Intergovernmental Oceanographic Commission

Workshop Report No. 93

IOC-UNEP Workshop on Impacts of Sea-Level Rise due to Global Warming

Dhaka, Bangladesh
16-19 November 1992

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1. BACKGROUND

Many international bodies like IOC, UNEP, WMO, ICSU, etc., have devoted considerable efforts to the subject of anticipated climate and sea level changes as these may cause serious environmental and socio-economic problems, particularly in the low coastal regions of developing countries.

In 1987, UNEP established in co-operation with IOC in selected cases, several Task Teams for assessment of potential impacts of climate changes and suggested policy options to mitigate and minimize possible adverse effects. The Task Team for South Asian Seas Region (SAS) comprising Bangladesh, India Pakistan, Sri Lanka and Maldives was headed by Dr. G. S. Quraishee of Pakistan as the co-ordinator. The SAS Task Team carried out its work according to the terms of reference and prepared a draft report.

IOC-UNEP proposed to hold a Workshop on the Impacts of Sea Level Rise due to Global Warming for South Asian Seas Region in 1992 in Dhaka, Bangladesh to: (i) discuss and finalize the Task Team report which was prepared earlier and (ii) to prepare a case study for Bangladesh which was likely to be the most severely affected country in case of climate and sea level changes. The National Oceanography and Maritime Institute (NOAMI) was invited to organize the Workshop. A four-day workshop was successfully held in Dhaka, Bangladesh, 16-19 November 1992, with active co-operation and assistance of the IOC Secretariat and relevant government departments, scientific organizations, universities and interested public bodies. The Workshop Programme is given as Annex I. Participants from Bangladesh, India, Pakistan and Sri Lanka attended the Workshop. IOC was represented by Dr. Quraishee, Fourth Vice-Chairman, and Mr. Yihang Jiang from the Secretariat. The list of participants is given in Annex IV.

2. OPENING

The Honorable President of the People's Republic of Bangladesh, Mr. Abdur Rahman Biswas, opened the Workshop held in the auditorium of the National Museum at 0900 hours on 16 November 1992.

Mr. M. Ahmed welcomed the participants on behalf of NOAMI and complimented IOC and UNEP for selecting Dhaka as the venue of the Workshop and suggested that Bangladesh would be the most suitable location for a pilot plan study for a long-term global monitoring system of climate and sea level changes. The low coastal belt of Bangladesh comprising a quarter of the country's land area holds a fifth of the population. The varied physical, geological and socio-economic settings of the long coastal belt would provide an ideal testing ground for a global monitoring system.

Dr. G. S. Quraishee thanked the organizers and expressed deep gratitude to the Honorable President for agreeing to inaugurate the Workshop which will discuss various aspects of a subject of great importance to South Asian countries. Their coastal areas play a vital role in industrial, agricultural, forestry and fisheries production. Facilities for comprehensive long-term and internationally acceptable standard data collection are lacking in some SAS countries. Suitable programmed funded by some UN or other aid-giving agencies could be implemented to meet training and equipment requirements.

President Abdur Rahman Biswas, in his inspiring inaugural address drew attention to the global dimension of the sea-level rise and climate change problem. He called for mobilization of enormous resources and adoption of appropriate technology for minimizing the socio-economic impacts of global warming and sea-level rise.

The President said the specter of climatic changes and concomitant sea-level rise, having potentials of devastating effects on most economic activities and even survival of people in the low coastal regions, have recently generated world-wide interest. He stressed the need for the preparation and activation of an integrated programme to meet the requirements of scientific understanding for reducing natural disasters. The President said that southern Bangladesh is prone to frequent natural disasters like cyclones, storm surges, coastal erosion and floods. These are short lived phenomena though they cause enormous loss of life and property. People face them with great courage and determination. President

Biswas said we have nothing to be frustrated about, but should be optimistic in resolving the warming problem by knowing the consequences of the phenomenon. We should utilize our resources with intelligence and invest our available resources in research activities.

The President said that environment and development are interlinked and environment is the subject which has no frontiers and the polluted environment of a country can also cause a serious threat to the environment of its neighboring countries.

At UNCED it was unanimously agreed that the unplanned industrial development and random exploitation of natural resources by developed countries had caused a serious threat to the environment of other countries, especially the developing countries. President Biswas said Bangladesh had signed two conventions at UNCED, namely the Biological Diversity Convention and the Climatic Change Convention.

The President stated that at present the resources of this planet are being enjoyed by a small minority of nations and these over-privileged people are also responsible, to a large extent, for environmental degradation of the world. He pointed out that such conditions do not stimulate normal growth towards economic emancipation, especially when the less developed nations are burdened with natural and man-made problems.

The President called for directing all human activities towards the less privileged people in this era of technological advancement.

Rear Admiral M. H. Khan who chaired the inaugural session, highlighted the ill effects of man's interference in nature's delicate ecological balance. For example the increase in content of $C0_2$ and trace gases in the atmosphere due to human activities has already initiated temperature increase and if unchecked, the rise may be up to 6°C in the high latitudes by the end of the 21st century and cause a sea-level rise of 1.5 meters. Some degree of uncertainty remains about the changes - but various scientific studies have started in the developed and developing countries to narrow down the uncertainties. It is a pity that UNCED failed to come up with a co-ordinated positive action plan. The publicized intentions of the developed countries are still practically confined to intentions level.

The Workshop was being held under the aegis of IOC and UNEP. They have sponsored regional studies for South Asian Seas Region on the consequences of the climate changes resulting in sea-level rise.

In India, a special committee has been appointed by the Government to study the climate and sea-level changes. The National Institute of Oceanography, Goa is mainly implementing the research programme. Similarly in Pakistan, the National Institute of Oceanography, Karachi, is actively working to analyze and evaluate the scenario as to how it affects Pakistan. In Sri Lanka, the National Aquatic Resources Agency provides the institutional support and co-ordination for relevant research activities.

Admiral Khan mentioned that Bangladesh scientists will present papers at the Workshop covering almost all aspects of the subject. He stated that Bangladesh's data base for definitive opinion on climate and sea-level changes is inadequate. Formation of a high-level committee to evaluate the situation and direct studies is needed. We must gather all relevant information to act and plan productive development in partnership with relevant programmed covering the environment and sustainable use of the resources available to us and take timely countermeasures to mitigate suffering.

The inaugural session concluded with a vote of thanks by Prof. D. K. Das, Chairman, NOAMI. He expressed sincere gratitude to the Honorable President for inaugurating the Workshop and delivering a very thought - provoking address that will encourage and inspire research workers in the field. Prof. Das thanked the IOC and UNEP for technical and financial support in holding the Workshop, as well as the foreign and local participants, the various governmental departments and institutions, the universities, and individual scientists who co-operated for success of the Workshop and the distinguished guests whose presence was an encouragement. Prof. Das thanked the communication media for providing suitable coverage.

3. TECHNICAL SESSIONS

During the Workshop, seven technical sessions were held from the morning of 16 November to the afternoon of 19 November. The venue of all technical sessions was the Seminar Room of the Institute of Engineers Bangladesh. Prof. Monirul Haque of Dhaka University, was the General Rapporteur of the technical sessions.

(i) Technical Session I

Technical Session I was chaired by Mr. Yihang Jiang of the IOC Secretariat and Mr. M. A. Rahim of Bangladesh University of Engineering and Technology (BUET) was the Rapporteur. A state-of-the-art and review of existing national programmed and scientific understanding were presented by four participating countries: India, Sri Lanka, Pakistan and Bangladesh.

Dr. R. Sengupta of NIO, Goa, India outlined the on-going research in his Institute with regard to global change and its consequences. He stated that the objectives of these programmed are: (i) to understand various physical, biological, chemical and geological processes, as far as the marine environment concerned; (ii) to understand paleo-environmental changes from the sedimentary record for insights on how the system works and (iii) to develop predictive capability for future changes.

Dr. M.D. Amarasinghe of National Aquatic Resources Agency, Sri Lanka, starting with some pertinent basic data of Sri Lanka, dealt with coastal habitats and resources. She mentioned the importance of fisheries of which more than 80% comes from coastal and deep sea fishing, tourism and marine recreation in the economy of the nation. Sea-level rise may inundate the densely populated coastal areas and structures and disrupt the commerce and economy of Sri Lanka. Dr. Amarasinghe mentioned that a major factor to be considered in the case of sea-level change, is the environmental effects of monsoon.

Dr. G. S. Quraishee presenting the Pakistan Overview, informed the participants that the National Oceanographic Commission of Pakistan, headed by the Minister of Science and Technology, has formed a sub-committee concerning the impact of sea-level rise due to global warming. The proposal made for Pakistan in the draft report of the Task Team has received the general approval of the Commission. He mentioned that the sea-level along the Pakistan coast at Karachi is rising at 1.1 mm per year. The records in Karachi from 1955 to 1988 indicate that the number of hot days with temperatures of 35° C or above indicate an increasing trend. The rainfall data of Karachi and Lahore from 1955 to 1987, shows no change in Karachi but an increasing trend for Lahore. He mentioned the Coastal Environmental Programme (CEMP) recently completed with assistance from ESCAP, the preparation of the Indus Basin Case Study in co-operation with Colorado University, utilizing GCM on Krey computer, and the joint US-Pakistan Programme in the Indus Delta Mangrove. A major study is the ocean circulation and SW Monsoon of the Arabian Sea region, a joint US-Pakistan programme started for a period of 5 years.

The Bangladesh overview was presented by Dr. A.A.Z. Ahmad, Chairman SPARRSO. He drew attention to the fact that the country, one of the most densely populated and poverty stricken, is also a victim of frequent natural calamities like tropical cyclones, tornadoes, floods, storm surges and droughts. Its coast line extends to 720 km and 21 percent of the population live in the low coastal belt. Any sea-level rise (SLR) will be a problem of ominous proportion for Bangladesh. He pointed out that global warming and sea level rise is still a debated issue and estimation of SLR say during the next 50 to 100 years is not possible. He provided estimates of coastal inundation due to different levels of SLR. 1.0 meter SLR will inundate approximately 10% of the country. He discussed the likely effects of SLR and stated some short-term, medium-term, and long-term protective measures should be thought of. Dr. Ahmad stressed the importance of establishing a network of a data collection system, a central data bank with easy access for research purposes, enhancement of co-ordination among different governmental and non-governmental agencies and gearing up of international and regional collaboration.

(ii) Technical Session II

Technical Session II held in the afternoon of 16 November, was chaired by Prof. K. K. Das of BUET and Chairman, NOAMI. Dr. Anwar Ali served as Rapporteur. This session and the next one covering the whole day of 17 November, were devoted to the presentation, discussion, modification, finalization and acceptance of the Task Team Report.

Dr. Quraishee, Task Team Co-ordinator for the SAS region, while commenting on the draft report that had been circulated earlier, provided a brief history of the activities of the Task Team. The circulated draft contained a summary of activities of the Task Team by the Co-ordinator, contributed papers by scientists from SAS countries and invited foreign experts at the Conference held in Islamabad, Pakistan, 1988. Dr. Quraishee also participated in deliberations on the subject in several other international meetings, including the meeting for review of progress of work of the Task Teams. Detailed discussions took place with the participation of all the foreign representatives and a number of Bangladesh scientists.

The Task Team Report was carefully reviewed at the Workshop. The final version of the Report will be edited by the Co-ordinator and published separately. Future activities in the SAS region with regard to sea-level change and its impacts have been proposed and are given in Annex III.

(iii) Technical Session III

In order to prepare the Bangladesh Case Study, the Technical Session III held during the morning of 18 November, was devoted to the presentation of sixteen papers by scientists from Bangladesh on subjects relating to sea-level, climate, holocene geology, cyclones and storm surges, socio-economic issues and implications of SLR, remote sensing techniques in monitoring and evaluating impacts etc. The session was chaired subsequently by Drs. S, K. M. Abdullah and Akbar Ali and Mr. A. K. M. Shahidul Hasan and Dr. A. Matin served as Rapporteurs.

The study on Mean Sea-Level in Bangladesh presented the monthly, annual and five-yearly variations of mean sea-level for the period 1977 to 1990 on the basis of data from six coastal tide stations. Strong seasonal variations in the monthly mean sea-level are observed. Adequate analysis and interpretation of the phenomena will depend on further observations

A statistical review of climate change in Bangladesh has been done on the basis of climate data of 43 years (1948-1990), by the Bangladesh Meteorological Department. On the basis of known weather patterns Bangladesh can divided into four regions - NW, NE, SW, and SE 2. Overall rainfall in Bangladesh was steady up to the early seventies and then has an increasing trend. The highest temperatures have not changed, but the minimum temperature is steadily increasing at 0.60C/ 10 yrs. Moderate cyclonic storms are decreasing and severe cyclonic storms show an increasing trend. Correlation between changes of monsoon and E1-Nino has been studied. During the discussion, the desirability of Bangladesh's participation in various international climatological activities was emphasized.

The Impact of sea-level rise on other disasters was analyzed, especially on the effects of storm surges, floods and erosion. Concerns were expressed on the increase of cyclone intensity, coastal flooding, salinity incursion and effects of coastal erosion.

A study on erosion-deposition pattern in the coastal area of Bangladesh using remote sensing was introduced. It has been found that the coastal configuration during the period from 1970 to 1990 remains more or less the same, but a considerable amount of erosion and deposition has occurred at the Meghna estuary, the most active part of the Ganges-Brahmaputra delta system. Sanwip Island was reduced to half. Severe erosion has been detected along the east coast of Bhola and in the areas from Rahnabad to Hariabhanga rivers. On the other hand, large deposition has been found along the Noakhali coasts. It is anticipated that any SLR will have adverse effects on the erosion-deposition pattern in the coastal front.

The paper entitled Geological Evidence of Late Holocene Sea-Level Fluctuations in the Coast of Bangladesh provides geological evidences - inland presence of transgressive cheniers, regressive beach ridges, progradational mud flats on Holocene sea-level changes in the south coastal region of Bangladesh. A geological study in the deltaic coastal areas suggests subsidence in the plain and upliftment in the coastal plain fringing Tertiary Chittagong Hills. A predictive model for future sea-level rise and its impact on the coastal areas of Bangladesh can only be, as recommended by the authors, established by careful and systematic analysis of geological data.

The importance of the mangrove afforestation on the predictive impacts of sea-level change was highlighted on the study of Mangrove Afforestation and Its Impact along the Coastal Belt of Bangladesh, The socio-economic impact was also emphasized with regard to economic, social, legal and political consequences for Bangladesh.

(iv) Technical Session IV

Technical Session IV was chaired by Mr. Yihang Jiang of IOC and Mr. M. F. Quyyum of Bangladesh Meteorology Department was the Rapporteur. The session was devoted to discuss, in detail, a number of studies in India, Pakistan and Sri Lanka as contributions to the regional studies.

Dr. R. Sengupta stated that some information was already provided while presenting the overview on 16 November. He presented to the session the special characteristics of the northern Indian Ocean comprising the Arabian Sea, the Bay of Bengal and the Andamam and Laccadive Seas. The desirability of marine research and pollution monitoring programme in the countries of the region was stressed.

From Pakistan, Dr. Tauqir Ahmed Ansari presented results on the indus delta mangrove studies and Dr. Mirza Arshad Ali Beg introduced socioeconomic implications of the rise in sea-level in Pakistan. Indus delta mangrove is depleting due to short supply of fresh water and nutrient-rich sediments by construction of barrages, storage dams, embankments and distribution canals upstream. In fact the flow to the sea is at zero level from mid-November to the end of March. Dr. Beg stated that the sea-level rise on the Pakistan coast has been of the order of 1.1 mm per year which is smaller than the global average of 1.5 mm per year. Meteorological records of the last 30 years indicates a rise of 1 ‘C for Karachi whereas a cooling effect has been observed in many other towns and cities, including Lahore. The impact of rise in sea-level would rapidly degrade the environment in lower Sindh by salinity intrusion and submerging vast tracts of land causing serious damage to agriculture, industry and natural resources exploitation. Rural-urban migration would increase causing ethnic problems.

Ms. M.D. Amarsinghe in her presentation on the possible impacts of sea-level rise in Sri Lanka, pointed out that a major factor with an immense bearing on the coastal environment of Sri Lanka, is the monsoon system. Coastal currents and littoral sand drifts are influenced by the two monsoons, the southwest and the northeast, and showed regular reversals of direction. A sea-level rise of 20 cm would result in permanent loss of 158,000 ha of coastal lagoons and estuaries. Coastal erosion will be aggravated not only by continued mining of corals, but by the creation of unfavorable condition of coral growth by increased depth of submergence. Detrimental effect areas will disrupt livelihood of a large percentage of the population depending on mangrove areas and their resources. Some Protective structures have been built up to provide protection against erosion. They cover only about 68 km of coast against approximately 300 to 375 km erosion prone coastline. Arrangements of detailed data collection and monitoring system were recommended.

(v) Technical Session V

Technical Session V was chaired by Dr. R. Sengupta of India and Dr. M.A. Quddus of Dhaka University was the Rapporteur.

Dr. Quraishee briefly described the proposals for future activities of the Task Team and discussions amongst participating countries were carried out. The Recommendation and Proposals for Future Activities is given in Annex IV.

(vi) Technical Session VI

Dr. M, D. Amarsinghe chaired the Technical Session VI and Mr. K. Karmakar served as Rapporteur. The session focused on the discussion of the proposal for Bangladesh Case Study and Work Plan.

Rear Admiral Khan presented the proposal for the Bangladesh Case Study. There was also a discussion on the present status of the country. The consensus was that adequate data in any relevant field for definite conclusions do not exist. Some studies and data collection are going on in a number of organizations, but it is recognized that a national focal point to co-ordinate observation and research activities is needed. Suggestions were made for the establishment of an infrastructure to co-ordinate relevant activities among various institutions.

The representative of UNDP informed the session of the planned regional and global activities in the field of environment and development of its organization. The Session expressed appreciation to UNDP for the information and continued support in the region.

The Bangladesh Case Study - Summary, Recommendations and Work Plan -was formally accepted and is given in Annex II.

(vii) Technical Session VII

Technical Session VII was chaired by Prof. M. Shahjahan, Vice Chancellor, Bangladesh University of Engineering and Technology. A final review of the deliberations of the four days of the Workshop was made. The Task Team Report was finalized and accepted and will be published separately.

4 CLOSURE

The IOC representatives expressed their satisfaction for the excellent arrangements, as well as for the in-depth discussions on a number of issues and positive outcomes. The representatives of India, Sri Lanka, and Pakistan conveyed thanks to the hosts for all the facilities extended.

Prof. M. Shahjahan, Chairman of the final session thanked all participants, the IOC representatives, the volunteer workers and the NOAMI staff, the distinguished guests, and the media for their excellent inputs towards the successful holding of the Workshop and declared the Workshop closed at 16,00 hours on 19 November 1992.

ANNEX I

WORKSHOP PROGRAMME

16 November 1992, Monday

Opening

Venue:	National Museum Auditorium
0900	Guests Arrive
0915	Arrival of the President of the People's Republic of Bangladesh, Mr. Abdur Rahman Biswas
0920	Welcome Address & Introduction
0930	Address by UNEP and IOC Representatives
0940	Address by the Honorable President
0950	Chairman's Address
1000	Tea Break

Technical Session I

1045-1330	National Presentations
	India Sri Lanka Pakistan Bangladesh
1330-1430	Lunch

Technical Session H

1430-1730	Task Team Report Presentation Discussion on Task Team Report

17 November 1992, Tuesday

Technical Session II (Contd.)

0900-1030	Discussion on Task Team Report (contd.)
1030-1045	Tea Break
1045-1315	Working Group Meetings to modify the Report
1315-1430	Lunch
1430-1530	Continued Working Group Meetings

1530-1630	Working Group report
1630-1730	Finalization of Task Team Report

18 November 1992, Wednesday

Technical Session III

0900-1100	Presentations on Bangladesh Case Studies
1100-1120	Tea Break
1120-1330	Presentations on Bangladesh Case Studies (Contd.)

Technical Session IV

1430-1700	Presentations on National Case Studies India, Pakistan, Sri Lanka

19 November 1992. Thursday

Technical Session V

0900-1000	Introduction on UNEP-IOC-WMO Pilot Project on Sea-Level Changes and Coastal Flooding
1000-1100	Proposals of future activities of IOC-UNEP Task Team for South Asian Seas

Technical Session VI

1130-1330	Future activities Formulation of Bangladesh work plan
1330-1430	Lunch

Technical Session VII

1430-1700	Final acceptance of the Task Team Report Recommendation and the Workshop report
1700-1730	Closure

ANNEX H

RECOMMENDATIONS AND WORK PLAN FOR THE BANGLADESH CASE STUDY

1. REQUIREMENTS OF CASE STUDIES

Meteorological studies show that rainfall variability is related to the change of temperature and in the last five years the lowest minimum temperature has an increasing tendency. However, for a better understanding of the regional climate change, it is recommended that future studies on longer periods based on the past 100-year records be carried out in combination with the development of numerical models.

An improved scientific understanding of marine environment and resources is required for Bangladesh for the reduction of natural disasters, e.g. storm surges and associated coastal floods, and for integrated coastal zone management and sustainable development. The requirements are summarized as follows:

(i) systematic observations of the coastal environment, including basic parameters, as sea temperature, salinity, wave actions and ocean current. Special efforts should be focused on the storm surge study and forecasting, since the coastline of Bangladesh was hit several times during the last decade with immense damages as a consequence.

(ii) establishment of a national oceanographic data center. A national data base management system is required to be set up for recording the field collection of data and to incorporate international data exchange for research and observation.

(iii) relevant studies on the causes and impacts of sea-level change.

- (a) geological studies show subsidence in deltaic coastal plain, whereas fringes of the Tertiary hill ranges are uplifting, especially the study on tectonic movement will provide scientific information on sea-level changes;
- (b) Approximately 2.5 billion tons of suspended sediments are carried to the Bay of Bengal annually, which largely effects ,the environmental conditions of the coastal areas of the Bay;
- (c) socio-economic impacts of sea-level may imply reduction of rice production due to both the climate change and coastal flooding;

(iv) upgrading of national capability on marine sciences is one of the most important tasks of the national programme. Capacity building through implementation of the programme may focus on:

- (a) training and education programmed for scientists and technicians to master necessary understanding and techniques;
- (b) utilization and maintenance of modern equipment for accurate measurements and observations of sea-level changes and other parameters.

2. WORK PLAN

In spite of the fact that studies in the field of sea-level change have been carried out, there is an immediate requirement for co-ordinating local and international activities in Bangladesh. For further development of marine sciences and related activities, NOAMI should be assisted bilaterally and internationally by IOC, UNEP and WMO as the focal point for a national systematic observational programme in Bangladesh. It is agreed that national on-going programmed in the field of sea-level change and impacts, by various departments concerned should be continued and encouraged in a co-ordinated way within a national sea-level project.

The important pilot project proposed by IOC, UNEP and WMO to set up a network of Cells for Monitoring and Analysis of Sea-Level (CMAS) should be established in Bangladesh in co-operation with NOAMI.

2.1 SHORT-TERM PROGRAMME

It is envisaged that pilot projects covering a similar time-frame as that of CMAS should be initiated in Bangladesh for the years 1993-1996 as follows:

(i) participation in all on-going IOC-UNEP-WMO activities and develop a nucleus of oceanographic research facilities;

(ii) organization of a storm surge workshop in co-operation between IOC, UNEP and WMO;

(iii) undertaking the following training programmed:

- (a) short-term courses: Post Graduate courses on meteorology, physical oceanography and coastal geology;
- (b) on-the-job training: to participate in ocean research cruises;
  a short visit programme for equipment handling;
- (c) long-term courses: education programme at PhD level.

(iv) to develop data center and disseminate information.

- (a) mapping of the possibly affected areas under different conditions of sea-level change
- (b) plan counter measures with global applicability for mitigation of Impacts.

(v) to participate in research projects on the greenhouse effect and its impact.

2.2 LONG-TERM PROGRAMME

Considering that scientists will receive short-term training ending 1996, projects for systematic observation of the marine environment and air-sea interaction will be undertaken in the next phase. The necessary project profile will be prepared in the intervening period.

2.3 FINANCIAL REQUIREMENTS

Appropriate funding for all short-term and long-term programmed will have to be bilaterally and internationally organized.

3. RECOMMENDATIONS

The Workshop carefully reviewed sea-level change and its impact on the South Asian Seas region in general and Bangladesh in particular; noting that the existing infrastructure for marine science needs to be strengthened, the Workshop recommended that:

(i) a national data base acquisition and management system be set up for collection, analysis and distribution of marine environment data which should be incorporated in global ocean data and information exchange system; (ii) further studies should be focused on:

(a) a joint inter-regional research for sea-level monitoring and coastal morphology using remote sensing;

(b) an inter-regional research project to determine spatial variance in the Bay of Bengal is recommended, which could include ocean current and influence of Swatch of No Ground at the head of the Ganges fan;

(c) forecasting cyclone and associated storm surge, the studies on modelling and prediction method should be given priority;

(d) predictive models to be prepared for socio-economic impact study on different scenarios of sea-level changes which should include:

mapping of the affected area with possible height of inundation with inclination of land from the coast;

assessment of ecological effect on mangrove, fisheries etc;

assessment of effect on food production and human habitation;

assessment of effect on communication and permanent structure;

plan of counter-measures

examination of counter measures of global applicability to minimize and mitigate suffering.

ANNEX III

PROPOSAL FOR FUTURE ACTIVITIES

The IOC-UNEP Workshop on Impacts of Sea Level Rise due to Global Warming was organized in Dhaka, Bangladesh, 16-19 November 1992. The draft Task Team Report was reviewed and modified by the Workshop and it will be submitted by the Co-ordinator of the Task Team. For future activities, the Workshop recommended the following:

(i) The extent to which the global warming and sea-level change would occur is not sufficiently known. Furthermore, it is not known what" will be the effect of other counter balancing forces, including the increase in biomass production, greater absorption of CO_2 and heavier rain fall. Systematic observations and research are needed to obtain a basic understanding, in particular for the regional properties;

(ii) Basic scientific data on environmental parameters are important to support marine environment research and management. Therefore, monitoring should be carried out under both national and international frameworks.

(iii) The regional studies on sea-level changes should be appropriately cc-ordinated with the regional components of international global programmed, which include the programmed sponsored by IOC, UNEP, WMO and other UN agencies, as well as the programmed sponsored by non-governmental organizations, e. g. ICSU-IGBP. It is recognized that programmed, such as JGOFS and LOICZ are closely linked with studies on sea-level change. The Member States of the region are encouraged to actively participate in these programmed.

(iv) All countries in the SAS region are members of SAARC. A project on Greenhouse Effect and its Impact on the Region has been initiated by the SAARC nations. The Task Team took note of this and recommended that these investigations should be operated in close collaboration with the IOC-UNEP project on the impact of sea-level change in this region.

(v) Local and regional tectonics of the coastal areas and-continental shelves should be studied in detail. Geological evidence indicate that local and relative sea-level fluctuations are taking place along the regional coasts. In order to establish relationship with the eustatic changes the following points should be considered:

   (a) a detailed geological study is needed to establish the history of sea-level change in the coastal area of SAS region;

   (b) long-term coastal monitoring system should be developed for further elucidation of coastal processes; and

   (c) collection, evaluation and interpretation of data pertaining to coastal conditions are essential in developing a predictive model for sea-level variations and changes and their impacts on coastal areas.

(vi) Construction of dams and river diversion impede the natural processes of sedimentation in the Indus Delta.

(vii) Quantification of socio-economic impacts of sea-level change should be given high priority in the SAS countries and relevant studies should be supported by national and international organizations.

(viii) Satellite observations should emphasis monitoring of various parameters associated with global warming and sea-level change.

(ix) A regional co-ordination mechanism should be established in order to carry out effective regional research and investigation of sea-level changes and related impacts. Each country of the region is encouraged to identify appropriate mechanisms for regional co-operation and co-ordination.

(x) International co-operation is needed for regional studies and capacity building. However, in order to facilitate effective implementation of programmed and to avoid duplication of efforts, co-ordination amongst international organization is recommended.

ANNEX IV

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