and Canada, the primary reason for renouncing the equidistance method was the difficulty of the persistent uncertainty as to sovereignty over Machias Seal Island and the Parties' choice of point A as the obligatory point of departure for the delimitation line.[137] In the *Nicaragua/Honduras* case, however, no similar factors existed. In fact, the Court resolved the question concerning territorial sovereignty over the disputed islands before proceeding with maritime delimitation. While the Court made no finding as to sovereign title over islands in the mouth of the River Coco because of the changing condition of the area,[138] it is inconceivable that this could be a decisive reason to renounce the equidistance method. It must also be noted that the bisector method adopted in the *Gulf of Maine* case differs from the method used in the *Nicaragua/Honduras* case. In the *Gulf of Maine* case, the Parties had already selected point A as the obligatory point of departure for the delimitation line. Hence the Chamber of the ICJ drew from point A two lines respectively perpendicular to the two basic coastal lines, that is to say, the line from Cape Elizabeth to the international boundary terminus and the line from that latter point to Cape Sable. At point A, these perpendiculars form a reflex angle of about 278°. The Chamber drew a line bisecting the reflex angle as the delimitation line in the first segment.[139] In short, an obligatory starting point A played a primordial role in drawing the bisector line. Conversely, in the *Nicaragua/Honduras* case, a starting point of the delimitation line was determined by the Court after it drew a bisector line, and the point played no role in drawing the bisector line. Given these differences, it appears doubtful whether the *Gulf of Maine* case provides a proper precedent in relation to the bisector method.

In relation to this, it will be recalled that in the *Guyana/Suriname* arbitration, Suriname urged the Arbitral Tribunal to use the bisector method on the basis of the *Tunisia/Libya*, *Gulf of Maine* and *St. Pierre and Miquelon* cases. According to

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[136] It will be recalled that the line of 52° in the second zone was criticised by Judge Oda because this line completely neglects the Libyan coastline by relying solely on the Tunisian coast. Dissenting Opinion of Judge Oda, ibid., 268-269, para. 179. Kolb also criticised the judgment on this point. Kolb, op. cit., note 23, 194. See also L.L. Herman, The Court Giveth and the Court Taketh Away: An Analysis of the *Tunisia-Libya Continental Shelf* Case, 33 ICLQ (1984), 830.

[137] ICJ Reports 1984, 332, para. 211.

[138] Judgment, op. cit., note 2, 41, para. 145.

[139] Concerning the construction of the single maritime boundary in the *Gulf of Maine* case, the following article is of particular interest: J. Cooper, Delimitation of the Maritime Boundary in the Gulf of Maine Area, 16 ODIL (1986), 59-90.

Suriname, the *Gulf of Maine* case provided the best example of the bisector method.[140] Nonetheless, the Arbitral Tribunal clearly discarded the "angle bisector methodology", by stating that:

> The Tribunal is bound to note that the coastlines at issue in these cited cases cannot be compared to the configuration of the relevant coastlines of Guyana and Suriname. For instance, the *Gulf of Maine* case where the angle bisector was utilised in the maritime delimitation between Canada and the United States bears little resemblance to the maritime area which is of concern in this delimitation. It seems to this Tribunal that the general configuration of the maritime area to be delimited does not present the type of geographical peculiarities which could lead the Tribunal to adopt a methodology at variance with that which has been practised by international courts and tribunals during the last two decades. Such peculiarities may, however, be taken into account as relevant circumstances, for the purpose, if necessary, of adjusting or shifting the provisional delimitation line.[141]

It appears that the above view can also apply to the *Nicaragua/Honduras* case.

Third, the method used in the *Guinea/Guinea-Bissau* arbitration is not the bisector method as used in the *Nicaragua/Honduras* case. As Weil correctly pointed out, "[t]he bisector method is possible only where two clearly distinguished coastlines form a sharply defined angle; otherwise it rests on artificially reconstructed coastal directions".[142] Nonetheless, the Arbitral Tribunal, in the *Guinea/Guinea-Bissau* case, drew a *grosso modo* perpendicular line to a straight line joining Pointe des Almadies and Cape Shilling. Consequently, only one coastline is involved in the system of a line perpendicular to the general direction of the coast. A perpendicular line to the general direction of the coast is nothing but an equidistance line based on the coast thus simplified.[143] In fact, Gidel regarded the perpendicular method as a special variant of the median line understood in its broad sense.[144]

It would follow from the above discussion that the *Tunisia/Libya, Gulf of Maine* and *Guinea/Guinea-Bissau* cases are not proper precedents for the bisector method used in the *Nicaragua/Honduras* judgment.

140 The *Guyana/Suriname* arbitration, op. cit., note 1, 118-119, paras. 369-370.

141 Ibid., 120, para. 372.

142 Weil, op. cit., note 131 (English version), 59.

143 Kolb, op. cit., note 23, 302.

144 G. Gidel, Le droit international public de la mer: le temps de paix, Tome III, La mer territoriale et la zone contiguë, reprint, Paris 1981, 769. See also Kolb, op. cit., note 23, 302; C. Carleton/C. Schofield, Developments in the Technical Determination of Maritime Space: Delimitation, Dispute Resolution, Geographical Information Systems and the Role of the Technical Expert, 3 Maritime Briefing (2002), (International Boundaries Research Unit), 20.

B. Lack of Scientific Methodology for Drawing General Direction of a Coast

A second question associated with the bisector method concerns the lack of a scientific method for identifying the general direction of coastlines.[145] In selecting the relevant coastal front, the Court considered several options. A first option, which was the primary proposal of Nicaragua, was the coastal fronts running from Cape Gracias a Dios to the Guatemalan border for Honduras and to the Costa Rican border for Nicaragua. The Court discarded this proposal because it would cut off a "significant" portion of Honduran territory falling north of this line.[146] A second option was the Cape Falso-Puta Gorda coast generating a bisector with an azimuth of 70° 54'. According to the Court, however, this coast is also inappropriate since it is quite a short façade (some 100 km) from which to reflect a coastal front more than 100 nautical miles out to sea.[147] A third option was a coastal front extending from Cape Camerón to Rio Grande generating a bisector with an azimuth of 64° 02'. In the Court's view, this coastal front would also overcompensate since the line would run entirely over the Honduran mainland and thus would deprive the significant Honduran land mass lying between the sea and the line of any effect on the delimitation.[148] In the end, the Court ruled that a Honduran coastal front running to Punta Patuca and a Nicaraguan coastal front running to Wouhnta were the relevant coasts for the purposes of drawing the bisector.[149]

Nevertheless, the Court specified no ground with respect to the selection of relevant coasts. It would seem that the Court attempted to avoid coastal fronts that would cut off a "significant" portion of the territory of the Parties. However, the term "significant" is so vague as to be devoid of objective content. It can also be observed that the Court attempted to ensure a balance between the length of the coastal façade and the extent of the maritime area generated from the façade. Yet it appears highly difficult to find an objective criterion in this matter. The inescapable conclusion may be that the bisector method is subjective in the sense that the result is changeable depending on the subjective selection of the general direction of the coasts. In relation to this, it must be noted that the problem associated with the identification of a general direction of the coast was already raised in the *Tunisia/Libya* and *Guinea/Guinea-Bissau* cases. In the *Tunisia/Libya* case, the ICJ drew a straight line drawn from the westernmost point of the Gulf of Gabes to Ras Kaboudia in order to identify the general direction of the Tunisia coast. However, Judge Evensen criticized the line on the grounds that it was drawn inland, some 11 kilometres from the actual sea-coast. According to the learned Judge, this is a

145 Pratt, op. cit., note 2, 38.
146 Judgment, op. cit., note 2, 82, para. 295.
147 Ibid., para. 296.
148 Ibid., 81, para. 297.
149 Ibid., 81, para. 298.

refashioning of nature.[150] In the *Guinea/Guinea-Bissau* case, the line representing the general direction of the coast cuts almost all the coast of Guinea-Bissau for nearly 350 kilometres and runs approximately 70 kilometres inside of the latter's territory. Arguably the line departed radically from the actual sea-coast, and the problem of the refashioning of nature is more serious than in the *Tunisia/Libya* case.[151]

Furthermore, considering that the coastlines of Nicaragua and Honduras are unstable, the line connecting two points on the coast is also subject to change with the passage of time. If this is the case, the question arises why a current bisector line between the general directions of two coastlines remains reasonable regardless of the change of coastlines, while an equidistance line so constructed today suddenly becomes unreasonable in the future.

C. Lack of Legal Ground of the Bisector Method

A third question pertains to the legal ground of the bisector method. In this respect, Nicaragua advanced a variety of reasons, such as: (a) the method produces an effective reflection of the coastal relationships; (b) the bisector produces a result which constitutes an expression of the principle of equal division of the areas in dispute; (c) the bisector method has the virtue of compliance with the principle of non-encroachment; (d) it also prevents, as far as possible, any cut-off of the seaward projection of the coast of either of the States concerned; and (e) the bisector method ensures "the exercise of the right to development of the Parties".[152] Nicaragua also referred to many relevant circumstances in order to demonstrate the equitable character of its own proposed bisector line.[153] Nonetheless, the Court refused to admit the pertinence of these factors. Indeed, the Court did not find them "legally determinative for the purposes of the delimitation to be effected".[154]

According to the Court, "the key elements are the geographical configuration of the coast, and the geomorphological features of the area where the endpoint of the land boundary is located".[155] Yet this does not seem to be a legal ground to justify the bisector method. It would seem that the bisector method was used merely for the purpose of convenience.

150 ICJ Reports 1982, 303, para. 19.

151 E. David, La sentence arbitrale du 14 février 1985 sur la délimitation de la frontière maritime Guinée-Guinée Bissau, 31 AFDI (1985), 385; Weil, op. cit., note 108, 238-239.

152 Judgment, op. cit., note 2, 79, para. 290.

153 Ibid., para. 291. The relevant circumstances include the incidence of natural resources, equitable access to the natural resources, the unitary character of the Nicaraguan Rise as a single geological and geomorphological feature, security considerations, and equitable access to the main navigable channel in the adjacent coastal areas.

154 Ibid., 80, para. 292.

155 Ibid.

VI. Conclusion

It is significant that the ICJ peacefully settled the territorial and maritime delimitation dispute between Nicaragua and Honduras. With all due respect to the Court's authority, a principal concern with the *Nicaragua/Honduras* judgment is that by rejecting the priority of the equidistance method at the first stage of maritime delimitations, this decision might undermine predictability of the law of maritime delimitation, and, thus, weaken the normativity of the law developed through jurisprudence. In light of the central importance of maritime delimitation in international law of the sea, it is desirable that rules governing them should be clear and predictable. As Judge Sørensen stated in the *North Sea Continental Shelf* cases, there is good reason to argue that the rules of international law should be so framed and constructed as to reduce causes of disagreement and dispute to a minimum. The clearer the rule, and the more automatic its application, the less the seeds of discord that will be sown.[156] It is also noteworthy that, in the *Libya/Malta* case, the ICJ itself stressed the importance of consistency and a degree of predictability going beyond the circumstances of each case.[157] By incorporating the equidistance method, the corrective-equity approach can enhance predictability as a requirement of law in the international community.[158] The corrective-equity approach developed by jurisprudence in this field may provide a useful criterion for limiting exaggerated unilateral claims by coastal States in an area where a maritime delimitation line is not yet drawn. Thus it will be necessary to maintain the unity of the law of maritime delimitation under the corrective-equity approach.[159]

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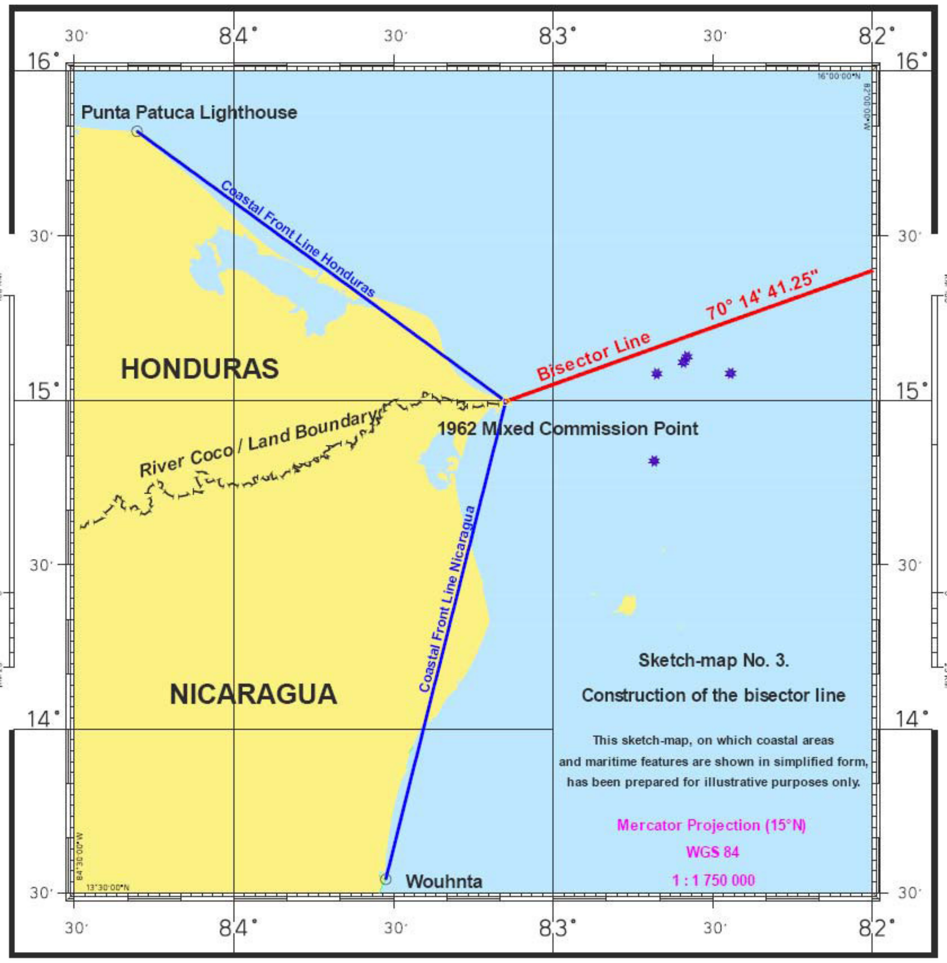
156 Dissenting Opinion of Judge *ad hoc* Sørensen, ICJ Reports 1969, 256. Akehurst also stated that: "Although it is desirable that rules of law should be just, it is perhaps even more desirable that they should be certain, clear and predictable", M. Akehurst, Equity and General Principles of Law, 25 ICLQ (1976), 809.

157 The *Libya/Malta* case, ICJ Reports 1985, 39, para. 45.

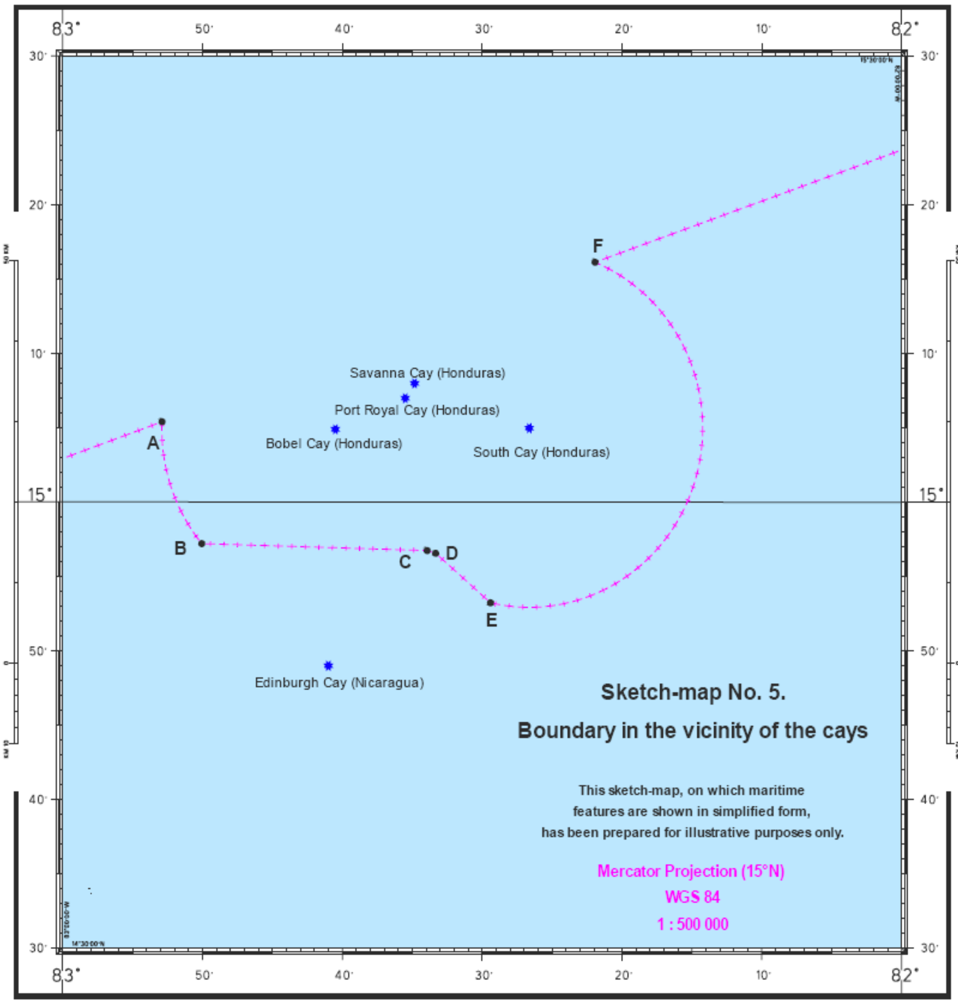
158 *Cf.* M. Bedjaoui, L'"énigme" des "principes équitables" dans le droit des délimitations maritimes, 17 Revista Española de Derecho Internacional (1990), 384.

159 In this regard, Judge Gilbert Guillaume's view, as expressed in the Sixth Committee of the General Assembly of the United Nations, should be remembered: "[I]t is encouraging to note that the law of maritime delimitations, by means of these developments in the Court's case law, has reached a new level of unity and certainty, whilst conserving the necessary flexibility. [...] *In all cases,* the Court, as States also do, must first determine provisionally the equidistance line. It must then ask itself whether there are special or relevant circumstances requiring this line to be adjusted with a view to achieving equitable results." (emphasis added) Speech by His Excellency Judge Gilbert Guillaume, President of the International Court of Justice, to the Sixth Committee of the General Assembly of the United Nations, 31 October 2001, 10.



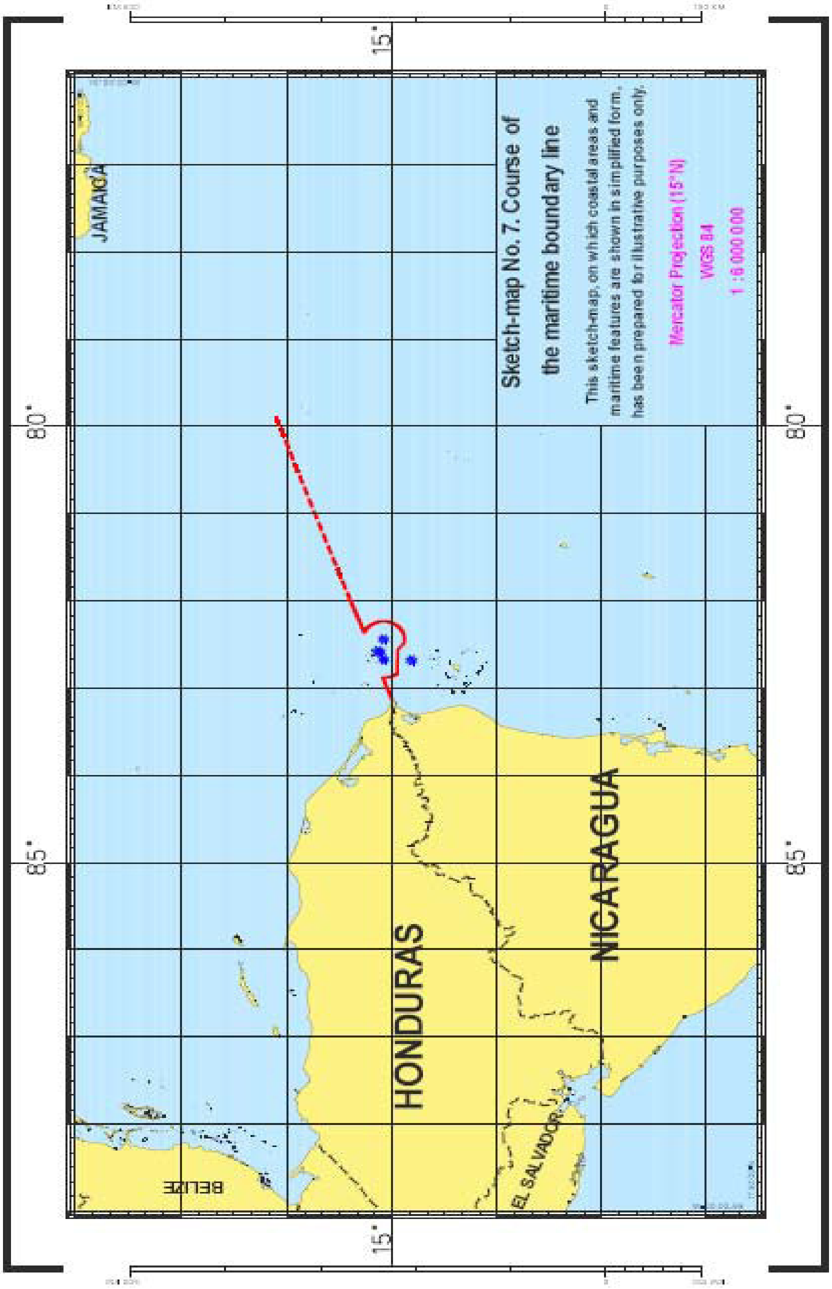
Source: Sketch-map No. 3 annexed to the *Nicaragua/Honduras* Judgment, ICJ Reports 2007, p. 82.

Figure 1



Source: Sketch-map No. 5 annexed to the *Nicaragua/Honduras* Judgment, ICJ Reports 2007, p. 86.

Figure 2



Source: Sketch-map No. 7 annexed to the *Nicaragua/Honduras* Judgment, ICJ Reports 2007, p. 91.

Figure 3

Annex IN-34

Note Verbale from the Ministry of Foreign Affairs of Bangladesh to the High Commission of India, Notification under Article 287 and Annex VII, Article 1 of UNCLOS, 8 October 2009.

MINISTRY OF FOREIGN AFFAIRS
GOVERNMENT OF THE
PEOPLE'S REPUBLIC OF BANGLADESH
DHAKA

পররাষ্ট্র দফতর
গণপ্রজাতন্ত্রী বাংলাদেশ
সরকার
ঢাকা

No. MOFA/UNCLOS/320/1

Note Verbale

The Ministry of Foreign Affairs of the Government of the People's Republic of Bangladesh presents its compliments to the High Commission of the Republic of India in Dhaka and with respect to the dispute concerning the maritime boundary of Bangladesh and India in the Bay of Bengal, the Government of Bangladesh has the honour to submit herewith the attached Notification under Article 287 and Annex VII of the 1982 United Nations Convention on Law of the Sea and the Statement of Claim and Grounds on which it is Based, (containing pages 1 to 6) in order to initiate arbitral proceedings for the delimitation of the Bangladesh-India boundary in the Territorial Sea, Exclusive Economic Zone, and the Continental Shelf.

The Government of Bangladesh has initiated these proceedings in furtherance of friendly relations with India, mindful of its obligation under Article 279 of the Convention to seek a solution for the settlement of its maritime boundary dispute by the means indicated in Article 33(1) of the Charter of the United Nations.

Pending the Final Award of a Tribunal constituted under Annex VII of the Convention, the Government of Bangladesh remains committed to ongoing negotiations with India for the equitable settlement of its maritime boundary dispute.

The Ministry of Foreign Affairs, Government of the People's Republic of Bangladesh avails itself of the opportunity to renew to the High Commission of the Republic of India the assurances of its highest consideration.

Dhaka, 08 October 2009

Ministry of Foreign Affairs
Dhaka
Govt. Bangladesh

The High Commission of the Republic of India
Dhaka

1982 UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

IN THE DISPUTE CONCERNING THE MARITIME BOUNDARY BETWEEN BANGLADESH AND INDIA

BANGLADESH v. INDIA

NOTIFICATION UNDER ARTICLE 287 AND ANNEX VII, ARTICLE 1 OF UNCLOS

AND THE STATEMENT OF THE CLAIM AND GROUNDS ON WHICH IT IS BASED

08 OCTOBER 2009

Dipu Moni

1982 UNCLOS-ANNEX VII ARBITRATION

NOTIFICATION
AND STATEMENT OF CLAIM

1. Pursuant to Articles 286 and 287 of the 1982 *United Nations Convention on the Law of the Sea* ("UNCLOS"), and in accordance with the requirements of Article 1 of Annex VII thereto, Bangladesh hereby gives written notification to India that, having failed to reach a settlement after successive negotiations and exchanges of views as contemplated by Part XV of UNCLOS, it has elected to submit the dispute concerning the delimitation of its maritime boundary with India to the arbitral procedure provided for in Annex VII of UNCLOS. A statement of claim and the grounds on which it is based accompany this notification, as required by Article 1 of Annex VII.

2. In accordance with the requirements of Annex VII, Article 3(b), Bangladesh hereby appoints Professor Vaughan Lowe QC as a member of the arbitral tribunal.

SUBJECT MATTER OF THE DISPUTE

3. The dispute concerns the delimitation of the maritime boundary of Bangladesh with India in the territorial sea, the exclusive economic zone ("EEZ"), and the continental shelf in the Bay of Bengal.

4. Despite the good faith efforts of both parties, and extensive negotiations over the past 35 years, Bangladesh and India have not succeeded in agreeing upon a maritime boundary in any part of the Bay of Bengal.

5. During these negotiations, including the most recent, which took place in March 2009, Bangladesh and India have exchanged their views regarding the settlement of the dispute, as required by Article 283 of UNCLOS.

Dipu Moni

6. Accordingly, mindful of its obligation under Article 279 of UNCLOS to settle any dispute concerning the interpretation or application of the Convention by the means indicated in Article 33(1) of the UN Charter, and in furtherance of long-standing friendly relations with India, Bangladesh hereby initiates proceedings under Section 2 of Part XV of UNCLOS to settle its dispute with India on the maritime boundary in the territorial sea, the EEZ and the continental shelf, in the Bay of Bengal.

JURISDICTION

7. Bangladesh and India are both parties to UNCLOS, having ratified the Convention on 27 July 2001 and 26 June 1995 respectively. Part XV of UNCLOS establishes a regime for the settlement of disputes concerning the interpretation and application of the Convention. Article 279 requires parties to seek a solution by peaceful means in accordance with the UN Charter. Article 283(1) further requires that when a dispute arises between States Parties, the parties should proceed expeditiously to an exchange of views regarding a settlement by negotiation or other peaceful means. Bangladesh has complied with the requirements of Part XV fully and in good faith.

8. As Bangladesh and India have failed to settle the dispute between them by peaceful means of their own choice, Article 281(1) allows recourse to procedures provided for in Part XV, including compulsory procedures entailing binding decisions under Section 2 of that Part. Article 286 allows these compulsory procedures to be initiated by any party to the dispute in the court or tribunal having jurisdiction under Section 2.

9. Article 287 governs the choice of compulsory procedures. Article 287(1) allows a State Party, by means of a written declaration, to choose one or more of the means for the settlement of disputes listed in the paragraph, which includes recourse to an arbitral tribunal under Annex VII. Since Bangladesh and India have made no declarations pursuant to Article 287(1), they are deemed by operation of Article 287(3) to have accepted arbitration in accordance with Annex VII.

Dipu Moni

10. It is further noted that Article 298 governing optional exceptions to applicability of Section 2 does not apply since neither Bangladesh nor India has declared in writing that it does not accept any one or more of the compulsory procedures referred to in Article 287.

11. Therefore, in conformity with Article 286, Bangladesh submits its dispute with India concerning the delimitation of their maritime boundary in the territorial sea, the EEZ and the continental shelf, in the Bay of Bengal, to an arbitral tribunal ("Tribunal") constituted in accordance with Annex VII, which has jurisdiction over the dispute in accordance with Article 288(1).

THE FACTS

12. Bangladesh and India are States with adjacent coasts in the Bay of Bengal.

13. The claims of Bangladesh and India overlap throughout the territorial sea, EEZ, and continental shelf.

14. In 1974, the Parliament of Bangladesh adopted the *Territorial Waters and Maritime Zones Act*. This Act defines Bangladesh's maritime boundaries with India and Myanmar in the territorial sea, the EEZ, and the continental shelf. The boundaries consist of two parallel lines extending southward on the meridians of longitude, from baselines corresponding to Bangladesh's coastline up to the outer limits of the continental margin.

15. Since 1974, India has proposed delimitation based on what is claimed to be an equidistance line. Bangladesh has rejected India's proposed line of delimitation as inequitable because, *inter alia*, the line, in combination with Bangladesh's concave coastline at the northern end of the Bay of Bengal, severely cuts off and reduces Bangladesh's maritime entitlement.

16. Since a Protest Note of 2008 concerning Bangladesh's oil and gas concessions, India has asserted an even more inequitable maritime boundary that goes beyond the originally proposed 1974 line. This new line cuts Bangladesh off from even more of its maritime entitlement.

Dipu Moni

17. On 11 May 2009, India submitted to the Commission on the Limits of the Continental Shelf information on its extended continental shelf. India's claim, which denies Bangladesh any portion of its continental shelf whatsoever beyond 200 nautical miles, is inconsistent with the principles and rules established by UNCLOS. Bangladesh shall submit its claims to an extended continental shelf by July 2011. When it makes its submission, Bangladesh will describe and justify its entitlement to an extended continental shelf, beyond 200 nautical miles from its coastal baselines, in the very areas where India has asserted claims in its submission to the Commission.

GROUNDS ON WHICH BANGLADESH'S CLAIMS ARE BASED

18. Bangladesh's claim is based on the provisions of UNCLOS as applied to the relevant facts, including but not limited to Articles 15, 74, 76 and 83.

19. Bangladesh's claim is also based on its Territorial Waters and Maritime Zones Act, 1974, and the subsequent Notification No. LT – 1/3/74 of the Ministry of Foreign Affairs of 13 April 1974.

20. Details of these grounds will be particularized at the appropriate stage in this arbitration, as determined by the Tribunal.

RELIEF SOUGHT

21. Bangladesh requests the Tribunal to delimit, in accordance with the principles and rules set forth in UNCLOS, the maritime boundary between Bangladesh and India in the Bay of Bengal, in the territorial sea, the EEZ, and the continental shelf, including the portion of the continental shelf pertaining to Bangladesh that lies more than 200 nautical miles from the baselines from which its territorial sea is measured.

22. Details of this claim will be particularized at the appropriate stage in this arbitration as determined by the Tribunal.

Dipu Moni

23. Bangladesh reserves the right to supplement and/or amend its claim and the relief sought as necessary, and to make such other requests from the arbitral tribunal as may be necessary to preserve its rights under UNCLOS.

Respectfully submitted,

Dipu Moni

Dr. Dipu Moni, MP
Foreign Minister
Ministry of Foreign Affairs, Dhaka
Government of the People's Republic of Bangladesh,
Agent

08 October 2009

Annex IN-35

Note Verbale from the Permanent Mission of Bangladesh to the Secretary-General of the United Nations, 29 October 2009.

PERMANENT MISSION OF BANGLADESH
TO THE UNITED NATIONS
227 East 45th Street 14th Floor, New York, NY 10017
Tel: (212) 867-3434 • Fax: (212) 972-4038 • E-mail: bangladesh@un.int
web site: www.un.int/bangladesh

No. PMBNY-UNCLOS/2009-

The Permanent Mission of the Peoples Republic of Bangladesh to the United Nations presents its compliments to the Secretary-General of the United Nations in his capacity as the depository for the United Nations Convention on Law of the Sea 1982 ("UNCLOS"), and draws his attention to the following observations of the Government of Bangladesh arising from his communication of 14 May 2009, Ref. No.CLCS.48.2009.LOS (Continental Shelf Notification) concerning the submission presented by the Republic of India to the Commission on the Limits of the Continental Shelf (the "Commission").

2. Based on its initial review of the Executive Summary of India's submission, the Government of Bangladesh observes that the submission fails to comply on both substantive and procedural grounds with UNCLOS and with the Rules of Procedure of the Commission (the "Rules"). Major elements of which are given below:

a. Delimitation of the continental shelf as well as the exclusive economic zone and the territorial sea in the Bay of Bengal between India and Bangladesh remains unresolved and the subject of conflicting claims and ongoing negotiations. Bangladesh has rejected and continues to reject all delimitations claimed by India in the Bay of Bengal, to the extent they infringe on the rights and claims of Bangladesh, as they are inconsistent with UNCLOS and general principles of international law. Bangladesh also objects to the proposed baselines as gazetted by India on 11 May 2009 and from which India purports to measure the breadth of its territorial sea, exclusive economic zone and continental shelf in the Bay of Bengal on the grounds that these too are inconsistent with UNCLOS and general international law. On 8 October 2009, Bangladesh initiated arbitration proceedings against India, pursuant to UNCLOS Article 287 and Annex VII, for the purpose of achieving a delimitation of the boundaries between Bangladesh and India in the territorial sea, exclusive economic zone and continental shelf. The unresolved delimitation in the Bay of Bengal is, therefore, to be considered as a dispute for the purposes of Rule 46 of the Rules, and of Annex I thereto.

b. In accordance with UNCLOS, including Article 76 and Annex II thereto, and the Rules of Procedure of the Commission, and in particular Annex I thereto, the actions of the Commission may not prejudice matters relating to the delimitation of boundaries between States with adjacent or opposite coasts. Yet, India's submission invites the Commission to do just that, because the areas claimed by India in its submission to the Commission as part of its putative continental shelf are the natural prolongation of Bangladesh and hence India's claim is disputed by Bangladesh.

c. India has claimed a natural prolongation of its landmass through to the outer edge of the 'Bay of Bengal sector' and the 'Western Andamans sector'. The Government of Bangladesh believes this assertion is not supported by morphological, geological, or tectonic evidences. Scientific research and analyses have established that the morphology of the seabed in the Bay of Bengal is marked by a regional slope where water depth gradually increases in a seaward direction from north to south. This characteristic contradicts the notion of an eastward prolongation of India's continental landmass, or of a westward prolongation of the landmass of the Andaman Islands, which would imply regional slopes at right angles to the coastlines of those two landmasses, i.e., from west to east, and from east to west, respectively. The characteristic also underscores the reality that the seabed in the northern and central Bay of Bengal owes much of its shape and composition to the high volumes of sediments that has emerged mostly from or across the landmass of Bangladesh over geological time. The entire central part of the Bay is known to overlie oceanic crust, as proven by seismic refraction and other geophysical studies and measurements. Hence for any State that borders upon the Bay of Bengal, the only natural prolongation that can be claimed is the one that arises from the accumulation of sediments over this oceanic crust in the seaward direction of its flow. In consideration of its location and shape of the sedimentary wedge, the accumulated sediments therefore comprise the exclusive natural prolongation of Bangladesh.

3. The Government of Bangladesh reserves its right to submit further comments in relation to the submission of India as and when a more qualified assessment can be conducted, including an assessment of emerging relevant scientific data. Bangladesh also reserves its right to submit comments on India's contentions regarding the purported applicability of the Statement of Understanding set out at the Annex II of the Final Act of UNCLOS III.

4. Recalling paragraph 5(a) of Annex I of the Rules, the Government of Bangladesh observes that, given the presence of a dispute between Bangladesh and India concerning entitlement to the parts of the continental shelf in the Bay of Bengal claimed by India in its submission, the Commission may not "consider and qualify" the submission made by India without the "prior consent given by all States that are parties to such a dispute."

5. In these circumstances, and in accordance with articles 76 and 83(3) of the Convention and Annex I to the Commission's Rules of Procedures, Bangladesh will make every effort to reach a practical arrangement with India that will allow the Commission, in accordance with paragraph 5(a) of Annex I to its Rules of Procedure, to consider both the submission of India and the submission that Bangladesh will make by July 2011.

6. The Permanent Mission of Bangladesh to the United Nations avails itself of this opportunity to renew to the Secretary-General of the United Nations assurances of its highest consideration.

29 October 2009

PERMANENT MISSION OF THE PEOPLE'S REPUBLIC OF BANGLADESH TO THE U.N.
NEW YORK

The Secretary General of the United Nations
New York, NY 10017

Annex IN-36

Note Verbale from the Ministry of External Affairs of India to the High Commission of Bangladesh, 6 November 2009.

सत्यमेव जयते

विदेश मंत्रालय, नई दिल्ली
MINISTRY OF EXTERNAL AFFAIRS
NEW DELHI

No.3682/JS(BSM)09

6 November 2009

Note Verbale

The Ministry of External Affairs of the Government of the Republic of India presents its compliments to the High Commission of the People's Republic of Bangladesh in New Delhi and with respect to the Note Verbale No. MOFA/UNCLOS/320/1 dated 8th October 2009 of the Ministry of Foreign Affairs of the Government of Bangladesh addressed to the High Commission of India in Dhaka, conveying the decision of Bangladesh to initiate Arbitral proceedings (under Article 287 and Annex VII of the 1982 United Nations Convention on the Law of the Sea) for the delimitation of the India-Bangladesh Boundary in the Territorial Sea, Exclusive Economic Zone and the Continental Shelf, and has the honour to state as follows:

1. The Ministry of External Affairs hereby appoints Dr. P. Sreenivasa Rao as Arbitrator in accordance with the provisions of Annex VII Article 3(c) of the Convention.

2. The decision of Bangladesh to refer the settlement of the India-Bangladesh Maritime Boundary to Arbitration is premature. Negotiations at the technical level, which were recently held between the Hydrographers, have been resumed after a gap of several years and after a mere two rounds of negotiations at the technical level, it is premature to conclude that this is a dispute which cannot be settled by negotiations.

3. It may be recalled that the land boundary is being resolved pursuant to the Agreement signed on 16 May 1974, that good progress has been made in demarcating the land boundary and that only a small area still remains to be demarcated, which includes the point on the coast from where the Maritime Boundary is to be delimited. The competence of the Arbitral Tribunal set up under Article 287 does not extend to determining the point at which the land boundary meets the coast. This needs to be determined prior to delimitation of the India-Bangladesh boundary in the Territorial Sea, Exclusive Economic Zone and the Continental Shelf.

4. Paragraph 19 of the document on the "Statement of the Claim and Grounds on which it is based", annexed to the Note Verbale of 8th October 2009, states that Bangladesh's claim is also based on its Territorial Waters and Maritime Zones Act, 1974, and the subsequent

Notification of 13 April 1974, However, under international law, the Maritime Boundaries between India and Bangladesh are to be settled in accordance with the rules of International Law, more specifically the provisions of the United Nations Convention on the Law of the Sea 1982, to which both India and Bangladesh are Parties.

5. The Government of India reserves it's right to raise the above preliminary issues before the Arbitral Tribunal.

The Ministry of External Affairs, Government of the Republic of India avails itself of the opportunity to renew to the High Commission of the People's Republic of Bangladesh, the assurances of its highest consideration.

The High Commission of the
People's Republic of Bangladesh,
New Delhi.

Annex IN-37

R. Bastia, S. Das and M. Radhakrishna, “Pre- and Post-Collisional Depositional History in the Upper and Middle Bengal Fan and Evaluation of Deepwater Reservoir Potential along the Northeast Continental Margin of India”, *Marine and Petroleum Geology*, Vol. 27, 2010, pp. 2051-2061.

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Pre- and post-collisional depositional history in the upper and middle Bengal fan and evaluation of deepwater reservoir potential along the northeast Continental Margin of India

Rabi Bastia [a,*], Suman Das [a], M. Radhakrishna [b]

[a] E&P Division, Reliance Industries Ltd., Navi Mumbai, Mumbai, India
[b] Department of Earth Sciences, Indian Institute of Technology Bombay, Powai, Mumbai 400 076, India

A R T I C L E   I N F O

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A B S T R A C T

The Bengal fan is the largest submarine fan in the world that has formed as a result of high sediment transport from the Himalaya by the Ganga–Brahmaputra river system. The Himalaya was formed as a result of the collision between the Eurasian and Indian plates. The initiation of this collision known as “soft” collision occurred around 59 Ma, whereas, the major collision, known as “hard” collision took place around 15 Ma ago. Prior to the collision, sediments into the Bay of Bengal were derived from the northwest by relatively smaller river system like Mahanadi–Godavari. The switching of river systems with time was not distinct but gradational. In the post- collision period, the sediment input from the NW was masked in most instances because of rapid sediment supply from the Himalaya to the north. Pre-collisional sediment dispersal pattern from the NW was largely affected by pre-existing basement high known as 85°E Ridge; this ridge was submerged during the post-collisional period. Post-collisional sediments are commonly referred to as the Bengal fan sediments and show huge accumulation along the shelf and beyond. High resolution 2D seismic data acquired along a corridor covering the upper, middle and distal parts of the present day active Bengal fan system indicates that the fan has prograded southward with time because of continuously increasing sediment supply and has, therefore, masked the effect of eustacy. The present day geometry of the fan shows a single active canyon and an associated single active fan. The active channel shows typical meandering pattern that shifts laterally with time. The seismic facies analysis indicates that both the pre- and post-collision basin has significant hydrocarbon potential. The thermogenic model is best suited for modeling source rock maturity in the pre-collision basin whereas both biogenic and thermogenic models best explain source rock maturity in the post-collision, younger Bengal fan. The wedge out against the 85°E Ridge is considered to be one of the important play types for hydrocarbon exploration in the deeper part of the basin. On the other hand, the channel levee complexes and frontal splay/basin floor fan are the possible target areas for petroleum exploration in relatively younger Bengal fan deposits.

1. Introduction

Submarine fan systems form the largest deep-water sediment bodies near continental margins and the depositional history of these sediments contains useful record of past land and marine climate, sea level changes, local and regional tectonic activity. Because of their huge sediment repository, very often, submarine fans are known to be potential areas of hydrocarbon exploration (Lopez, 2001). On the basis of tectonic setting, Shanmugam and Moiola (1988) classified submarine fans into four types: (i) immature passive-margin fans (North Sea type); (ii) mature passive-margin fans (Atlantic type); (iii) active-margin fans (Pacific type); and (iv) mixed-setting fans (Bay of Bengal). Based on the sediment supply, they can also be broadly divided into four types such as the mud rich (Amazon fan, Flood et al., 1991), sand rich (Sierra Nevada, California, Busby-Spera, 1985), mud-sand rich (California deep sea basin fan, Normark, 1970) and gravel rich fans (Upper Jurassic system in North Sea, Hurst et al., 2005)

The Bengal Fan is bordered by the Indian continental shelf in the west, continental shelf of Bangladesh in the north and Sunda trench in the east (Fig. 1). It is one of the largest submarine fans in the world covering the entire Bay of Bengal from 20°N in 1400 m water

* Corresponding author:
E-mail address: rabi.bastia@ril.com (R. Bastia).

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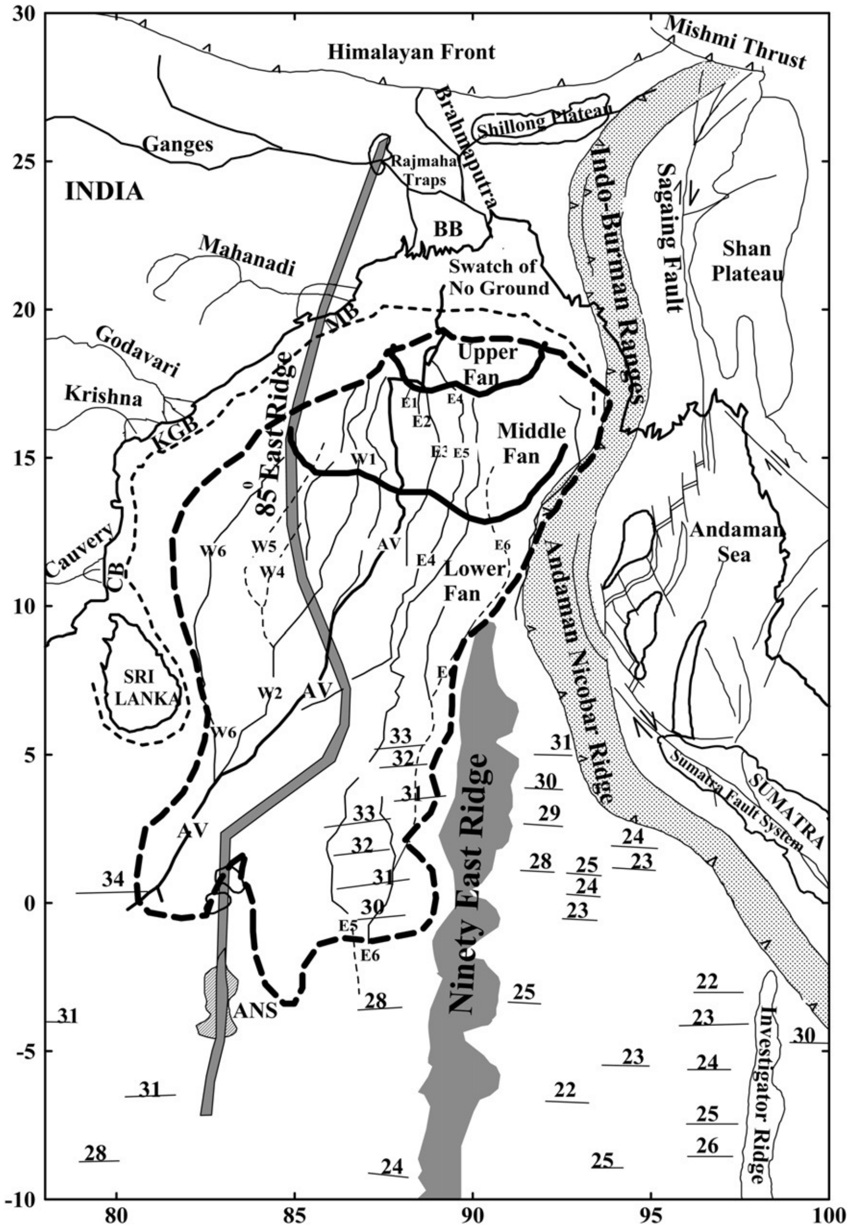

Fig. 1. Tectonic map of Bay of Bengal and the adjoining regions (modified after Curray, 1991). Thick dashed line indicates the outline of Bengal Fan, E1–E6 and W1–W6 are channels on either side of the active channel AV after Curray et al. (2003). The sub-division of Bengal Fan into upper, middle and lower fans from north to south is indicated with thick east-west lines.

depth to 7°S at 5000 m water depth over a N–S length of 3000 km (Curray and Moore, 1971). Though some of the major rivers from eastern India feed into the Bay of Bengal from the west, sediments of the fan are largely contributed by the erosion of the Himalayas and transported by the Ganga–Brahmaputra River system (Curray and Moore, 1971; Curray et al., 2003). Although soft collision (Curray et al., 2003) between India and Asia can be considered as the time of the initiation of the fan, the major sediment supply started after the hard collision during Mid-Miocene which caused continuous progradation of the Bengal fan southward. Detailed seismic reflection and refraction studies as well as echo sounding investigations in the Bengal Fan by several previous workers gave rise to valuable information on the stratigraphic development, sedimentation history of the fan as a whole (Curray and Moore, 1974; Curray et al., 1982, 2003) and evolution of channel–levee system (Curray et al., 2003; Schwenk et al., 2003, 2005). The time of initiation of the fan in the northern part is considered to be Early Eocene (Curray, 1994) and the regional unconformity at Early Eocene (55 Ma) is considered to differentiate between pre- and post-collisional deposition. The timing of initiation of fan becomes younger towards south pointing to progressive progradation of the Bengal fan. However, an Early Miocene age for initiation of the fan has been observed in southern part of the fan (Cochran, 1990). This indicates that the possibility of deposition of fan sediments in Pre-Miocene period in the northern proximal part of the fan cannot be ruled out.

This paper presents results obtained from the analysis of high resolution seismic data acquired along a corridor covering the upper, middle and distal parts of the present day active Bengal fan system (Fig. 1) to understand the development of the depositional fairway in pre- to post-Bengal fan deposition. In addition, we characterize different types of sediment flows for constructing the

Annex IN-37

paleogeography during Mio-Pliocene time. High-resolution multibeam bathymetry data has been used to reinterpret parts of the present-day active channel system. Finally, the results of this study have been integrated to explore the development of possible petroleum system during pre- and post-collision history of the Bengal fan.

2. Regional geologic setting

The Bengal fan covers the entire Bay of Bengal from 20°N to 7°S over a length of 3000 km. The width of the fan varies between 1430 km at 15°N and 830 km at 6°N with an area of approximately 3×10^6 km^2 excluding the area of Nicobar fan (Curray et al., 2003). Towards north, the deepest sedimentary section of over 22 km is observed below the Bangladesh shelf and the sediment thickness progressively decreases towards south (Curray, 1994).

2.1. Morphology

The Bengal fan is fed by two major river systems Ganga and Brahmaputra. The transfer of the sediments from the delta to the fan is guided through a canyon deeply incised into the shelf; this canyon has been referred to as the 'Swatch of No Ground' (Emmel and Curray, 1985; Kudrass et al., 1998; Michels et al., 1998). The head of the 'Swatch of No Ground' lies in about 38 m water depth, and the canyon continues south for 160 km as a long, straight trough to a depth of 1400 m, with an average gradient of 8.2 m/km. High rates of deposition takes place at the inner end of the canyon floor as sediments are trapped and mobilized by storms and tidal currents (Kudrass et al., 1998). However, the supply of sediments to the canyon has greatly reduced since the Holocene (Curray et al., 2003). The sediments supplied through the active fan are deposited in the deeper part in the abyssal plain through active channels. However it is believed that at any point of time only a single channel (consequently a single fan) was active. Considerable amount of shifting of active canyon has also been observed (Curray et al., 2003). Therefore, the present day geometry of the Bengal fan is a collage of several subfans that were active during different geological times. A regional scale map of the present day active channel was presented by Curray et al. (2003). High resolution multibeam bathymetry images along a segment of this active channel system (Fig. 2) show highly meandering nature of the channel along with a sharp bend of the active channel near 18°N. Based on the present-day stratigraphic architecture and bathymetric (fan surface) gradient, the Bengal fan has been divided into three sub-environments, the upper, middle and lower fan (Emmel and Curray, 1985) (Fig. 2). The boundary between upper-middle fans occurs approximately at 2250 m water depth while the middle-lower fan boundary occurs at 2900 m. Considerable variation in grain size, structure and morphology of channel levee complex is also observed in each of these three sub-divisions (Curray and Moore, 1974).

2.2. Tectonic history

The tectono-stratigraphic succession as well as detailed marine geophysical investigations in the Bengal Fan and the adjoining margins gave considerable insight on the early rift-drift history, India-Asia collision scenario, sedimentation and the growth of the Bengal Fan as well as the formation of the 85°E and the Ninetyeast ridges (Curray et al., 1982; Curray and Munasinghe, 1989, 1991; Curray, 1994; Gopala Rao et al., 1997; Krishna, 2003; among many

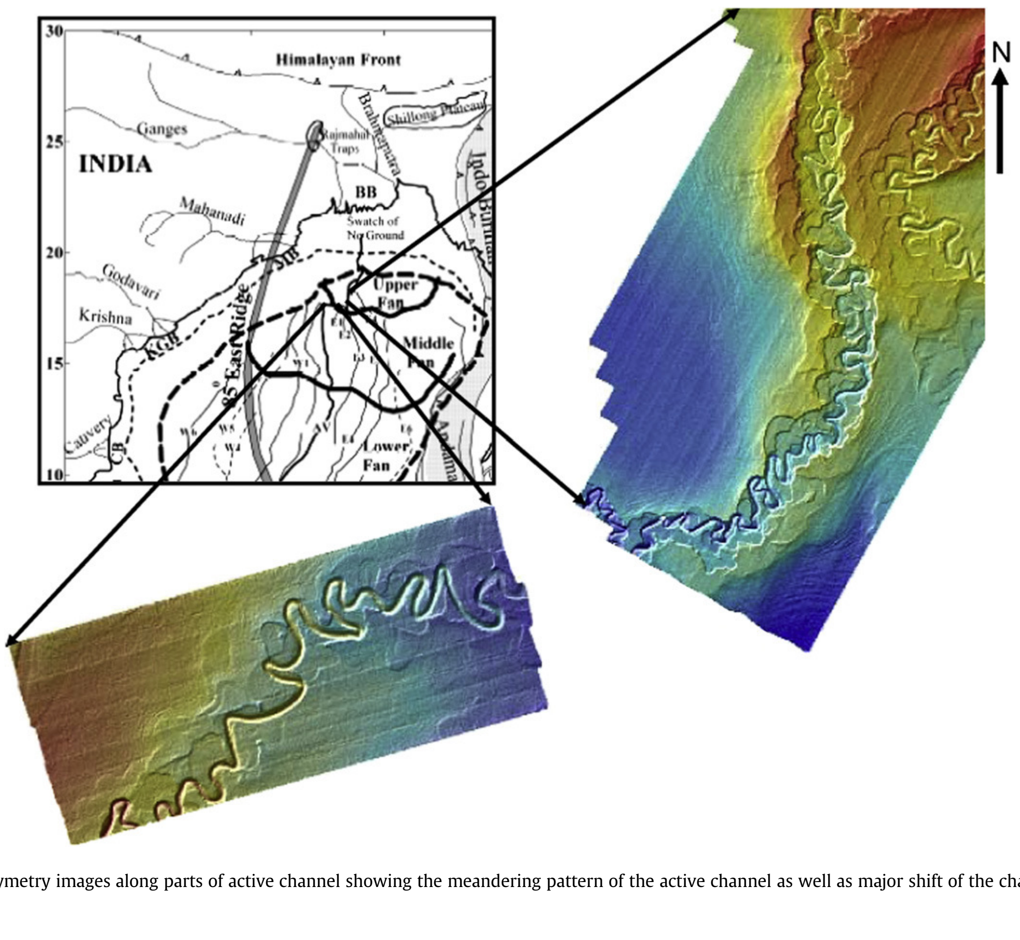

Fig. 2. Multibeam bathymetry images along parts of active channel showing the meandering pattern of the active channel as well as major shift of the channel near 18° latitude.

others). There were three main episodes in the disintegration of Gondwana mainland (Storey, 1995), the initial rifting started in early Jurassic time (180 Ma), the second stage occurred in early Cretaceous (120 Ma) and the third stage occurred in late Cretaceous time (92–100 Ma). The formation of crust beneath the Bengal fan initiated during early Cretaceous with the separation of Antarctica from India in a NW–SE direction. This orientation changed to NS with major plate reorganization around 90–80 Ma (Klootwijk et al., 1992). The basin is dissected by two almost N–S trending ridges namely the 85°E and the Ninety east ridges that are believed to be related to the Crozet and Kerguelen hotspots respectively (Curray et al., 1982; Curray and Munasinghe, 1991). Of these, the 85°E ridge, passing through the study area is now a completely buried structure characterized by gravity low and complex magnetic signature. The origin of this ridge is still enigmatic. Formation of this ridge has been explained as the trace of a hotspot during the time interval of 117–84 Ma (Curray and Munasinghe, 1991), as the result of volcanism along a fissure/crack (Ramana et al., 1997), and as an intraplate ridge that was part of and formed on an older oceanic crust (Krishna, 2003).

During India's northward drift, the initial "soft" collision between India and Asia might have occurred around 59 Ma (Fig. 3) and initiated the Himalayan uplift (Curray and Munasinghe, 1989). The subsequent "hard" continent-continent collision of the Indian plate with the Asian landmass resulted in the closing of the marginal sea behind the Tethyan island arc at around 15 Ma (Middle-Miocene) and initiated the main Himalayan orogeny. The resultant topographic high associated with the Himalaya caused significant increase in sediment supply (Alam et al., 2003). The initiation of Bengal fan has been marked by a strong unconformity that can be traced throughout the fan. This unconformity is recognized as the Paleocene–Eocene hiatus by Curray et al. (2003) and indicates a period of non-deposition that separates pre-Bengal fan sediments from the Bengal fan sediments. Late Miocene (~8 Ma) records the intraplate deformation of the oceanic lithosphere which is evident from the concentration of compressional stresses related to the continuing collision of India and Asia (Cloetingh and Wortel, 1985). Tertiary deposition in the Bengal Fan was significantly influenced by the early Eocene Himalayan orogeny, and continued through India/Asia plate collision to the present day. As a result of this massive Tertiary sedimentary influx, the Bengal Fan is recognized as the largest fan system in the world (Curray et al., 2003).

3. Data

Hydrocarbon exploration during the last decade along the eastern continental margin of India in both shallow and deep water areas has resulted in the generation of a large volume of high-quality 2D and 3D seismic data. In the present study, some of the processed seismic sections covering the active channel–levee system in the upper-to-lower fan sub-divisions of the Bengal fan have been utilized. Available high-density seismic data is further used to prepare isochronopach maps in order to understand the main depositional fairway and its implication on the hydrocarbon potential of the basin. In the absence of deep-water wells in Bay of Bengal, correlation from shallow water wells has been extended to the deeper part. The seismic stratigraphy approach has been applied to examine the continuity of stratigraphic surfaces from shallow to deep water. As studied by earlier workers (Catuneanu,

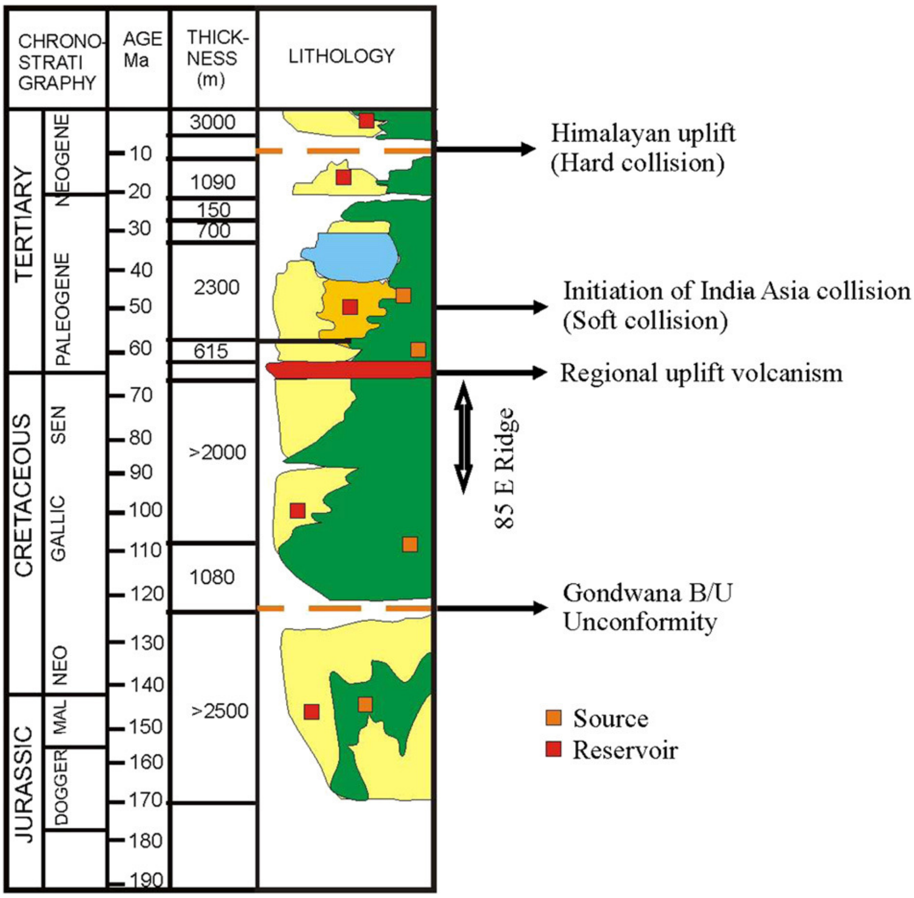

Fig. 3. Shows simplified lithostratigraphic column along with major tectonic events and the possible source and reservoir facies representing the study area.

2008), all sequence boundaries present in deep water may or may not be linked towards the shelf, but, deep-water processes cannot be independent of the processes operated in the shelf. Therefore, with proper understanding, such an attempt can be considered as a good approximation to obtain information regarding deep-water stratigraphy and processes.

4. Results and discussion

The interpretation presented in this section is made mainly based on available 2-D and 3-D seismic data integrated with regional tectono-stratigraphic information.

4.1. Depositional pattern

The isochronopach maps for the total sediment thickness in the region (Fig. 4) show development of larger sediment accumulation in the north and west part of the Bengal fan. However, this map alone is not sufficient to discuss the depositional pattern in different times, as multiple systems were active in the region during the development of the basin. The river system from the west (Mahanadi, Godavari as for example) was mostly active during pre-collisional period, whereas the rivers from north (Ganga, Brahmaputra river system) was active from post Paleocene onwards following the onset of "soft" collision. The regional seismic section presented in Fig. 5 shows the onlapping of Bengal fan derived sediments against the Mahanadi slope. However, from zoomed part of the section, it seems that the onlap does not follow one single surface (sharp separation between the two systems) as there are times (in the post Eocene) during which the Mahanadi

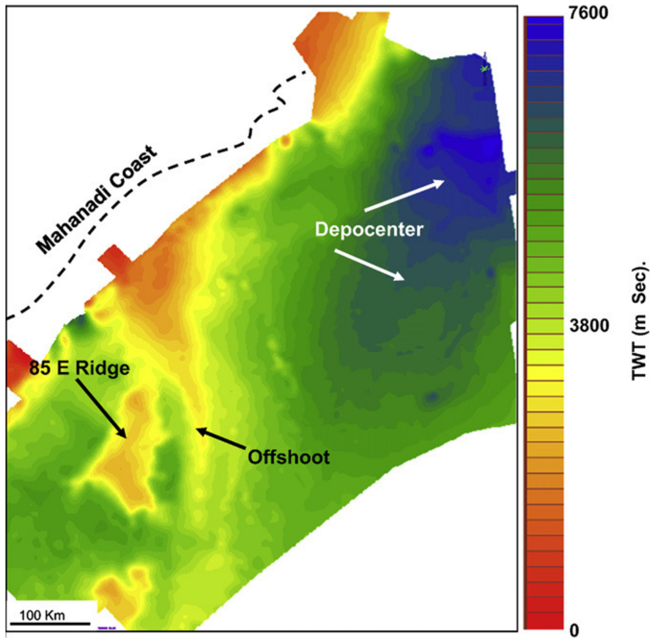

Fig. 4. Sediment isopach (in time) map of the study area showing the total sediment thickness. Note the thickness increment towards the north (marked as depoceneter) and thickness reduction over the 85°E ridge and its offshoot as well as towards Mahanadi shelf.

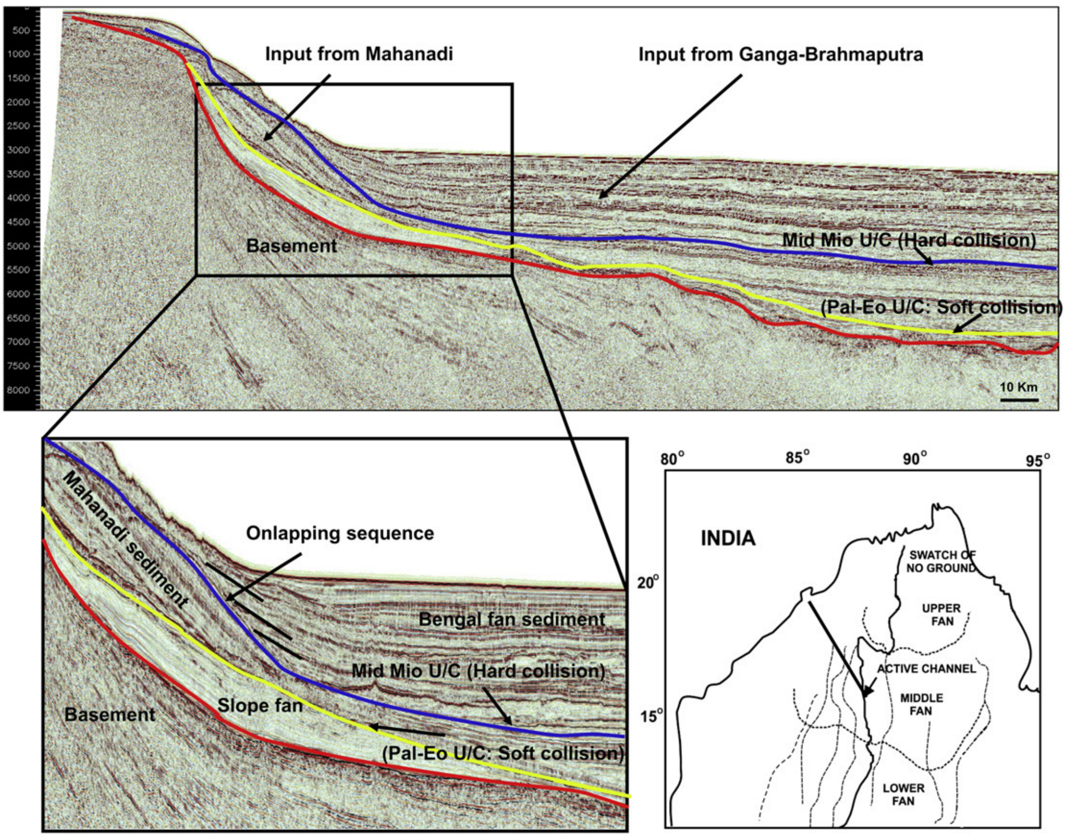

Fig. 5. Seismic section showing two systems that were active in different geological times. While river systems from west (Mahanadi and Godavari) were active during Pre-Eocene time, the Ganga–Brahmaputra dominated the Bengal fan system became active following the India-Asia collision. Major sequence boundaries related to tectonics are marked (see text for details).

slope also contributes sediments in the deeper basin. Despite the contribution from west (Mahanadi), it can be stated with certainty that sediment input after the "hard collision" is much higher from N–S river system in comparison to Mahanadi. In addition, the sediment dispersal pattern was also controlled by two major tectonic events (i) the emplacement of 85°E Ridge, and (ii) collision between Asian and Eurasian plates and uplift of Himalayas in the north. In view of this, we discuss the sediment dispersal pattern under the three broad divisions.

4.1.1. Pre-collision (>59 My)

Prior to soft collision (>59 My), no active depositional system has been reported from north and the major sediment supply in this part was mostly from west. The prevailing rivers Mahanadi, and Godavari can be considered as major sediment source in pre-collisional pre-Bengal fan time. The major tectonic event that affected the sediment distribution during this period was the emplacement of 85°E ridge (Fig. 6). Although the origin of this ridge is a matter of debate, its presence as pre-existing basement high significantly controls the depositional fairway for the Paleogene sediments. However, as the 85°E ridge was not present as a continuous structural high, minor sediment accumulation has been observed towards the east of the ridge within the sub-basin.

4.1.2. Between soft and hard collision (59 My–15 My)

During this time, the Bengal fan system was initiated and the sediment accumulation was mostly confined towards the northern part. A very week depositional fairway can be observed from the isochronopach map (Fig. 7a). The time slices in semblance volume presented in Fig. 7b and c shows the development of channel system from north which supplied the sediment further into the deeper part of the basin.

4.1.3. Post-hard collision (<15 My)

The "hard" collision marks the rapid rise of Himalaya and sediment supply increases manifold from this period onwards; the depocenter was also shifted southward (Fig. 8a). Many channel–levee systems have been developed which transport the sediment further into the abyssal plain forming splay deposits beyond the toe of the slope. Typical sequence in the proximal part of the fan shows vertical building of mud flow-splay-channel levee deposits (Fig. 8b and c). The active channel levee system is formed by erosion of inter channel lows with formation of HARP (High Amplitude Reflection Pattern) deposits (Weber et al., 1997; Schwenk et al., 2005). The levee is formed by overspilling of mud. HARP is also observed at the base of the channel and referred as splay/ frontal lobes in the study area.

4.2. Progradation of the Bengal fan with time

The scrutiny of available 2-D seismic lines from the present day proximal, middle and distal fan reveals continuous progradation of the Bengal fan with time. Fig. 9 shows three seismic lines that provide the strike-view of available western deep-water Bengal Fan sediments and is part of the present day upper fan. The Neogene section is interpreted in the context of a prograding submarine fan system, with a vertical change from unconfined distal lobe and fan fringe deposits progressively overlain by channelized units, and capped by a succession of very large channel–levee type systems.

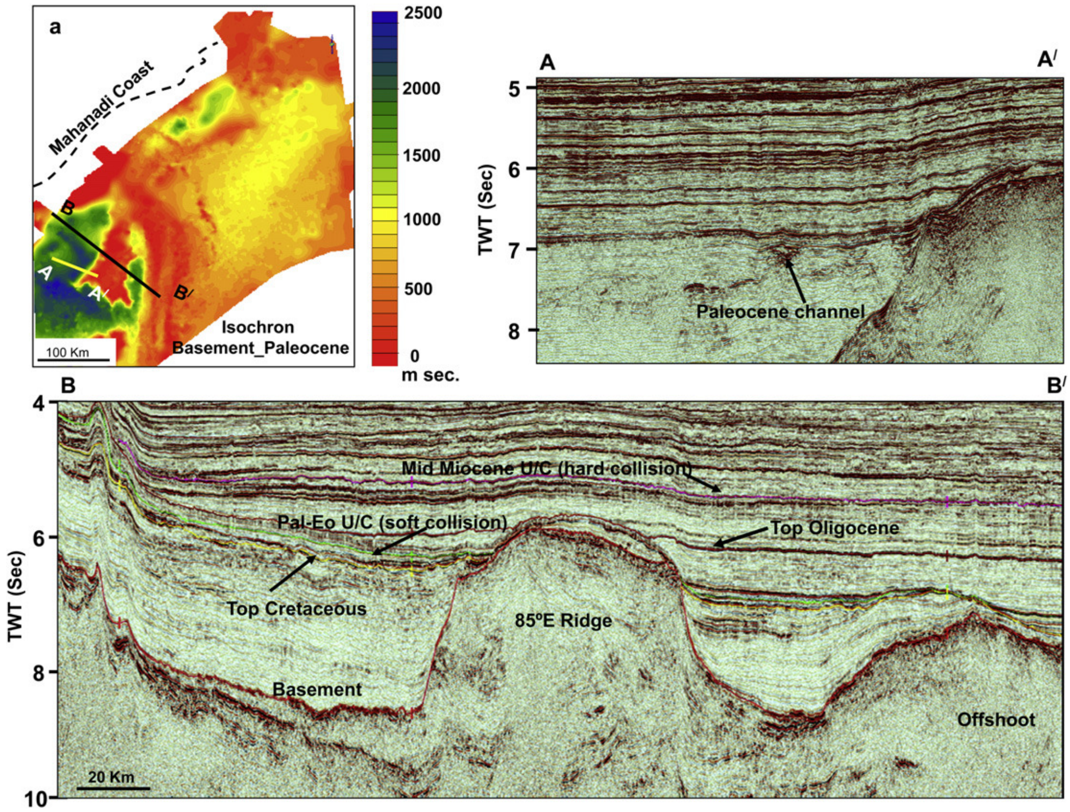

Fig. 6. Sediment isopach (in time) map of the study area showing the pre- "soft collision" (Pre-Eocene) sediment thickness. Important to note the Cretaceous depocenter towards west of the 85°E ridge, indicating that during this period ridge was acting as barrier for sediment supply towards east. The profiles (A–A′ and B–B′) shows prominent high amplitude channel towards western basin of 85°E ridge which wedges out against the ridge. Also important to note the presence of restricted mini basin on either side of the ridge which can be considered to have better source rock potential.

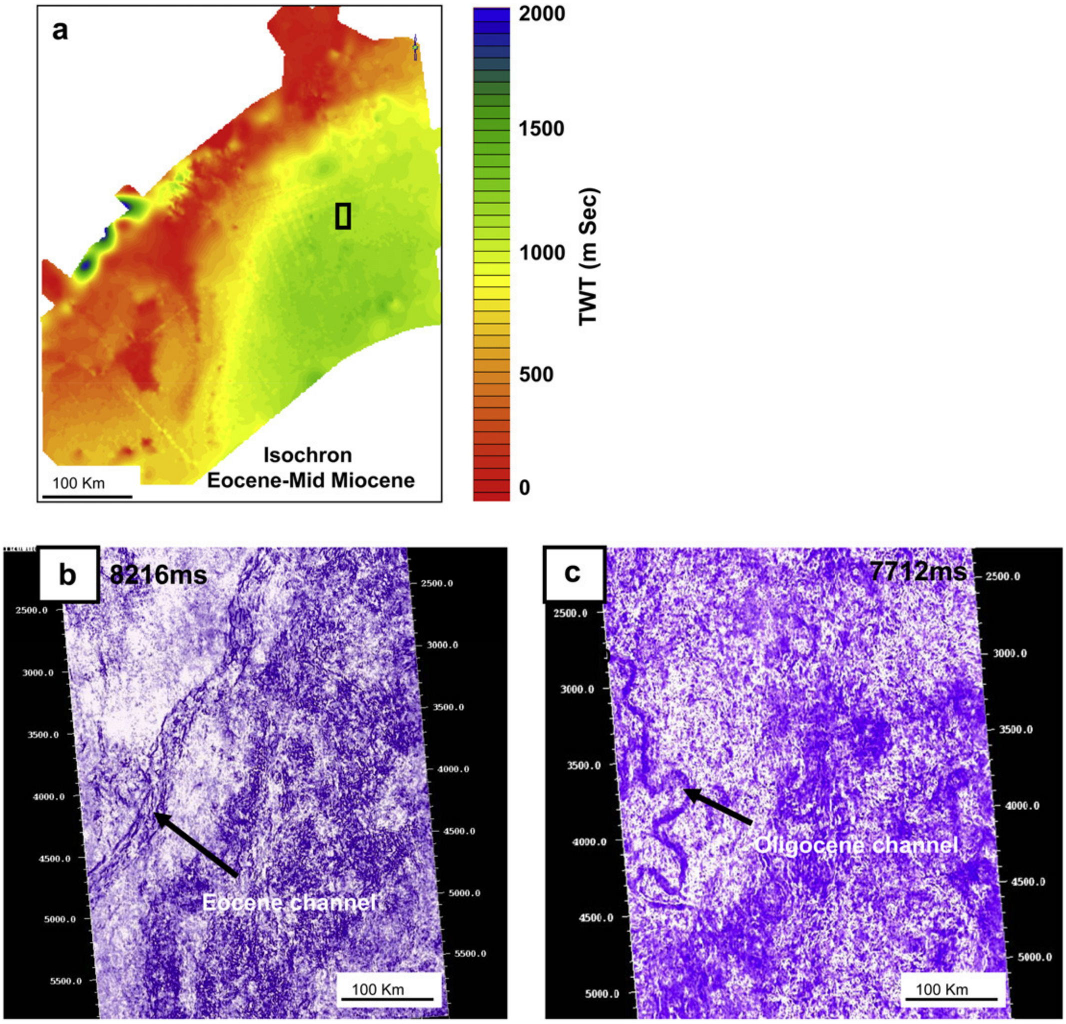

Fig. 7. (a) Sediment isopach (in time) map of the study area showing the "soft to hard collision" (Post-Paleocene to Mid-Miocene) sediment thickness. The map shows shifting of depocenter from west (before soft collision) towards east indicating initiation of Bengal fan during this time. Time slice equivalent to (b) Eocene and (c) Oligocene level showing presence of N–S trending meandering channel obtained from high resolution 3D seismic coherency volume which indicates that Bengal fan system was active as early as Eocene however channel activity was less compared to post hard collision growth of the fan.

The seismic lines in Fig. 10 provide a strike-section of western part of the deep-water Bengal Fan Sediments in the present day middle fan environment. The seismic sections record the progradation of the Bengal fan from lower to middle fan environments during the Neogene. The majority of the section in this area corresponds to the lower fan environment, with channel–levee height reduced considerably relative to the more proximal sections described above. The majority of Paleogene section consists of variable amplitude, continuous seismic facies with increasing truncation of reflectors into the Pliocene. The seismic lines in present day distal fan on the other hand records only lower fan lobes (Fig. 11). The parallel high amplitude reflection can be interpreted as occurrences of sheet sands in the frontal lobe.

Conceptual paleogeographic diagrams were constructed as part of this study and are presented for both the Miocene and Pliocene (Fig. 12). The major mud flow (Fig. 12a) deposits probably marks the major base level fall in the basin. Mud flows are observed within the upper fan region. The splay deposits are expected further down into basinal part. Comparison of Fig. 12a and b clearly shows southward progradation of overall facies with time. Sediment input from Mahanadi and Godavari is also schematically depicted, which indicates that even during Mio-Pliocene time there were times when sediment from Mahanadi were transported beyond the continental slope and formed unconfined sheet turbidites/ splay deposits.

4.3. *Reservoir potential of the deepwater depositional system*

With the advent of new technologies in the recent times exploration targets have been extended more into the deep water abyssal plains. The major element with respect to reservoir aspect of the system are channel levee complexes. In different fans, the sinuous channel levee system has been the focus of hydrocarbon exploration (Kolla et al., 2001). The possible depositional model for the Bengal fan is shown in Fig. 12. The major influx of sediments was from west in the pre-collision (Pre Eocene) time. Presence of 85° E ridge system gave rise to restricted mini basins that increased preservation potential for source rock because of restricted circulation. Thermogenic model best explains the hydrocarbon generation during this time. As discussed earlier, the input from the west also continues in the post-collision period. Wedges against 85°E ridge could also act as good entrapment locations for pre-Eocene petroleum system.

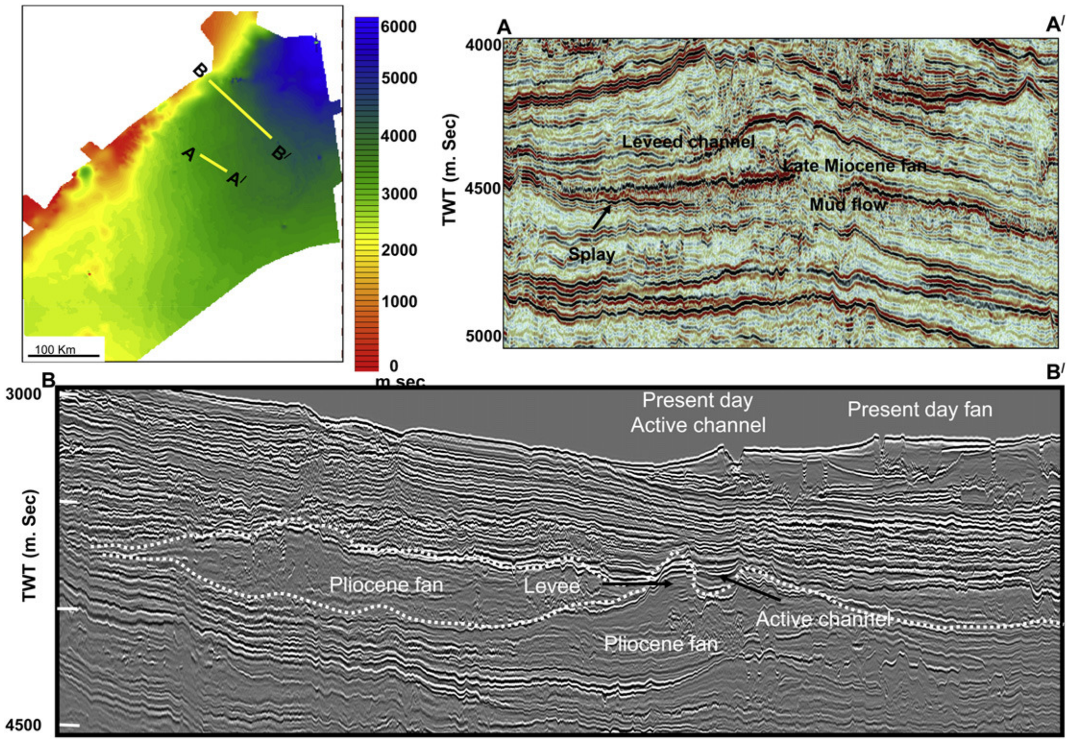

Fig. 8. Sediment isopach (in time) map of the study area showing the "post-hard collision" (Post-Mid Miocene) sediment thickness that indicates major depocenter towards north. The huge sediment loading is related to rapid rise of Himalaya and therefore much faster growth of Bengal fan which transport the sediment in deeper basinal part. Characteristic seismic facies during Miocene (A–A') and Pliocene (B–B') showing deep water sequence buildup involving mud flow followed by splay and followed by channel–levee facies. The location of present day active channel is shows in profile B–B′.

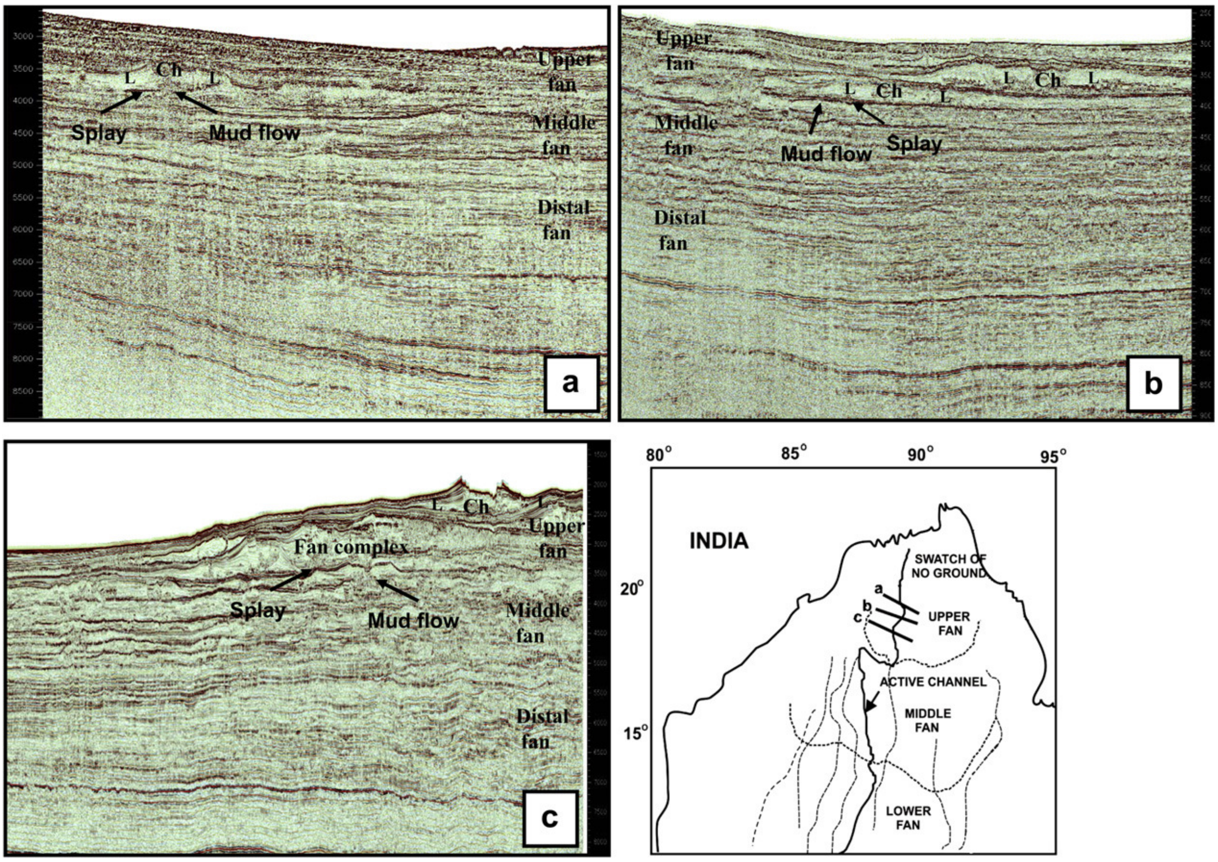

Fig. 9. Profiles (a–c) across the present day upper fan showing shifting of distal fan system to younger proximal fan therefore indicating continuous progradation of Bengal fan with time. The proximal part in shallower section is characterized by mud flow-splay and leveed channel.

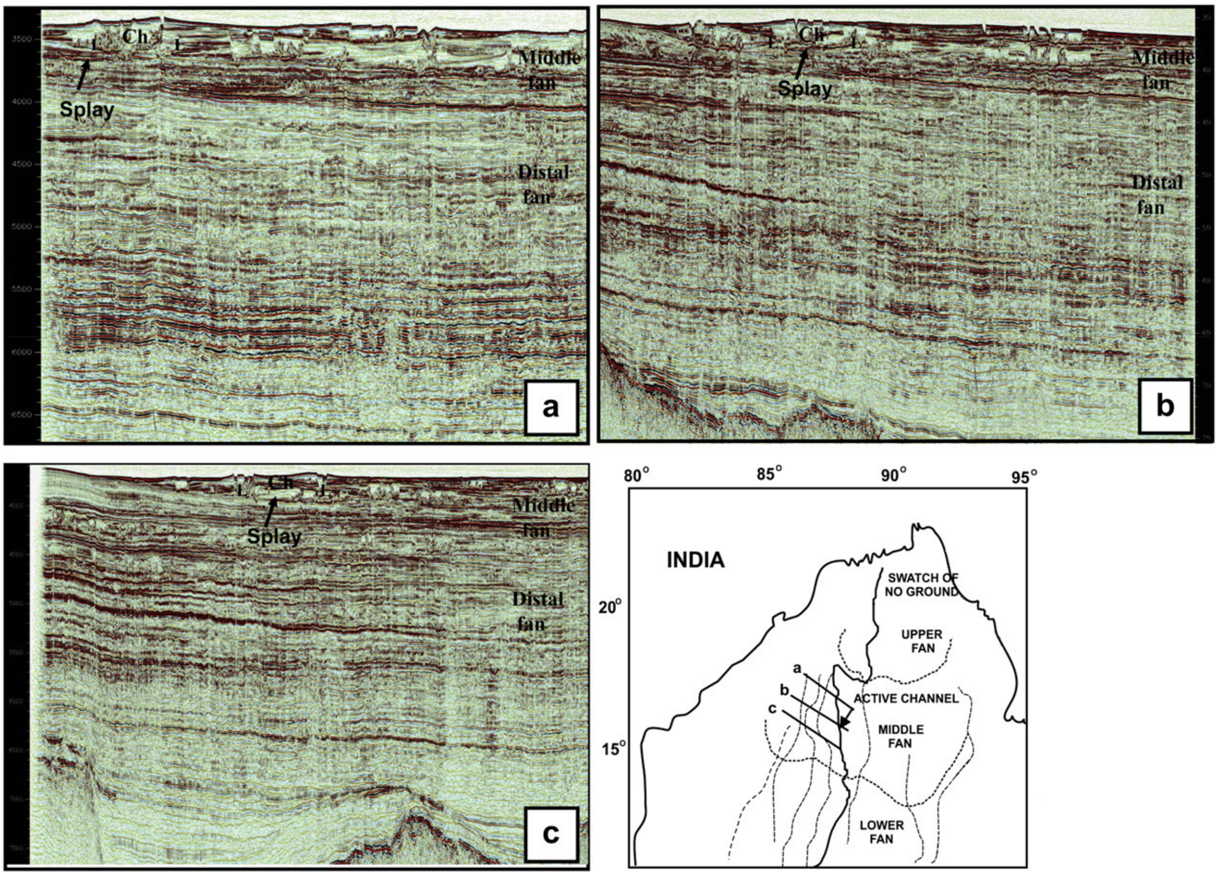

Fig. 10. Profiles (a–c) across the present day middle fan characterized by channel levee and splays. However, deeper section is mostly comprises of Channel–levee facies. Important to note the absence of mud flow in middle fan.

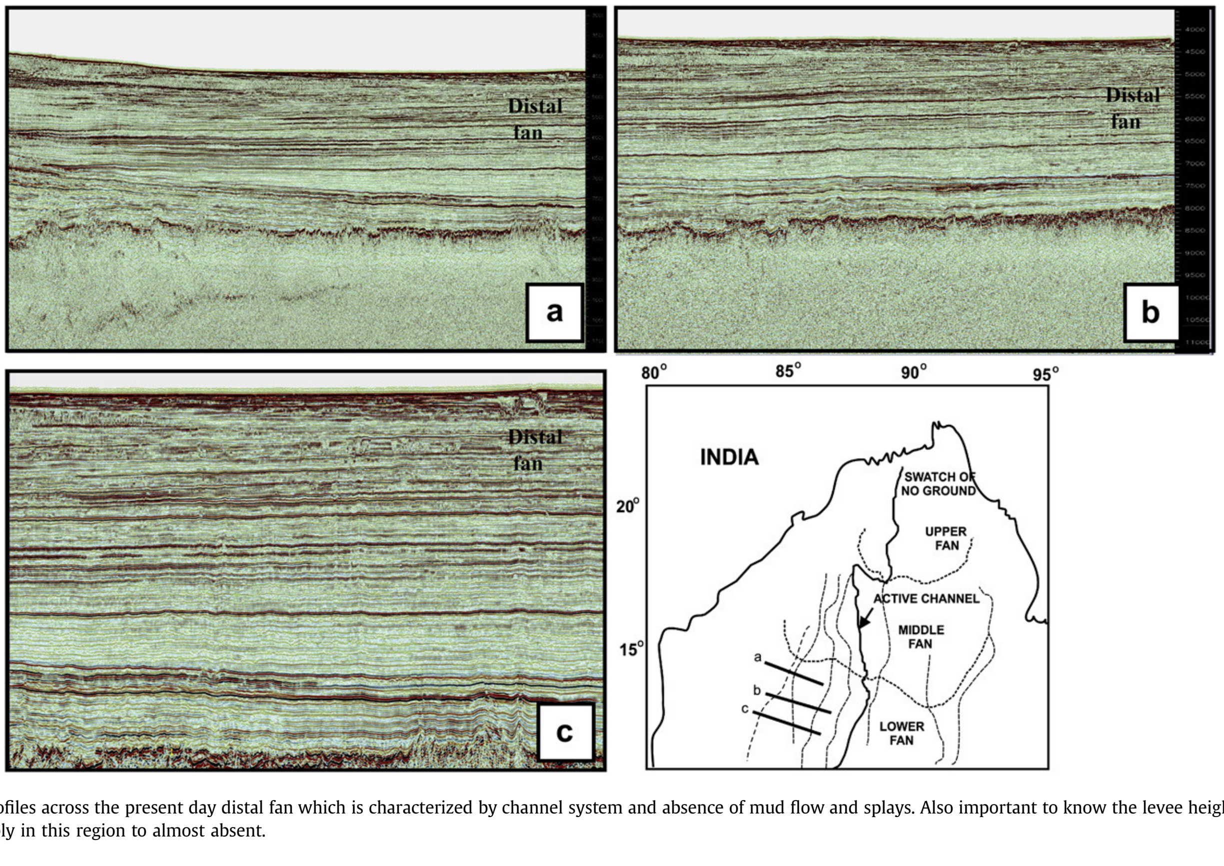

Fig. 11. Profiles across the present day distal fan which is characterized by channel system and absence of mud flow and splays. Also important to know the levee height reduces considerably in this region to almost absent.

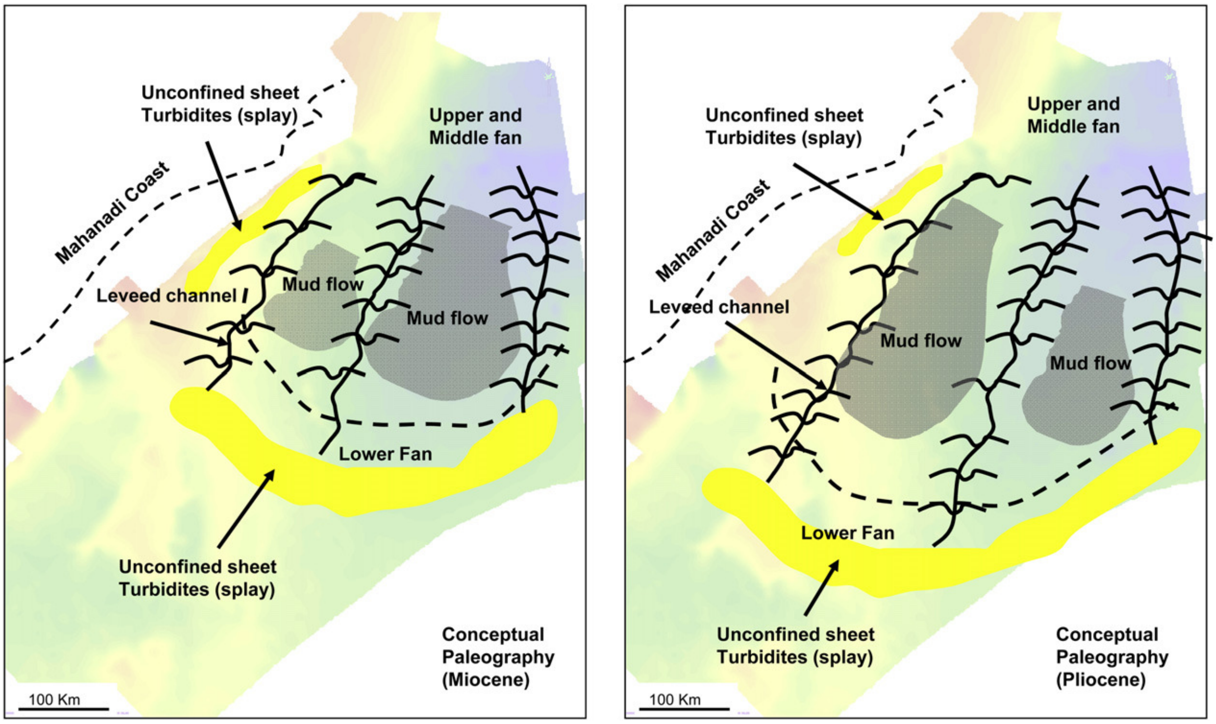

Fig. 12. Conceptual paleogeography in Miocene and Pliocene indicating seaward shifting of facies during progradation. The extent of mud flows and expected splay deposits are shown.

On the other hand, post-collision Bengal fan is believed to contain good reservoir because of its huge sediment supply. The possible location should be channel–levee complexes. The high amplitude reflection packets representing basin floor fan/frontal splay are also expected to have good reservoir potential provided connectivity and amalgamation of sand deposit are maintained (Kolla et al., 2001; Schwenk et al., 2005). It can be stated that the exploration target also depends on the location of sand deposit with respect to fan system. In the distal part, the frontal splay/basin floor is of more importance, whereas channel levee deposits play an important role in present day upper and middle fan. Unlike the deeper Cretaceous–Paleocene section the shallower Mio-pliocene petroleum system is more likely to have mixed thermogenic and biogenic source. Pure stratigraphic entrapment condition is expected for the younger section. For the mud rich system like the Bengal fan, vertical seal is not a problem, however, for updip seal, the truncation of reservoir facies by younger mud flows is favorable.

5. Conclusions

From the above analysis, the following conclusions can be drawn.

- Pre-collisional depositional pattern was controlled by emplacement of 85°E ridge that divided the basin into mini sub-basins. The restricted environment between basement highs provides good opportunity to develop hydrocarbon source rock facies.
- Post-collisional depositional pattern in the study area is interplay of different system from N–S and NW–SE. While, the N–S trending Bengal fan trend became more prominent after post-Mid Miocene ("hard" collision) period, there were times when the deeper part received sediments from Mahanadi also.
- Although channel levee deposits are of prime interest for reservoir facies, the frontal splay/lobes are expected to have better reservoir quality because of higher sand–mud ratio. Very high sediment input in the post-mid Miocene onwards resulted in supply of sediments to much deeper parts and sand bearing frontal splay could also be focus of interest from a hydrocarbon reservoir point of view.

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Annex IN-38

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Feasible Solution of Protection and Adaptation Strategy for Coastal Zone of Bangladesh

Md. Mafizur Rahman[1], Shishir Kumar Biswas[2]

Abstract

The Bay of Bengal is the breeding ground for tropical cyclones and Bangladesh is the worst victim in terms of fatalities and economic losses incurred. Among the 508 cyclones that have originated in the Bay of Bengal in the last 100 years, 17 percent have hit Bangladesh, amounting to a severe cyclone almost once every three years. Of these, nearly fifty three percent have claimed more than five thousand lives. The high number of casualties is due to the fact that cyclones are always associated with storm surges. Storm surge height in excess of 6m is not uncommon in this region. The elevation of land is around 12 feet at 2.5km from the sea shore where it is around 22 feet at 100km inland from the sea shore in western and central regions of the country. Moreover there are many low lands, flood plains, rivers and channels within this 100km range. Thus the southern regions usually go under water during surge and face uncountable damage by destructive wind speed. Agricultural fields lose fertility due to erosion, sedimentation, sea-spray and saline water intrusion. Damage of crops and vegetations affects national food production and security. Loss of lives, livestock, damage of crops, contamination of water sources, destruction of house, transportation system, embankment and other development structures not only stop the flow of livelihood at a sudden, these infirm the long term social, health care, economic development and policy of the government. Every year, huge amount of budget needs to allocate for relief, medication, subsidy and post-disaster phase of socio-economic recovery, reconstruction and maintenance works in coastal area.

During the disaster, there is shortage of water supply and food apart from the loss of homestead, crop and livestock. Loss of the rural roads leads to a missing link for the supply of relief and rehabilitation facilities at the quickest possible time. This paper aims at a conceptual protection and adaptation strategy for the coastal population of Bangladesh at an affordable manner. The recommended strategy involves minimum intervention to the existing locality and thus a minimum of cost being involved with the maximum possible facilities to available at the end of the victims specially during and immediately after the disaster. The main theme of the adaptation strategy is the modification of the landscape to the smallest extent in order to facilitate the shelter for human being and livestock, storage of harvested crop, water supply, sanitation and the transportation network. Feasibility of the proposed theme has been analyzed from different direction applying scientific logics. Species of the salt tolerant crops have been mentioned targeting the food and job security. The paper proposes the minimum coastal zone that should be brought under the adaptation strategy at the initial pilot stage. The ecological balance of the affected locality is also considered in the adaptation strategy as well.

Key word: Cyclone, adaptation, landscape, wetland, mangrove, species, salt tolerant crop.

Introduction

The coastal zone of Bangladesh, an area covering 47,211 km² facing the Bay of Bengal or having proximity to the Bay, and the exclusive economic zone in the Bay (Islam, 2004), is generally perceived to be a zone of multiple vulnerabilities. Records of last 200 years show that at least 70 major cyclones hit the coastal belt of Bangladesh and during last 35 years nearly 900,000 people died due to catastrophic cyclones (Islam, 2004). The government of Bangladesh has already identified the zone as “vulnerable to adverse ecological process” (ERD, 2003). The opportunities and potentials of the zone have not received much attention, and also the disaster mitigation approaches are seen as curative measure rather than protective, which make questions for sustainable coastal belt planning and development.

To improve the overall situation, comprehensive long term disaster management is necessary. Cyclone shelter, embankment have insignificant role to mitigate the impacts of disaster. The best way is to introduce natural protective barriers with proper planning and design. In this paper the role of several components of nature in disaster mitigation has been described and a combined design and strategy have

[1] mafizur@gmail.com, Bangladesh University of Engineering & Technology.
[2] shishir_40@yahoo.com, Bangladesh University of Engineering & Technology.

been mentioned. The design will be easy to implement in an affordable cost and people will get opportunities to involve in alternate income generating activities; improvement of overall production and health situation. In the initial stage this strategy can be experienced in a coastal island to evaluate its grade of sustainability.

Vulnerability of coastal area

Bangladesh is situated at the interface of two contrasting settings with the Bay of Bengal and the North Indian Ocean to the south and the Himalayas to the north. The geographical location, low and almost flat topography, very high population density, etc. have made this country one of the most vulnerable countries of the world to be affected by the impact of climate change. The funnel-shaped northern portion of the Bay of Bengal causes tidal bores when cyclones make landfall and thousands of people living in the coastal areas are affected. Of the 508 cyclones that have originated in the Bay of Bengal in the last 100 years, 17 percent have hit Bangladesh, amounting to a severe cyclone almost once every three years (GoB, 2008). From the statistical analysis of the recorded cyclones over the last 200 years, it has been found that number of occurrences of major cyclones has drastically increased in the recent decades. While the number of cyclones was 3 during the period of 1795-1845 and 1846-1896 respectively, the number increased to 13 during 1897-1947 and 51 during the period of 1848-1998.

The country has three distinct coastal regions, namely the western, central and eastern regions. The western zone is very flat and low and is crises-crossed by numerous rivers and channels. The central region is the most active one and continuous process of accretion and erosion is going on there. The eastern region is covered by hilly areas and it is more stable and has a long beach there. Some parts of western region have the capacity to stand against cyclone disaster where Sundarban, the largest mangrove forest exists. But the other parts of the coastal area have no significant protective barrier to dissipate the cyclone and tsunami energy. It is observed that the elevation of land is around 12 feet at 2.5km from the sea shore where it is around 22 feet at 100km inland from the sea shore in western and central regions of the country. Moreover there are many low lands, flood plains, rivers and channels within this 100km range. The elevation of those areas varies from 12 feet to 18 feet. In fact the major portion of land here is this type. As a result, in any types of moderate cyclone, the devastating impact expands more than this range. Bank erosion, saline water intrusion, and inundation in large scale are common matters in every cyclone disaster. The reality can also be found from the recent cyclone “AILA” hit Bangladesh at May 25, 2009. Maximum average wind speed was 110 km/h. The range of inland area affected by this disaster has been shown in Figure 1. It was reported that crops of about 323454 acre, 613778 households were fully or partially damaged and 3928238 peoples were affected in this cyclone (DMB, 2009). The wind speed of the previous cyclone landfall Bangladesh varied from 85 km/h to 260 km/h caused strong surge of height up to 7.8m. The Multi-purpose Cyclone Shelter project (MCSP) in Bangladesh (1993) modeled storm surge along the Bangladesh coast with the help of GIS. MCSP also prepared a table which shows surge height for cyclones of varying strength in Bangladesh (Table 1).

Table 1: Typical storm surge height for cyclones of varying strength in Bangladesh

Wind velocity (Km/h)	Storm surge height (m)	Wind velocity (Km/h)	Storm surge height (m)
85	1.5	195	4.8
115	2.5	225	6.0
135	3.0	235	6.5
165	3.5	260	7.8

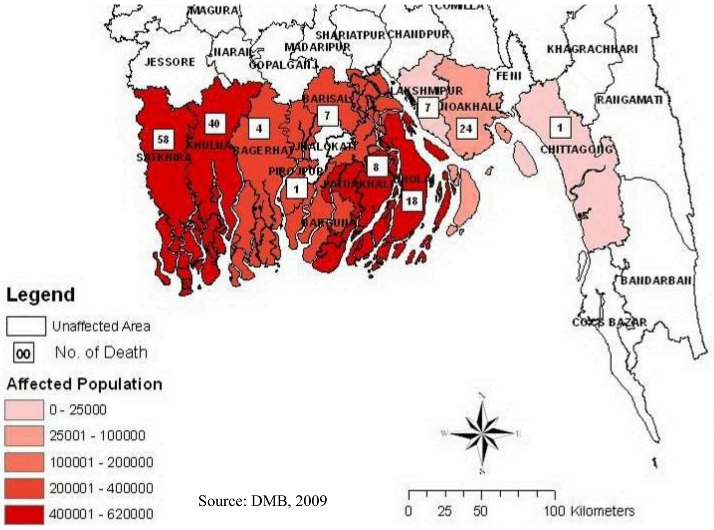


Figure 1: Range of inland area affected by cyclone "AILA"

Protection by improved coastal natural barrier

Cyclone and after cyclone situation analysis revels that for any types of moderate cyclone, the common occurrences are, i) destruction due to wind force and surge, ii) loss of lives, livestock and crop by tidal wave, iii) loss of soil fertility for spread of sea-spray, saline water intrusion and sedimentation, iv) water source contamination v) extensive environmental pollution, vi) spread of diseases and vii) unemployment and starvation. Embankment and cyclone shelter have very little protective capacity of these occurrences. But to resist the devastative impacts of cyclone it is necessary to develop natural protective barrier in a planned way changing coastal landscape considering all kind aspects as much as possible. In this context the following combined design of landscape from seashore to several kilometer inner lands may provide significant assistance to overcome almost all kinds of impacts of cyclone disaster and tsunami.

Zone of storm wave-sediment interaction

A range of seashore goes under water during high tide everyday and leaves it as bare land during ebb. If a 500-800 meter width of land area including the tidal area of interference can be kept as bare land it will act as "Zone of storm wave-sediment interaction". It can slow hurricanes, reduce their wave energy and protect the interior wetland. This land has the capacity to absorb incoming wave energy. It is the one side benefit and the other side is this extended bare land can be effectively used for the improvement of tourism industry in the country. The coastal people will get alternate source of employment facilities reducing the dependence on risky job of fishing in the ocean.

Wetland

Wetlands act as sponges to soak up excess water. Coastal marshes serve as storm surge protectors and help to reduce storm damage when hurricanes or tropical storms come ashore. Inland wetlands function like natural tubs, storing flood waters that over-flood riverbanks, surface areas and protecting adjacent and downstream property. According to EPA (2001), a one-acre wetland can typically store about three-acre feet of water, or one million gallons. An acre-foot is one acre of land, about three-quarters the size of a football field, covered one foot deep in water.

In the seaward side wetland, several water and salinity resistive plants and crops can be cultivated to yield more food production. But the main challenge is to identify the level of salinity and types of species, which can grow in that level and have high food or market value. Local name of some oryza species, Jamainaru, Lakshmikajal, Patnai Balam, Horkuch, Morichshail, Ashfal, Raniselute, Kajalshail, Pokkali, Nona Bokra and salt tolerant modern varieties (SMVs) IR29, BRRI dhan 29, BRRIdhan 40, BRRIdhan 41 etc. have high potential in saline environment (Laisa, et al, 2004).

The interior wetland has also some capacity to impart strength to the total protective system dissipating cyclone energy. Water enters into the interior low land during surge remain longer period getting no way to drain away. Proper management of this wetland may provide diverse benefit in normal time as well as in time of emergency. In normal season water and saline tolerant crops or mix cropping system can be exercised. New invented paddy, Swarna Sub1, BR11 Sub1, IR64 Sub1 and Sambamasuri Sub1 are highly recommended at this zone. The attractive features of these species are the sustainability in flood water or inundated condition more than 15days and short time period of harvest. In case of 12 months inundation this zone can be utilized for fish culture. After cyclone disaster, interior wetland can act as waterway of transport. It will make possible to send relief goods using waterway immediately after disaster to the affected groups.

Forest

Forests and tree roots provide a protective cover of vegetation that anchors soils, slows and soaks up water runoff. Deforestation worsens the impacts of hurricanes and other storms, increasing the likelihood of mudslides and flooding. Studies show that coastal forests like mangroves and cypress stands shield the coastlines by reducing wave height and energy. Areas buffered by mangroves were less damaged by the 2004 tsunami than areas without tree vegetation. Mangroves trap and stabilize sediment and reduce the risk of shoreline erosion because they dissipate surface wave energy. It is the attribute that makes mangroves a potential natural solution for particular coastal protection problems.

The fact that surface waves propagating within a mangrove forest are subject to substantial energy loss due to two main energy dissipation mechanisms: (1) multiple interactions of wave motion with mangrove trunks and roots; and (2) bottom friction. The resulting rate of wave energy attenuation depended strongly on the density of the mangrove forest, the diameter of the mangrove roots and trunks and on the spectral characteristics of the incident waves. Typically, wave energy is attenuated by a factor of 2 within 50 meters of the front of the mangrove forest. Hence, the wave heights are typically attenuated by a factor of square root 2 given that the wave energy is related to the square of the wave height (Braatz et al., 2007). The role of mangroves in reducing the sea-waves has been scientifically proved. For instance, a six-year-old mangrove forest of 1.5 km width will reduce 1 m high waves at the open sea and 0.05 m at the coast (Mazda et al., 1997). Energy dissipation is not only the main protective activity of forest against cyclone. Sea-spray enters and spread in the coastal area and inland with wind. Mangroves reduce the wind speed and capture sea-spray. It increases the turbulent flow of sea-spray, provides rough surface and easily capture the sediment and sea-spray.

But position, height, width, continuity and density of plants and trees are very important to consider for the reduction of wind speed, strength and direction. Plants with loosely dense and low height should be in the front position seaward side. The medium dense and moderate height plants should be in the middle position and finally most dense and tallest trees should be planned after the medium height mangrove row.

Stabilized elevated bank

An elevated land with sufficient stability is necessary to build up after the end of mangrove belt. Alignment, elevation, width, layer by layer compaction and slope should be designed properly. To impart more stability in affordable expanse, mat made of jute or scrap cloth can be used. In most vulnerable areas or where more protection is needed, concrete sea-wall with proper design need to be constructed.

The elevated bank creates wave reflections and promotes sediment transport offshore. It should be constructed along the whole coastline; if not, erosion will occur on the adjacent coastline. From the previous study it is found that only sea-wall, embankment or elevated land easily get eroded and damaged. But mangroves before sea-wall or embankment stabilize those structures and protect from wind speed and tidal wave.

Human habitat

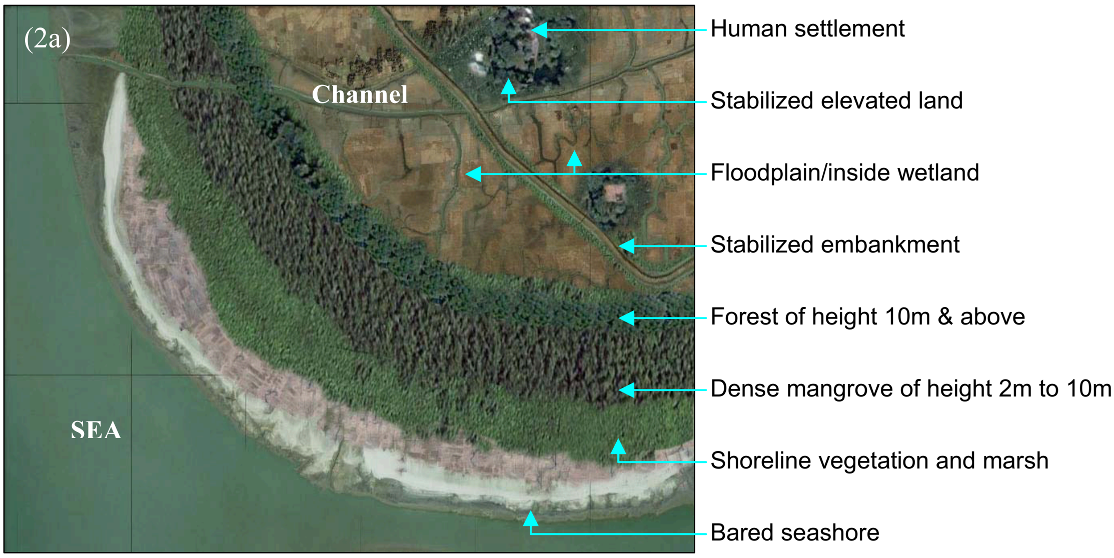
Human settlement in most of the coastal areas in Bangladesh is isolated and unprotected. Devastating wind force and surge easily attack the unsupported houses and other structures with full energy. For this, though the recent developed warning system providing decent role in evacuation but the resource damage is not decreasing substantially. To improve this conditions some specific areas should be taken under development plan. Housing and other structures should be built on elevated land which will remain beyond the normal flood level. This developed land should have stable slope and soil protective vegetations. Housing and other structures will be supported by tall and dense trees. People will live there in community based and there should have adequate facilities of potable water supply and sanitation.

Emergency response

It becomes the main task to shift people of vulnerable areas to cyclone shelter or other safe area before the landfall of cyclone. Most of the cases, the time available for evacuation are far less than the time required. If the time of approach of disaster is possible to extend, more life will be saved and large margin of resources can be restored from damage. There are some species like Sonneratia, Kandelia candel etc. can increase the arrival time of tsunami a lot and save lives and livestock by giving enough time to shift them to shelter. It was predicted with empirical evidence that Sonneratia and Kandelia candel forest of 1 m width can defer the time of Tsunami attack by 727 and 343 seconds respectively (Braatz et al., 2007).

Post disaster relief distribution activity and to reach adequate food, water and medication are very important to support the affected peoples. Damage of roads, embankment and other infrastructure make this very difficult. But if there are alternate provisions to transfer goods and emergency facilities to the affected areas, significant number of post disaster causalities and spread of diseases can be prevented.

Considering all kinds of aspects, affects of disaster, land characteristics, human behavior and action plan of Bangladesh government disaster management, an improved coastal design and strategy has been developed that is presented in figure 2a & 2b.



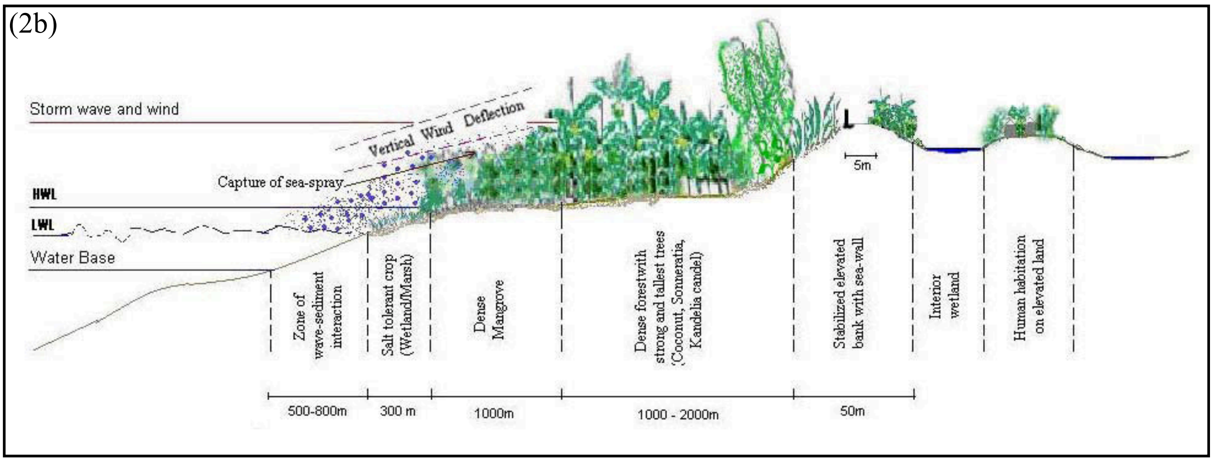


Figure 2: (a) Arial view of the proposed design of coastal area **(b)** Cross section of the proposed design of coastal area (including sea-wall)

Features of the proposed design

The main feature of the proposed design and strategy is to assure more involvement of natural barrier in a planned way. Other characteristics are as follows

- 500-800 m zone of wave sediment interaction
- At least 1km wide marsh and mangrove belt after previous zone
- Cultivation of Salt and water tolerant crops in seaward side before mangrove, which will act as marsh.
- Trees with loosely dense and low height in the front position seaward side, the medium dense and moderate height trees in the middle position and finally most dense and tallest trees will be planted after the medium height mangrove row.
- Build up 25m wide and 4m high elevated land with 5m wide crest. Proper compaction, slope stability, mangrove and vegetation before embankment must be assured. Construction of concrete sea-wall where necessary.
- Reforestation as long as possible in interior side from embankment.
- Preservation of low land and flood plain
- Fish culture or cultivation of submerged crops in floodplains and low lands
- Human settlement on stabilized elevated lands having proper communication system.

Implementation of the proposed design and strategy will provide benefits in four ways. All parts of the design have specific role in disaster mitigation, protection of lives and resources, improvement of living standard and preservation of coastal environment as a whole. These are separately described in table 2.

Except sundarban area, the proposed design can be implemented in almost all parts in coastal area since major development has not yet been done here and these areas remain in unprotected condition. To evaluate the effectiveness and sustainability of the proposed design, “Char Manica” (22°08′N and 90°41′E) can be a suitable area to implement it as a pilot project. The whole take should be performed on the basis of priority analysis. Some parts of the area need to bring under instance adaptation action in the first stage then the next stage should be completed as shown in figure 3.

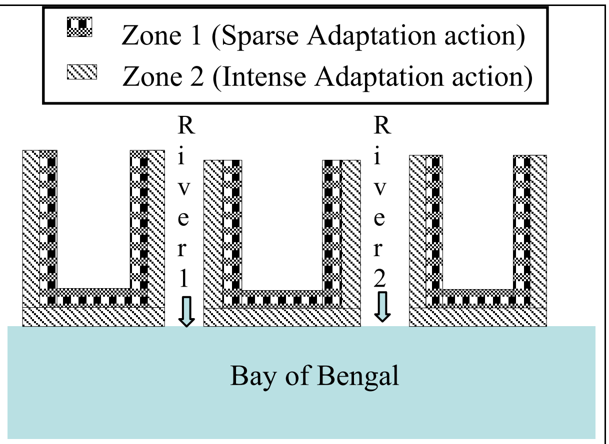


Figure 3: Priority of area under adaptation

Table 2: Beneficial role of different components of the proposed design and strategy in coastal area

Component	Beneficial role			
	Disaster mitigation	**Protection of lives and resources**	**Living standard and resource development**	**Preservation of environment**
Zone of storm wave-sediment interaction	Absorb tidal energy and protect sea-ward wetland	Reduce cyclonic power	Improvement of tourism, employment facilities	Coastal biodiversity conservation
Wetland/Marsh land	soak up excess water, increase of friction force	Surge height reduction	Cultivation of salt tolerant crops, food production, alternate income generation activity, less dependence on fishing in ocean	Absorption of polluted matter, improvement of coastal ecology
Forest/Mangrove	Reduction of wave energy, wind force, runoff, surge height, sea-spray, sediment transport, land erosion, increase of bank stability, tsunami approach time and change of wind direction	Decrease of sudden shock of disaster, death toll, loss of soil fertility, damage of house, embankment, infrastructures, crops and vegetations.	Collection of fruits, flowers and leaves with high medicinal, honey, wood and other materials. Improvement of tourism, employment facilities	Improvement of wildlife, ecosystem and coastal stability. Minimization of post disaster environmental pollution.
Elevated bank	Strong protective barrier to lessen impact of disaster	Act as protective land to facilitate transport and stay of lives temporarily	Serve as way of transport to carry products to growth center	Protection of interior lands and water bodies from contamination, salinity and sedimentation.
Interior mangrove and low land	soak up more water and impart more protection	Preservation and stabilization of land for human habitation.	Vegetation, crop cultivation and fish culture	Salinity reduction and ecological balance.
Protected human settlement	Act as island during flood and inundation	Protection of lives and livestock from tidal wave	Stable habitation, decrease of migration rate.	Minimization of pollution from causalities.

Feasibility

The proposed coastal landscape will not be difficult to implement if necessary steps are taken from local level to national level identifying it as priority issue. Some question may arise of availability of specific plant and mangrove species provide best performance. But those species are not rare in Bangladesh coastal region. Moreover, there is Sundarban, the largest mangrove forest in the world having 334 species of trees, shrubs and epyphites (BFD). According to BFD, 1,39,700 hectare forest land of Sundarban remains in Bangladesh section is declared as World Heritage Site. The main tree species in this forest are Sundri (Heritiera fomes), Gewa (Excoecaria agallocha), Keora (Sonneratia apetala), Baen (Avecennia officinalis), Dhundul (Xylocarpus granatum), Passur (Xylocarpus mekongensis) etc with 15cm and above diameter. Sundri is the most important tree in the Sundarban which is distributed over 73% of the reserve. Extent of Sundri is followed by Gewa, Baen, Passur, Keora etc . Mangrove afforestation along the entire southern coastal frontier is an innovation of foresters. The forest of central and northern districts covering an area of 1,20,000 is intermingled with the neighboring settlements and fragmented into smaller patches. Sal (Shorea robusta) is the main species in central and northern districts with other associates like Koroi (Albizzia procera), Azuli (Dillenia pentagyna), Sonalu (Cassia fistula), Bohera (Terminalia belerica), Haritaki (Terminalia chebula), Kanchan (Bauhinia acuminata), Jarul (Lagerstroemia speciosa), Jam (Syzygium spp) etc. Some non-mangrove species also available in Bangladesh like Hijlibadam (Anacardium occidentale), Neem (Azadirachta indica), Bash (Bambusa arundinacea), Latkon (Bixa orellina), Sondal (Cassia fistula), Bilati jhau (Casuarina equisetifolia), Narikel (Cocos nucifera), Jhal (Salvadora persica), Ritha (Sapindus emarginatus), Dumla/Poreshpipal (Thespesia populneoides Kostel), Nishinda (Vitex negundo) (WAFC) have multiple benefits for toughening coastal environments against the negative impacts of wind and water.

Casuarina is one species that is both tall and quite salt-tolerant and can be used on the landward side of the shelter behind the low-level protection afforded by shorter species. This species is very durable, and can survive in powerful storm surge. Rhizophora apiculata and Rhizophora mucronata are two species commonly used in mangrove restoration and afforestation. Their stilt roots provide extra support against strong winds and the wave action of tropical cyclones and tsunamis (Selvam et al., 2005).

Hurricane surges that are catastrophic (i.e., 7-20 feet) rapidly submerge marsh vegetation, but not forested wetland vegetation. Surge waves moving over marches get a rougher bottom than a smooth sediment. For the combined purposes of reducing wind speed, increasing salt deposition and reducing storm surge in coastal areas, however, wider shelters is advantageous. The “rough” surface created by the shelter belt increases the size of turbulent eddies and brings more small droplets and salt particles into contact with the vegetation, where they can be captured and prevented from travelling further inland.

Windbreaks substantially reduce wind speed on the windward side for a horizontal distance of 2–5 H, where H is the height of the barrier (Figure 3). U is wind speed in the lee of the shelter and U_o is the speed at the same location if there were no shelter. Windbreak height (H) is the most important factor determining the downwind extent of the sheltered region and usually is employed as the measure of its length. In shelterbelts with species of various heights used throughout the belt, the average height of the tallest species usually is taken to represent H. Since the coastal zone of Bangladesh is funnel shaped, the tracks of cyclone attacked before found to be passed nearly at right angle to the central coast line i.e. the incident of attack IA is nearly 90º. The proposed design is a combined landscaping with tallest trees having height 10m and above at the end of the belt. Analyzing the figure 4 it can be obviously said that implementation of the design will reduce the devastating wind speed significantly.

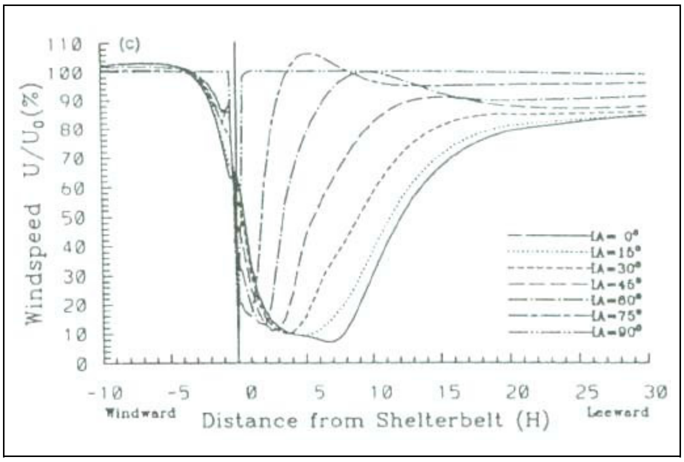


Figure 4: Percentage reductions in wind speed (U) upwind and downwind of a shelterbelt of width 1 H for various attach angles (IA) of the wind. (Source: Braatz et al., 2007)

The coastal region of Bangladesh is still unprotected and human habitation is not developed. Bare land, haphazard human settlement is the common characteristics of central southern coast. But the population is increasing day by day. So, it is the right time to take necessary steps for comprehensive research of selecting best options to meet all kinds of issues and integrated actions to develop a rigid protective coastal barrier.

Government Strategy and the proposed concept

The Government of Bangladesh (GoB) is committed to increase the resilience to coastal disaster; reduce the risks coastal disaster poses to national development; and rapidly develop the country. GoB has the Climate Change Action Plan which is a 10-year programme (2009-2018) to build the capacity and resilience of the country for meeting the challenge of climate change. The needs of the poor and vulnerable, including women and children, will be mainstreamed in all activities under the action plan. In the first five year period (2009-13), the programme will comprise six themes with sub programmes of each theme (MoEF, 2008). It is required to mention that the proposed design and strategy in this paper for coastal areas in Bangladesh directly or indirectly supports almost all the themes selected by GoB. More specifically the supported themes (T) and sub programs (P) are as follows-

- Food Security, Social Protection and Health (T1)
- Improvement of cyclone and storm surge warning (T2P2)
- Risk management against loss on income and property (T2P4)
- Repair and maintenance of existing coastal polders (T3P3)
- Adaptation against tropical cyclones and storm surges (T3P6)
- Preparatory studies for adaptation against sea level rise (T4P3)
- Monitoring of ecosystem and biodiversity changes and their impacts (T4P4)
- Afforestation and reforestation programme (T5P7)
- Revision of sectoral policies for climate resilience (T6P1)
- Strengthening human resource capacity (T6P3)
- Strengthening institutional capacity for climate change management (T6P4)

Conclusion

Coastal disaster management associated with food and life are the major concerns of coastal countries throughout the world. Every year GoB need to allocate a large amount of budget for cyclone disaster management, coastal development, repair and maintenance. Large number of cyclone shelter has already been made and warning system is modernized. These are contributing to minimize death toll a lot. But integrated management for preservation of land, embankment, infrastructure, water sources and overall environment from severe cyclone are not been seen yet. The dispatch of food, goods, medication and after disaster relief distribution system are still facing great difficulties for lack of proper planning and damage of routes. It is found that the overall damage and losses due cyclone Sidr was US$1674.9 Million. But if the Sidr effect could be minimized 20%, around 335 million dollar would be saved from instant losing and this could be used for more development works. The main feature of the proposed coastal design and strategy in this paper is to mitigate the affects of disaster by introduction of natural protection systems as much as possible and simultaneously, development of adaptation capacity of the local community with maximum utilization of existing environment. In one side, protective barrier will minimize the disaster effects; preserve the land fertility, potable water sources, infrastructures and resources. In other side, salt tolerant submerged crops, wetland and forest will give people more opportunities to yield more, improving living standard and adding additional in national income. Conservation of bio-diversity and ecosystem balance is also a crucial part of the proposed strategy.

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Annex IN-39

List of Agreements concluded by India with neighbouring countries.

Indonesia

Agreement between the Government of the Republic of India and the Government of the Republic of Indonesia relating to the delimitation of the continental shelf boundary between the two countries (with annexed chart), 8 August 1974 (entry into force: 17 December 1974);

Agreement between the Government of the Republic of India and the Government of the Republic of Indonesia on the extension of the 1974 continental shelf boundary between the two countries in the Andaman Sea and the Indian Ocean, 14 January 1977 (entry into force: 22 December 1980);

Maldives

Agreement between India and Maldives on Maritime Boundary in The Arabian Sea and Related Matters, 28 December 1976 (entry into force: 8 June 1978).

Myanmar

Agreement between the Socialist Republic of the Union of Burma and the Republic of India on the Delimitation of the Maritime Boundary in the Andaman Sea, in the Coco Channel and in the Bay of Bengal (with maps), 23 December 1986 (entry into force: 14 September 1987);

Sri Lanka

Agreement between Sri Lanka and India on the boundary in historic waters between the two countries and related matters (with map), 26 and 28 June 1974 (entry into force: 10 July 1974);

Agreement between Sri Lanka and India on the maritime boundary between the two countries in the Gulf of Mannar and the Bay of Bengal and related matters (with map), 23 March 1976 (entry into force: 10 May 1976);

Supplementary Agreement between Sri Lanka and India on the extension of the maritime boundary between the two countries in the Gulf of Mannar from position 13 m to the trijunction point between Sri Lanka, India and Maldives (point T), 22 November 1976 (entry into force: 5 February 1977);

Thailand

Agreement between the Government of the Kingdom of Thailand and the Government of the Republic of India on the delimitation of sea-bed boundary between the two countries in the Andaman Sea (with chart and exchange of notes), 22 June 1978 (entry into force: 15 December 1978);

Agreement between the Government of the Kingdom of Thailand and the Government of the Republic of India on the maritime boundary in the Andaman Sea from point 7 to the tri-junction point T, 27 October 1993 (entry into force: 17 January 1996);

Indonesia and Thailand

Agreement between the Government of the Kingdom of Thailand, the Government of the Republic of India and the Government of the Republic of Indonesia concerning the determination of the trijunction point and the delimitation of the related boundaries of the three countries in the Andaman Sea, 22 June 1978 (entry into force: 2 March 1979);

Maldives and Sri Lanka

Agreement between Sri Lanka, India and Maldives concerning the determination of the trijunction point between the three countries in the Gulf of Mannar, 23, 24 and 31 July 1976 (entry into force: 31 July 1976);

Myanmar and Thailand

Agreement between the Government of the Union of Myanmar, the Government of the Republic of India and the Government of the Kingdom of Thailand on the determination of the trijunction point between the three countries in the Andaman Sea, 27 October 1993 (entry into force: 24 May 1995).