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IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP
Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)

The contributions of science to integrated coastal management

GESAMP REPORTS AND STUDIES No. 61

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- GESAMP -

THE CONTRIBUTIONS OF SCIENCE TO INTEGRATED COASTAL MANAGEMENT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1996

NOTES

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PREPARATION OF THIS STUDY

This study has been prepared on the basis of the work of the GESAMP Task Force on Integrated Coastal Management, established by the 24th Session of GESAMP, New York, 21-25 March 1994.

A formal meeting of the Task Team was held in Rome, 28 November to 2 December 1994, which reported to the 25th Session of GESAMP, Rome, 24-28 April 1995. It reviewed experience with the application of integrated approaches to coastal management, based on a number of case studies prepared by its members. Building upon that work, four additional case studies that focused only on mature programmes, were commissioned and later reviewed at two meetings of the chairmen of the Task Force with selected experts, held in Oslo, 11-15 December 1995 and in Rome, 12-16 February 1996. This report was completed at these meetings and subsequently reviewed by the 26th session of GESAMP, Paris, 25-29 March 1996, and approved for publication in its present form.

Contributions to the work of the Task Force by the following experts are acknowledged with appreciation: Richard G.V. Boelens, Robert E. Bowen, Chua Thia-Eng, Ingwer J. De Boer, Danny L. Elder, Edgardo Gomez, John S. Gray (Co-chairman), Graeme Kelleher, William Matuszeski, Liana McManus, Heiner Naeve (Secretariat), Magnus Ngoile, Stephen B. Olsen (Co-chairman), Jayampathi I. Samarakoon, Randell G. Waite and Helen T. Yap.

The work of the Task Force was jointly sponsored by the United Nations (UN), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization - Intergovernmental Oceanographic Commission (UNESCO-IOC), the World Meteorological Organization (WMO), the International Maritime Organization (IMO) and the World Conservation Union (IUCN). The Secretariat was provided by FAO.

The Terms of Reference for the Task Team on Integrated Coastal Management were as follows:

(1) Present a concise description of the structure of ICM emphasizing its scope and objectives;

(2) Identify and evaluate the scientific elements (social and natural) required to support the stages of the ICM process drawing on an analysis of ICM case studies;

(3) Identify factors and approaches that have either facilitated or impeded the incorporation of science into ICM.

EXECUTIVE SUMMARY

In this report, GESAMP draws on experience from programmes in different geographic and socioeconomic settings to identify how science and scientists can contribute to the effectiveness of Integrated Coastal Management (ICM).

The goal of ICM is to improve the quality of life of human communities who depend on coastal resources while maintaining the biological diversity and productivity of coastal ecosystems. Thus, the ICM process must integrate government with the community, science with management, and sectoral with public interests in preparing and implementing actions that combine investment in development with the conservation of environmental qualities and functions.

In the opinion of GESAMP, successful ICM programmes will involve:

a) public participation whereby the values, concerns and aspirations of the communities affected are discussed and future directions are negotiated;

b) steps by which relevant policies, legislation and institutional arrangements (i.e., governance) can be developed and implemented to meet local needs and circumstances while recognizing national priorities;

c) collaboration between managers and scientists at all stages of the formulation of management policy and programmes, and in the design, conduct, interpretation and application of research and monitoring.

From its consideration of existing experience on ICM structures and procedures, GESAMP has derived a conceptual framework to identify for each stage in the management process, the necessary contributions from natural and social scientists. GESAMP recognizes that progress towards sustainable forms of coastal development will be achieved by ICM programmes that cycle repeatedly through the stages of the management process. Each cycle may be considered a generation of an ICM programme.

It is clear that the management of complex ecosystems subject to significant human pressures cannot occur in the absence of science. The natural sciences are vital to understanding ecosystem function and the social sciences are essential to elucidating the origin of human-induced problems and in finding appropriate solutions. The need to design studies in accordance with clearly-stated objectives is particularly important. Scientific techniques and procedures that are particularly useful to ICM include resource surveys, hazard and risk assessments, modelling, economic evaluations and analyses of legal and institutional arrangements. Scientific support is also needed in the selection of management control measures and in preparing material for public information and education.

Despite great differences in the social, economic and ecological conditions in the countries from which the four case studies were drawn, there is remarkable consistency in the lessons learned about the contributions of science to ICM. They demonstrate that scientists and managers must work together as a team if scientific information generated for ICM is to be relevant and properly applied for management purposes. Since the two professions have different perspectives and imperatives and approach the solution of problems differently, the objectives and priorities for programmes must be derived, tested and periodically re-evaluated by scientists and managers working together.

GESAMP recognizes the need to build constituencies for ICM initiatives and the importance of matching policies and management actions to the capabilities of the institutions involved. Some countries experiencing severe coastal degradation and where remedial measures are urgently required, may not have the necessary frameworks for environmental management and must focus much of their effort initially on creating the institutional context in which effective resource management can occur.

CONTENTS

ABSTRACT

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection)
The contributions of science to coastal zone management.
Reports and Studies, GESAMP. No. 61. Rome, FAO. 1996. 66 p.

The scope, objectives and defining features of Integrated Coastal Management (ICM) are briefly described and a conceptual framework for the effective operation and evolution of ICM programmes is presented. ICM is a dynamic and continuous process by which progress towards sustainable use and development of coastal areas may be achieved. ICM programmes therefore have the dual goals of conserving the productivity and biodiversity of coastal ecosystems while improving and sustaining the quality of life of human communities. This requires the active and ongoing involvement of the interested public and the many sectoral groups with interests in how resources are allocated, development options are negotiated and conflicts mediated.

Selected case studies from a diversity of settings in developed and developing nations reveal striking commonalties in the interplay between science and ICM and demonstrate that effective ICM cannot occur in the absence of science. The natural sciences are vital to understanding the functioning of ecosystems and the social sciences are essential to comprehending patterns of human behaviour that cause ecological damage and to finding effective solutions. Scientists and resource managers often have different perspectives and imperatives. Nevertheless, as the case studies clearly suggest, they must work together as a team through all stages of an ICM programme and reach agreement on the scientific work needed to address priorities and guide policy development. The case studies also underscore that programmes must tailor their scope and objectives for a given period to the capabilities of the institutions involved. Where such institutions are weak, and the constituencies required to support an ICM initiative are not yet in place, programmes must first work to create societal conditions wherein the community will be receptive to the aims and procedures of resource management.

Key Words: coastal management, science and public policy, policy process, public participation, resource management.

1. INTRODUCTION

In a number of previous reports, GESAMP discussed the priorities for global action in managing coastal and marine environments and the contributions that science can make to these important tasks. The following extracts from the report of the Twentieth Session of GESAMP (GESAMP, 1990) are particularly relevant to the present document:

> *"The concept of sustainable development implies that the present use of the marine environment and its resources shall not prejudice the use and enjoyment of that environment and its resources by future generations. Past practices that have neglected this principle are the fundamental cause of many current environmental problems."*
>
> *"Development inevitably implies environmental change. The challenge for marine and coastal zone management is to balance short-term development needs against long-term sustainability of ecosystems, habitats and resources such that the range of choices and opportunities available to future generations is not diminished by the consequences of present development choices."*
>
> *"Comprehensive area-specific marine management and planning is essential for maintaining the long-term ecological integrity and productivity and economic benefit of coastal regions."*
>
> *"The effectiveness of management actions to protect the ocean cannot be assessed without scientific analysis and knowledge. Accordingly, comprehensive protection strategies should incorporate scientific principles; however, it is recognized that decision-making frequently involves considerations other than scientific arguments. Close interaction among scientists and decision-makers is essential."*

At the international level, much attention has been given to articulating the need for Integrated Coastal Management (ICM), the scope of ICM programmes and the issues they should address. Relevant documents from international fora include Chapter 17 of Agenda 21 of the United Nations Conference on Environment and Development (United Nations, 1993), the Noordwijk Guidelines for Integrated Coastal Zone Management (World Bank, 1993), the report of the World Coast Conference (IPCC, 1994) and numerous technical reports released by international organizations, including UNEP (1995), FAO (Clark, 1992; Boelaert-Suominen and Cullinan, 1994), OECD (1993) and IUCN (Pernetta and Elder, 1993). Several GESAMP reports (e.g., GESAMP, 1980; GESAMP, 1991a; GESAMP, 1994) have addressed the interrelationships between the condition of coastal and marine environments and human activities.

Coastal and marine environments are particularly vulnerable to over-exploitation because they include large areas traditionally considered to be "commons". Before and since Garrett Hardin's essay *The Tragedy of the Commons* (Hardin, 1968), there has been ample evidence that the long-term effect of uncontrolled human activity on the commons is usually to degrade or destroy it. Furthermore, coasts often include areas where a diversity of incompatible activities compete for limited space and resources. The profits and benefits of some activities are confined to minorities, while costs are imposed on the community and the environment.

Although a clear understanding of the factors involved is often lacking, widespread concern over the condition of coastal environments has led to demands by the public for the right to participate in decisions affecting the coast and for better protection of coastal resources. As a result, there has been parallel development of ICM programmes in various parts of the world that actively involves the public in improving the management of coastal areas. In economic terms, these methods aim to ensure that the costs generated by one sector of society are not imposed

on the community generally. The four case studies examined in this report attest to the centrality of this public process.

This report is offered as guidance to those responsible for the oversight and funding of ICM programmes, those engaged in the design and implementation of programmes and the natural and social scientists who participate in the ICM process. While the experience upon which this report is based represents a wide range of settings and approaches it underscores the many commonalities in the factors that influence how the sciences can contribute to ICM programmes and thus affect the success of these initiatives.

2. THE OBJECTIVES AND SCOPE OF INTEGRATED COASTAL MANAGEMENT

2.1 Objectives

Integrated Coastal Management (ICM) is a process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources. **The overall goal of ICM is to improve the quality of life of human communities who depend on coastal resources while maintaining the biological diversity and productivity of coastal ecosystems.**

Expressed in this way, the goal of ICM is clearly consistent with national and international commitments to **sustainable development** for all environments (terrestrial and marine), from the headwaters of catchments (watersheds) to the outer limits of exclusive economic zones (EEZ), whether or not they are subject to multiple jurisdiction.

Central to success in achieving this goal is the need for ICM to provide an equitable, transparent and dynamic governance process that is acceptable to the community.

2.2 ICM in the Context of Environmental Protection and Management

In a previous report on *Global Strategies for Marine Environmental Protection* (GESAMP, 1991a), GESAMP presented a framework for environmental protection and management that provides for the various political, social and scientific inputs that are needed in developing programmes to protect the environment and to ensure the sustainable use of natural resources. The framework is applicable to all sectors of the environment, terrestrial, freshwater and marine. Environmental management is, therefore, an implicitly **holistic** process and the approach to managing coastal areas is fundamentally the same as that which should be used to manage a nation's environmental heritage in its entirety.

From its analyses of environmental problems confronting coastal areas and communities of the world, including those highlighted by the case studies reviewed in this report *(see Annexes 1-4)*, we conclude that a majority of ICM programmes will need to deal with one or more of the following three conditions:

- **Over-exploitation** of renewable resources, either directly by harvesting or by the destruction or modification of habitats and disruption of predator/prey and other ecological relationships;

- **Conflicts** that arise where several human activities that depend on the same area and/or resource are incompatible;

- **Insidious damage**, including loss of biological productivity and diversity, that may result from cumulative impacts of different practices.

Table I
The Scope and Focus of ICM Programmes

Chapter 17.5 of Agenda 21 describes the scope and process of ICM programmes. The text calls for programmes that:

- identify existing and projected uses of coastal areas with a focus upon their interactions and interdependencies;
- concentrate on well-defined issues;
- apply preventive and precautionary approaches in project planning and implementation, including prior assessment and systematic observation of the impacts of major projects;
- promote the development and application of methods such as natural resource and environmental accounting that reflect changes in value resulting from uses of coastal and marine areas;
- provide access for concerned individuals, groups and organizations to relevant information and opportunities for consultation and participation in planning and decision-making.

2.3 *Principal Features of ICM*

ICM is a continuous and dynamic process that addresses the use, sustainable development and protection of coastal areas. ICM requires the active and sustained involvement of the interested public and the many stakeholders with interests in how coastal resources are allocated and conflicts are mediated. The ICM process provides a means by which concerns at local, regional and national levels are discussed and future directions are negotiated. The concept of an integrated approach to the management of coastal areas is intentionally broad and has four elements:

Geographical: It takes account of interrelationships and interdependencies (viz., physical, chemical, biological, ecological) between the terrestrial, estuarine, littoral and offshore components of coastal regions;

Temporal: It supports the planning and implementation of management actions in the context of a long-term strategy;

Sectoral: It takes account of interrelationships among the various human uses of coastal areas and resources as well as associated socio-economic interests and values;

Political/Institutional: It provides for the widest possible consultation between government, social and economic sectors and the community in policy development, planning, conflict resolution and regulation pertaining to all matters affecting the use and protection of coastal areas, resources and amenities.

The emphasis on integrated management means that ICM programmes should:

- encourage an interdisciplinary analysis of the major social, institutional and environmental issues and options affecting a selected coastal area followed by a decision on the issues that should be addressed within a given period. The analysis should take into account the

interactions and interdependencies among natural resources and different economic sectors. An ICM process must consider all relevant practices in a given locale—typically including fisheries, aquaculture, agriculture, forestry, manufacturing industry, waste disposal and tourism—in the context of the needs and aspirations of the communities affected. It should distinguish between issues that are likely to be important over long time-scales (e.g., climate change, population growth and the consumption habits of society) and more immediate concerns such as those associated with the governance process, conflicts among user groups and current social, economic and environmental conditions.

- initiate a **dynamic policy process** that is explicitly designed to evolve through experience, rather than an inflexible plan that provides for a limited set of responses to immediate problems. This requires continuous improvement of the information base, ongoing assessment of policies, administrative arrangements and options for problem resolution, and a robust administrative system. Such learning and adaptation requires the sustained monitoring and evaluation of trends in the condition and use of the ecosystems in question as well as the effectiveness of governance responses in order to periodically refine the design and operation of the programme.

- provide a **formalized governance structure and set of procedures** to provide continuity and to maintain confidence in the management process. ICM programmes are most likely to build and maintain active constituencies within the societies affected when the planning and decision making process is transparent and participatory. The programme must be accountable for its actions and must demonstrate that it has the capacity to resolve conflicts and implement its policies and plans. Without strong constituencies both within central government and at the local level, no ICM programme can be both effective and sustainable.

- promote **concern for the equity issues** posed by existing methods of resource allocation. The maintenance of critical stocks of natural resources, ecosystem processes and environmental qualities are goals that transcend the present and require consideration of the benefits and opportunities that should be available to future generations.

- commit to **making progress towards the goal of sustainable development** and therefore achieving a balance between both development and conservation. ICM must aim to combine and harmonize investment in development with conservation of environmental qualities and functions. This is because human populations share a common suite of needs and demands that include employment, housing, education, health care and basic utilities as well as a healthy natural resource base that can maintain the goods and services that sustain communities. In most cases an ICM programme cannot define or achieve sustainable levels of development in a single step. Progress will be made only by maintaining a programme through a series of generations, each of which is marked by the completion of the five stages in the ICM process *(see Section 3)*.

Once formally adopted, ICM programmes have institutional identity typically granted by legislation or an executive mandate. Formalized ICM programmes therefore have continuity as independent organizations or as a programme administered through a network of organizations. In both cases' roles and responsibilities for planning and implementation are clearly delineated. The institutional structure typically contains distinct but clearly linked mechanisms for (i) achieving interagency coordination at the national or regional level (e.g., through an interministerial commission, authority or executive council) and (ii) providing for conflict reduction, planning and decision-making at the local level.

2.4 Boundaries and Scale

Ideally, the geographic boundaries for an ICM initiative should encompass a stretch of coast and adjacent ecosystems that are linked by common natural (e.g., climatic, physical, biological)

features and/or by the occurrence of particular human activities. This would include those terrestrial systems that significantly affect the sea, or are affected by their proximity to the sea, and those marine systems affected by their proximity to the land; it implies boundaries that (a) include those areas and activities within watersheds that significantly affect the coast, and (b) may, in certain cases, extend seaward to the edge of the continental shelf or the Exclusive Economic Zone (EEZ).

In practice, the boundaries of first generation ICM programmes *(see below)* are often determined by the specific issues that the programme selects for its initial focus. For example, a programme that is initially most concerned with issues of coastal erosion and tourism development might reasonably adopt boundaries that are narrower than those of a programme concerned with water quality or fisheries.

Related to the problem of boundaries is the question of scale. ICM programmes usually cover geographic areas within a particular country rather than the whole country or only parts of whole ecosystems as in the case of a bay or watershed shared by two or more countries. The area addressed by an ICM programme may be large or small but the boundaries set should suffice for most local management decisions. Decisions and actions required in addressing the needs of the region may transcend the delineated boundaries. Furthermore, decisions made at a higher political or national level often have great significance for the area being managed.

The question of scale is particularly important for communities that rely on resource exploitation in a particular area. Once the requirements of the population exceed the ecosystem productivity, the manager must consider external subsidies or the need for alternative resources if the consumption rate or quality of life of the community is to be maintained. The alternative is to reduce demand for the resources. Reducing the population by emigration is seldom practical.

3. THE CONTRIBUTIONS OF SCIENCE TO THE STAGES OF AN ICM PROGRAMME

The papers referenced in Section 1 provide detailed descriptions and diagrams of the steps in the ICM process and others (e.g., Chua and Scura, 1992) have provided conceptual frameworks for linking management processes and options with specific issues. The simplified sequence of stages presented here is consistent with, and draws from, these publications and focuses on the contributions of science. The stages are summarized in Figure 1 and discussed in greater detail below. As the figure clearly illustrates, these five consecutive stages form an ongoing, iterative process that may go through a number of cycles before the programme is sufficiently refined to produce effective results. Each completion of the five stages may be termed a generation of a programme.

The types of scientific support required by ICM evolve with each stage in the process; a synopsis of the main scientific inputs at each stage follows. Additional information on selected natural and social science techniques and approaches is given in Section 4.

3.1 Stage 1: Issue Identification and Assessment

This is where the requirements of an ICM programme are initially defined and assessed. It is essentially a process of compiling, integrating and prioritizing information that defines the environmental, social and institutional context within which the ICM programme will proceed. The major topics to address are as follows:

Assessment of the condition of coastal systems:

- characterization of significant habitats, species and biological communities, living and non-living resources and their interrelationships;

- identification of trends in the condition and use of resources and amenities;
- estimation of short and long-term implications of such changes for the environment and society;
- identification of particular sub-areas and conditions that warrant priority within the ICM programme.

Assessment of the policy and institutional context:

- roles and responsibilities of agencies as they relate to priority ICM issues;
- assessment of institutional capability, capacity and credibility for addressing these issues;
- identification of existing policies and goals relevant to these issues.

Assessment of the development context:

- assessment of trends in quality of life indicators;
- identification of stakeholders for priority ICM issues, their values and interests;
- initial assessment of societal perceptions of the issues and their implications.

Clearly, Stage 1 is crucial because it provides the foundation for subsequent stages in the process that leads to a full-fledged ICM programme. Despite the range of information to be compiled and assessed, it should be possible to carry out Stage 1 within a period of 6-18 months.

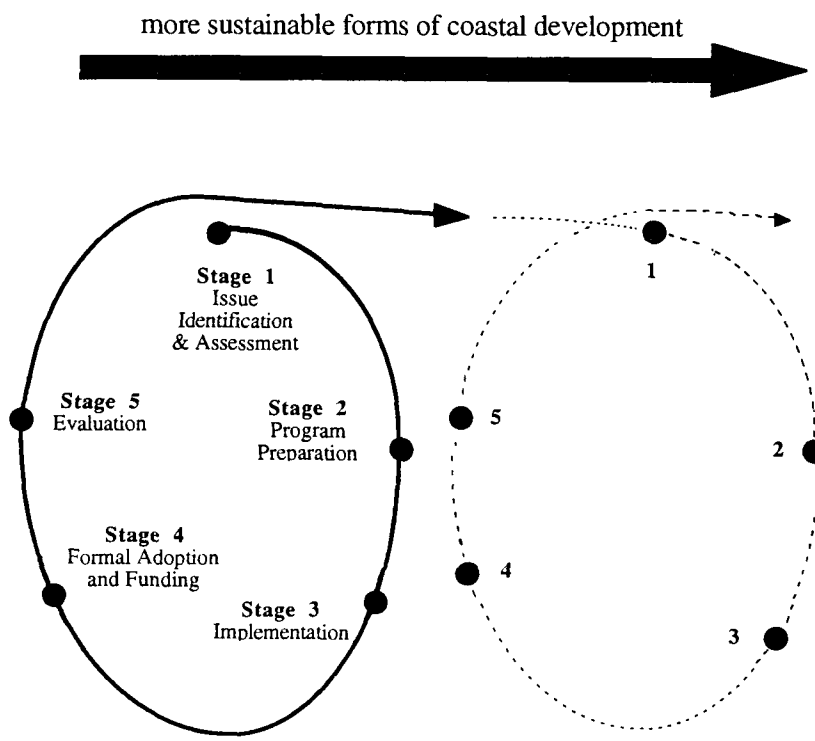

Figure 1. The stages of the ICM cycle to which sciences contribute.
The dynamic nature of ICM requires feedbacks among the stages and may alter the sequence, or require repetition of some stages.

Scientific input to Stage 1

The process of sorting through and assessing large amounts of information of variable quality on a wide range of topics requires skill and judgment. The assistance of natural and social scientists, preferably those familiar with local and national circumstances, will be needed to find existing information, to assess its relevance and quality and to clearly define and prioritize the issues to be addressed. The linkages between issues must be defined and evaluated. Stage 1 should also identify any obvious gaps in scientific knowledge, their likely implications for the ICM process and the practical possibilities for filling them within a realistic time-frame.

A team of natural and social scientists should participate in the participatory process of preparing a document (e.g., a programme profile) that describes, in general terms, the various issues on which the programme will focus and the associated values, policies or constraints under which the programme will operate. Such scoping documents should identify the long and short-term implications of existing trends and suggest priorities for action. Such documents are an essential basis for consultations among managers, scientists and the public at large on the goals and priorities of the programme.

3.2 Stage 2: Programme Preparation

In contrast to the relatively rapid assessments of Stage 1, this stage involves a more protracted consultative and planning process that evaluates different options for action. This process may take several years. The main purpose is to develop a management plan that constitutes "a vision for the future" and that expresses, in realistic and tangible terms, the qualities of the environment to be achieved and maintained, the way in which resources should be allocated and any necessary changes in patterns of resource use and human behaviour. During this stage the specific objectives of the programme must be clearly defined. These should reflect the aspirations and values of those with an interest in the areas and resources to be managed. It is important to ensure that this process of planning and evaluation of options provides sufficient time for meaningful incorporation of stakeholders at the community level such that constituencies are built that will actively support the management objectives and strategies that are selected as the programme's focus.

Since the planning process is complex, continuing for several years and involving large numbers of people, the best approach may be to generate and test a variety of strategies and objectives, thereby building confidence in, and support for, a decreasing number of options. Thus, the planning process may involve several iterations comprising analysis, debate and pilot-scale implementation as the ICM team explores the feasibility of alternative management actions and associated governance requirements.

During the initial (viz., first generation) planning cycle, it may be advisable to focus on a few, relatively small-scale, areas where management policies and techniques can be implemented and to postpone attempts to manage the entire coastline until subsequent generations of the programme. This is often the most responsible approach to dealing with a crisis, such as coral reef blasting or mangrove destruction, where some early and visible action may be needed pending research to find the optimum solution.

Scientific input to Stage 2

Natural and social scientists should be well represented on the ICM team during the programme planning phase both to explain and expand on the findings of the Stage 1 assessments and to assist in defining and planning studies to fill important gaps in information. It is especially important that research be initiated early in the programme to address:

- the characteristics and conditions of coastal systems that cause concern or otherwise warrant attention;

Table II

Scientific questions relevant to the destruction and restoration of coastal habitats

What is the scale of habitat destruction?

This is logically the first question to be addressed. Subsequent management and scientific action would be dictated by perception of the magnitude of the problem. Detection of the scale of habitat destruction is aided by modern technological tools, such as remote sensing, acoustic surveys of sediments and Geographic Information Systems (GIS). Reference to historical records is often indispensable, as is anecdotal evidence.

What are the natural processes that maintain habitat integrity?

Intelligent resource use, including land use, and planning and zonation, is premised on a knowledge of natural processes that could lead to alterations in habitat characteristics such as topography and productivity over the long-term.

What are the dynamic linkages among habitats that need to be considered in maintaining sustainable use of their resources?

Habitats which are spatially separated are often dependent on each other for the exchange of material and energy. An example is the recruitment of important species of reef fish and probably coral larvae from other habitats or areas which serve as nursery areas.

Can the links between habitat degradation and human activities be quantified?

This involves studies on the characteristics of human activities that relate to alterations in the national resource base (growth, migration, decline), such as changes in patterns of resource use and in the application of technology to exploit resources.

How many species are actively dependent on the habitats concerned?

Are all species equally important for conservation purposes?

What are the spatial and temporal scales of natural habitat recovery?

When management appreciates the areal extent and length of time involved for degraded habitats to recover naturally, decisions must be made regarding the necessity of intervention. Insights into the natural processes underlying recovery (including spatial and temporal scales) may be derived from natural events, e.g., observations on recolonization following a large scale disturbance (e.g., a hurricane).

Which species play a key role in natural recovery process?

Particular species play more critical roles than others in terms of maintaining ecosystem functions (e.g., productivity, nutrient cycling, predation). Such knowledge will guide restoration strategies which, for logistic reasons, may have to focus on the minimum complement of species to achieve natural recovery.

- the governance process itself, i.e., the decision-making process, compliance with voluntary or regulatory controls on various practices and/or behaviour;

- the factors and processes that regulate these characteristics and conditions.

Scientists should work with managers to prepare concise statements of objective for research and monitoring, clearly defining what is to be measured and why, and in identifying methodologies, facilities and personnel needed for the studies to be cost-effective and successful. For each priority issue to be addressed, scientists and managers should together formulate specific questions that are to be resolved through subsequent scientific investigations. Questions relevant to one particularly common issue, the destruction and restoration of coastal habitats, are given in Table II.

Specific Stage 2 tasks to be addressed by the ICM team and to which natural and social scientists should contribute, typically include:

- estimating the relative influences of anthropogenic and natural factors in causing particular changes to coastal systems and resources;

- characterizing the likely short and long-term consequences for society of existing trends in the condition and use of the coastal environment;

- assessing the social and economic benefits which stem from various options for the use and exploitation of coastal resources and amenities;

- formulating approaches to mitigate or reverse environmental degradation;

- estimating the social, environmental and economic costs and benefits of alternative actions.

3.3 Stage 3: Formal Adoption and Funding

Formal adoption of a programme will generally require a high-level administrative decision, for example by the head of a government agency, a minister or the cabinet, or perhaps by presidential endorsement. It will include consideration and agreement of a budget (i.e., levels and sources of funding) for each phase of the programme. A phased budget has certain advantages. For example, a preliminary budget could be adopted to allow the scientific research and baseline monitoring developed in Stage 2 to be initiated in advance of other programme elements.

It is to be expected that plans for ICM programmes will be subject to detailed scrutiny and questioning, and will often need revision, before they are formally approved. Consequently, this stage may be characterized by a dramatic change from the technical to political aspects of the ICM process. The interests of governmental agencies and commercial sectors affected by the programme may give rise to new and unexpected arguments that the ICM team must address. Similarly, formal approval often does not guarantee adequate funding. Securing the funds required for implementation of an ICM plan may require another round of planning to review possibilities for cost reduction and increased efficiency and perhaps a slower rate of implementation. The process is one of bargaining and accommodation.

Scientific input to Stage 3

Access to scientific advice is useful, and sometimes essential, when attempting to react quickly to the issues that emerge during the political bargaining process. Topics that are typically closely examined and challenged, and that involve natural and social sciences are:

- cost/benefit and decision analysis;

- arguments over whether the proposed actions can be reasonably expected to produce the results being promised, both in changed behaviour and the condition of the ecosystem.

3.4 Stage 4: Implementation

At this stage in the ICM process, the management plan becomes operational and the emphasis shifts to the introduction of new forms of resource development and use, new institutional arrangements and monitoring systems and the application of new controls, regulations and incentives.

Enforcement is an essential element of programme implementation and one which clearly demands a constant supply of reliable and readily interpretable monitoring data.

Successful implementation of an ICM programme invariably presents new, sometimes unforeseen, challenges and the ICM team must be able to respond to these while maintaining momentum within the core programme. Priority activities during this stage typically include:

- conflict resolution;
- inter-agency coordination;
- infrastructure construction;
- development actions;
- public education;
- training of management or enforcement personnel;
- planning and research on new areas or problems.

Scientific input to Stage 4

From this stage, monitoring should be re-focused to measure changes in the areas and resources to be protected, the practices to be modified and changes in the forms of development that the programme seeks to provide. Such monitoring must be designed to generate data that can be compared with results from the baseline studies and to the specific development and conservation objectives contained in the programme plan. The design, implementation and management of these studies is an essential function for the ICM team and its supporting scientific bodies and advisors.

Key roles for natural and social scientists at this stage are to assist other ICM team members in translating information from monitoring programmes and assessing the efficacy of new measures. This is part of the learning process and is particularly important where management techniques and approaches are tested on a pilot scale. Scientists should test the hypotheses developed in Stages 1 to 3 and on which the programmes' actions are based. They should also give advice on whether elements of the programme should be revised or adapted to improve their effectiveness or efficiency and on developing new technologies that help attain programme objectives. This process of learning and adaption should continue throughout the implementation stage and is nourished by scientific knowledge and skills.