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Workshop report No. 26

# Workshop on Coastal Area Management in the Caribbean Region

Mexico City,
24 September - 5 October 1979

Unesco

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Workshop Report No.26

# WORKSHOP ON COASTAL AREA MANAGEMENT IN THE CARIBBEAN REGION

Mexico City, 24 September - 5 October, 1979

## SUMMARY REPORT

Organized by the IOC Association for the Caribbean and Adjacent Regions (IOCARIBE), the Ocean Economics and Technology Branch of the United Nations (OETB), supported by the Division of Marine Sciences of Unesco, the United Nations University (UNU) and the United Nations Environment Programme (UNEP) and hosted by the government of Mexico.

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| No. | Title | Publishing Body | Languages |
|---|---|---|---|
| 1 | CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia /Report of the IDOE Workshop on/; Bangkok, Thailand, 24-29 September 1973. UNDP (CCOP), 138 pp. | Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok 2, Thailand | English |
| 2 | CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974. (Unesco Technical Paper in Marine Sciences, No.20) | Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France | English Spanish |
| 3 | Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974. | IOC, Unesco Place de Fontenoy 75700 Paris, France | English French Spanish |
| 4 | Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador, 4-12 December 1974. | FAO Via delle Terme di Caracalla 00100 Rome, Italy | English Spanish |
| 5 | IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975. | IOC, Unesco Place de Fontenoy 75700 Paris, France | English Spanish |
| 6 | Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975. | IOC, Unesco Place de Fontenoy 75700 Paris, France | English |
| 7 | Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/ Unesco/EAC, Nairobi, Kenya, 25 March - 2 April 1976. | IOC, Unesco Place de Fontenoy 75700 Paris, France | English (full text) Extract and Recommendations also in: French Spanish Russian |
| 8 | Joint IOC/FAO(IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976. | IOC, Unesco Place de Fontenoy 75700 Paris, France | English |

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| 9 | IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Spanish<br>Russian |
| 10 | IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Spanish<br>Russian |
| 11 | Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>Spanish |
| 11<br>Suppl. | Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>Spanish |
| 12 | Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects, Fort-de-France, Martinique, 28 November - 2 December 1977. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>Spanish |
| 13 | Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area, 16-18 January 1978. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>Spanish |
| 14 | IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas, Abidjan, Ivory Coast, 2-9 May 1978. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French |
| 15 | CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-east Pacific, Santiago de Chile, 6-10 November 1978. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France<br><br>CPPS<br>Señor Miguel Bakula<br>Secretario General de la Comisión Permanente del Pacífico Sur<br>Vanderghem 590<br>Lima 27, Peru | English<br><br>Spanish |
| 16 | Workshop on the Western Pacific, Tokyo, 19-20 February 1979. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Russian |

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| 17 | Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS), Moscow, 9-11 April 1979. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English |
| 17<br>Suppl. | Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOSS Data Processing and Services System, Moscow, 2-6 April 1979. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English |
| 18 | IOC/Unesco Workshop on Syllabus for Training Marine Technicians, Miami, 22-26 May 1978 (Unesco reports in marine sciences, No.4) | Division of Marine Sciences, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Spanish<br>Russian |
| 19 | IOC Workshop on Marine Science Syllabus for Secondary Schools, Llantwit Major, Wales, U.K., 5-9 June 1978 (Unesco reports in marine sciences, No.5) | Division of Marine Sciences, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Spanish<br>Russian |
| 20 | Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources, Bandung, Indonesia, 17-21 October 1978. | Office of the Project Manager<br>UNDP/CCOP<br>c/o ESCAP<br>Sala Santitham<br>Bangkok 2, Thailand | English |
| 21 | Second IDOE Symposium on Turbulence in the Ocean, Liège, Belgium, 7-18 May 1979. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Spanish<br>Russian |
| 22 | Third IOC/WMO Workshop on Marine Pollution Monitoring, New Delhi, 11-15 February 1980. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>French<br>Spanish<br>Russian |
| 23 | WESTPAC Workshop on the Marine Geology and Geophysics of the Northwest Pacific, Tokyo, 27-31 March 1980. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>Russian |
| 24 | WESTPAC Workshop on Coastal Transport of Pollutants, Tokyo, 27-31 March 1980. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English |
| 25 | Workshop on the Intercalibration of Sampling Procedures of the IOC/WMO/UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters, Bermuda, 11-26 January 1980. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English |
| 26 | IOC Workshop on Coastal Area Management in the Caribbean Region, Mexico City, 24 September - 5 October 1979. | IOC, Unesco<br>Place de Fontenoy<br>75700 Paris, France | English<br>Spanish |

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## RAPPORTEUR

Harris B. Stewart, Jr.

## Introduction

The present report summarizes the content of the invited papers, panel discussions, and participants' comments presented at the Workshop on Coastal Area Development and Management in the Caribbean Region held in Mexico City from 24 September to 5 October 1979 at the Universidad Nacional Autónoma de México. The Workshop was jointly organized by the IOC Association for the Caribbean and Adjacent Regions (IOCARIBE), the Ocean Economics and Technology Branch (OETB) of the United Nations and supported by the Division of Marine Sciences of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations University (UNU) and the United Nations Environment Programme (UNEP). It was attended by 29 participants from various countries in the Caribbean region and four observers. The Mexican Government acted as host.

It should be mentioned that this endeavour was organized in accordance with the Economic and Social Council resolution 1970 (LIX) of 30 July 1975, requested by the Secretary-General, to take effective measures for the promotion of a better and wider application of marine technology suitable for developing countries in their endeavours relating to coastal areas, including the provision of assistance in the matter of training, institution building and implementation of appropriate technology. Also, the IOC Working Committee for Training, Education and Mutual Assistance in the Marine Sciences (TEMA) at its second session in July 1977, adopted Resolution TEMA-II.13 in which it advised that the IOC, in conjunction with ICSPRO agencies, take the necessary steps to implement training courses on coastal area development and management and on technical and scientific aspects of marine pollution.

As its title indicates, the Workshop was developed to familiarize selected participants, having high level policy-making and planning responsibilities, with the concept of coastal area development within the programme of national development planning and to introduce them to the prerequisites of a management approach to coastal area development. The invited participants represented a broad spectrum of decision-makers including government officials, planners, developers, ecologists and university researchers, all of whom in one way or another were involved in coastal and marine development in the Caribbean region. The programme included 17 formal papers by invited experts in various aspects of the coastal area, panel discussions on multiple and conflicting uses, on the human resources required, and on the physical, geological, chemical and ecological aspects of the coastal area.

As was pointed out during one of the discussion sessions, the coastal area is not only where the sea and the land meet, but - more importantly - it is where the sea and man meet. It is, therefore, an area of often conflicting uses. If, for example, coastal waters are used as a dump site for large volumes of wastes, the local fishery may decline; if a recreational beach is bulkheaded and used as the site for an oil refinery, the recreational use is ended. Mangrove nursery grounds for sport and commercial species and potential sites for industrial development constitute a common Caribbean coastal area conflict. A coral reef which attracts many tourists to nearby hotels may be threatened by pollution from the hotels themselves. Groins

and jetties to protect a harbour entrance may result in the destruction of adjacent beaches, and the list goes on. Intelligent planning for coastal area use can forestall some of these problems and assure optimal utilization of a major national resource - the coastal area. This was the major concept the Workshop was designed to impart to the attendees.

This report has been prepared so as to present, in a condensed form, the salient issues developed during the Workshop. It also provides a timely summary of the more important points presented in the formal papers which will be published at a later date and which can be used for a more complete treatment of the various topics which could only be summarized in this document. It is hoped that this report will be utilized by the attendees to assure the consideration of the coastal areas as a discrete element in any planning effort for future national development. Included in this report (Annexes I and II) is a listing of the title and author of each paper presented at the Workshop as well as a listing of the names and addresses of all participants.

For the purposes of this summary report, the lectures and discussions were grouped into six major categories: description of the coastal area, coastal area problems and experiences, data and information requirements, planning and management methods, United Nations activities and human resources.

The report does not seek to formulate definite conclusions on each issue but rather to point out the main problems raised in the papers and in the discussion. The space given to particular points raised in the papers and the discussions reflects no judgement regarding their importance. It is determined by the time which could be afforded for the relevant discussion, and the need for brevity. The report does not, of course, necessarily represent the unanimous acceptance by the participants of every point made.

Description of the Coastal Area

Any attempt to formulate a management plan for the coastal region of any nation must start with an understanding of the complex and dynamic coastal environment itself. As one participant stated "It is difficult to manage something we do not understand". Although the physical, sedimentary, chemical and biological aspects of the coastal area are all interrelated and constitute a complex and dynamic ecosystem, each of these aspects was presented separately by a specialist in that particular field.

The general circulation in the Caribbean Sea is part of the larger global oceanic circulation, and physical oceanographic studies have shown that the dominant characteristic of Caribbean currents is their high degree of variability in both time and space. In the nearshore waters, the general regional circulation pattern is usually masked by local wind-driven currents, tidal currents, and river discharge. Along the shore, the littoral or longshore current regime is of particular importance, as these coastal currents transport large quantities of sand and are the major mechanisms for moving pollutants into or out of the coastal waters. The extreme variability of these nearshore currents requires a time-series of observations over a broad range of tidal, wind, wave, and river discharge conditions. Only with data adequate to understand the physical processes controlling the variations in coastal currents can one predict with any reliability the effects of man's intervention in this system. Will a beach be eroded or built up if a jetty is built here? Where will the oil go from an offshore tanker spill? Will pollutants introduced into a river move over a much-visited coral reef or onto a popular bathing beach? Will a newly-dredged ship channel remain open or will it require repeated maintenance dredging? These are typical of the questions that coastal area managers should ask and which can be answered intelligently only if the nearshore current regime is understood.

Various techniques have been developed for obtaining the necessary data on coastal circulation. These vary from the simple and inexpensive use of free-drifting drogues followed by a boat and located by horizontal sextant angles to the complex and expensive arrays of moored or bottom-mounted continuously recording current meters. The techniques used should be determined by the minimum data requirements and the resources available.

Of particular importance from the geological point of view is the understanding of beach and nearshore sedimentary processes, for they drastically affect such coastal activities as port and marina development, solid waste disposal, beach preservation, and any industrial, commercial, or private construction along the coast or in the nearshore waters.

Many examples from the Laguna de Términos, Campeche were given, illustrating the development of the coastal plain and adjacent areas. Most of the sediments are of a terrigenous nature and are carried by the river systems and distributed by various processes of different intensity (fluvial, marine, colic and biological).

On the large scale are such processes as plate tectonics and sea-floor spreading, sea-level changes, tides and the waves and storm surges related to tropical storms. Small scale processes that need to be considered are beach changes, sediment transport - both alongshore and across the beach - changes in beach slope and the entire beach profile, erosional and depositional processes, biological processes relating to coral reefs, marshes, and mangrove shores.

The complex and dynamic nature of the coastal areas of the Caribbean is best illustrated in the beach and nearshore areas, and the most intelligent approach in planning for beach or nearshore development is to try to accommodate rather than to control these processes. This last is a most important point and needs to be stressed. In most instances, the sea is considerably stronger and more persistent than man. Attempts to control or change coastal processes have traditionally been considerably less than totally successful. For example, a breakwater constructed to prevent deposition of sand in a channel may result in deflected longshore currents carrying sand seaward of the littoral drift so that beaches down-current are seriously eroded because their sand supply has been cut off.

In summary, the geological description of the coastal area covered eleven major points:

1. Collision of the Caribbean plate with North and South America has resulted in present-day tectonic features;

2. There has been a tectono-eustatic lowering of worldwide sea level since the end of the Cretaceous, with glacio-eustatic fluctuations during the Pleistocene superimposed upon that decline;

3. Oceanic tides are caused by interactions of the earth-moon-sun system;

4. Climatic conditions superimposed on spring tides may result in coastal flooding;

5. Wind generated waves approach the coast as swell, converging upon headlands and diverging in embayments;

6. Estuarine circulation is classified in terms of salinity distribution and circulation;

7. At the shore sediment size and the degree of sorting decrease landward and seaward of the breaker zone, and beach slope is a function of grain size;

8. Tides, water-table, storm cycles, seasons, and long-term sea level changes all change the profile of the beach;

9. Depositional and erosional features may be natural or the result of human intervention along the coast;

10. Primarily biological environments found along the coast include estuaries and salt marshes, coral reefs, and mangroves. The Caribbean region is located in the low-latitude coastal-classification zone; and

11. Characteristics of the low-latitude Caribbean region are mixed tides and a low tidal range, east coast swell, runoff averaging 500-1,000 m per year, abundant coastal sediment, tropical salt marshes, Atlantic Province coral, Occidental Province mangrove with some tidal woodland, and modern-day beachrock. Coastal water, rivers, lagoons, and estuaries have traditionally been used as convenient places to get rid of waste materials we do not want

on land. However, we must have a vastly improved understanding of the ability of these waters to assimilate man's wastes without causing some undesirable effect. The spectre of pollution of the rivers, estuaries, lagoons, and coastal waters hangs heavy over the Caribbean. However, it is not a question of dump or do not dump, but rather a question of how much of what wastes can we put at one place for how long a period without having some unwanted end result? Pollution studies must be continued and accelerated and the results made available to those decision-makers who must weigh the relative importance of using the coastal area as a waste dump against the importance of the other uses which would be inhibited by such pollution.

Further consideration of the chemical aspects of the coastal area included a description of the role of lagoons and estuaries as "holding tanks" for land-derived pollutants. The effects here are related to the inland climate as it affects runoff into the coastal area, the marine-fresh water interactions in lagoons and estuaries, and the recycling of pollutants by organisms as a mechanism for increasing the residence time of contaminants in these areas.

The recent increase in our concern about pollution in the coastal areas has resulted primarily from the introduction of new man-made chemicals such as DDT and the PCB's. Pollutants were classified for the purpose of discussion as natural or artificial. The former includes naturally produced hydrocarbons such as those from seafloor seeps, some heavy metals (e.g., mercury and cadmium), neurotoxins from the dinoflagellate blooms as red tides, and heavy contractions of products derived from nutrients such as nitrates and phosphates.

One problem encountered is the differentiation of natural pollutants from the same materials produced by man - for example, marine-produced organic material and sewage-derived sludge in marine sediments. Man-made pollutants were subdivided into industrial, radioactive, petrochemical, agricultural, domestic, and cooling water pollutants.

The prime point made was that the indiscriminate use of coastal waters as a dump site for our land-derived wastes can lead to unwanted effects that far outweigh the utility of the sea as a convenient disposal site. Further, coastal development and management plans should include consideration of potential pollution problems and provide for the appropriate studies to allow this hazard to be avoided.

Although the snow-capped mountains and fjord-type estuaries of south-western Canada are hardly typical of the Caribbean, the problems created by indiscriminate multiple uses of such coastal areas as Howe Sound and the Fraser River estuary are similar to those to be expected if a similar lack of planning for multiple and often conflicting uses takes place in the coastal areas of the Caribbean. In Howe Sound, Canada, for example, the presence of log rafts and stray floating logs from the intensive logging operations presented a hazard to the ferry boats that carried people or goods through the sound. Tailings from a coastal copper mine were dumped in the sound to the detriment of the local commercial and sport fisheries, and pulp mill wastes detracted from the recreational use of the waters of the Sound. Although the Canadian environmental setting is vastly different from that of the Caribbean region, the example of Howe Sound indicates the sort of problems that materialize when coastal resources are subjected to many uses without prior planning. The lesson here for the Caribbean was abundantly clear.

Description of climatological conditions is essential to coastal area planning and offshore projects. The increased economic activities in coastal zones in all parts of the world have clearly demonstrated the need for long series of climatological observations at the coast or in off-shore waters. These are often lacking and the Caribbean Region is no exception.

Broad classification of coastal areas can provide a basis for a crude assessment of ecological values and the potential damage from coastal development. Such classifications can include:(1) production of renewable living resources; (2) exposure of coast to open sea; (3) configuration of coastline (straight coast, embayments, lagoons, etc.); (4) freshwater runoff characteristics; (5) topography (steepness and breadth of intertidal area); (6) substrate (rock, cobbles, gravel, sand, mud); (7) character and dynamics of sedimentary materials; (8) vegetation; and (9) fauna. Further breakdowns in the classification can be provided in coastal configurations, estuarine types, beach slope, substrate characteristics, vegetal cover and faunal populations. Indices can be developed for the nearshore physical classification which are useful for the nearshore physical classification that can be applied for evaluation of biological capability. Mangroves, as a unique coastal feature of tropical and subtropical areas, are given special consideration in coastal classification of the Caribbean region. They provide food and shelter for a wide and varied group of fish and shellfish and they bind shoreline sediments to prevent erosion. Similarly, tropical seagrass ecosystems merit attention as a food source for the estuarine ecosystem, because of their rapid growth rate and high organic productivity and as a stabilizing medium for shoreline sediments. Man can affect these ecosystems directly, by dredging and filling operations, and indirectly, by reducing protection against such natural phenomena as storm-generated waves. Coral reefs are also highly vulnerable to effects of development in tropical and subtropical coastal ecosystems, particularly from suspended sediments.

Port and harbour construction or enlargement invariably involve disturbance and often restructuring of segments of the coastal environment. When such a disturbance occurs in particularly sensitive coastal areas, e.g., estuaries, there can be acute and long-term ecological impact on populations of species, communities and ecosystems. Dredging and filling operations, associated with construction of ship-loading facilities, can seriously disrupt certain critical food chains leading to important commercial species in an estuary. For example, sedge meadows in an estuarine flood plain may serve as the base of the food chain, not only for avian wildlife, but also for fish. Detritus formed from these vascular plants when they die down contributes to the food of amphipods, which are in turn eaten by juvenile fish. The roots and rhizomes of sedge in tidal channels also provide habitat for the amphipods. Thus, even though the sedge meadows are usually above high tide level, they may be a vital component of an estuarine ecosystem, and their destruction can affect the indigenous estuarine living resources, as well as anadromous fish which may use the estuary as a nursery area. Such rooted aquatics as eelgrass also provide detrital material as food, as well as habitat for invertebrates and fishes. Mangroves can serve a similar purpose in semi-tropical areas.

Disruption of productive habitat in estuaries should be avoided as much as possible. Ideally, port and harbours should be confined to less productive coastal areas. Rocky foreshores, rather than gently-sloping productive mud flats in the path of river water, would be preferred environmentally. Structures on pilings, which allow water to flow through freely, alter nearshore current patterns less than those with solid foundations. Moreover, pilings can also provide a substrate for attachment of invertebrates as a source of food for species higher in the food chain.

An early step in the process of planning for coastal area management is the development of coastal atlases. These should consist of maps of coastal land ownership, land use, demography, climatology, coastal geology, habitats, flooding potential, vegetation, and such other characteristics as may be needed by the planners. These maps must be based on accurate data, or inappropriate decisions will result. The development of such coastal area maps by Puerto Rico and the States of Washington and Delaware in the United States should be reviewed by the nations in the Caribbean in order to determine the utility of this technique as a tool in their own coastal planning process.

The major points made in the presentation of the ecological aspects of the coastal area were: (1) that plans for the protection of ecologically important coastal areas should be included in any long-range coastal plan; (2) that environmental considerations should be included in the plans for any coastal development project; and (3) that coastal maps constitute an important early step in the process of planning for coastal development.

During the panel discussion following the presentation on the description of the several aspects of the coastal areas as an ecological system, the following points were made:

1. It must be remembered that in the less developed countries, the financial and human resources and the scientific and technical facilities are quite different from those of the developed countries;

2. The quantity and quality of environmental data required for coastal area management should be determined as a function of the development proposed;

3. It would be nice if we knew all about all aspects of the coastal system, but this is not possible in the short term. Thus, environmental studies will often need to be restricted to providing the absolute minimum of knowledge required to assess the environmental effects of (or on) a specific development project;

4. The transfer of scientific and technical equipment and techniques must take into account the ability of the recipient country to utilize them on a continuing basis. Overly sophisticated equipment lies unusable throughout the Caribbean because spare parts or the ability to repair it are not available locally;

5. The required level of sophistication of data acquisition systems should be determined prior to the initiation of an environmental measurement project in the coastal area;

6. There is a need for enunciating long-term national objectives to know the extent to which additional human resources will be required;

7. Education and training specifically in coastal processes rather than in global oceanography are needed in the Caribbean, and the emphasis should, at least initially, be on the applied aspects of marine science;

8. The social, political, and economic aspects must be included in the planning for coastal area development;

9. Because coastal processes are no respecter of national borders, an effort should be made to co-ordinate coastal area management plans and programmes with adjacent nations;

10. Although today's coastal problems may command immediate attention, planners must consider what future problems might result from short-sighted solutions;

11. The major difference between islands and continental areas insofar as coastal area planning is concerned is that such planning is a relatively small part of the overall national planning effort for continental nations, whereas it is the totality of the national plan for island nations of which the land areas are essentially all within the coastal area; and

12. Although programmes of long-term environmental research in the coastal area are highly desirable, often the exigencies of time will require that management decisions be made on the basis of a common sense best guess - even at the risk of incurring the wrath of the dedicated environmental researcher.

## Coastal Area Problems and Experiences

The Government of the Republic of Honduras plans to develop facilities to attract international tourism to the shore of the Caribbean Sea. As a start, they are building two hotel complexes, one at Roatan Island (Archipiélago de la Bahía) and the other at Tornasal, west of Tela city.

This plan only partially notes the impact that increased tourism would have on the environment,and it is not taking into account the probable social impact on the region's population. Like some other areas in the Caribbean, Honduran coasts have an impoverishment of natural resources, especially forests and some populations of land and sea creatures. This has had an adverse effect on one of the main tourist attractions, the coral reefs.

As a first step in the programme to protect the natural and human environments, it is necessary to prepare specific development models. This will stimulate the creation of areas to protect natural resources and designate protected areas and national parks.

An essential element in the Honduras plan is the improvement of the educational system at all levels. Included in the curriculum should be the teaching of environmental awareness so that concern for the wise management of the available natural resources will become a national characteristic.

The Honduran coastal ecosystem has been adversely impacted by the extensive cutting or burning of the upland forests. Patterns of coastal erosion and sedimentation have been modified. Turtles and crocodiles, once common in the coastal areas, have virtually been eliminated, the

manatees have disappeared, and the populations of parrots and the white-tailed deer have been declining steadily. It is a case where ignoring the consequences of man's activities has led to serious degradation of a coastal ecosystem.

The island of San Andres was cited as another example. In this case, a rapid growth of the tourist industry with its resulting marine pollution threatened the beaches and coral reefs which were major elements in attracting the tourists originally. With the influx of tourists came drugs and prostitution on a large scale, roads were built and the small airport was enlarged. Although the tourism sector benefited, it was at a high social and environmental cost that might have been avoided had a comprehensive development plan been an early step in the programme.

Although the formal adoption of well formulated development plans and policies is a goal greatly desired, the example of Trinidad and Tobago shows that sometimes intelligent development can proceed even in the absence of such a plan.

The two-island republic of Trinidad and Tobago possesses the usual mix of coastal resources found in most Caribbean islands. In addition, Trinidad and Tobago is endowed with oil and gas deposits both on land and offshore at varying distances from its coastline. These hydrocarbon resources provide the building blocks for rapid economic and social development, and programmes that are already underway indicate that the next few years will see tremendous activity in the field of energy-intensive industrial development. Most of these development activities are located within the coastal area. More particularly, the industries are sited directly on natural shorelines or artificially created waterfronts since they all rely on marine transport.

Because of the interaction of natural coastal resources and coastal-based heavy industrial activity, Trinidad and Tobago is subject to all the risks inherent in this kind of intensive coastal area development in island territories. In an ideal situation in which environmentally sound development goals were adopted, development decisions would flow from an appropriate national policy framework, preferably adopted at the highest political levels, through a set of scientifically based guidelines to actions which can be implemented by means of well designed strategies and techniques. In other words, what would be most applicable is a disciplined approach to decision-making on development and protection of environmental resources, which is possible only within a well established planning process.

Although the ideal is rarely achieved, the experience in Trinidad and Tobago, even in the absence of formal policies and guidelines, indicates that opportunities do exist for the evolution and application of workable strategies and techniques in coastal area development and management. Furthermore, it shows that technicians need not await policy declarations in order to evolve and apply such strategies and techniques as are available.

Despite the importance of the coastal area, both as a natural resource and as a development zone, no specific recognition is given to it as a geographic or functional entity for decision-making purposes. Furthermore, there is no attention to the special development requirements of coastal areas in policy statements. In fact there is a significant gap in development policy articulation. There has been no national or economic development plan or programme for Trinidad and Tobago since the fourth plan came to an end in 1974. The 1978 draft National Physical Development Plan addressed

itself to the general question of planning for physical development, but it is weak in the area of policies, strategies, and techniques for coastal area development.

Nevertheless, the physical planning system has produced the few significant examples of a rational approach to coastal area development problems. Born of the critical need highlighted by these efforts there is now under way the most comprehensive and scientific programme of coastal area management under the aegis of the Institute of Marine Affairs. All of this, it must be emphasized, is taking place in the absence of any policy framework.

Although the examples of Honduras, San Andres, and Trinidad and Tobago relate to national problems with aspects unique to each country, the coastal impact of oil spills within the Caribbean Sea is, in contrast, a problem on the regional scale.

The maritime transport of hydrocarbons in the Caribbean region has increased considerably in the island countries and Central America. The increase in petroleum activities in the island countries produced an increase in the maritime transport of hydrocarbon by seven times during the period 1965-1975. On the northern coast of South America, 80% of the cargo is hydrocarbons, and in other areas of the Caribbean and Central America, hydrocarbon cargo represents 63% and 43% respectively. The northern coast of Venezuela, the Panama Canal, and some narrow passages in the Caribbean present some risks to navigation.

Recent statistics published by IMCO show that in the period from 1962-1978, there were 55 accidents in the world with an oil leak of 1.5 million tons. Of these accidents, three occurred in the Caribbean, and it was estimated that probably 150,000 tons were discharged in the Caribbean area. It is considered to be a critical area, with the Panama Canal Zone and the Gulf of Mexico as one of the main areas of oil leaks.

The capacity of the Caribbean region for combatting oil spills is related to three main aspects: (1) preparation of a contingency plan; (2) training of personnel for assuming specific responsibilities related to the former; and (3) availability of equipment and materials to respond as promptly as possible. Trinidad and Tobago, Venezuela, and Mexico have started to build up their capacity by acquiring equipment, training personnel locally as well as overseas, and by paying special attention to the design of a national contingency plan. The international and regional character of the problem indicates the importance of the adoption of international conventions on marine pollution, particularly the adoption of MARPOL 1973 with its protocol of 1978 which would have a great effect on the reduction of pollution levels by routine operation of ships.

In a multi-national panel discussion of the coastal area management problems in several of the Caribbean countries, the following points stand out as most relevant to the purposes of the Workshop:

1. In Mexico, there is no government agency with specific responsibility for the coastal areas, but rather many agencies have responsibilities which include portions related to the coastal areas. Responsibility for urban and

port development, petrochemicals, tourism, and fisheries, for example, is in different federal agencies with little, if any, co-ordination among them. Needed are a co-ordination mechanism, scientific studies of the entire coastal area, planning for coastal development, and a national initiative to undertake the necessary steps leading to wise coastal area development and management. The environmental problems resulting from inadequate planning for the Rio Balsas iron and steel plant and the extensive pollution in Acapulco Bay were cited as specific examples. However, two pilot scientific studies have been initiated, one on the Pacific coast and one at Laguna de Términos on the Gulf of Mexico coast, being carried out by the Universidad Nacional Autónoma de México.

2. In Trinidad and Tobago, the Point Lisas Industrial Port Development Corporation (PLIPDECO) is undertaking the development of a massive industrial complex on the shore of the Gulf of Paria. This presents conflicts in coastal use, but there is no policy guidance for developments of this sort and no recognition of the coastal area as a region with unique planning requirements. An additional problem arises because the perspective of the marine scientists studying coastal ecology differs from that of the operationally oriented developer. A more general problem is related to the fact that, like many other Caribbean nations, Trinidad and Tobago has traditionally turned its back to the sea. An education programme directed toward marine and coastal awareness has been initiated at the Institute of Marine Affairs.

3. Venezuela's coastal area was described as "an area of uses and abuses." There are ports, commercial fisheries, industrial development, petroleum recovery, tourism, housing, and recreational uses of the coastal area, but there is also a heavy pollution level from petroleum, mercury, and agricultural chemicals. However, to date, there have been only declarations of intentions to regulate activities in Venezuela's coastal area.

4. The major coastal environmental problems in Honduras are related to the extensive deforestation of the upland areas. These include problems of coastal erosion and sedimentation, some shortages of fresh water due to increased rapid runoff, and the pollution caused by the introduction of increased amounts of agricultural pesticides and fertilizers into the coastal waters. Various institutional solutions are possible, but perhaps the most promising would be to locate a national commission on the environment within the Ministry of Agriculture, because the problems have been generated primarily through the nation's agricultural practices.

5. Puerto Rico has multiple uses of its coastal area. Located there are large pharmaceutical plants, water-cooled power plants, petroleum refineries, seaport facilities and a heavy tourism industry with waterfront hotels and apartment buildings. But the problems are there also. Hotels and condominiums built at the water's edge have caused down-drift beach erosion and have cut off recreational beaches from public access, and the coastal industries and inland sugar mills and copper mines have resulted in pollution of coastal waters. However, Puerto Rico has used photogrammetric techniques to prepare a series of maps of coastal land use. These inventory maps show the locations and extent of swamps, lagoons, beaches and other coastal land forms, critical areas and areas of potential flooding are identified, demography and woodland coverage are shown together with other aspects of the coastal area of concern to managers.

6. Other comments called for a resolution of the apparent dichotomy between scientists and administrators; the coastal area is not generally recognized as a separate geographic entity requiring special governmental attention; there must be a creation of public awareness of the unique-resource nature and problems of a nation's coastal areas, as Puerto Rico has done with lectures, radio, TV, and newspaper coverage; in Guatemala, the coastal shrimp population has been seriously depleted due to the introduction into the coastal lagoons of pesticides used on the cotton fields. However, as in some other nations, the land people constitute a much more powerful economic group than do the sea people; and interagency meetings on coastal area problems provide one possible mechanism for attaining co-ordination.

Data and Information Requirements

The nature of the coastal area problems emphasizes the need for a wide variety of information from the natural environment plus social, economic, demographic, cultural, and political information.

The number of variables of interest for studies of the natural environment was estimated *grosso modo* as one hundred. This plus the socio-economic, demographic, and cultural variables indicate that the collection of information should be done within a defined framework to avoid excessive cost and over-specification of the system.

In the Caribbean countries, a fair amount of data exists in each of the above-mentioned disciplines. However, its utilization is difficult for the following reasons:

1. The data are dispersed, and data banks do not exist for centralization, administration, and dissemination of information to users;

2. Data coming from observations or recording instruments are obtained without an organizational framework and without interpretation. Consequently, they cannot be utilized immediately;

3. It is difficult to assess the quality of data and to compare them with similar information from other sources due to the data compiler ignoring data quality and collection techniques; and

4. The direct applicability of the data is not always possible because the collection was originally done for purposes other than those of the actual user.

Even though the data on natural environments are similar in developed and developing countries, the socio-economic and cultural data should receive a *sui generis* treatment according to local conditions. Listings from developed countries are not generally applicable to developing countries.

In relation to selection of measurement techniques and instruments used, the sophisticated techniques of recording on magnetic tape one or more variables are too costly and inaccessible for almost all Caribbean countries. There is no need of oceanographic ships for measurement in coastal areas where small boats will suffice.

Prerequisites for a modernand efficient information system are: information itself, information hardware, and administration of the information. All the Caribbean countries have the capacity to possess these components, even though the degree of sophistication indicates differences from country to country. Several measures were suggested for the creation of an information system for coastal area management and development. The measures are, among others:

1. Collect, correlate and compare information for specification of priorities in research and planning;

2. Initiate experimental programmes in limited geographic areas where more information is available and operations are easier; and

3. Determine mutual needs in: data, data acquisition systems, processing, evaluation, storing, retrieval, and management of data.

Instead of designing a single system to collect, analyze, and store data in all disciplines for coastal area management and development, the criteria should be:

1. Define variable which typifies the system under study;

2. Perform scalar analysis in time and space for choosing optimum survey intervals;

3. Analyze cost-benefit for diminishing amount of investment without sacrificing the resolution of measurements;

4. Identify primary and secondary sources of information in order to avoid unnecessary duplication; and

5. Start or utilize existing efficient information systems for management.

Of the wide range of data and information needed for management of the coastal area, marine meteorological parameters are basic in any study or planning effort. Meteorology has been organized in various ways and tries to organize itself further in order to provide the best support to coastal development.

Information on the state of the atmosphere over the coastal zone, on the variation of wind with altitude or local wind phenomena typical of a region should be studied in detail. Many coasts are liable to be struck by storms which are not of local origin; in the Caribbean region for example, it is hurricanes. In planning terms, the inclusion of protective measures and an operational system to predict severe storms should be considered as a prime need. In this respect, national meteorological services play a key role assisting countries by providing meteorological information for the prediction of storms and other hazardous weather phenomena, and it is in this light that the World Weather Watch Programme (WWW) was developed and co-ordinated by the World Meteorological Organization (WMO).

Countries in the Caribbean area co-ordinate their efforts under WMO Region IV (North and Central America) Hurricane Operation Plan. The plan follows the principles used in the entire WWW system and is in operation throughout the year.

The growing awareness of the coastal region as an area of increasing technical and economic activity imposed new pressures for obtaining detailed information on the environmental conditions of the area. The installation of a coastal observing station, however, has to be considered very carefully by meteorological authorities, due to the need of extracting a maximum of information from a limited network of coastal observing stations.

The Commission for Marine Meteorology of WMO, under a project called "Marine Coastal Climatology", has started working on this problem. It should be determined whether a permanent coastal meteorological station needs to be set up or whether a series of short-term measurements might be sufficient. All these trends and newly perceived needs show that national meteorological services need to be involved at a very early stage in developing planning studies. Only in this way would it be possible for them to meet the demands for data, for assessments of climatological probabilities as well as the necessary forecast and warning services.

Remote sensing has proven to be a highly effective means of obtaining a broad range of environmental data for use in constructing coastal area maps and assessing coastal resources. The advantages gained by the use of remote sensing for coastal planning have been well demonstrated, for instance, in Delaware, Costa Rica, Puerto Rico and Mexico.

The use of remote sensing techniques for the mapping of wetlands in the coastal area is a good example of what can be done in the Caribbean. A common requirement of many coastal management programmes is information on the boundaries, extent and condition of wetland areas -- information which is difficult to acquire in the expansive, often hostile wetland environment. As a result, efforts to accumulate data concerning tidal wetlands have recently come to rely more and more on remote sensing techniques. These techniques have been extensively developed for the characterization of emergent vegetation - so important a part of the wetland ecosystem - and are now routinely used to inventory wetland resources because of the large reduction in time and effort achieved over that required by conventional surveys.

Economic pressures to extract oil and other deposits, to increase the harvest of food, to protect the coastline and at the same time maintain existing waste disposal sites, are also creating a need to monitor the properties of large estuarine and coastal water bodies. The excessive amount of boat time and cost of ground survey teams required to collect synoptic data over such regions is causing investigators to look for more effective means of performing this task. The use of remote sensing from aircraft and satellites when properly co-ordinated with ship measurements appears to offer a promising solution.

Satellite data have been used with notable success in observing water features which are relevant to the dynamics and the composition of surface waters. The remotely sensed data are limited to surface waters because of the limited penetration of light into the water. Even with this limitation, there is a large amount of useful information available, particularly if multispectral digital techniques are used to enhance and analyze the digital data and to correlate them with timely surface measurements obtained by ships.

Aerial photography has been used in Costa Rica for environmental and other studies for many years, including coastal mapping flights conducted by the Instituto Geografico Nacional. A typical application of aerial photography is the environmental impact study of the new port of Caldera conducted by a consulting firm and government agencies. However, the more recent ecological studies of the Gulf of Nicoya will involve satellites, aircraft and ships to determine land use changes around the Gulf and their impact on pollutant input and mangrove losses in the Gulf. It is hoped that this study can be expanded to encompass the entire Pacific coast of Costa Rica.

What has been done with remote sensing in Costa Rica can be done for those other nations in the Caribbean that require an adequate description of their coastal areas. They should give serious consideration to establishing contact with the U.S. National Aeronautics and Space Administration (NASA) in order to obtain LANDSAT satellite imagery of the coastal areas in which they are interested. The approach is first a search for the appropriate coverage, secondly to wait for receipt of the points, and thirdly to request the digital tapes for those prints of special interest.

The regional nature of natural coastal systems was used to suggest a rationale for regional coastal information concepts.

The users of coastal resources are broadly defined as those who physically use the coastal zone as well as those who plan and manage the use of coastal resources. In addition to the direct users and managers of the coastal resource systems, there is the coastal research community which both produces and also uses information and data regarding coastal resources. There are obviously both differences and similarities in the data and information needs of each type of user group.

Given the various types of users of coastal resource information and recognizing the regional character of coastal resource system, the following goals of regional coastal information centres were proposed: information awareness, information accessibility, information availability, and information application.

A spectrum of coastal information centre models was suggested, and two examples illustrating the two ends of the spectrum were presented. One example depicted a data/information centre which actually collected, stored, and disseminated information, and a number of other related services were defined. The second example was an "information central" concept where providing information about information was the major function.

The marine advisory services concept was described and related to the regional information centre concept. Marine Advisory Service field agents who provide a technical assistance service to coastal resource users were described.

Coastal information activities in the U.S. were reviewed and an appendix describing in detail one of three existing regional coastal information centres in the U.S. was presented.

The relationship of coastal information centres to research activities was discussed and three basic relationships defined. These relationships were connected to the knowledge of other similar ongoing research activities in the region, facility and expertise sharing, and commonality of data collection.

It was recommended that if a regional coastal/ocean information programme were to be expanded or initiated that it include the concept of marine advisory services.

Planning and Management Methods

The elements, principles, and procedures that compose what is known as the "coastal area management process" were examined in a series of four papers.

Under a global perspective, the coastal area is subject to the structure and interaction of two systems: the ecological system that relates man and his environment and the spatial system that relates the coastal area with other regions in a complex exchange of economic, social, political, and cultural flows.

The bio-physical and socio-economic systems are the primary components of the coastal area. Among others, four critical issues condition the process, i.e., the formulation of a national coastal policy, the training of personnel, the urban-industrial coastal area as a planning unit and the integration of the coastal area both as a planning unit itself as well as within the national planning framework.

Planning and management of the coastal area prove to be extremely complex processes. Its complexity is derived not from the process itself, but from the elements to be managed and the diverse influences that underlie the process. The first of them is the physical environment. Since it is a transitional area or interfaces among the land, the sea, and the atmosphere, unique and distinctive phenomena and processes are present that severely influence (and limit) the utilization of the coastal resources. The coastal area is where man concentrates a great proportion of his activities, and it is from there that he launches his efforts for exploring and exploiting new offshore resources.

In terms of spatial management, it is a significant area whose relative importance in the regional framework should not be avoided because it has and will have a considerable influence in the modalities of growth of other regions in a country. Its sphere of action is wide and frequently goes beyond the artificial limits imposed by an operational delimitation.

This is why a coastal policy, as well as any development strategy that is potentially applied in the area should depart from a global evaluation of the role of the coastal area within the national planning framework and be complementary to sectorial and regional development strategies.

The coastal area is a complex environment comprised of many closely interrelated ecosystems. It is constantly under stress as a result of natural actions and human activities. It is a limited resource facing nearly unlimited demands, and requires sound management if it is to remain useful to man over the long run. The methods and tools of systems analysis can help to organize information needed by the decision-maker in his resource allocation choices and can help to define the data and knowledge which research programmes should generate to aid in this process. A close and continuing relationship between the researcher and planner is essential for the wise allocation of coastal resources. The tools shown - network diagrams, matrices, etc - when properly constructed, can provide a common frame of reference for both the researcher/scientist and the planner/decision-maker.

An environmental assessment study is one which attempts to specify the nature and degree of interaction between an economic activity and its physical environment. There are several types of techniques for carrying out this assessment, viz. matrix techniques, ecosystem modelling systems analysis, and project evaluation. However, the power and limitations of these techniques must be realized.

The process of environmental assessment in its fundamental form does not change regardless of the technique chosen. It is this process which should be established in developing countries, with project evaluation being the most readily applicable and relevant method.

A social cost-benefit analysis was developed for a proposed oil refinery located in the coastal area of a developing island country. Differences between private financial and social economic benefits were pointed out, and examples were given of how to quantify economic losses from environmental pollution and degradation.

A social cost must be assigned to the interference of coastal development with aesthetics and amenities, i.e., a value must be placed on the 'quality of life'. Quantifying this concept is difficult, even in industrial market economies like those of the most developed countries.

In some cases, the market can give an indication about social costs of environmental degradation. In the case of an economy dependent on foreign tourism, for example, if tourist expenditure declines as a result of some neighbouring industrial development, this provides a lower limit to the social value placed on coastal amenity. If a beach is simply wild and undeveloped, it is more difficult to quantify its social value in economic terms.

The problem of social evaluation of environmental capital is more difficult in developing countries, where there may be more pressure for development. However, the operation of 'free' markets will always result in a zero, or low, value being assigned to the environment, or 'natural capital'. There will be no automatic incentive to ration use of environmental resources and to protect their productivity. The environment, in this case the coastal environment, must be rationed in a quasi-market, one of essentially a political nature.

Economists and coastal scientists can, by working together in developing a common language and conceptual approach to the environment, act as an effective and far-sighted constituency to protect environmental capital from an economic calculus which is often too short-sighted and narrow in focus.

Different types of legislation have now been introduced in various countries to deal with their perceived needs in the coastal areas. Some legislative measures are designed for planning purposes, e.g., regulations on zoning and the imposition of building prohibitions or the acquisition of land, as methods for controlling urban development in coastal areas. Some are designed to deal with critical situations in certain sections of the coast, particularly because of mineral exploitation or tourism. Others have as their goals conservation, preservation or protection in coastal areas. Laws to establish nature reserves or sanctuaries, or to prevent oil pollution are examples of this type. Still others are designed to provide financial and institutional needs; they either require better co-ordination among existing administrative units or establish a central co-ordinating unit to ensure consistent implementation of decisions by all agencies concerned.

It should be pointed out, however, that the legislative measures so far taken specifically for the development of coastal resources remain scanty. Where such measures have been taken, they are largely single-purpose or piece-meal. A systematic approach is yet to emerge.

The coastal areas in most countries remain governed by the general legal regime applicable to all areas. They are subject to the same laws governing land use, town and country planning, and resource exploitation. They have not been treated differently or separately. Certain drawbacks may result from this situation. First, the general legal regime may not have taken into account adequately the special characteristics of the coastal areas, which require consideration of a much broader spectrum of elements (e.g., geological and environmental) hitherto excluded under the scope of existing laws, which are designed to deal with general situations only. Secondly, perhaps more importantly, the coastal areas are subject to numerous single-purpose laws executed by different agencies and institutions. Hardly any horizontal links exist among those laws and among their executing agencies. This situation often results in lacunae, conflicts or overlapping jurisdictions.

Coastal legislation can be grouped in five categories:

(a) Adaptation to the coastal areas of town and planning techniques;
(b) Measures for the protection of shorelines;
(c) Integrated natural resources management;
(d) Special plans for critical sections of coastal areas; and
(e) The establishment of national guidelines.

United Nations Activities in the Region

Various United Nations agencies have on-going programmes in the Caribbean that, to varying degrees, contribute to the understanding of the complex coastal system (IOC/IOCARIBE, FAO/WECAF, WMO, PAHO/WHO, and UNEP as a partial list).

IOC/IOCARIBE

IOCARIBE is a regional association of 21 IOC Member States. Through international co-operation and mutual assistance, the Association seeks to stimulate the broad development of marine science in the greater Caribbean region. There are three major categories of IOCARIBE activities:

1. Marine Science programmes: oceanographic research designed to provide needed information for proper management and development of marine resources; included are studies in support of Antillean trap fisheries, spiny lobster, environment and substrate mapping, petroleum pollution monitoring and a 1981 symposium on the marine science aspects of sea turtle research.

2. Support and services: regional marine science development is supported by an established IOCARIBE Regional Data Centre, a planned documentation and information service, and the general dissemination of information such as national programme plans, research ship activities, and news in general.

3. Training and education: recognized as a critical factor in development, training and education functions include advanced degree scholarship assistance, short-to-long-term training courses, seminars and workshops, ship-board training, and assistance in acquisition of equipment and instrumentation and in their repair and intercalibration.

FAO/WECAF

The WECAF Project (INT/77/016) is an outgrowth of the WECAF Commission established by the FAO Council in November 1973 for the development of fisheries in the Western Central Atlantic including the Caribbean Sea and the Gulf of Mexico.

The participants in the WECAF Project are largely members of the WECAF Commission, although participation is open to non-member countries who either utilize the living resources of the region or who assist countries of the region with the development of their fisheries. At present there are 27 participating countries, all of which are situated in the area.

The purpose of the Project in the long run is to bring about the most effective use of the fishery resources of the WECAF area through the development of fisheries of under-exploited stocks, especially those accessible to small-scale fishermen; the promotion of the better use of existing catches and of appropriate management actions for stocks that are heavily exploited. The more immediate objectives are to act as a co-ordinating mechanism, to advise on the development of appropriate fishery policies and their harmonization at all levels, from the national to the inter-regional, and to facilitate international assistance for the attainment of these aims. This involves activities on:

1. Resource exploitation and utilization
2. Resource monitoring
3. Fishery administration and legislation
4. Training - this last activity is designed to support directly or through bilateral or other arrangements training at all levels in all fishery sectors.

The activities carried out by the Project for the realization of these objectives fall into three categories:

(a) Area-wide inter-regional programmes designed to deal with problems concerned with the entire WECAF area;

(b) Sub-regional programmes for particular groups of countries having common problems; and

(c) Activities directed to individual countries related to sub-regional or regional development in the area.

The first two categories, namely, those covering area-wide inter-regional programmes and sub-regional or group country programmes, include the following activities: the evaluation and monitoring of fishery resources, particularly in co-operation with other research entities in the region, for example, fishery institutes, universities, intergovernmental and international organizations, etc.; the improvement of fishery statistics and their compilation and distribution throughout the region; research on fish processing and utilization, e.g., the utilization of fish discards, especially the shrimp by-catches; seminars, training centres and workshops on a variety of subjects, in particular: management of fishery enterprises; government policies for stimulating fishery developments; resource evaluations; fishery management and legislation; fishery co-operatives and their management; consumer education and promotion; training of fishermen, extension workers and administrators.

With respect to project activities directed at individual countries, these consist of advice to governments, institutions and fishery enterprises on fishery development programmes including in particular: choice of fishing gear, equipment and vessels; fish processing and handling, including quality control; marketing; training and education; management of private and public fishery enterprises; improvement of fishery statistics; formulation of fishery legislation and policies; and the development of adequate fishery extension services.

World Meteorological Organization (WMO)

The WMO has four programmes applicable to coastal development and management in the Caribbean region:

1. The World Weather Watch Programme (WWW), implemented in the Caribbean Region according to the "Regional Association IV (North and Central America) Hurricane Operational Plan". The Plan is described in WMO Publication No. 524.

The WWW Programme consists of three systems:

- Global Observing System (GOS)
- Global Telecommunication Systems (GTS)
- Global Data Processing System (GDPS)

Under the WWW Programme, the National Meteorological Services of WMO Member States co-operate in the taking of synoptic weather observations, their international exchange, quality control and processing, and in the

provision of forecasts and warnings. The GDPS includes data storage and retrieval. The various WWW activities are described in the WMO Series of WWW Planning and Implementation reports.

2. Joint IOC/WMO Integrated Global Ocean Station System (IGOSS)

IGOSS, in conjunction with the WWW Programme, includes the collection, international exchange and processing of ocean data in a real-time mode, at the present time in particular bathythermograph observations in the upper 400 meters of the oceans. Activities under the ocean observational network include telecommunications arrangements for data buoys and other fixed platforms. The system is global and incorporates the Caribbean Region.

The IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring includes: (a) regular visual observation of oil slicks and other floating pollutants; and (b) collection and analysis of samples of sea water.

Manuals describing procedures and practices of IGOSS activities are contained in the IOC series of Manuals and Guides.

3. Programme of Marine Meteorological Services (MMS)

Under this programme, WMO Member States co-ordinate their provision of marine meteorological services to shipping, fisheries and other activities on the high seas, to activities in coastal and offshore waters and to maritime operations in ports. MMS include the collection of marine climatological data in a non-real-time mode, their storage at selected international data centres and publication of annual summaries of these data. A special project is concerned with "Coastal marine climatology"; the objectives of the project are to arrange for an adequate coverage of climatological stations in coastal areas of the world.

The MMS are described in the WMO Guide to Marine Meteorological Services, Publication No. 407.

4. World Climate Programme (WCP)

This new Programme, established by the Eighth WMO Congress in May 1979, aims at the description and understanding of the world's climate and its variations. It consists of four subprogrammes:

- Climate Data Programme
- Climate Research Programme
- Climate Applications Programme
- Climate Impact Programme

For the Caribbean region, the Climate Data Programme should, in particular, be of interest, since it co-ordinates internationally existing activities and develops the methodology for use by WMO Member States in their establishment of an adequate data base of climate research and applications, both on a global scale and on regional scales including regional coastal areas. Since the oceans constitute an important element for climate, oceanographic data are included, and for these data close co-operations with the IOC has been established.

PAHO/WHO

The objective of the PAHO/WHO programme in the Caribbean is to assist the Member Governments in improving environmental health conditions as part of their social and economic development effort and integrate such endeavours with other health activities. While considerable progress has been made, many problems still remain to be solved. In summary, the PAHO technical co-operation activities in the Caribbean are concerned with:

1. At the end of 1977 the status of water supplies on an overall basis for the countries of the Caribbean area indicates that out of a total of 141 million inhabitants in the countries for which data are available, 55 million (39%) are not served by adequate water supplies.

2. The availability of urban sewerage services has failed to keep up with the extension and improvement in water supplies. Available data indicate that at the end of 1977 none of the countries, with the exception of Panama, reached the goals established in the Ten-Year Health Plan of providing sewerage service to 70% of the urban population. The sewerage situation appears more critical in the Insular Caribbean where 60% of the islands reported little or no services.

3. The lack of sanitary sewers, particularly in urban areas, is creating problems with the pollution of rivers and beaches. Studies indicate that less than 10% of the sewage produced in the Region is adequately treated.

4. The collection and disposal of solid waste constitutes a growing problem necessitating urgent attention, and the analysis of existing data shows that the management of solid waste lags behind all other public services.

5. Government control over water pollution is minimal as is the enforcement, and the control of environmental pollution stemming from industrial and urban activities is gradually becoming a health problem in the region. Most countries are experiencing rapid population growth, industrialization and urbanization with consequent pollution of air, water, soil and food resources and effects on human health.

In relation to these problems, the Environmental Health Program of PAHO includes potable water supply, sewerage technology, solid waste management, air and water pollution control, and occupational health. This programme is executed through a co-operative effort with Member Governments utilizing the Organization's environmental health resources including the technical staff at the Pan American Center for Human Ecology and Health (ECO) in Mexico City, and the Pan American Center for Sanitary Engineering and Environmental Sciences (CEPIS) in Lima, Peru. At the request of Governments, the Centers are providing assistance to the Caribbean region in the areas of research, training, information exchange and technical assistance.

PAHO's environmental health activities include co-operation with other international agencies or regional bodies concerned with this field.

Among other activities, the Organization is actively collaborating in the joint UNEP/ECLA project for Environmental Health Management in the Wider Caribbean (CEP) and has recently completed an Overview of Environmental Health Conditions in the Wider Caribbean in connection with the project.

In addition, PAHO/WHO have assisted various countries in the Caribbean region in carrying out a rapid assessment of each country's readiness to accelerate activities during the United Nations International Water Decade (1981-1990).

PAHO has also assisted in the development of solid waste programmes and management plans in Trinidad, Cuba, Venezuela, Jamaica and the Bahamas and through various projects either internally financed or acting as executing agency for UNDP assisted various countries in developing comprehensive programmes of water and air pollution control including Mexico and Venezuela.

PAHO will continue to support Member Governments' efforts for a better environment and seek means to maximize human resources through technical co-operation among developing countries. The development of a regional network of collaborative national centres in technical consultation, training, research, information collection and dissemination will also form an important strategy on the part of the Organization to fulfil its responsibilities.

United Nations Environment Programme (UNEP)

Within the United Nations Environment Programme (UNEP), the Caribbean Environment Project (CEP) has been developed in co-operation with the Economic Commission for Latin America (ECLA) to prepare a Caribbean Action Plan for Sound Environmental Management. The objectives of the preparatory activity of CEP are to identify environmental problems of the area, the resources available to deal with them, environmental activities already taking place, and objectives for future action. The ultimate goal of CEP is to develop an Environmental Action Plan for the Caribbean which would promote a wholesome and harmonious development of man, his natural environment and his productivity in the region.

CEP involves over 30 territorial communities which are united by the waters of the Caribbean Sea and the Gulf of Mexico. All of the territorial communities, excluding five, share the coastline marking this body of waters. The remaining five (the Bahamas, El Salvador, Guyana, French Guiana and Suriname) have close economic, historical and cultural ties with the rest of the area. Nineteen of the participating countries of CEP are island countries, 13 are continental countries of North, Central and South America. English is the predominant language in 15 of the territorial entities, Spanish in 11, French in 4, Dutch in 2.

As early as 1974, the Governing Council of the UNEP designated the Caribbean as one of its priority areas of environmental action. In 1976 at the Governing Council's Meeting, several delegates urged UNEP to establish a programme for the Caribbean.

CEP is one of the activities of the Regional Seas Programme of UNEP. It emerged as a consequence of UNEP's international concerns and the wishes of Caribbean nations for attention to their needs.

In fact, shortly before the 1976 meeting of UNEP's Governing Council, a Latin American Preparatory Meeting had agreed on the need to address the environmental concerns of the Caribbean. At the same time, the Caribbean Development and Co-operation Committee (CDCC) had identified several spheres of action with important environmental implications.

The work of the Caribbean Environment Project formally began in May 1977, when the Project Office opened. Between August and September 1977 the office completed its staffing. The Project is scheduled for completion in 1980, with the adoption of the Caribbean Action Plan. After this, it is expected that the Action Plan will be implemented.

Both CDCC and delegates to the 1976 Governing Council Meeting emphasized the need to evolve indigeneous Caribbean strategies. UNEP was urged by delegates to rely as fully as possible on indigeneous resources and institutions, since the Caribbean area had distinct ecological, social, economic, cultural and political characteristics. CDCC also pointed out that "whatever strategies are selected for development and co-operation in the Caribbean, the solutions should come basically from the Caribbean itself if such strategies are to have any chance of success".

CEP approaches its task by investigation, consultation and collaboration. An Advisory Panel of regional experts advises on the activities of the project throughout its various phases. There is also ongoing co-operation with interested UN bodies.

Continuing consultation among countries of the area is the basic tool for formulating and revising the Action Plan. It is hoped that regional consultation will assist in the development of co-ordinated strategies. By the beginning of 1980, CEP expects its final Draft Action Plan to be ready for presentation to Governments.

There are eight areas of concern in the Action Plan:

(1) The Sea
(2) Environmental Health
(3) Human Settlements and Habitat
(4) Tourism
(5) Natural Resources and Ecosystems
(6) Industry and Technology
(7) Natural Disasters
(8) Energy

The first priority will be the improvement of the capabilities of the Caribbean territorial communities.

(a) to assess and manage their natural resource base;
(b) to minitor the changing features of their environment, particularly in coastal and marine areas.

The official title of the Project is "The Joint UNEP/ECLA Project for Sound Environmental Management in the Wider Caribbean Area". Some of the environmental concerns in the Caribbean include:

- Oil Spills
- Deforestation
- Coastal erosion
- Disposal of liquid and solid waste
- Effects of natural disasters
- Planning of coastal development

CEP's activities seek to provide a framework for concerted action by the countries of the region to cope with the major environmental hazards and to develop practical programmes designed to ameliorate the unwanted side effects of economic development.

Many of the area's environmental needs can best be satisfied, and will continue to be principally addressed by single countries acting independently. However, multilateral co-operation can strengthen and supplement national efforts.

The benefits of co-operation are perhaps clearest in addressing joint concerns, which by their nature lie outside the control of any single country such as management of major marine pollution incidents or management of marine resources. Multilateral co-operation can be equally beneficial in responding to common concerns, such as deforestation or harbour pollution.

Regional arrangements exist at the multinational level for various types of marine-related activities, such as fisheries conservation and management, environmental protection, and marine scientific research. The negotiating texts which have emerged from the Third Law of the Sea Conference have called for regional and/or sub-regional arrangements in connection with enclosed or semi-enclosed seas, and it is suggested that such an arrangement might in time be developed for coastal area planning and development in the Caribbean Sea area. The arrangement would initially be at a low priority level, involving information exchange, the convening of seminars, and joint training efforts. In order to consider such a move, it was suggested that an ad hoc co-ordinating committee be established within the framework of IOCARIBE, OETB or some other body, to look more closely into the issue of the feasibility of regional action in coastal area development within the Caribbean.

Human resources

Appropriate human resources - scientists, economists, planners, and other professions and technical support personnel - constitute one sine qua non in any nation's efforts to plan intelligently for the development and management of its coastal area. In a panel discussion of this aspect of the coastal problem, the following observations were made:

1. Mexico, in anticipation of future requirements for trained personnel, utilized the UNESCO programme which provides experts for teaching - in this case, experts in physical oceanography, marine geology, and chemical oceanography. The programme also serves other Caribbean countries by offering opportunities for education towards the MS and Ph.D. degrees at UNAM. Other countries in the region could benefit by establishing similar UNESCO programmes.

2. Trinidad and Tobago has 15 professional planners and feels that, for adequate planning, a nation also needs technicians, graduate researchers in planning, geographers, sociologists, and demographers. However, in Trinidad and Tobago, these human resources are unevenly distributed so that no critical mass of the full spectrum of specialist is available. Most small island nations have in fact no planners, and this should be corrected, but training in planning per se is not available in the region, and students must go elsewhere for this education.

3. Cuba's coastal problems are similar to those of other Caribbean nations including pollution, beach erosion, and coastal industrialization. At the ministerial level, there is the Comité Estatal de Ciencia y Técnica. Coastal and other needs are presented to a Junta Central de Planificación that establishes ad hoc commissions and makes final decisions. Although there is no training specifically for coastal area managers, the Ministerio de Educación Superior is responsible for all university educational programmes.

4. UNESCO has various programmes in the development of human resources. Its Intergovernmental Oceanographic Commission (IOC) co-ordinates numerous multidisciplinary programmes, and its Regional Association for the Caribbean and Adjacent Regions (IOCARIBE) is responsible for all IOC projects in the region. Numerous UN agencies have training programmes available, and the co-ordination is accomplished through the Inter-Secretariat Committee for Scientific Programmes Relating to Oceanography (ICSPRO).

The Ocean Economics and Technology Branch (OETB) of the United Nations has overall responsibility for coastal area management within the United Nations system. Its activities include:

- Courses at the interregional level (Berlin);
- Courses at the national level: Guatemala and Ecuador have requested such courses. These are designed according to the needs of the recipient country with the help of other UN agencies and, if possible, national experts are utilized.

5. The shortage of personnel trained in the disciplines required for coastal area planning in the Caribbean is critical. Recommended by Jamaica were: (a) a roster of pertinent professionals available to work in the region; and (b) the possible initiation of a regional marine advisory service.

6. There is a need for well-educated specialists in the basic sciences, but in Latin America there is a tendency to over-specialize. One requirement is for academic research institutes for developing long-term research programmes that could serve as the basis for coastal area management. However, such institutes must be geared to local needs rather than transplanting programmes from outside the region.

7. A curriculum for the training of marine technicians has recently been published by the IOC and provides guidelines for establishing such courses in countries at various stages of development.

8. One or more universities in the region should establish courses in planning - including coastal area planning - rather than have personnel trained outside the region in a non-Caribbean framework.

9. One effective educational technique is to establish institution-to-institution relationships with universities in the more developed countries for the exchange of faculty and students.

10. To combat the "brain drain" of personnel from the region who have received advanced degrees abroad, employment positions should be available in their home country at a salary level commensurate with the level of the

employee's education. This instead of having the salary established as a function of the job regardless of whether the person in that position has only a high school education or a Ph.D. with years of experience.

11. The experience of the United Nations University (UNU) coastal management training programme in Indonesia indicates that actual field work in the coastal area is an essential element in such training.

In summary, the present scarcity of the required human resources in the Caribbean region is a major impediment to the initiation of the planning and studies needed if coastal area management in the region is to become a reality. Training opportunities for planners, scientists, and technicians are available through numerous of the UN agencies and in co-operation with universities in the more developed countries. These avenues should all be investigated to determine the best means of developing the human resources required by each country.

## Conclusions and suggestions for further action

In summary, the coastal area of the Caribbean - as elsewhere - is a highly variable and complex ecosystem. In many areas, it is presently subject to stress from the multiple and often conflicting uses to which it is subjected. In other parts of the region, development of the coastal area has yet to take place, but in both cases there is a very real need for the intelligent planning that is an essential precursor to good development and enlightened management. Numerous coastal problems have already arisen in the region due to the lack of adequate planning for coastal area development. Present data and information systems are inadequate. The tools and methodology for planning and management of coastal area resources are available, but the specialized education and training of the necessary planners, scientists, economists, and others needed to accomplish the task are not presently available in the region. Several of the United Nations agencies have programmes that can be useful to nations in the area, but there first needs to be an increased national awareness of the importance of coastal area planning before those and other forms of assistance can be effectively utilized.

Although this Workshop was strictly an educational endeavour, several suggestions for future action surfaced during the discussions, and the participants felt it would be useful to include them in this summary report:

1. A roster or register of specialists who could assist in coastal area planning should be prepared and circulated throughout the Caribbean nations.

2. The United Nations might organize a task force to assist in the resolution of multiple-use conflicts in coastal areas.

3. A coastal marine advisory service organized on a regional basis could provide assistance not only in the resolution of coastal area use conflicts but also to those actively engaged in coastal activities.

4. Educational programmes for planners, administrators, and technicians should be established. These might include short courses by visiting specialists taught on site in the host country and specialized courses taught at the sponsoring institution to which personnel would come from the Caribbean region. A basic course on resource management drawing on economics, engineering, ecology, and applied mathematics should be included in any such educational programme.

ANNEX I

List of title and author of contributions presented at the Workshop on Coastal Area Development in the Caribbean Region

Description of the Coastal Area

1. Resumen de la Circulación Oceánica General en el Atlántico Norte, Mar Caribe y Golfo de México
   Submitted by Manuel L. Hernández Avila

2. Aspectos Geológicos de la Zona Costera con Particular Enfasis en la Laguna de Términos, Campeche
   Submitted by Rodolfo Cruz-Orozco

3. An Overview of Beach and Nearshore Processes
   Submitted by Maurice L. Schwartz

4. Hidrología y Contaminación en Lagunas Costeras y Estuarios
   Submitted by Alfonso V. Botello

5. Ecosystem Protection in Coastal Area Development
   Submitted by Michael Waldichuk

   Summary of the panel discussion following the presentation on the discussion of the Coastal Areas.

Coastal Area Problems and Experiences

6. El desarrollo turístico en el litoral hondureño del Mar Caribe y sus probables impactos ecológicos y sociales
   Submitted by Santiago R. Olivier

7. The Evolution of Strategies and Techniques in Coastal Area Development and Management in Trinidad and Tobago
   Submitted by Kenneth B. Snaggs

8. Contaminación producida por el Transporte Marítimo en America Latina
   Submitted by Ignacio Vergara (IMCO)

   Summary of the panel on "Multiple uses and resource development: case histories"

Data and Information Requirements

9. Adquisición de Información para el Desarrollo y Ordenación de las Zonas Costeras en la Región del Caribe
   Submitted by Luis E. Herrera

10. Marine Meteorological Application to Coastal and Offshore Activities
    Submitted by George Verploegh (WMO)

11. Remote Sensing as a Cost-Effective Tool for Integrated Planning of Coastal Resource Development
    Submitted by Vytautas Klemas

12. Coastal Resource Information Centres and Advisory Service Concepts
    Submitted by John M. Armstrong

Planning and Management Methods

13. El Proceso de Ordenación de la Zona Costera
Submitted by Stella Maris A. Vallejo

14. Tools and Methods in Resource Management, Planning and Research
Submitted by Philip B. Cheney

15. Environmental Assessment Techniques: Their Applicability to Coastal Management
Submitted by Eapen Chacko

16. Main Trends in Coastal Legislation
Submitted by Roy S.K. Lee

17. Problems and Management of the Marine Environment in Indonesia
Submitted by Sujatno Birowo

United Nations Activities in the Region

18. IOCARIBE, Its Programs and Activities in the Gulf and Caribbean Region
- The WECAF Project
- Programmes of WMO Applicable to Coastal Development and Management in the Caribbean Region
- PAHO/WHO Environmental Health Program in the Caribbean
- UNEP - What you should know about the Caribbean Environment Project

19. Regional Cooperation in Coastal Area Development in the Caribbean Region
Submitted by Lewis M. Alexander

Human Resources

Summary of the panel on "Human resources available or needed for coastal area development and management in the Caribbean Region"

ANNEX II

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