Intergovernmental Oceanographic Commission
Workshop Report No.97

IOC Workshop on Small Island Oceanography in relation to Sustainable Economic Development and Coastal Area Management of Small Island Developing States

Fort-de-France, Martinique
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UNESCO

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1. INTRODUCTION

At UNCED, the United Nations Conference on Environment and Development (Rio de Janeiro, June 1992), the special concerns of Small Island Developing States (SIDS) were singled out. In Agenda 21, Chapter 17 of UNCED, UN agencies were especially requested to address the needs of SIDS within their special area of expertise. Accordingly, the Intergovernmental Oceanographic Commission (IOC) of UNESCO decided to convene a meeting on the oceanography of small islands.

At the annual meeting in February 1992 of the officers of the IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), Dr. Gunnar Kullenberg, Secretary IOC, requested that IOCARIBE undertake to organize and conduct a workshop that specifically addressed SIDS issues. The Sub-Commission agreed and Dr. George A. Maul (USA), IOCARIBE Vice-Chairman, volunteered to chair the effort. He recruited four eminent scientists from the region to assist in the programme development: Dr. Artemio Gallegos (Mexico), Mr. Calvin Gray (Jamaica), Dr. Avril Suing-Chang (Trinidad & Tobago), and Dr. Georges Vernette (France). Although the Workshop was to be conducted on a small Caribbean island, it was understood that a global view was to be taken.

A proposal was prepared for presentation at the Fourth Meeting of the IOCARIBE Member States in December 1992 (SC-IOCARIBE-IV). After much discussion and with the collaboration of the United Nations Environment Programme's Caribbean Regional Coordinating Unit (UNEP/RCU), SC-IOCARIBE-IV recommended conducting the Workshop according to Annex I. The Representative of France (Mr. Alain Soulan), agreed to request the support of his government and to conduct the Workshop on the Caribbean island of Martinique, French Antilles.

Financial support for the Workshop was solicited from a variety of organizations, and eventually acquired from the U.S. National Oceanic and Atmospheric Administration, the University of Puerto Rico, UNEP's Caribbean Environment Programme, the IOC, and METEO-FRANCE, the workshop's host. Funding for the meeting totaled about US$ 35,000, and support in kind for salaries, travel, transportation, and facilities was generously provided by the attendees' organizations and especially by METEO-FRANCE.

The plan for the Workshop was to have an interdisciplinary group from varied backgrounds, but all of whom were interested in the SIDS issue. Annex I is the Workshop Programme, and it reflects membership from amongst oceanographers, meteorologists, geologists, geographers, economists, coastal managers, hydrologists, social modellers, fisheries scientists, environmentalists, and administrators. A series of lectures (see Annex II) each followed by discussion and debate was the basic meeting format. Ample time was available for in-depth consideration of varied points of view and perhaps most importantly, for familiarity with the specialized languages of each of the disciplines represented.

The meeting was held at the offices of METEO-FRANCE in Fort-de-France, Martinique, and was attended by thirty participants from fifteen countries; the list of participants is given in Annex III. Although the meeting was held in the Caribbean, experts from the Atlantic, Pacific, and Indian Oceans were present. The Workshop was advertised in international journals. It is clear from the lack of participants from small island states at the Workshop that one of the most important issues is to develop training, education, and mutual assistance programmes for SIDS scientists and administrators.

In order to best preserve the meeting results and to make them available to a wide audience, it was agreed to publish the lectures in the Coastal and Estuarine (book) Series of the American Geophysical Union (AGU).

The AGU series was considered most likely to have a very wide audience, to provide high-quality printing, and since it is a non-profit organization to keep the cost to a minimum. Consideration for translation into other languages is an option for the future. The title of the book will be "Small Island Oceanography", and the effort was announced to the international scientific community at the 1994 Ocean Sciences Meeting held in San Diego, California, 21-25 February 1994 (Annex IV).

2. MAIN RESULTS

Most Small Island Developing States undoubtedly will lack the infrastructure and personnel required to take advantage of modern coastal area management techniques. Indeed, some of the so-called "modern solution technology" may not be useful in real-life SIDS situations. The Workshop participants were made acutely aware of the level of problems and problem-solving by breaking into three groups and actually considering a typical coastal management issue recently encountered in the British Virgin Islands. The problem description and the solutions approached by the interdisciplinary teams form one part of this section of the report.

Rather than create a meeting statement, the conferees chose to spend the time by breaking into five working groups to identify oceanographic science information essential to support coastal zone management in the following problem/issue areas:

(i) Water Quality;
(ii) Natural Hazards Prediction and Response Planning;
(iii) Harvest of Living Marine Resources;
(iv) Shoreline Coastal Dynamics;
(v) Habitat Conservation.

In addition to identifying that these five coastal zone management issues are of paramount importance to SIDS, important cross-cutting aspects were listed, including oceanic, atmospheric and socioeconomic modelling, monitoring, education, training, data sharing, regional coordinating and networking, and appropriate methodology development.

For the sake of brevity, a summary of each of the papers delivered at Martinique will not be included in this section; the interested reader is referred to Annex II. The group did discuss the World Coast Conference (The Netherlands, 2-5 November 1993), an issue not in Annex II. Concern was expressed that the World Coast Conference lacked adequate technical background for many members of AOSIS (Association Of Small Island States). It was emphasized that the Association should be persuaded from the perspective of technical issues and not only be politically driven. Workshop members strongly felt that the three "C's" knitting together the participants in Martinique: COMMUNICATION, COLLABORATION, and COORDINATION should pay a strong role for small island developing states.

A PRACTICAL PROBLEM:

The Workshop practicum (Annex V) was designed by Dr. Gillian Cambers, based on an recent situation in the British Virgin Islands (BVI). The central issue involves using SCUBA to harvest conch and lobster, and the question is: Does SCUBA fishing significantly deplete the fish stock? Not only is the question to be answered quickly (typically a month or less), but it must be done so with very limited personnel and equipment. The following paragraphs represent the summary response from the three groups.

Group 1: Achieving sustainable exploitation identifies a basic conflict between competing interests. In the short term, it is recommended to replace the ban on SCUBA with permits; to create a seasonal ban; to create size limits and/or catch limits. For the longer term (6 months say) the suggestion was to conduct a resource study; to involve the fisherman in the licensing procedure and in surveillance; to provide retraining and education of both tourists and fisherman; and to review a marine parks proposal.

Group 2: Create a mechanism for an annual permit by auction or lottery; allow permits to be resold. This would naturally result in enforcement by permit holders. The fishery needs reserves, therefore a temporary (seasonal) ban on SCUBA is warranted (up to 3 years); regulate the buyers. Need for basic fishing (fisherman independent) data; conduct needed research from license fees; use fees to train fisherman for alternate employment. The BVI should not back away from existing legislation due to political pressure.

Group 3: There is insufficient information to establish the direction of the catch per unit effort; SCUBA ban may be unwarranted. In the short term in order not to create conflict, involve the media to create an alarm; make the public share-holders rather than regulators with draconian measures; strictly observe existing laws. In the long term, a social cost must be put on the activity; all SCUBA diving/fishing must be included in legislation; work with the consumers not to buy illegal size catch; set up a series of reserves; fund research and education with a possible shift towards mariculture.

Discussion following the group reports suggested that it was necessary to divide the regulation into three fisheries: conch, lobster, and fin-fish. The perception throughout the region is that fisheries are being depleted, and therefore certain international aspects need to be considered. Overwhelmingly there is a need for scientists to work with the fishermen in order to prevent emergencies, and decisions need to be flexible as new research is reported.

OCEANOGRAPHIC SCIENCE INFORMATION REQUIRED:

In this section, the oceanographic data required for problem definition and solution in the five SIDS primary problem areas identified during the Workshop are enumerated.

WATER QUALITY: Data needs to address water quality requirements include currents, bottom topography, water chemistry, temperature, turbidity, rainfall, waves, light, and salinity. The format needed for data to be useful includes paper copy, time series (trends), maps (spatial) and oceanic models of several type including conceptual box models, diagnostic data assimilation models, and prognostic (forecast) models. Education and training needs include oceanographic model operators, chemists, technicians, and graduate student support. In terms of data sharing and coordination, there needs to be better coordination between universities and public agencies, between university departments, and between regional agencies (in particular it was suggested that the UN insure that the FAO, WMO, IMO, IOC and UNEP meet at least annually to coordinate overlapping activities and to report to the member states on their progress).

NATURAL HAZARDS PREDICTION AND RESPONSE PLANNING: Data needs include physical parameters describing the ocean/atmosphere interface and the subsurface ocean in real time, climatological time series for analysis of the past trends, and easy access to satellite imagery and image processing algorithms. There is a need for regional specialized marine centers with capability for on-line data acquisition, processing, and analysis, and that can provide training with respect to specialized products that may be island specific. In general, there also needs to be improved observation networks, database management, and regional modelling - both oceanographic and meteorological. Storm-proof coastal sea level/weather observatories are required to adequately measure storm surge and wind waves.

HARVEST OF LIVING MARINE RESOURCES: The system is not deemed sustainable at the present, and much of the data needs have been made clear in the practicum discussed above. Of primary interest are ocean circulation prognostic models that are particularly tuned to forecast upwelling, and models that integrate biological variables in their results. Data to validate these models is continually required, and includes temperature, salinity, chlorophyll, winds, and fishing indices. Since some harvesting is pelagic, the 10 km resolution regional models are of the proper scale, but for the reef and coastal fisheries, there will have to be very fine resolution models nested into the regional models. Most importantly, there will have to be communications systems established to provide the model output to the fishermen and a feedback network to insure that the models are performing the needed tasks.

SHORELINE COASTAL DYNAMICS: In this problem area, information is required for physical planning including setbacks, natural habitat response to erosion, classification of shorelines, trends in shoreline changes (*i.e.*, from say mangrove to mudflat), reef ecology, riverine input to the coastal zone, bottom topography, sediment budgets, water column properties, waste disposal, wave directional spectra, and mining activities. Long term tide gauge observations of sea level change are critically needed in SIDS in order to assess future shoreline change due to water level differences with time. Additionally, there is a need for information on coastal structures and reports from other agencies with good and/or bad experience in managing the shoreline.

HABITAT CONSERVATION: Oceanographic "information" rather than simply data is required, in particular circulation on the fine-scale (1-5 km), the mesoscale (20 km or so) and the basin scale (order 100 km). The information needed includes temperature, salinity, turbidity, sea level, nutrients, and general planktonic statistics. Models need to be developed to give a physical foundation for interpretation of the biological data, in particular model packages that can be run on existing PC machines with limited data; a clearinghouse of models and modellers should be created; a case study repository should be developed; and a "standard" set of "circulation types" should be made available.

In general, there is a need to merge geophysical models, socioeconomic models, and observations. For example, if global climate change brings about a sea level rise, the effects need to be quantified in terms of the socioeconomic, natural habitat, shoreline, water quality, marine harvest, and hazards response impact. But global climate models and their predictions do not take into account very local effects, such as land uplift due to tectonic activity (for example). Therefore for the issue of sea level rise, observations are also required since in the case of tectonic uplift, the local effect may be sea level fall. Hence for SIDS in particular, a balance between observations and models, and between regional networking and intra-country coordination, and between reason and tradition, are all necessary to progress towards sustainable economic development.

3. CONCLUSIONS

A clear definition of "just what is a small island?" will probably be the focus of endless debate. Apparently the complete definition will require three geographical parameters. For example: total population of less than say 100,000 persons; total area of say less than 10,000 square kilometers; population density of say more than 25 persons per km^2 of "usable" land. Unfortunately geography alone is inadequate to express the socioeconomic dimensions of such a definition, which may have to include income, opportunity, health, and a host of other intangibles. Ultimately "small island developing state" will be a political definition, and the challenge for scientists and managers will be to create a coordinated process to achieve sustainable development.

All coastal zone management decisions in small island developing states are ultimately political because the body of law is not well developed. SIDS coastal managers can usually only make recommendations. Therefore the managers and scientists need to learn to work within the system; they need to become involved in the political process. Lack of coastal resources information is a major problem, and even the most egalitarian politician finds weakened conviction where there is no database. For this reason, the Environmental Impact Assessment is a little used tool, although it is in the early stages of development in many SIDS.

The time scale of change is typically one generation, *i.e.,* 30 years or so. Whether sustainable economic development is compatible with such time scales in the future is a matter for serious debate. Through the following steps the coasts can provide sustainability:

(i) create the political will;
(ii) perceive the need for coastal zone management;
(iii) embark on infrastructure building;
(iv) create an integrated plan; and
(v) implement the plan openly and fairly.

The challenge will be to continue the interdisciplinary dialog started during this Workshop on Small Island Oceanography in relation to Sustainable Economic Development and related Coastal Area Management of Small Island Developing States.

WORKSHOP PROGRAMME

Sunday, 7 November

1900	Informal Gathering: Discussion of draft agenda; time requirements for presentations; logistics of meeting rooms; plans for publication of meeting chapters in an AGU "Coastal and Estuarine Studies" volume.

Monday, 8 November

0830-0900	Opening: Statements by IOC (F. Robles); US-NOAA (G. Maul - Chairman of the Workshop); METEO-FRANCE (A. Soulan - host).
0900-1230	*Session 1*: 5 papers (with coffee break, 30 minutes).
1430-1800	*Session 2*: 5 papers (with coffee break, 30 minutes).

Tuesday, 9 November

0830-1230	*Session 3*: 6 papers (with coffee break 30 minutes).
1430-1800	*Session 4*: 5 papers (with coffee break 30 minutes).

Wednesday, 10 November

0830-1030	*Session 5*:	3 papers (with coffee break 30 minutes).
1100-1230	*Session 6*:	Exercise in Problem Solving
1430-1700	*Session 6*:	(con't): Reports on solutions
1700-1900	*Session 7*:	Concluding discussion on follow-up, possible small islands oceanography programme preparation, and contribution to (or input to) the First Global Conference on the Sustainable Development of Small Island Developing States.

The following distribution was accomplished:

Session 1 and 2:	Oceanography and Meteorology
Papers by:	Bowman, Gallegos, Lazure, Watlington, Michel, Maul & Hendry, Gray, Mandar, Daniel, Bleuse
Session 3:	Islands
Papers by:	Vernette, Klingebiel, Hendry, Granger, Holthus, Durand

Session 4:	Chemistry, Biology, Fisheries
Papers by:	Vicente, Mahon, Gourmelon, Proni, Daniel
Session 5:	Management
Papers by:	Robles, Engelen, Wolf, Cant, Templet, Garcia, Busby, Cambers
Sessions 6 and 7:	Problems, solutions, programme formulation, planning and input towards the Global Small Island Developing States Conference.

ANNEX II

ABSTRACTS OF THE SCIENTIFIC PAPERS

Section I: Summary

Chapter 1: *G.A. Maul*
Oceanic Science in Relation to Sustainable Economic Development and Coastal Area Management of Small Islands.

Small island developing states (SIDS) were recognized at the United Nations Conference on Environment and Development (UNCED, June 1992) as requiring special attention by the scientific community in order to address problems associated with sustainable economic development and coastal area management. The Intergovernmental Oceanographic Commission of UNESCO convened a meeting on small island oceanography (Martinique, 8-10 November 1993) that brought together specialists from marine science, geography, hydrology, ecology, fisheries, management, economics and sociology. Thirty participants from 15 countries and SIDS in the Atlantic, Pacific and Indian Oceans approached the challenge from UNCED with cross-cutting lectures, debates, and problem solving exercises focusing on the three "c's" of successful interdisciplinary endeavor: communication, collaboration, and coordination.

Oceanographic science information to support coastal zone management was deemed essential to the following five related SIDS issue areas: 1. Water Quality; 2. Natural Hazards Prediction and Response Planning; 3. Harvest of Living Marine Resources; 4. Shoreline Coastal Dynamics; and 5. Habitat Conservation. Cross-cutting solutions to these 5 issues areas emphasized the need for numerical modelling, enhanced monitoring and inter-calibration, education and training, data sharing, regional coordinating and networking, and appropriate methodology development for decision making. In particular quantitative data from coastal physical oceanography was identified as of the highest priority in an Issues/Solutions matrix, and the expanded use of PC or workstation computer models that integrate the physical environment with socioeconomic response such as climate change, sea level rise, and population growth was recommended.

Section II: Physical Sciences

Chapter 2: *M.J. Bowman, D.E. Dietrich, and C.A. Lin*
Observations and Modelling of Mesoscale Ocean Circulation near a Small Island.

Observations are presented of near surface circulations around the island of Barbados (13°10'N; 59°30'W) in the spring of 1990 and 1991, using a combination of hull mounted ADCP and geostrophic calculations. The circulation showed highly variable characteristics between the two years. In 1990 the flow patterns suggested topographic steering in a clockwise sense around the Barbados Ridge located north of the island. In 1991, two island-scale eddies were observed in the offing of the west and east coasts (an anticyclone and cyclone, respectively), which were suggestive of Von Karman-type eddies. Preliminary three dimensional numerical simulations of flow past an idealized island with Barbados-like characteristics (*viz.*, shape, depth, stratification, latitude) show that the disturbance to the ambient flow by the presence of the island is very extensive and exists for a distance of at least eight island diameters downstream. For realistic flow velocities and eddy viscosities, the island readily sheds Von Karman-type vortices, which have a shedding period of about 10 days (per pair), and which have a strong three-dimensional structure.

Chapter 3: *A. Gallegos*
Descriptive Physical Oceanography of the Caribbean Sea.

The Caribbean Sea (CS) is the largest marginal sea of the Atlantic Ocean. It has a surface extension of 2.52×10 km^2; almost twice as large as that of the Gulf of Mexico, and its volume (6.48×10 km^3) is twice that of the Mediterranean Sea. The north and eastern boundaries of the CS are the Greater and Lesser Antilles, respectively. It is limited to the south by the irregular coasts of Venezuela, Colombia, and Panama. The western boundary of this major sea is the Central American eastern zig-zag littoral.

The CS is located between 8°N and 22°N latitude and 60°W and 89°W longitude, which implies north-south extensions close to 1500 km and east-west breadths of the order of 3000 km. In fact, connecting distances between pairs of selected diametrically-opposed ports within the region are: Bridgetown (Barbados) to Cancún (Mexico), 3030 km; Colón (Panama) to Cienfuegos (Cuba), 1440 km; Puerto Estrella (Colombia) to Oviedo (Dominican Republic), 600 km.

The CS has an average depth of 4400 m. It consists of five principal basins. From east to west, the first is the Grenada Basin, with an average depth of 3000 m, immediately to the west of the Lesser Antilles. The second (and largest) is the Venezuela Basin, which has an average depth of 5000 m and connects with the Grenada Basin trough wide channels across the Aves Ridge at depths not greater than 1800 m. Waters from the Atlantic Ocean have direct access to the Venezuela Basin through the Jungfern-Anegada (sill depth: 1875 m) and Mona (sill depth: 475 m) passages.

The Beata Ridge, a north-south submarine escarpment between the island of Hispaniola and Colombia, separates the Colombia Basin from that of Venezuela, but there is a wide submerged pass that allows water exchange at depths in excess of 3600 m, close to the average depth (4000 m) of the Colombia Basin.

The fourth basin is the Cayman Trench with a record depth of 7100 m. The average depth of this elongated basin is 6000 m and has direct seawater exchange with the Atlantic Ocean through the Windward Passage (sill depth: 1690 m). It also connects with the Colombia Basin across the Jamaica-Haiti Passage (sill depth: 1475 m) and the various submarine channels that cut across the ridge between Jamaica and the Honduras-Nicaragua continental shelf, with maximum sill depths of 1600 m.

The Yucatan Basin has an average depth of 5000 m and links the CS with the Gulf of Mexico via the Yucatan Channel. Since the sill depth of this passage is 2040 m, only under unusual dynamic conditions, such as large amplitude internal waves or extreme compensatory flows, can seawater of depths greater than the sill be exchanged between these two large bodies of water. The Cayman Ridge, with its axis marked by the Cayman Islands, the Rosario Reefs and the Misteriosa Bank, separates the Yucatan Basin from the Cayman Trench but allows seawater exchange from the surface down to depths close to 4000 m.

There are other smaller marginal basins, gulfs, and bays within the CS which are very important on their own, have particular characteristics, pose controversial problems,...real Pandoras' boxes that demand detailed attention. For example, the Cariaco Basin is a unique feature in the world. It has a shallow sill depth (200 m) and is ordinarily ventilated by water from the Venezuela Basin. In recent years, geochemical evidence suggests the ventilation has ceased, and this can be interpreted as being caused by a decrease in the strength of the Caribbean Current. This has profound global climatic implications because the Caribbean Current contributes significantly to the oceanic heat flux from the tropics to mid-latitudes where air-sea interaction is the primary mechanism of moderating North Atlantic climate.

Unfortunately, the scope of the present regional description is far too general to aboard local aspects with further details. Just to mention some of the most important, apart from the Cariaco Trench, there are the basins of Bonaire and Tobago. As to the major bays and gulfs one should refer to Paria, Venezuela-Maracaibo, Mosquitos, Darien, Honduras, Batabanó, Guacanayabo and Gonave.

Probably the most important physiographic feature of the CS is the barrier formed by the Antillean Arc that does not permit much interaction with the deep waters of the North Atlantic Ocean. This feature confirms the CS as a two-layer ocean with the lower layer at rest (an interesting point for modellers of the circulation of the CS).

Chapter 4: *R.A. Watlington and M.C. Donoso*
Oceanic Features Influencing Small Island Circulation Patterns: Case Studies.

Some areas of Caribbean oceanography may have particular impact on the ability of coastal communities, particularly small island states, to pursue sustainable development and coastal management. These areas are: the variability of the circulation of the Panama-Colombia Counter Current; the movement of pollutants and other flotsam through the islands of the Antillean chain; and the existence throughout the Caribbean of ocean thermal gradients, optimal for the extraction of energy. Cooperative studies in different fields of oceanography and the sharing of resources by the institutions of the Intra-Americas Sea constitute an efficient response to the increasing regional demand for better knowledge of the sea. This multilateral approach will benefit both island and coastal states.

Chapter 5: *P. Lazure, J.C. Salomon, and M. Breton*
Subtidal Circulation in Fort de France Bay.

Two numerical models have been used to study coastal circulation around Martinique and Fort de France Bay. The last three-dimensional model is more advanced than the global study because the bay is partly isolated from external influences. After a review of past studies, the first results of the global model and the three-dimensional model used for the study of the bay are briefly presented. The main aspects of the circulation are then outlined and an application to the bacteria transport is presented.

Chapter 6: *G.A. Maul, M.D. Hendry, and P.A. Pirazzoli*
Sea Level, Tides, and Tsunamis.

Small islands have intimate contact with oceanic phenomenon, and in many cases their geography is a totally marine environment. Accordingly, catastrophic events such as tsunamis can affect their entire land area, and rising global sea level is feared to flood whole nations. In a survey of sea level at numerous small islands, it is shown that in many cases sea level is falling and has been for centuries, and that any effect of global change is very site specific. Tides, in general, have a smaller range at islands than at continental sites, but even though tidal observations are essential for determining vertical datums and for predictions, many small island developing states do not operate tide gauges. Tsunami prediction, for example, requires improved bottom topography information at most sites, but again the observational network for issuing warnings and improving such forecasts is oftentimes absent. A commitment by small island developing states to initiate observations and to participate in regional research and monitoring programs is considered essential for effective decision making to assist sustained economic development.

Chapter 7: *J. Wolf*
Practical Aspects of Physical Oceanography for Small Island States.

The problems to be solved for a small island state in obtaining physical oceanographic data in a cost-effective manner are addressed. Examples are taken from experience in Trinidad and Tobago.

Chapter 8: *C.R. Gray*
Design Values of Extreme Winds in Small Island States.

Records of surface wind speed data recorded at Norman Manley and Sangster International Airports in Jamaica since 1951 are analyzed using different methodologies with a view towards selecting the most appropriate for extreme winds associated with tropical cyclones. Annual maximum 1-min wind speed from 1885 to 1988, associated with tropical cyclones in the region, are then analyzed to establish design values of extreme winds in small island states.

The mixed Fretchet type extreme value distribution [after Thom, 19__] is used for the annual series of maximum monthly average wind speeds. The Fisher-Tippet Type II, which is an exponential transformation of the Type I distribution, is applied to the annual series of maximum 1-min winds associated with tropical cyclones; the Lieblein Fitting Technique is also applied to negate the effect of the moments giving poor estimates. The estimates obtained from the analysis of maximum 1-min winds indicate that, on an average, at least once every 50 years a 1-min sustained wind speed of 168 mph is likely to be equalled or exceeded anywhere within the path of tropical cyclones. These statistics and their interpretation are of utmost importance since investigation of numerous cases of building damage due to wind action has shown that, while some failures were undoubtedly due to defects of workmanship, many cases of damage resulted from an under-estimate of wind forces in the design of buildings and other structures.

Chapter 9: *P. Daniel*
A Real-Time System for Forecasting Hurricane Storm Surges over the French Antilles.

A depth-averaged numerical storm-surge model has been developed and configured to provide a stand-alone system to forecast hurricane storm surges. The atmospheric surface pressure and surface winds are derived from an analytical hurricane model and require only hurricane positions, central pressures, and radii of winds. The model has been adapted to run on a personal workstation in a few minutes. The storm-surge model was tested in hindcast mode on three hurricanes which gave significant surges over Guadeloupe and Martinique during the last 15 years.

Section III: Geology and Ecology

Chapter 10: *O.E. Granger*
Geography of Small Tropical Islands: Implications for Sustainable Development in a Changing World.

Small tropical islands, although physically diverse and ranging from rugged mountainous terrain of volcanic antecedents to low-lying, flat coralline reefs, are the products of similar tectonic activities and geologic structures from the Cretaceous to Recent times. They can be classified according to their location and mode of formation into: islands of trench/arc systems, oceanic islands, and islands associated with continental plate dynamics. There may be combinations of types in the same geographic location. The crustal instability that underlie their genesis is the source of economic strength of some but of disasters that threaten their viability as developing independent states. Their economic bases are their varied terrestrial and oceanic bioproductivity systems which are not generally robust. In a few cases, that base may include some mineral deposits of economic value, *i.e.,* gold, silver, copper, nickel, bauxite. In addition to socioeconomic constraints on sustained development such as hegemonic marginalization, serious balance of payments problems, diseconomies of scales, limitations on natural resources base, dependence on a very narrow range of generally uncompetitive export products and foreign aid, environmental constraints to development face these small islands and island states: a limited supply of fertile soils, unreliable water supply that may become more restricted and even less reliable with global warming, geologic and meteorologic disasters that include volcanic eruptions, earthquakes, hurricanes and typhoons, floods and droughts that periodically, and perhaps more frequently in the next fifty years, completely destroy the already shaky economic base. With global warming and its anticipated oceanic impacts including increased storm intensities, coastal and estuarine inundations, salinization of coastal aquifers, changes in the spatial and temporal distribution of rainfall, increased temperatures and hence increased evapotranspiration, these constraints will be exacerbated. Solutions are not easy but present and expected constraints on sustained development must be taken into consideration now in preparation for an increasingly vibrant socioeconomic future. More importantly, small tropical islands must attempt to define the nature and scope of sustained development on their own terms and in keeping with their cultural and social presuppositions rather than externally imposed expectations and definition.

Chapter 11: *G. Vernette*
Small Island Geology: An Overview.

Different processes allow for the construction of islands. Some of these processes correspond to volcanic and tectonic activities and occur in plate boundaries (island-arc systems and ocean ridge islands) or far from plate boundaries (intraplate volcanic islands). Another process is diapirism, which is related to sea level change. Islands can also be constructed by hydrodynamic processes (barrier islands) and terrigenous input in deltas and estuaries; finally, in tropical zones numerous islands are constructed by coral reefs.

Chapter 12: *M. Hendry*
Geological Processes and Related Management Problems of Small Islands in the Western Central Atlantic.

No Abstract.

Chapter 13: *A. Klingebiel and G. Vernette*
Geology and Development Facilities of Small Islands Belonging to the Atlantic Margin of Africa and Europe.

From a geological and oceanographic point of view, the eastern side of the Atlantic Ocean is characterized by a passive margin structure, related to the opening of this ocean since the lower Mesozoic period and to the mechanism of seafloor spreading responsible for continental drift. Among the three major continental plates (African, Iberic and European), only the European Plate contains numerous small coastal islands; this difference seems to be due to both a difference in climatic erosional processes, *i.e.,* effects of Pleistocenic glaciations on the European Plate, and chiefly to stronger and younger tectonic and isostatic events that occurred during Mesozoic and Cenozoic periods in the northern hemisphere. The main coastal island systems from south to north are Bissão and Los Islands next to the Guinean coast and all the numerous coastal islands of Europe from the Bay of Biscaye to the Norwegian Sea.

However, the three plates are cut by transverse faults through which magmatic extrusions build up volcanic relief and oceanic islands. These main fractures and volcanic systems from south to north are Cameroon, Fernando-Po, Príncipe, São Tomé, Senegal, Cape Verde Islands, Atlas Mountains (Morocco), Canary Islands, the Azores, northern Ireland, the Faeroe Islands (Denmark), and Iceland. Thus, various kinds of islands may be distinguished within the eastern margin of the Atlantic Ocean:

(i) Volcanic islands, comprised of basaltic plateau and volcanic cones.
(ii) Pre-continental islands, comprised of old metamorphic basement and folded sedimentary substratum.
(iii) Coastal barrier islands.

No coral reef islands occur in this oceanic system.

Knowledge of the geological structure of the insular areas is basic to understanding the main characteristics of the land and shelf morphology, the location and nature of potential renewable and/or nonrenewable resources, elaborate economic development schemes, and coastal management programs.

Oceanographic and atmospheric data are also basic within a global model of fluxes occurring in these insular systems and contributing to their environmental budget. Rainfall and fresh water resources, solar energy, wind energy, hydraulic and sea energy, and the determination of exceptional physical conditions are all factors that may limit biosphere and hydrosphere usage.

Chapter 14: *G. Garcia Montero and J.L. Juanes Marti*
Coastal Erosion and Mitigation: The Case of Varadero Beach, Cuba.

Varadero Beach, one of the most important tourist resorts of Cuba, has been experiencing an erosive trend of its shoreline for the past 25 years. Shoreline retreat has been estimated at 1.2 m/yr with an average sand loss of 50,000 m^3/yr. The main results of a research program for beach erosion studies are presented; this includes the results of a mitigation program applying artificial beach nourishment that has been developed since 1987, with a total of 700,000 m^3 of sand nourished to the beach. The main causes of beach erosion and the reasons for specific mitigation actions are explained. The application of these results to other small island countries could be inferred.

Chapter 15: *F. Durand, C. Augris, and P. Castaing*
Surficial Geology on the Insular Shelf of Martinique (French West Indies).

Sedimentological investigations were undertaken on the insular shelf of Martinique by IFREMER and the University of Bordeaux using complementary techniques such as side-scan sonar and echosounder analysis, sediment grab samples, and camera-towed photography along the seafloor. The results presented herein show two major sedimentary facies: the volcanic facies, situated north and northwest of Martinique, transported as detrital inputs or by the wind, and the organogenic facies, located on the eastern and southeastern sides of the island, produced by the destruction of autochthonous coral and algae formations. These two gradients, governing the patterns of the littoral and neuritic deposits, mix in variable proportions and characterize different sedimentary areas. Consolidated formations and dynamic structures have also been identified.

Chapter 16: *V.P. Vicente*
Littoral Ecological Stability and Economic Development in Small Island States: The Need for an Equilibrium.

No abstract.

Chapter 17: *M. Pommepuy, A. Derrien, F. Le Guyader, D. Menard, M.P. Caprais, E. Dubois, E. Dupray, and M. Gourmelon*
Microbial Water Quality on a Caribbean Island (Martinique).

To assess microbial water quality, bacterial and viral studies were carried out in Fort de France Bay from 1992 to 1993. The objectives were to evaluate fecal contamination of rivers and sewage discharged into the bay and the behavior of fecal bacteria in seawater. In this study, molecular techniques such as the polymerase chain reaction (PCR) were used to detect the main pathogenic viruses encountered in hydric environments, *i.e.,* Hepatitis A virus (HAV), rotaviruses (RV), and enteroviruses (EV), while bacterial contamination was evaluated by β-galactosidase activity using 4-methyl-umbelliferyl-B-D-galactoside (MUGal) and conventional techniques. Results showed that rapid techniques are successful in evaluating microbial contamination. In less than an hour bacterial analyses of fecal coliforms can be assessed; only two days are required for viral results by PCR. Martinique's rivers were found to be more often highly contaminated by urban sewage. Viral RNAs were detected in 50% of the rivers, but no correlation between viral and bacterial contamination was noted in this study. An indication of the impact of sewage discharge in coastal areas was provided by fecal bacterial die-off rate studies. T90 was found to be less than 4 h in sunny weather and less than 30 h during the night or cloudy weather. The die-off rates found in Martinique are often shorter than in Europe, especially at night. This result can be attributed to local water conditions such as temperature, oligotrophic water, and quality of sunlight intensity.

Chapter 18: *R. Mahon*
Fisheries of Small Island States: Oceanographic Research and Information Needs.

Small island states are primarily tropical. Their fisheries are mainly artisanal or small-scale commercial, and can be viewed as shelf-based, mostly in coral reef habitats, or offshore oceanic. The former tend to be traditional, while the latter tend to have developed or expanded recently with extended jurisdiction. With regard to the fishery and fishery- related characteristics examined in this paper, small island states differ more from mainland states than they do among themselves in different regions of the world. Island states can be characterized as small and densely populated with relatively large areas of shelf and exclusive economic zone (EEZ). However, the yields of offshore pelagics (tunas/billfishes/mackerels) and shelf fishes (other fishes) are relatively low per unit area of EEZ and shelf, respectively, in comparison mainland states. Lower yields from island shelves than from continental shelves may be partly due to productivity; however, island EEZs should be able to produce similar yields to those of mainland countries.

The institutional and infrastructural basis for fisheries development and management is weak in most small island states, particularly in relation to the newly claimed EEZs. Research requirements in support of management is generally identified as being of fishery socioeconomics and fish population dynamics (stock assessment). Oceanography is seldom cited as a high priority need. This may be partly due to the high cost of physical oceanographic research and the almost non-existent capability for this type of research in small island states. However, physical oceanographic information can provide valuable insights for fishery managers and developers, and can sometimes be accessed incidentally, as in the case history presented for the southeastern Caribbean. Physical oceanographic information of value for fisheries is usually acquired for other purposes. Better coordination among users and collectors could result in a significant increase in availability of physical oceanographic information to fisheries managers, with a minimal increase in the cost of acquisition.

Section IV: Management

Chapter 19: *G. Cambers*
Toward Integrated Coastal Zone Management in Small Island States.

This paper will discuss Integrated Coastal Zone Management (ICZM) within the context of small island states, with particular reference to the Caribbean area. In particular, it is proposed that a stronger link should be forged between the regional research institutions and the professionals on the ground within governments who are implementing ICZM.

Chapter 20: *R.V. Cant*
Water Supply and Sewerage in a Small Island Environment: The Bahamian Experience.

The Bahamas islands comprises several hundred low lying limestone islands which are well suited to and heavily dependent upon the tourism industry. Unfortunately, water supplies and liquid waste disposal present serious problems in such an environment and these have impacted the economic development of the islands. Specific problem areas include the availability and distribution of freshwater resources. Water systems are proving to be difficult and costly to develop and few residential communities can afford the full cost of water supplied by alternate methods such as reverse osmosis. Groundwater resources in this environment are also very prone to man's abuse and are exceedingly vulnerable to pollution. Mistakes have been made which have resulted in serious, long-term damage. Liquid and solid wastes are proving difficult to manage and dispose of, and appropriate technology needs to be applied where conventional methods are found to be unsatisfactory.

Experience has shown that adequate legislation and regulation are required to control and protect water resources, and there needs to be an institutional structure that can administer and enforce the fair use of these resources. In small island states all those involved in the environment and water supply sector have to work diligently to make the public aware of the issues involved, and the potential consequences of inaction, so that the public will accept whatever measures are needed to safeguard the future.

Chapter 21: *P.F. Holthus*
Coastal and Marine Environments of Pacific Islands: Ecosystem Classification, Ecological Assessment and Traditional Knowledge for Coastal Management.

Coastal and nearshore marine environments in the tropical island Pacific are subjected to severe and extensive impacts from a variety of sources of degradation and destruction. In spite of the importance of coastal and marine environments to the small islands of the Pacific, there is only limited scientific information available on these areas. Integrated coastal zone management (ICZM) is urgently required on the small islands of the Pacific to ensure the sustainable use, development and conservation of coastal and nearshore marine environments. Information on the biological, ecological, geological and oceanographic characteristics of these environments is an essential basis to ICZM. Although much research is needed to provide information for the scientific management of coastal and marine environments in the Pacific, these areas will not be able to be managed with scientific rigor for some time due to the limited amount of research underway. However, a substantial amount of information on coastal and marine environments can be readily obtained through several approaches which are being employed in the Pacific and may have relevance to other small islands.

In the tropical island Pacific, three complimentary approaches are being used to rapidly and cost effectively obtain information on coastal and marine environments as a basis for ICZM and sustainable development:

(i) Inventorying of marine ecosystems using a regional classification system. A comprehensive, hierarchical classification of the ecosystems of the tropical island Pacific was recently developed. This allows ecosystems to be inventoried on a systematic, regionally valid and comparable basis in order to determine conservation priorities on local, national or regional scale. A preliminary inventory of ecosystems in U.S. affiliated islands has tested and refined the classification system, especially the marine component. The marine classification for the tropical island Pacific may be useful in the inventory of marine ecosystems of other tropical islands.

(ii) Undertaking of Rapid Ecological Assessments of nearshore marine areas. A methodology for undertaking Rapid Ecological Assessments of nearshore marine areas has been successfully developed and applied to a growing number of islands to obtain information on their biological and physical characteristics as a basis for coastal management planning and other aspects of sustainable development.

(iii) Collecting of traditional knowledge of marine ecosystems from indigenous experts. Pacific island marine resource users hold a wealth of traditional knowledge on their marine environments, much of which is invaluable to the management of marine ecosystems. This rich knowledge is rapidly being lost and efforts to collect this information as part of coastal management planning have been made, but much more work is urgently required.

Chapter 22: *N.J. Shah and J.-C. Michel*
Oceanographic Processes and Sustainable Development in Seychelles

No abstract.

Chapter 23: *P.H. Templet*
Coastal Management, Oceanography, and Sustainability of Small Island Developing States.

New emphasis by the United Nations on sustainable development as a result of UNCED has led to an increased need for developing nations to implement environmental planning and management programs. An important management approach for coastal areas, and by inference, island states, is that of integrated coastal management (ICM) which seeks to resolve conflicts among coastal users, encourage appropriate coastal development and discourage development which is detrimental to coastal resources. The American Samoa Coastal Program is presented as one model which may have application to developing island nations. A cultural-based model which relies heavily on science stands the best chance of being useful to developing nations and recommendations are made on ways to develop such programs. Lessons learned from the development process indicate that spatial presentation of data is helpful in gaining acceptance. The role of science and oceanography in ICM program development is discussed and suggestions on making both more relevant to planners is presented. Sustainable development and a development transition based on risk, natural and man-made, is presented as a means of understanding sustainability. Reducing man-made risk is posed as one condition of sustainability.

Chapter 24: *P. Daniel*
Environmental Economy of Small Islands: The Example of Martinique.

No abstract.

Chapter 25: *E. Blommestein*
Sustainable Development and Small Island Developing Countries.

No abstract.

Chapter 26: *L.A. Busby*
Socioeconomic Databases in the Caribbean: Status and Desiderata.

This paper examines the question of data availability to assist the planning process. It evaluates the holdings of information sets that can effectively guide Governments to making development plans that place importance on sustainable development. The paper examines datasets that exist at present and attempts to explain there existence and incorporation as desirable information bits for planners through the effective communication to Governments of the importance of the phenomena dealt with in these datasets. The importance of the environment is made and the desirability to have it enter into the consciousness of the planners is registered. The paper identifies effective communications and persistence as the two pillars on which the success of the move to gain more prominence for the environment as a planning concern must rest.

Any discussion on sources of information within the frame of reference as indicated by the title of the paper must address a wide spectrum of statistics. It must also examine their usefulness in the data set that must inform the planner, the entrepreneur interested in Marketing or indeed any other aspect of business. Within the context of a discussion on the environment, one might wish to focus on the effect of styles of primary production, agro-processing and industrial activities and their effect on the environment as they contribute to the social and economic progress of our Caribbean societies.

At the outset I wish to make the point that information cannot be compartmentalized and used to the maximum in a partial manner (*i.e.* divorced from other statistics). The entrepreneur operating in the Agricultural or indeed any other sector would do well to make use of a data set wider than statistics of agricultural production, daily retail prices of selected agricultural products or GDP. The decision to purchase any good or service is made against the backdrop of a complex of variables considered and is usually explained through the instrument of a demand function. Other items such as industrial production statistics, imports, demographic variables and a host of imponderables influence the decision to purchase or not to purchase. This in turn will exert some effect on the decision to invest. The investor must therefore be in tune with the determinants of demand.

The planner, on the other hand, must be aware of the implications of the proposed investment, not only on the labor market but also on the entire society through the impact of the investment on the country's natural resources and other elements of the environment. The need for a wide range of statistics is therefore well understood. In addition, the need to make country comparisons makes the case for a regional database of socioeconomic statistics available for wide access and use.

Chapter 27: *G. Engelen, R. White, and S. Wargnies*
Numerical Modelling of Small Island Socioeconomics to Achieve Sustainable Development.

The aim of this paper is to propose and develop a modelling framework instrumental in the exploration of policies aiming at sustainable development for small islands. The essential requirements of models representing realistically small island socioeconomics are presented briefly. We emphasize the integrated, dynamic, and spatial approach that is required. The modelling framework consists of different modules that represent interaction mechanisms at different geographical scales. It allows for a tight integration of detailed environmental qualities with the socioeconomic characteristics of small islands. Finally, we elaborate on a number of model extensions considered to be useful in "measuring" sustainability and to display its intrinsic uncertainty. The paper is an extension of our earlier work on developing modelling and decision support tools to analyze the impacts of climate change on socioeconomic systems.

Summary of information required for integrated coastal zone management decisions of small island developing states to achieve sustainable economic development

Required Oceanographic Science Information	Water Quality	Hazards Prediction & Response Planning	Harvest of Living Marine Resources	Shoreline Coastal Dynamics	Habitat Conservation
air-sea fluxes	✓	✓			
bottom topography	✓	✓		✓	
chlorophyll	✓		✓		
currents	✓	✓	✓	✓	✓
diastrophism		✓		✓	✓
imagery	✓	✓	✓	✓	✓
light	✓		✓		✓
model, diagnostic	✓	✓	✓	✓	✓
model, prognostic	✓	✓	✓		
plankton	✓		✓		✓
precipitation	✓	✓		✓	✓
riverine input	✓	✓	✓	✓	✓
salinity	✓		✓		✓
sea level	✓	✓		✓	✓
temperature	✓	✓	✓		✓
tides		✓		✓	
training	✓	✓	✓	✓	✓
tsunamis		✓		✓	✓
turbidity	✓				✓
upwelling		✓	✓		
water column chemistry	✓		✓		✓
wind waves & swell	✓	✓		✓	
winds	✓	✓	✓	✓	

ANNEX III

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ANNEX IV

EOS ABSTRACT (Vol. 75(3), pp: 208, 1994)

Small Island Oceanography

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Small island developing states (SIDS) were recognized at the United Nations Conference on Environment and Development (UNCED, June 1992) as requiring special attention by the scientific community in order to address problems associated with sustainable economic development and coastal area management. The Intergovernmental Oceanographic Commission of UNESCO convened a meeting on small island oceanography (Martinique, 8-10 November 1993) that brought together specialists from marine science, geography, hydrology, ecology, fisheries, management, economics and sociology. Thirty participants from 15 countries and SIDS in the Atlantic, Pacific and Indian Oceans approached the challenge from UNCED with cross-cutting lectures, debates, and problem solving exercises focusing on the three "c's" of successful interdisciplinary endeavor: communication, collaboration, and coordination.

Oceanographic science information to support coastal zone management was deemed essential to the following five related SIDS issue areas: 1. Water Quality; 2. Natural Hazards Prediction and Response Planning; 3. Harvest of Living Marine Resources; 4. Shoreline Coastal Dynamics; and 5. Habitat Conservation. Cross-cutting solutions to these 5 issues areas emphasized the need for numerical modelling, enhanced monitoring and inter-calibration, education and training, data sharing, regional coordinating and networking, and appropriate methodology development for decision making. In particular quantitative data from coastal physical oceanography was identified as of the highest priority in an Issues/Solutions matrix, and the expanded use of PC or workstation computer models that integrate the physical environment with socioeconomic response such as climate change, sea level rise, and population growth was recommended.

ANNEX V

PRACTICUM: DOES SCUBA FISHING SIGNIFICANTLY DEPLETE CONCH AND LOBSTER STOCKS IN THE BRITISH VIRGIN ISLANDS?

Background

The BVI are an archipelago of 50 islands, 160 km east of Puerto Rico. The population is 20,000 people. The economy is based on tourism and offshore financing, with fisheries third in order of importance. There is a fledgling Coastal Zone Management Agency in the BVI - the Conservation & Fisheries Department (CFD).

The Fisheries Industry

The fisheries industry is based on a small scale artisanal (reef) fishery. Fisheries contributes 3% to the GDP. There are a total of 280 fishermen, with 150 fishing boats. Fish traps are the most important gear. Sports fishing is an important economic activity; this fishery has not been included in the above statistics. As yet the BVI has not moved towards longlining or the exploitation of deep water species, although this is being given consideration. A comprehensive data collection system has only been in place since 1992, so few data are available.

Against a background of sparse data, there are signs that the reef fishery has been depleted. Similarly estimations are that the conch fishery has declined from the maximum sustainable yield (MSY) of 188 tonnes to 59 from shallow habitats, and can only be found in 60 feet+ water depths. The lobster fishery is producing amounts of lobster equal to or slightly less than the Maximum Sustainable Yield.

SCUBA Fishing

Diving with SCUBA gear has been conducted in the BVI since the late 1970's. In 1986 two Haitian boats were intercepted. There were two mother ships and 16 dinghies, and there were compressors on board with hoses going down to the divers. This operation was moving like a wall taking everything on site on the shelf.

In addition local SCUBA divers have begun operations. Following incidents such as that described above, the commercial fishermen and the Fisherman's Association made a very strong lobby to the Government to ban SCUBA fishing. Their concerns were threefold :

- Declining catch in the reef fishery which they attributed to SCUBA fishing, at least in part.
- SCUBA fishermen interfering with their traps.
- SCUBA fishing methods which basically clean out everything on the sea bottom.

Due to the concerns of the commercial fishermen, the CFD were asked to make a recommendation - fast (within weeks). They attempted to discuss the matter with the local SCUBA fishermen, but to no avail; these fishermen were not willing to discuss the matter, and in one case guns were pulled on the Fisheries Officers.

A recommendation was made that SCUBA fishing be banned completely. This law was passed in 1990. It must be borne in mind that an election was imminent and the commercial fishermen represented a significant number of votes.

Between 1990 and 1992, the law was publicized by the CFD, and warnings were given on several occasions to SCUBA fishermen. Yet the fishing continued unabated. During this time many complaints were received about SCUBA fishing activities, and particularly the fact that foreigners were coming in to fish with SCUBA. In addition there was a complete ban on conch fishing in the US Virgin Islands between 1987 and 1992, yet this fishery continued in the BVI. Both territories share the same bank.

In 1993 on a surveillance patrol, a group of SCUBA fishermen were caught. In the following court case, which received considerable publicity, fines of $100 were levied, the magistrate was lenient since this a first offence, and also it was the first time such a case had come to court.

Following this case the local SCUBA fishermen came to the CFD requesting that the law be changed since their livelihood was being threatened. Meetings were held and their points were as follows:

- Divers do not interfere with traps.
- Decline in catch in fish traps may be a function of the number of traps, the prevalence of ghost traps, the mesh size and environmental degradation (eg. pollution and loss of mangroves) so why blame the SCUBA fishermen for this?
- Divers exercise selectivity in their method of fishing.
- There is a lack of communication between divers and other fishermen.
- The SCUBA fishery is a local industry, and provides lobster and conch for the visiting tourists.
- They were willing to work with the CFD.

Present Situation

The SCUBA divers, of which there are about ten operations, have lobbied the Minister responsible for fisheries and the Chief Minister, requesting that the law be changed such that permits can be given for local SCUBA fishermen. The Ministers are sympathetic to this request, and while they have asked the CFD for an opinion, they are leaning towards changing the law as a matter of priority.

Decision to be made

The CFD has to make a decision within a matter of weeks, what should that decision/recommendation be? There is, of course, the opportunity to make a decision now and make provision for a review say in 1 or 2 years time after certain data has been collected.

You are asked to advise on what the immediate decision should be and if a longer term data collection programme is to be started, what should this involve. You are asked to bear in mind the following constraints :

- The CFD has a staff of 10 persons, 5 of whom are graduates, there is one 35 foot boat and a small inflatable. They are responsible for the management of all coastal resources so their workload is heavy.

There are, in addition, 4 fisheries inspectors with their own boats, however, these individuals do little more than collect data.

- The area of the BVI is 153 sq. km, the Territorial Sea (out to 3 nautical miles) covers an area of 1,469 sq. km. There is in addition to a 200 mile Exclusive Fishing Zone.

- There is a marine division of the police, with one boat, who assist with fisheries surveillance, but their priorities are drugs.

- A total ban on any activity is far easier to enforce than managing a particular fishery through selective licensing.

- Fisheries surveillance in the BVI is poor, bear in mind three years passed before a conviction for SCUBA fishing was made.

- One of the key SCUBA divers is a close friend/relative of the Chief Minister.

- Assistance could be sought from an AID agency for assistance in finding a long term solution to this problem, but bear in mind such assistance takes at least 1 year, and usually more, to mobilize.

- There is internal inconsistency within the Government system - there is a law banning SCUBA fishing, yet the Immigration Department is allowing locals to sponsor foreign divers to come in and fish.

ANNEX VI

LIST OF ACRONYMS

ADCP	Acoustic Doppler Current Profiler
AGU	American Geophisical Union
AOML	Atlantic Oceanographic and Meteorological Laboratory (USA)
BVI	British Virgin Islands
CFD	Conservation and Fisheries Department (BVI)
CIBAMAR	Cinematique De Bassins et Marges (France)
CNO	Comité Nacional de Oceanología (Cuba)
CS	Caribbean Sea
ECLAC	Economic Commission for Latin America and the Caribbean
EEZ	Exclusive Economic Zone
FAO	United Nations Food & Agriculture Organization
GOOS	Global Ocean Observing System (IOC)
HAV	Hepatitis A Virus
ICM	Integrated Coastal Management
ICML	Instituto de Ciencias del Mar y Limnología (UNAM) (México)
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions
IMO	International Maritime Organization
ICZM	Integrated Coastal Zone Management
METEO-FRANCE	Meteorological Service (France)
NOAA	National Oceanic and Atmospheric Administration (USA)
PCR	Polymerase Chain Reaction
RV	Rotaviruses
SIDS	Small Island Developing States
UNAM	Universidad Nacional Autónoma de México
UN	United Nations
UNCED	United Nation Conference on Environment and Development
UNEP/RCU	United Nation Environment Programme Regional Coordinating Unit
WMO	World Meteorological Organization

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