MANUAL OF COASTAL DEVELOPMENT PLANNING AND MANAGEMENT FOR THAILAND

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Preface and Acknowledgements

The Purpose of the Manual

This manual is a guide to the planning and management of coastal resources. It describes the structure and function of various eco-systems found in the coastal zone and presents guidelines for their development and management. The manual also investigates specific development activities, illustrates how these might adversely affect the coastal eco-systems, and sets out certain management & planning measures to reduce environmental impact and locational conflict. The manual also provides techniques for evaluating coastal resources so that decisions affecting them are based on a full consideration of their environmental and economic values.

The manual provides an approach to planning for the multiple use of coastal resources. Such an approach enhances the possibilities for sustainable development. But multiple use in turn requires that all agencies with an interest in the coastal zone be willing to integrate and co-ordinate their activities. This manual shows why this is necessary and helps the different agencies to understand the needs of sectors other than their own.

This is the first time such a manual has been created for the Thai coastal zone. We expect its use will highlight gaps and inconsistencies. The manual does not intend to provide the final say on the issue of coastal zone development and management. It should be reviewed and rewritten in a year or two by the agencies that use it, after additional experience has been acquired.

Intended Users

The manual has been written primarily for those agencies directly concerned with the development and management of coastal resources,

primarily the Land Development Department, the National Environment Board, the Office of the National Economic and Social Development Board, the Department of Fisheries, the Royal Forestry Department and the Tourism Authority of Thailand. However it is hoped that all institutions with an interest in the coastal zone including research institutes, university departments and private consulting firms will find the manual useful.

How To Use This Manual

Much of the material contained in the manual has been drawn from a variety of sources and where necessary has been adapted to the Thai situation. The manual pretends neither to be original nor exhaustive. The intention is simply to present a preliminary framework and provide ready access to information to those working in the field of coastal development planning and management. Users will certainly benefit from familiarising themselves with the general approach outlined in the manual but perhaps specific sections will be of greater interest to specific users. The manual is only intended to get the user 'started'. Much of the information may therefore be insufficient and in that case the reader's attention is drawn to the bibliography where more detailed work is cited. It is in this sense that the bibliography is not simply an appendage but an integral part of the manual. The manual is not meant to be a substitute for thinking and much of the information that appears in the manual must be adapted and refined to suit particular coastal conditions as well as the resources of individual institutions and agencies.

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Introduction

The coastal zone is extremely important to Thailand's society and economy. It brings together a unique collection of natural resources such as gas, water, minerals, food, beaches and high quality landscape and plays a major role in the country's transportation network. Thus it provides an economic base and a physical location for industry, commerce, and tourism. But the coastal zone is ecologically complex and sensitive and may be susceptible to natural hazard and human despoilation. Great care must be taken to develop its potential without destroying its assets by overexploitation, overuse, or pollution.

The Socio-economic Value of the Coastal Zone

It is difficult to find accurate data to quantify in monetary and areal terms the use made of the coastal resources in Thailand. The following information, however, is indicative.

Forestry

According to data determined by ERTS-1, mangrove forests cover an area of about 309,700 hectares. A land survey of the maritime provinces conducted by the Royal Forestry Department revealed a total of 176,273.35 hectares designated for felling and 43,607.18 hectares given over to public use. The majority of the mangrove is located in the Andaman coastal provinces of Ranong, Phangnga, Krabi, Trang and Satun.

Fishing and Aquaculture

Figures for 1982 reveal that around 1.9 million tons of marine fauna were caught in Thailand with an estimated value of around 14.2

million baht and 134,000 tons of freshwater fauna with an estimated value of around 4.7 million baht. In 1982 a total of 19.756 fishing boats were registered. In addition it was estimated that around 29,906.5 hectares have been used for coastal aquaculture including shrimp and mollusc farming.

Agriculture

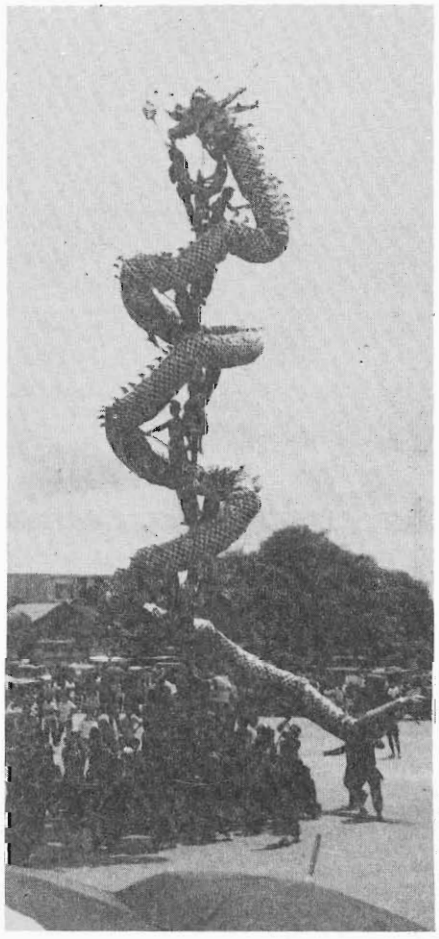
The main agricultural uses of the coastal zone are rice fields, nipa plantation and horticulture crops.

Minerals

Around 124 mines operated in the coastal zone with a tin output of about 23,754 tons in 1983. With regard to the production of salt, figures for 1973 show around 395,000 tons were produced from ponds which covered 65,956 rai (10,553 hectares).

Tourism

The tourism sector now accounts for a higher share of Thai exports than does the traditional stalwart, rice. In 1983 it was estimated at around 25,000 million baht with rice earning 20,000 million baht. Consumption expenditure per tourist averaged 2,328.56 baht/day. With regard to the two main coastal resorts, Pattaya had 0.59 million guest arrivals staying an average of 3.99 days and Phuket had 0.23 million guest arrivals with the average length of stay being 3.58 days. Thus these two resorts alone account for 28 per cent of all guest arrivals in Thailand.



Many coastal areas have a rich cultural life which contributes both towards their social cohesion and economic welfare

Human Settlements

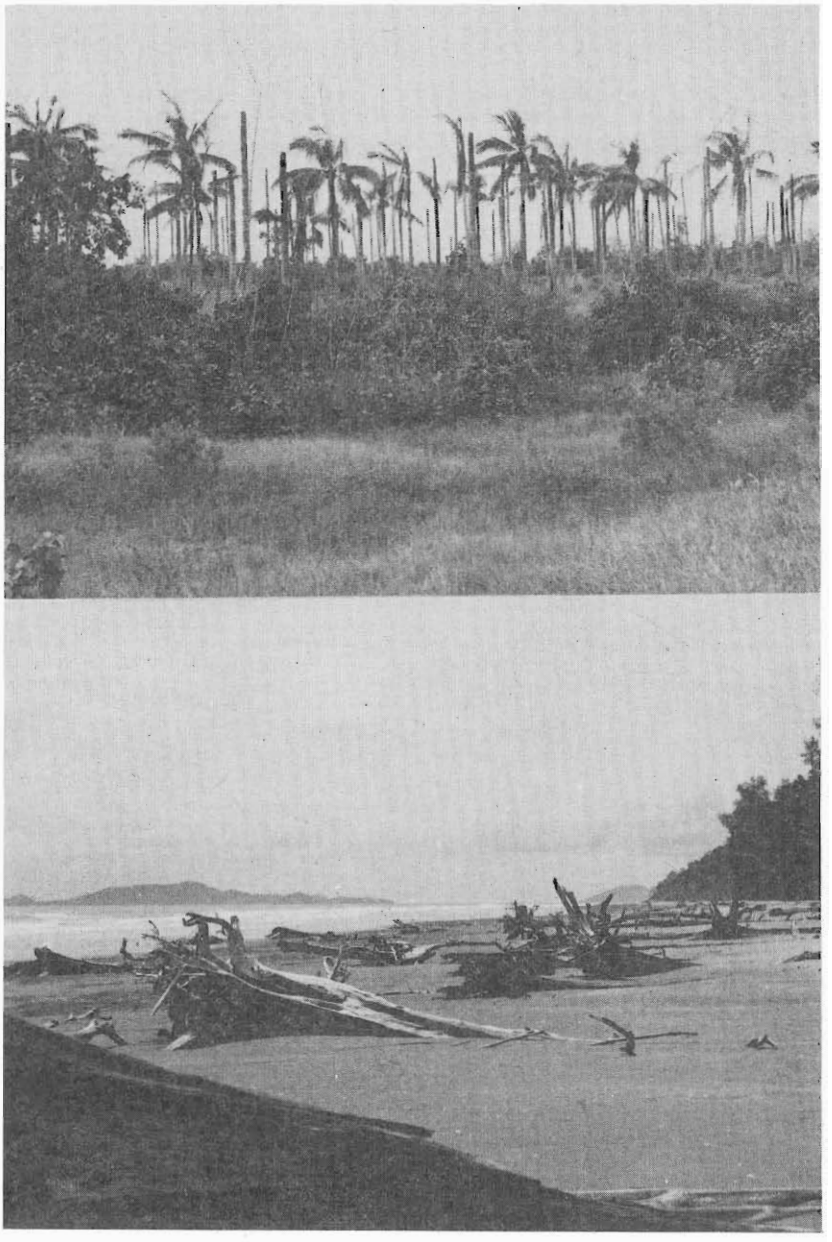
Thai coastal settlements consist chiefly of fishing villages, fishing and farming villages, farming villages, urban-industrial communities and migratory communities. It has been estimated that there are 1,563 fishing villages and more than 90,000 fishing households in 23 coastal provinces. Migratory communities consist only of approximately 400 households. There is no data available on the other categories of human settlements.

Industry

No precise data is available on industry in the coastal zone but clearly many developments are attracted to the coastal zone for its access to transport facilities and to huge quantities of water. In the first category we can include those industries sensitive to the cost of bulk transport and functionally dependent on the existence of large ports eg. refineries, grain silos, mills etc. Those in the second category require large quantities of water for cooling and processing but are not necessarily linked to a port eg. power plants, chemicals, etc. Thailand's economic development strategy is now based on increasing industrialization and internationalization and the coastal areas of the Eastern Seaboard and the Upper South have been designated as economic development poles.

The Value of Coastal Ecosystems

Thai coastal ecosystems (beaches, estuaries, coral reef, mangrove and mudflat, etc.) provide habitats for marine associated organisms upon which higher level species depend for food, and provide resting and feeding areas for migratory waterfowl and shorebirds. Both mangrove swamps and estuaries have special ecological significance



Environmental problem in the coastal zone :

1. Salt intrusion has killed off many of the coconut trees in Samut Songkhram Province
2. Coastal erosion in Ranong Province

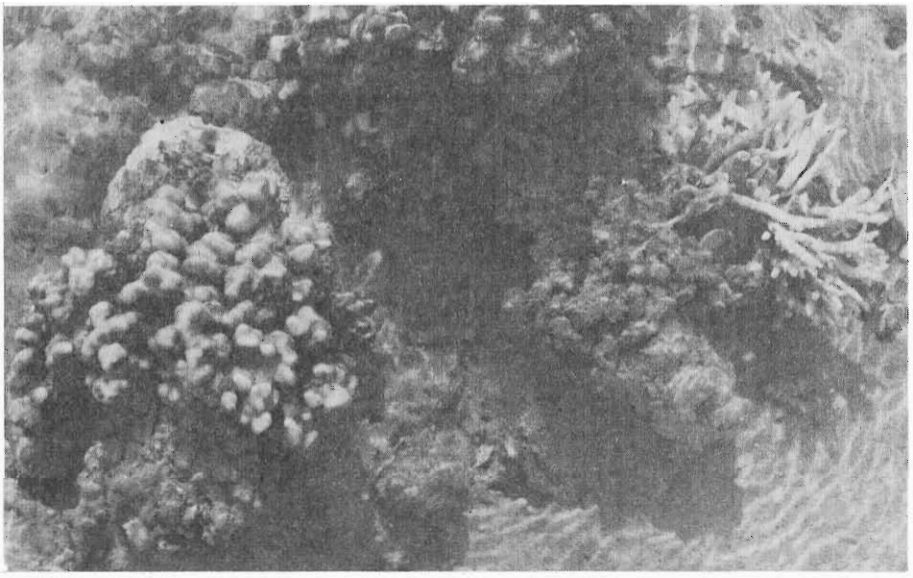
as spawning, nursing and feeding grounds for numerous species of economically important fish and shellfish. Coral reefs concentrate nutrients to support productive ecosystems and the high production of fishes in the surrounding seas. Dunes, mangrove forests and coral reefs also provide natural buffers against flooding, erosion and storm wave damage when appropriately managed.

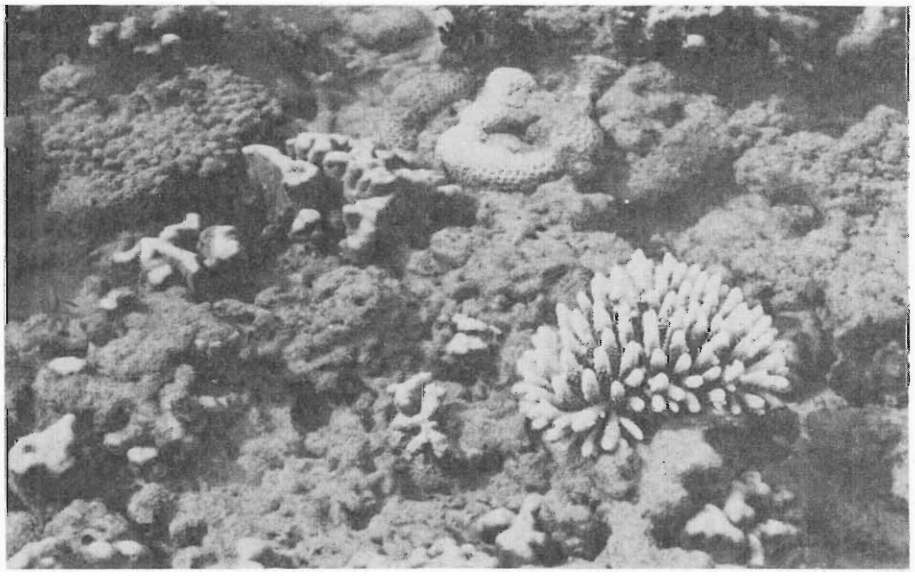
The ecological condition of the coastal zone is also highly significant for tourism. This sector of the economy is very dependent on an unspoiled natural environment. Whereas in many development activities environmental quality can be traded in return for non-environmental benefits, in the case of tourism environmental quality is a basic resource and must be maintained at the highest possible level.

Problems and Issues in Coastal Development

The main problems in coastal development are : the deterioration of coastal resources by destruction, over-exploitation and un-economical use; and problems relating to development activities along the coast which have created many adverse effects on coastal resources. Major coastal resources in Thailand, especially mangrove forests, beaches, coral reefs and marine coastal waters have been damaged or degraded and are in need of urgent management.

Large areas of mangrove forests have been destroyed and over-exploited for many purposes. Statistics suggest that mangrove forests are being cleared at a higher rate than before. During 1975-1979, mangrove forest areas decreased at a rate of about 2 percent per year compared to that of about 1 percent per year during 1961-1975. Mangrove forests are being converted for residential, commercial, industrial, and agricultural developments. The deterioration of mangrove areas along the southern coastline of the Andaman Sea for example was caused by mining activities. These activities also contributed to a decrease





Only a few remaining corals in this group after sedimentation has smothered them.

in both fishery production and aquaculture production. In addition, there is an increasing demand for forest wood products and this has resulted in the exploitative clear-felling of the forests. Moreover most mangrove forest concessionaires have displayed a lack of interest in replanting. In these situations, the basic habitat and its ecological functions are lost, and the loss is frequently greater than the value of the substituted activity.

Coral reefs have been degraded, and in some cases destroyed by siltation and sedimentation created by off-shore and on-shore tin mining, and illegal and destructive fishing practices. Dynamiting for fish harvest has been practiced near various islands along the Andaman Sea coast and in the Gulf of Thailand coral has been harvested for use as ornaments and semiprecious jewelry for the tourist market. Exotic coral species have been collected for marine aquariums. Tourist visits to the reef systems have resulted in breakage from boat anchors and souvenir collecting.

Thailand has many beautiful beaches and scenery attractive to tourists, however some kinds of recreational development along the beaches and some other development activities, degrade this aesthetic value. For example tourism itself induces problems of solid wastes and domestic wastes. Resort developers have been fencing and constructing down to the shoreline. Sedimentation from tin-mining and tar-balls also deteriorate the beach system. Beach erosion has resulted from sand dredging and tin mining on or near the beaches and by coral reef destruction.

The development of human settlements, industry, tourism resorts and harbors along the coast has caused considerable pollution of marine waters. This is especially so in the Gulf of Thailand. The pollution is due primarily to the uncontrolled discharge of liquid and solid wastes from the aforementioned human activities. Pollution of marine waters has also arisen from approved mining activities which discharge silt. Thermal pollution results from the discharging of hot water by industry. Oil spillage from tankers and other ships as well as sewage, solid waste,

and bilge discharges from ships at sea or in port are serious problems. This increasing pollution can be extremely hazardous to human health and to marine and estuarine ecology (eg. mangroves and coral reefs). Even small amounts of pollution are detrimental to tourism and recreational uses of the marine waters.

Natural hazards are another category of problem found in the coastal zone but apart from evidence of flooding during the monsoon period the types of hazard, extent of hazard damage, and the role of ecosystems in damage control are not well documented and require research.

Perhaps the major issue in coastal development is the lack of co-ordination among different departments concerning coastal resource use and management. This has arisen partly due to jurisdictional conflicts eg. The Royal Forestry Department which has authority to grant concessions has at time leased out mangrove forest to concessionaires without taking into account the need of aquacultural promotion in the area (this comes under the responsibility of the Fisheries Department).

Need for Improvements in Coastal Zone Management

At present, various agencies are concerned with coastal resource management, planning and development. For example, the Office of National Environment Board (ONEB) has set up general policies and measures covering sea shores, beaches, mangrove forests, fisheries, coral reefs and offshore minerals and has, according to the Proclamation for Types and Sizes of Projects Required For EIA (see Appendix 1), stipulated that developers of major projects along the coast such as heavy industries, ports and harbours, hotels, and offshore-tin mining have to submit EIA reports to ONEB for consideration and approval. ONEB has also instituted guidelines for the preparation of Environmental Impact Statements for such projects (see Appendix 2). However whilst the NEB's Proclamation lists a whole range of projects which can potentially have an adverse

impact on the coastal zone, not all projects are routinely subject to Environmental Impact Assessment. Clearly some other measures are required to control the potential adverse effects of, for example, housing developments, roads, and hotel or resort facilities with less than 80 rooms. Perhaps the City and Town Planning Act of 1975 may provide the legal basis for controlling these types of development in the coastal zone but a thorough review of the legal situation is required to determine in what circumstances and exactly how this might be done.

Moreover, although the Supplemental EIS Guidelines for Coastal Zone Development present in Appendix 2 are a good start they are rather rudimentary and may be of limited use to those inexperienced in coastal development. For example, Table 1 of the Guidelines indicating the environmental parameters involved in the analysis of coastal development projects would benefit from the inclusion of the type of information contained in the checklists and matrices presented later in this manual.

The system of EIA in Thailand is still evolving and adaptations are taking place as experience indicates this is necessary.

The Land Development Department has responsibility for preparing Provincial coastal land development plans for all the coastal areas of Thailand and at present 12 of these master plans for coastal land development have been prepared. These plans have hitherto focussed on defining coastal land and water areas as "preservation", "conservation" and "development" zones and they fall within the rural development tradition of planning to improve the utilization of land resources and meet the needs of the local community. The plans have been completed in a remarkably short space of time and as a result have relied almost entirely on secondary data. Clearly future plans need to strike a better balance between the use of primary and secondary data and this will come mainly through devoting more time to plan formulation.

Moreover the planning and management concepts used in the plans are rather land oriented and insufficient attention is given to the water component. Hence little information about coral reefs, fishery reproduction zones etc. is given.

A number of sectoral agencies also play a role in the coastal zone these include the Department of Fisheries, the Royal Forestry Department, the Ministry of Industry, the Tourism Authority of Thailand etc. However this proliferation of agencies often has led to sectoral pressures for the development of single purpose uses of coastal resources rather than sustainable or optimum multiple use of the resources.

The Cabinet has established two administrative bodies to deal with the issue of coastal land development. These are the Central Coastal Land Development Sub-Committee established within the Ministry of Agriculture and Cooperatives in 1975 and the National Committee on Mangrove Resources established within the Office of National Research Council. However, even though there are policy guidelines and measures, and administrative bodies concerned with coastal resources and uses, problems of coastal resources deterioration and conflicting resource uses still exist. These problems cannot be easily solved since at present there is no specific legislation for coastal zone management and no single agency has full authority for such management. The established administrative bodies also lack legislative authority to deal with the problem of coastal zone management.

These problems and shortcomings call for the improvement of policies and management guidelines. To solve the problem of conflicts in exploitation of coastal resources, namely, mangrove forests, aquaculture, mining and fisheries resources, inter-agency cooperation and coordination and the integration of development activities are urgently needed. This subject is taken up and developed in Section 6.

Section 1. Definitions, Concepts and Principles

Introduction

Coastal Zone Management and Planning is a relatively new field which is gradually developing its own vocabulary of terms. As yet there is little agreement on the use of terms or on any of the various definitions that abound in the literature on the subject. For this reason we present at the outset definitions of certain terms that occur throughout the manual.

- *Coastal Zone* - refers to a broad geographic area in which terrestrial and marine factors are mixed to produce unique landforms and ecological systems. The term zone is used to denote a landward and a seaward area within which marine influences can be found in landward areas and terrestrial influences can be traced in the marine environment. For example freshwater or sediment derived from upland areas flows to the coast and out into the sea. These terrestrial influences modify the salinity of coastal waters and bring nutrients to enrich coastal food chains. Marine influences can be traced inland, as for example saline water intrusion into estuaries and rivers, tidal energy subsidies or saline coastal soils. Together the marine and terrestrial influences create unique associations of plants and animals which are normally not found in upland or purely marine environments. Mangrove and coral reefs are two examples.

- *Coastal Ecosystem* - Ecologists use the term ecosystem to describe the plant and animal populations found in association with the non-living environment (water, soil, nutrients, etc.) which function together in a given area. It is the varying combination of and interaction between plants animals and the non-living environment which helps to distinguish between different ecosystems. A pond and a mangrove

forest are ecosystems of greatly different character. The unique combination of marine and terrestial conditions in tropical coastal areas creates ecosystems which are not found anywhere else. Mangrove and coral reefs are perhaps the most unique of the tropical coastal ecosystems in terms of the functions they perform and the economic and environmental goods and services they provide.

- *Resource System* - a resource system describes the interrelationship between man's use of the goods and services provided by the environment and the environment itself. A fishpond is a resource system. A feature of coastal environments and individual ecosystems such as mangrove is that one ecosystem can support a variety of resource uses. If there is specific use made of a resource characteristic of an ecosystem, then the ecosystem can be considered a resource system. Alternatively, all the individual forms of direct or indirect use of resources provided by a mangrove could be added together to describe a broader resource system. This point is an important one to bear in mind because planning strategies aimed at developing the full potential of coastal ecosystems must consider the wide range of individual resource systems supported by the structure and functions of those ecosystems. All too often one resource opportunity is maximized and all other resource opportunities are ignored and/or their potential value is reduced.

- *Management* - management is an activity which attempts to control factors which have an influence upon a course of events whose path and outcome we wish to influence to meet specific objectives. One example of environmental management is where we attempt to manage forest clearance practices in a watershed to reduce erosion and to prevent siltation of reservoirs used for irrigation.

- *Development* - as used in this manual accepts as a basic premise the concept of sustainable use. Sustainable use of coastal resources implies dynamic balance activated through economically

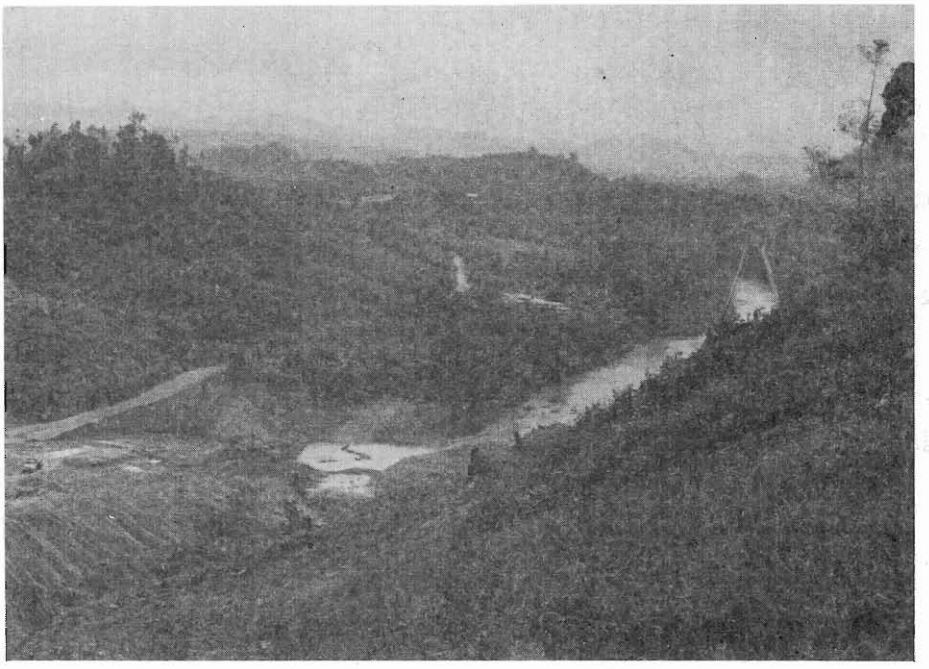
sound and socially just changes. Moreover it places a high value on maintaining the natural resource base and avoiding as far as possible inflicting unacceptable damages to the natural systems being developed.

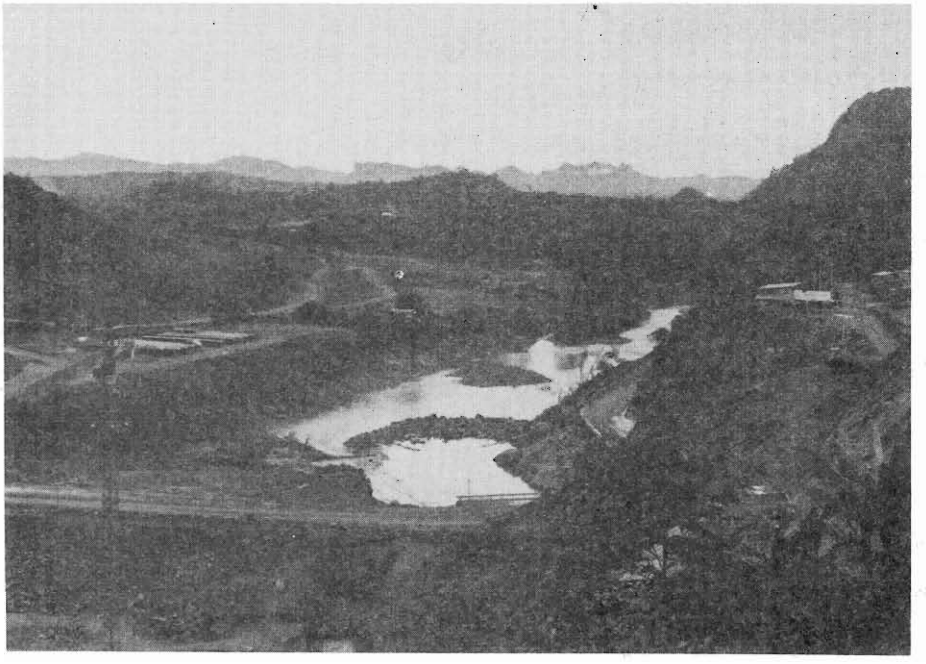
- *Planning* - as used in the manual refers to the process by which the statutory authorities and others produce plans and select development projects.

- *A Plan* - is a document resulting from a completed planning exercise. It contains a dynamic analysis of the situation, a statement of goals, objectives, or targets to be achieved, a description of projects and programs of action to be undertaken to achieve the goals, objectives or targets. It addresses the means to be used, who will use them, when and how the plan will be implemented and by whom.

It is useful to distinguish between a top-down and a bottom-up approach to planning. In the former, the national objectives define the function that the area to be planned will have in the country's development during the period of the plan. The Eastern Sea Board and the Upper South Plan are top-down plans. In the bottom-up approach the development plan is based more exclusively on an assessment of the potentials and problems of the area in question (physical, social, economic), makes the best possible use of the available resources to resolve these problems, and tries to assure the participation of the local population.

In general the approach to planning best suited to the coastal zone is one where resource management is considered early in the planning process. This is so because environmental problems generally result from inter-sectoral competition over the use of natural goods and services. A focus on resource management right at the beginning of the planning process means that such sectoral conflicts can be minimized and the need for costly and time-consuming environmental impact statements avoided. This method will also make it easier to achieve multiple-use objectives.





Management of upland areas is often necessary to prevent damage to downstream coastal resources

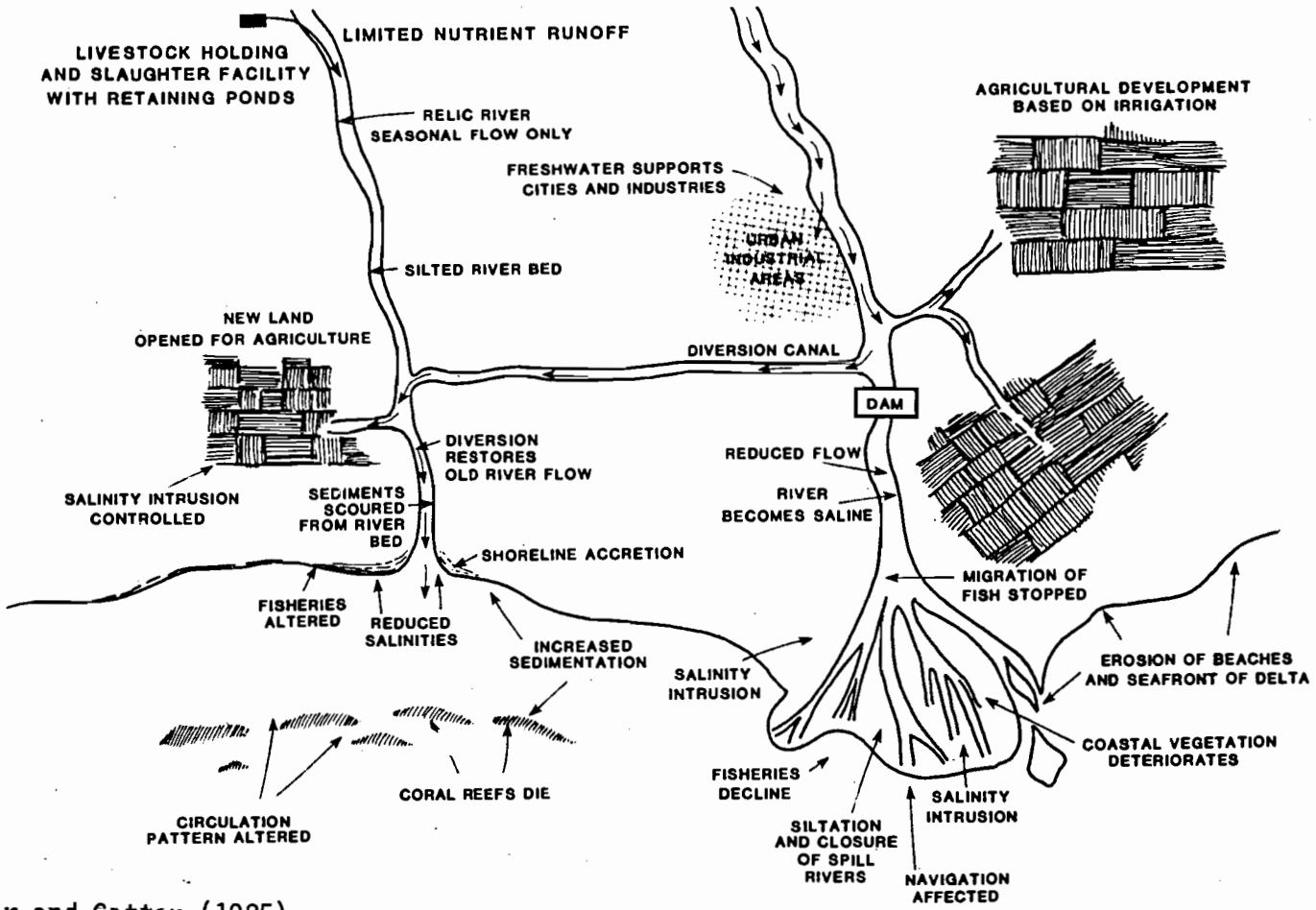
- *Coastal Resource Management and Planning* - refers to the management of coastal resources (including ecosystems) and the organization of the process of development through planning to maximize development within the limits of the coastal environment to sustain that development. A feature of this approach is the development of coastal resource opportunities to support multiple forms of use and fulfil multiple objectives.

Major Management Considerations for Coastal Management and Planning

(A) The boundaries of the coastal zone are difficult to define and can theoretically encompass major watersheds and the 200 mile seaward limit adopted by coastal nations. It is less important for management purposes to create an accurate definition of a zone and more important to use it as a means of identifying special coastal features and factors which inluence the management and development of coastal resources. For example, poorly managed upland deforestation and conversion to agriculture can lead to changes in the hydrologic regime of watersheds and accelerated erosion. Although, for practical management purposes upland development can be handled separately from coastal development, attention must be paid to the influence of upland management practices because they have a direct effect upon coastal activities downstream. See Fig. 1.1.

For planning and management purposes it is not necessary to define a rigid, all encompassing zone. It is however, very important for planners to understand the management requirements of coastal resources including effects of upland or marine activities.

(B) Coastal areas are complex and dynamic. The mix of terrestial and marine influences creates what ecologists refer to as an "ecotone" - an area of transition where species of marine and terrestial origins are found. High energy subsidies and rich nutrient inputs to coastal areas both create energy rich, biologically productive



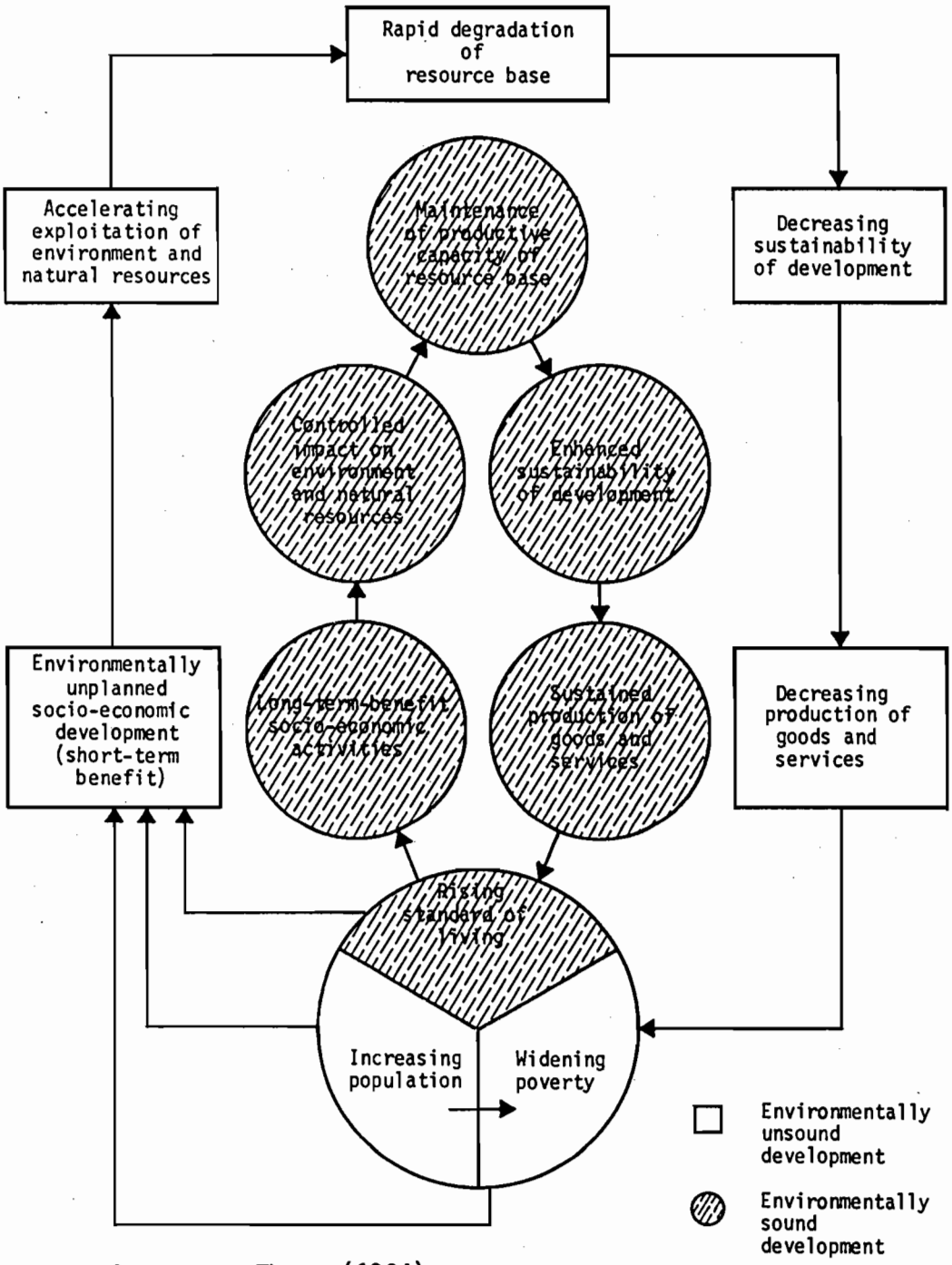
Source : Snedaker and Getter (1985)

FIGURE 1.1 Impact of upland agriculture on coastal resources

and very diverse ecological systems. In such areas rich and diverse ecological systems provide many valuable environmental services (coastal erosion control, buffer to storms, nutrient exchange, shelter and breeding areas for finfish and shellfish) and a range of economic goods (mangrove fuelwood, charcoal, fish). While these services and goods are of great value, coastal areas are also very dynamic and are sensitive to changes which can upset the equilibrium of powerful forces, such as tides, waves and winds. For example, the mining of coral to produce limestone removes living reef material which reduces the erosive power of waves. In Sri Lanka and Indonesia coral mining is blamed for the erosion of valuable beaches and shorelines. Similarly, the removal of mangrove forests can change sediment transport in littoral (nearshore, shallow waters) areas and can increase storm damage from wind and wave forces inland from the mangrove. This is of particular importance when considering the development of agriculture or aquaculture in coastal areas.

(C) Renewable coastal resources are limited in any given period of time, and the economic demand for a given resource whether fish, wood or land commonly exceeds the supply. To assure that renewable resources remain available to future generations, coastal resource management has as one of its major goals the sustained utilization of coastal resources. The criterion for sustained utilization is that the resource should not be harvested, extracted or utilized at a level which is more than that amount which can be either produced or renewed over a similar time period. In essence the concept of sustained utilization is rooted in the idea that the resource base is a capital investment with an annual yield; it is therefore the yield that is utilized and not the capital investment i.e. the resource base. By preserving the resource base, annual yields are assured for future generations. However this requires a development process that is sensitive to the needs of the environment. See Figure 1.2.

When planning for the conservation or development of coastal resources, it is essential to take into account both direct and indirect effects of any activity on adjacent systems. This approach to resource



Source : Theys (1984)

FIGURE 1.2 The relationship between the environment and development

development and utilization brings together the concepts of sustainable use and obtaining the greatest yield from the best multiple uses of the resource within a framework that plans for both long-term and multisectoral use. The concept of greatest yield from the best multiple use is based on the premise that specific resource systems (often treated as isolated systems) are alway components of a larger ecological system that contains many other resources with economic and social values. Another premise is that resource sub-systems tend to be highly integrated and dependent upon one another. For example mangrove forests are often thought to be of limited economic value and are intensely exploited for charcoal or chip wood production or converted into fish ponds, factory or port sites or for human settlement development. This neglects their important role in coastal fisheries and in coastal protection. The greatest yield that can be obtained from the best multiple use concept requires that all actual and potential uses for the resources in question be determined so as to assure that the sum of the opportunity costs is minimal. These opportunity costs represent the value of those opportunities that would otherwise be derived from using other resources, as opposed to committing one resource for an exclusive use. By taking into account all actual and potential uses of resources, it is possible to determine the greatest potential yield from the best multiple uses that would result in the smallest opportunity cost possible. Another premise of the sustainable use concept is that each unit of land or water has a carrying capacity, that is that there is a finite and determinable yield or productivity that can be derived for each unit; further use will seriously effect these units' continued ability to produce at the same or similar rates. This idea of carrying capacity can be applied to many aspects of coastal resources eg. fishes associated with a coral reef, the area of a mangrove forest, the use of a beach for tourism etc. With accurate estimates of carrying capacity it becomes possible to carefully regulate exploitation intensity so as to obtain the greatest possible yield which can be sustained in the long-term.

Basic Principles of Coastal Resource Management and Planning

Coastal resource management and planning is a means of developing, organizing and controlling the use of coastal resources to meet nationally defined needs, goals and objectives. Coastal areas contain some of the most biologically productive and diverse environments on the face of the earth. The resource development potential of these environments is great, however the form and intensity of individual uses require careful management if the development potential of the renewable resources is to be maximized and to yield sustainable forms of development.

A series of basic principles which apply to the management of coastal environments and the resources they contain may be listed as follows :

1. *The coastal zone is unique and has special needs for management and planning.* Traditional land-based or marine-based forms of management and planning must be modified to be effective for the transition area between land and sea.

2. *Water is the major integrating force in coastal resource systems.* Every aspect of a coastal management and planning program relates to water in some way, requiring unusual and complex institutional arrangements.

3. *Coastal zone land and water uses must be jointly planned and managed.* The CMP process recognizes coastal lands, waters, and intertidal areas as an interacting and indivisible unit that lies between the dry land and the open seas.

4. *Sustainable development of coastal resources is a major purpose of coastal management and planning.* An important premise is that renewable resources should be managed to provide optimum social/economic benefits on a perpetually sustainable basis.

5. *Multiple use of renewable coastal resources is emphasized by coastal management and planning.* Single, exclusive use of particular coastal resource units is discouraged by CMP in favor of multiplicity of uses whereby conservation and development become compatible goals.

6. *The focus of coastal management and planning is on common property resources.* While planning and management strategies may of necessity include control on use of private activities and properties, the main purpose of CMP is usually the caretaking of common property resources.

7. *Integrated, multiple-sector involvement is essential to coastal management and planning.* A major purpose of CMP is to coordinate the initiatives of the various coastal economic sectors toward long-term optimal social-economic outcomes, including resolution of use-conflicts and beneficial tradeoffs.

8. *All levels of government must be involved in the coastal management and planning process.* Coastal areas and coastal resource systems are often administratively complex because of the degree of shared jurisdiction and the amount of common property resources involved therefore, CMP activities need to involve all levels from national to village governments.

9. *Coastal management and planning boundaries are issue based and adaptive.* There is no single description of "coastal area" or "coastal zone" for the CMP process; boundaries are delineated on the basis of the problems CMP attempts to solve and must be adaptive to the evolution of the process.

10. *Coastal management and planning is structured for incremental implementation.* While CMP benefits from being organized in a nationwide, comprehensive format,

it can be implemented on either a region by region basis or a resource by resource basis.

11. *Coastal management and planning emphasizes the nature-synchronous approach to development.* The most cost-effective approach to coastal development is to respect the strength of natural forces operating at the coast and to design projects to utilize or adapt to these forces i.e., to "design with nature".

12. *CMP emphasises the importance of Environmental Assessment.* This entails strategic investigations at the initial stages of planning and focusses on the abilities of environmental systems to support different types and levels of development and to respond to alternative forms of management. This differs from EIA in that the former addresses the question of how environmental systems can assist development whereas the latter addresses the question of how the environmental impacts of development can be reduced. EIA can come at a later stage in the development planning process and can profitably build upon the more broadly based EA. Both EA and EIA should be incorporated into any coastal management and planning program.

13. *Special forms of economic and social evaluation are required by coastal management and planning.* The complexities of coastal renewable resources development requires special methods be devised in order to clarify the development alternatives and the costs and benefits each alternative involves.

Note : These principles have been very slightly adapted from the 13 principles prepared by John Clark for the U.S. Department of the Interior. A new principle, number 12 in this list, has been added which incorporates principle number 13 in John Clark's original list.

Section 2. Development Planning and the Coastal Zone

We should differentiate between development planning for the coastal zone and development planning for a region or sub-region which includes a coastal zone within its geographical boundary. The difference is partly one of geographical scale. But in addition, in the former case the exclusive focus on the coastal zone leads to a strategy that gives priority to the multiple-use of the coastal resource base. In the latter case the focus on the general socio-economic development of the area and its role in national development places emphasis not only on the resource base but also on all other development forces, some of which may even originate outside the study area e.g. finance, population or raw materials. In this case there may be very strong pressures to use coastal resources for large scale single-uses such as ports and industrial sites. Despite these differences the planning process required in each case should address many similar tasks, including :

(a) identifying the natural goods and services available from the ecosystems within the geographical boundary of the study;

(b) identifying potential uses and conflicts in the use of these goods and services; and

(c) helping to promote the potential uses and to resolve any conflicts through integrating and co-ordinating development efforts.

To carry out these tasks, the relevant resource/environmental assessment units have to be identified. In the case of the coastal zone these will generally be based on coastal land forms, i.e. flood plain, beach, etc. or on specific coastal ecosystems such as mangrove or coral reefs. This will provide units relevant to the general assessment of natural systems and the identification of critical management factors as well as the identification of potential uses of goods and services

provided by the ecosystem. Here it should be noted that integration of uses can be based upon potential uses of goods and services of a single ecosystem or a group of ecosystems. The use of resource environmental assessment units makes an important contribution to the basic planning and management system for deciding resource uses and for identifying agencies or interested bodies concerned with developing those uses (See also section on Environmental Assessment). The identification of potential uses is based upon :

(a) the potential theoretical uses of the ecosystem (e.g. as identified in the Mangrove and Coral Reef Handbooks)

(b) existing uses and the bio-physical condition of the ecosystem

A comparision of these two will provide the appropriate potential multiple and single uses to be promoted. Some existing uses may be discontinued or altered and new uses substituted or added on.

In order to transform the use potential into a plan for implementation the agencies concerned will need to agree on what level or intensity of use and what mix of use is acceptable. Decisions will have to be made about feasible locations for the suggested multiple and single uses. Once these steps have been carried out relevant management controls and techniques for integrating uses and co-ordinating developments in terms of sequence and timing will be necessary.

This transformation into a plan for implementation will require a thorough knowledge of the social and economic systems as they concern the coastal zone. Therefore as well as resource or environmental assessment, social and economic systems have to be assessed. This involves a number of steps :

(I) Analyse trends and forecasts for the development of activities and show how consideration of national and local targets (objectives) and different sectoral policies affect appraisal and utilization of coastal resources

(II) Analyse economic influences on the transformation and

use of coastal resources e.g. inputs and outputs, markets and fiscal conditions

(III) Analyse social and cultural influences on the use of coastal resources. Identify cultural based resource utilization practices which might act as models of conservation and sustainable use. Cultural traditions might also be considered as a valuable resource for tourism. Identify needs, opportunities and constraints of the social systems in coastal area

(IV) Analyse institutional characteristics as they effect resource transformation and use e.g. ownership, custom, levels of decision making, sectoral responsibilities

The planning process is partly technical and specialists from a variety of disciplines will necessarily be involved in the planning exercise. This is to ensure that the problem dynamics are properly understood and that the potential for resource development is fully and appropriately evaluated. The process also necessarily involves the development of mutual understanding with a variety of government agencies and concerned individuals to determine if optimal resource development strategies are acceptable and practical. Hence the proposed planning process is an iterative one in which strategies based on the appropriate mix of uses will be formulated, evaluated by specialists and non-specialists and adapted and refined to meet the special conditions of the area which is the subject of the planning exercise.

The outcome of the planning process is a product. This will be a plan which will provide a framework which can guide resource managers, direct national and local investments, direct public investments in coastal land utilization, tourist development and coastal works and guide the activities of other agencies whose regulatory functions or investments have an impact on the coastal zone.

With regard to the regional or sub-regional planning process the approach developed by the Organization of American States is recommended.

This approach aims for the "effective management of renewable natural resources using integrated approaches to regional planning and project design. The goal of this approach is to prepare a rational plan in which all development sectors have been assessed for their effects on all the resources in a given geographic area. It implies significant co-ordination among sectors and the flexibility to modify activities to avoid resource depletion and assure long-term economic productivity" (see Ref. 6 p. 2). This should however be supplemented by materials which deal specifically with coastal ecosystems as there is no coastal zone case study in the OAS book. With regard to development planning for the coastal zone a suggested approach is outlined in Table 2.1.

Planning Techniques and Approaches

Techniques in planning are essentially concerned with providing facts, making value inputs or facilitating decision-making. There is a wide range of techniques available and each has its strengths and weaknesses. Different techniques will be used at different stages in the planning process (see Table 2.1). They will be selected by the planner usually as a result of his familiarity with them or as a result of the resources at his disposal and rarely because one technique is by any objective criteria considered to be "the best" or the only one that is appropriate. It has been impossible in this manual to cover in detail more than a few of the techniques available to the planner and the reader who is interested in familiarising himself with others is directed to the bibliography. We have selected some of the techniques which have been used extensively for planning coastal areas, these are : environmental assessment and economic evaluation which are covered in Section 3, and zoning, checklists, and matrices which are dealt with later in this section.

TABLE 2.1 Provincial Coastal Zone Development Planning Process

STEPS	TASKS	SPECIAL TECHNIQUES	PRODUCT	NOTES
1. Prepare Work Plan	Review Terms of Reference. Identify resources of time and manpower and tasks to be completed as outlined here. Allocate tasks and decide on the frequency of meetings to share information, ideas etc.	Chronogram, Network Analysis	Chronogram, Network Analysis	Use of outside staff should be considered if resident planning team lacks some particular discipline or expertise
2. Define the Coastal Zone	Identify and map the zone's land and sea boundaries. This might encompass the coastal facing watershed and the continental shelf (if present)	- Geomorphological analysis - Soil surveys - Forest survey etc.	Map	N.B. For management purposes the most important thing is to understand the system rather than to have precise and fixed boundaries. Different definitions may be necessary for different purposes e.g. to understand eco-system functioning or to analyse the coastal community and the coastal dependent local economy. Attention must be paid to management factors that will influence coastal resource management such as upland deforestation or agricultural practices which may have potential downstream impacts
3. Review existing condition and identify major problems, needs and opportunities within the coastal zone. Review existing plans, projects etc. in or effecting the coastal zone	Problems might include water pollution, erosion or loss of habitat, over exploitation of fisheries, depletion of coastal forests, destruction or degradation of tourism and recreation areas, conflicting resource uses. Needs include conservation of resources, promoting the coastal-dependent local economy, avoiding the siting of development in or near vital or preservation areas. Opportunities might be the identification of under exploited resources, the harmonious development of coastal tourism etc.	Brainstorming Nominal Group Technique Questionnaires Interviews Forecasting/ Trend extrapolation	Inception Report including Written Statement and Maps	Hold discussions with provincial and district level officials as well as the representatives of sectoral ministries, the local community and local interest groups When reviewing higher level plans the focus should be on their impact on (a) the provincial coastal zone (b) the coastal community (c) the coastal-dependent local economy Analyze economic, social and cultural factors that influence the use and transformation of coastal resources Analyse trends and forecasts for the development of activities and show how consideration of national and local targets and different sectoral polices effect coastal resources. Analyse institutional and legal arrangements as they effect resource use and transformation e.g. ownership, custom etc.

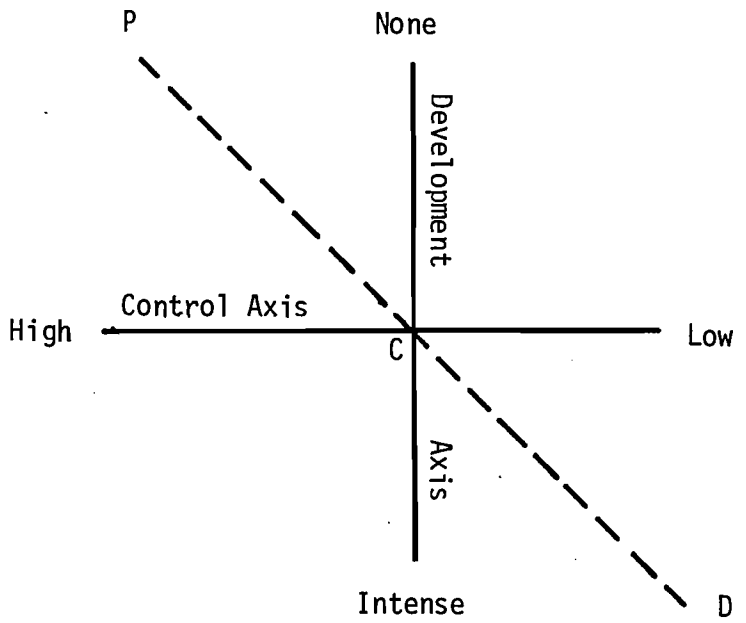
STEPS	TASKS	SPECIAL TECHNIQUES	PRODUCT	NOTES
4. State the goals and objectives of the coastal zone development plan	When the problems, needs and opportunities are analyzed and organized and all existing plans and policies reviewed these then form the basis of the direction of the plan. The most important goals and objectives will be given higher priority and attention although some may be potentially conflicting. They should cover all potential economic and environmental resources, uses and functions of the coastal zone	Goal compability/ conflict Matrix. Nominal Group Technique, Weighting, Relevance trees	Written statement of goals, objectives and policies	These should be compatible with plans at a higher level if they exist e.g. National, Regional, or Provincial socio-economic development plans. The writteen statement can be revised as new information comes to light
5. Make an inventory and Map Coastal Resources and Uses	Undertake interviews, literature reviews, aerial photography or remote sensing studies and field work as time allows to describe and map significant coastal resources and uses. Determine which uses, functions, and values are important for the Province	Economic evaluation, Modelling, Environmental Assessment Checklists and Matrices	Map and Statement Technical Appendix	Stages 5&6 incorporate the environmental assessment procedures outlined in Section 3 of the manual. The inventory should be conducted with sufficient comprehensiveness and scale to provide information to implement coastal policies and resolve conflicts between policies on an area to area basis. Inventories should give information about categories of resources (e.g. coral reefs, beaches, mangrove forests), categories of uses (e.g. fishing areas, public rights of way), and categories of functions (e.g. water recharge areas, flood zones etc.). See also environmental assessment steps 2&3
6. Identify sub-areas on the basis of the relationships between ecosystems and potential and existing uses	Self-evident	Overlay technique using soil maps, existing uses, ecosystem maps etc.	Map and Statement	E.g. vital areas, fishery reproduction zones, productive mangrove areas, aquaculture zones etc. Define areas for : (a) multiple use for sustainable development (b) exclusive use for specific uses e.g. ports (c) general prohibition of alteration to the structure and functions of an area/system. See EA steps 4&5
7. Formulate coastal policies	Analyze the results of the inventories, evaluate alternative actions and designate which uses, functions and resource values will take precedence. Designate areas of particular concern with threatened or vulnerable functions and uses requiring special attention. Integrate with the results of Step 3	Sieve mapping, Valuation, Matrices, Planning balance sheet	Skeleton Report with Statement and Maps and Project profiles	

STEPS	TASKS	SPECIAL TECHNIQUES	PRODUCT	NOTES
8. Outline how the policies will be implemented	This might include such options as Preservation, Conservation and Development Zones, marine parks, limits on levels of use and exploitation, public rights of way, resource development projects. This will also include specifying the administration procedures and enforcement actions to be used to ensure that future proposed coastal developments will comply with the policies and other forms of guidance	Zoning, Avoidance etc.	Written statement	
9. Prepare the draft Plan, Co-ordinate with other agencies and obtain public input	The procedures and actions conducted in the previous steps should be organized and presented to coastal zone users, scientists, planners and managers for review and comment. This process will determine whether the plan is acceptable, enforceable, accurate and complete	Public participation	Draft Plan	Shortage of time may well 'encourage' the planning team to neglect this stage but this should be resisted as far as possible. At least some scientists/researchers should be approached for their comments
10. Revise, finalize and submit the plan to the relevant committee	Incorporate valid comments and suggestions and review the necessary regulatory, judicial or legislative directives to ensure the plan can be realized Determine what institutions will be responsible for the implementation of each part of the plan	Organizational Responsibility Charting Technique (ORCT)	Final Plan	
11. Monitoring and Evaluation	Self-evident	Data bank, environmental and welfare indicators	Evaluation Report	This is a vital part of any plan-making process but appears to be often neglected in Thailand. This being the case there is no real way to evaluate and adjust the plan. Discussions should be undertaken with the Committee on Coastal Land Development to create monitoring and evaluation procedures and designate personnel to undertake this

Note : Adapted from Maragos et al, 1983

- ZONING

Because there are a number of potential uses (often incompatible) which compete for space in the coastal zone there is a need for a land-use planning approach which can deal with this. One approach often used is known as environmental zoning. Normally this approach divides the geographical area in question into 3 zones depending on the degree of development allowed and the number of controls exercised. See Fig. 2.1.



P = Preservation
C = Conservation
D = Development

FIGURE 2.1 Model of zoning

Development Zones - environmental areas "which because of physiography, drainage or other factors are comparatively suitable for development, and which have a reduced ecological, recreational and public importance. Lands which could be developed directly or with only minor alteration would be classified as "development" (Clark, 1974).

Preservation Zones or vital area - these areas "which provide invaluable public benefits-such as recreation, aesthetics, economic, and hurricane flood protection and which are intolerant of development" (Clark, 1974). These are areas which it is recommended should be preserved without any development and protected from degradation. "Preservation" areas include coral reefs as well the as waterways, mangroves and marshes, which all form critical parts of the same productive and valuable coastal wetlands community; shellfish beds; grassbeds; dunes and beachfront; breeding areas, nursing areas, wintering areas etc.

Conservation Zones - these areas "include the remaining lands, those marginally suitable for development and of important but non-critical ecological significance. These serve as a buffer between the preserved and the developed areas. They require special precautions when being developed" (Clark, 1974).

To successfully implement an environmental zoning system, there are two basic requirements.

(a) There must be a willingness on the part of the relevant agencies or institutions to maintain and enforce zoning regulations.

(b) There must be a clear method for determining the basis for zoning decisions. These decisions are ultimately

political in nature, but they must be based on good and accurate consideration of economic, ecological and aesthetic factors and thus require sufficient information and a multi-disciplinary approach.

According to Odum (1976) wherever possible it is good practice to :

(a) Use recreation zones as buffers between conservation and development zones

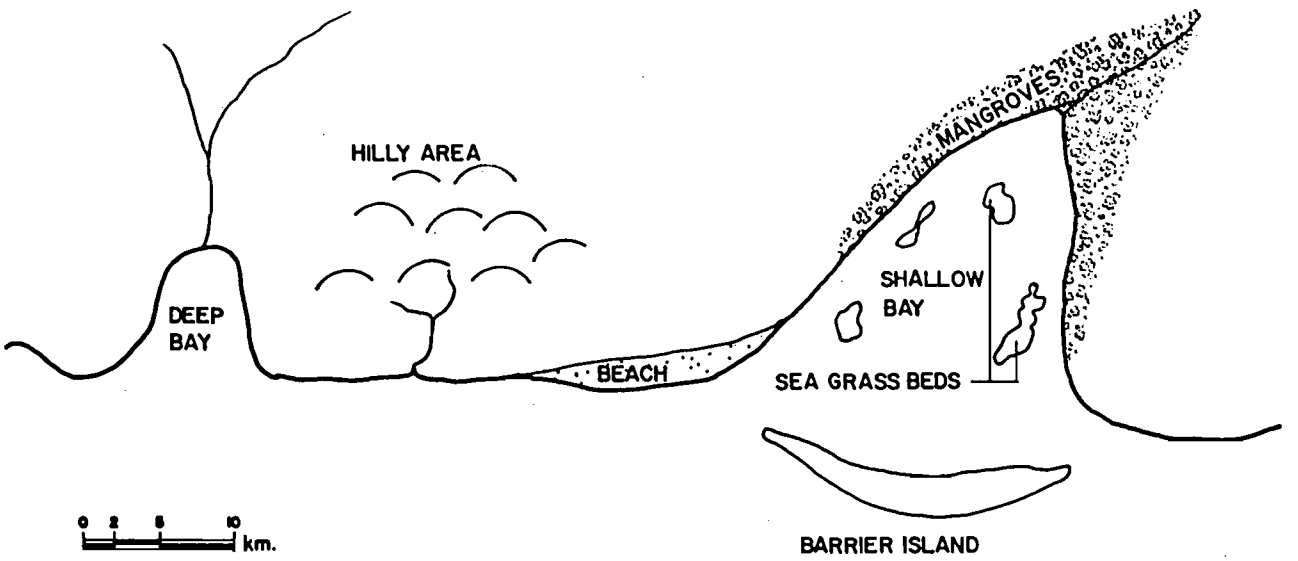
(b) Use recreation, conservation or preservation zones for areas such as beaches and floodplains where intense development is hazardous

(c) Place preservation zones within conservation zones, thereby providing the greatest possible protection

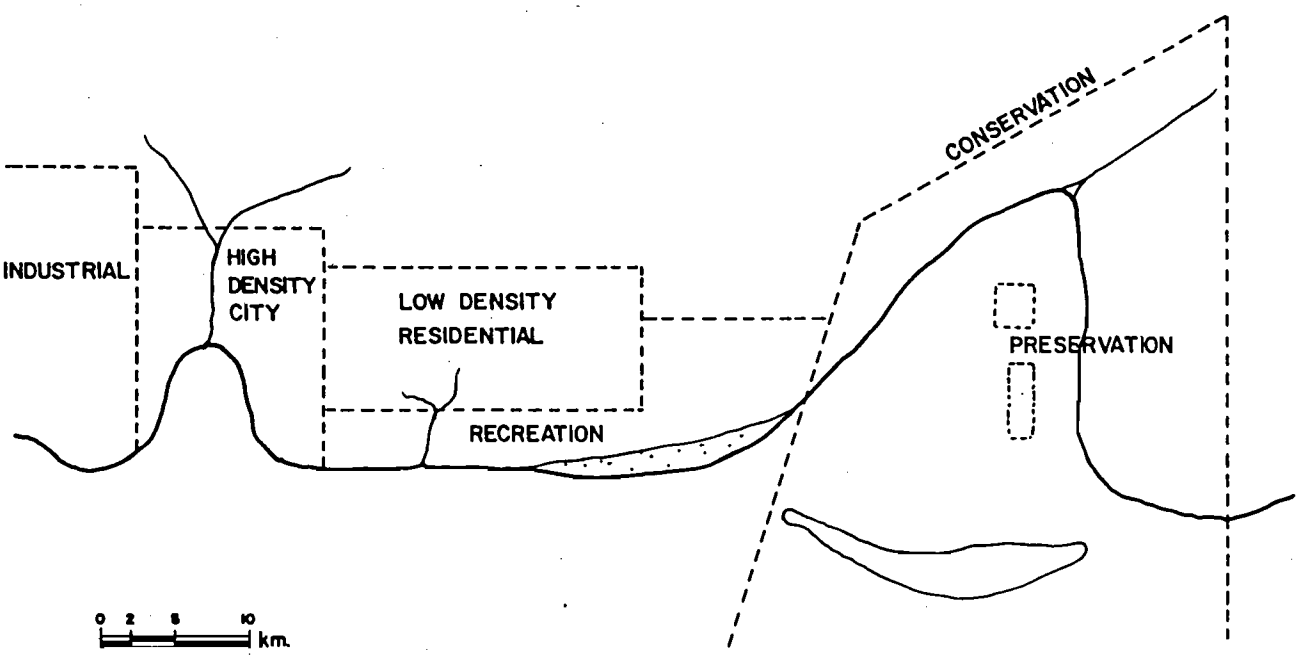
These good practice guidelines are illustrated in Figure 2.2. The designated zones should be reviewed from time to time and should not be treated as unchangeable. At some stage it may be quite feasible to allow part of an area previously designated as a conservation area to be intensively developed. However before any decision to do this a full economic evaluation and environmental assessment should be carried out.

As mentioned in the section on environmental assessment the coastal zone can also be classified in terms of area devoted to multiple uses or single uses. This approach can be incorporated into the preceeding Preservation/Conservation/ Development framework. Once this is done it will be necessary to get some idea of the level of management and investment required and to identify key agencies responsible for implementing the strategy.

FIGURE 2.2 Illustration of zoning in coastal planning



(A) This hypothetical example shows an expanse of undeveloped coastline containing a number of different environments with varying possibilities for conservation or development



(B) This is one possible management solution for the coastal area shown above. The conservation zone contains a number of smaller preservation zones which are designed to protect such diverse features as bird rookeries and seagrass beds

Source : Odum (1976)

- CHECKLISTS

A methodical approach to coastal zone planning requires, as a minimum criterion, that all important phenomena be identified. The determination of which things are important involves the consideration of all the possible things that might be important. Many things will prove to be unimportant; but without a systematic approach to identifying phenomena, some important phenomena might be neglected.

Checklists are the principal methodology at this early stage of analysis. The following checklists of environmental functions and of activities in the coastal zone have been developed to serve as reminders for planners. These lists are preliminary. They should be expanded, edited, and rearranged as experience with coastal zone planning accumulates.

Checklists can serve additional functions beyond that of reminding planners to look for and consider all things. Their function can be extended through the inclusion of rankings of each item with respect to its cultural, economic, or environmental importance or with respect to its sensitivity to mismanagement or susceptibility to change through planning and better management. Beyond simple rankings, checklists can also include qualitative notes. With each item in the checklist, reminders can be included with respect to its relation to other items in the checklist. Systems diagrams and matrices naturally flow from checklists that include this level of information.

Good checklists organize problems. They naturally serve as a means of assigning and keeping track of the investigative responsibilities of each member of the planning team. Checklists also readily evolve into the bases of filing

systems for the library and for the computer data base on coastal zone planning.

Checklists serve such basic methodological functions that we often ignore their importance as a methodology. In fact, good checklists are an essential methodological tool and probably, furthermore, the most important tool in the identification and synthesis of key information for planning. Bad or unproductive starts in the planning process can frequently be overcome by returning to the initial checklists and giving them a thorough "overhaul".

Nevertheless, checklists have shortcomings, some of which can be overcome by the use of other organizational techniques such as matrices or networks.

Two types of checklists which are extremely valuable for coastal zone planning and management are activities checklist and an eco-systems functions checklist. Examples of these are produced in Table 2.2 and 2.3 respectively.

- MATRICES

A matrix is a two-dimensional checklist. The one shown in Table 2.4 provides a simple example of the advantages of a matrix for conveying information.

The primary advantage of matrices is that they help identify important interactions between activities or environmental phenomena which must be kept in mind during the investigative and formulative stages of planning. During the presentation stage, matrices can be used to help convey the importance of interactions to those who approve and work with the plan. As in the case of checklists, the cells of a matrix can contain quantitative estimates or rankings of the importance of various interactions. The cells can also contain

TABLE 2.2 Coastal activities checklist

1	Aquaculture and mariculture - shrimp farm - oyster farm - cockle and mussel farm - pearl farm - fish farms	12	Off-shore oil and gas development
		13	Land clearing, site preparation
		14	Dredge-and-fill
		15	Salt pan
2	Near-shore fisheries	16	Solid waste disposal
3	Off-shore fisheries	17	Sewage discharge
4	Agriculture and farming - coconut plantation - rice - nypa palm - horticulture crops - grazing - Other	18	Recreation and tourism
		19	Water resource development - irrigation - ground water supply
		20	Human settlement
		21	Industry
5	Forestry (mangrove and upland)	22	Watershed activities - forestry - agriculture - dams - mining - industry - human settlement - others
6	Shipping		
7	Harbours, ports and jetties		
8	Roads and causeways		
9	Electric power generation		
10	Military facilities		
11	Mining - sand mining - gravel mining - tin mining		

TABLE 2.3 Ecosystem functions checklist

	Production Functions
1.	Beaches - supply of sand and shells
2.	Mangrove Swamps : - supply of cooling water - supply of salt production - supply of biomass to fisheries (a) Nearshore fisheries (b) Nursery function for young fish and shrimps - supply of biomass to mussel culture and fish culture - supply of food, fuel, wood (construction), drugs, paper production, household items and agriculture materials (fertilizer) - green manure
3.	Mudflats : - supply of clay - supply of biomass to nearshore fisheries - supply of biomass to mussel culture, oyster culture and fish culture
4.	Estuaries : - supply of sand and clay - supply of nutrients from rivers and the open sea, and benthic organisms - supply of biomass to fisheries, mussel culture and fish culture
5.	Seagrass beds : - supply of biomass to fisheries (a) Nearshore fisheries (b) Nursery function for young fish and shrimp - supply of biomass to mussel culture, fish culture
6.	Coral reefs : - supply of biomass to fisheries, and nursery function for young fish and shrimps - supply of biomass to pearl farm and fish culture - supply of white sand for beaches and small islands - supply of building materials - supply of ornamental products - supply of raw materials for medicine and drugs

	Support Functions
1.	Beaches : - support of shipping routes and harbours - support of areas for settlement - support of areas for recreation & tourism - support of areas for breeding ground (turtles)
2.	Mangroves Swamps : - support of areas for recreation (camping' bird watching fishing etc.) - support of areas for breeding grounds - support of areas for animals habitat

- acting as dumping ground for dredged material
- support of areas for stabilization of coastal sediment
- receiving fresh water from sluices and rivers

3. Mudflats :
   - support of areas for animals habitat
   - support of areas for breeding ground

4. Estuaries :
   - support of shipping routes and harbours
   - support of areas for recreation (fishing)
   - support of areas for human settlement
   - support of areas for breeding ground

5. Seagrass beds :
   - support of areas for breeding ground
   - support of areas for animals habitat
   - support of areas for surface erosion protection

6. Coral reefs :
   - support of areas for recreation
   - support of areas for damage protection of land, islands and beaches from wave damage and shoreline erosion

Information Functions

- opportunity for recreational experience of nature and landscape
- signal function, indicating possible deterioration of the environment
- opportunity for scientific studies and education
- genetic reservoir

Regulation Functions

- influence on the carbon dioxide and oxygen ecoromy of the atmosphere and coastal waters
- possible biotic regulation, i.e. preventing diseases and pests among organisms
- mineralization of organic compounds and subsequent release of soluble nutrients

Functions which are based on the ethical and aesthetic values of the environment

- conservation of plants, animals, communities and processes which occur in coastal regions naturally, and those which use the area on migration routes

TABLE 2.4 Simple matrix for conveying information

Modules →

Water Bodies and Landforms	Coral Reefs	Mangrove Forests	Beach Ecosystems	Estuaries and Lagoons	Seagrass Beds	Coastal Agriculture	Upland Agriculture	Coastal Aquaculture	Capture Fisheries	Exploitative Clear-Cutting	Maintainable Mangrove Forest Harvesting	Fuelwood and Other Renewable Resources	Oil and Gas Operations	Power Generation	Ports, Harbors, and Marinas	Roads, Rails and Bridges	Shore Protection	Waste Disposal and Disease Control	Coastal Recreation and Tourism	Water Resource Development	Industrial Siting	Coastal and Marine Mining	Salt Manufacture
Islands	•																		•		•	•	
Nearshore Waters	•								•						•			•	•		•	•	
Open Coast	•		•			•			•						•		•	•	•		•	•	
Barrier Islands			•												•	•			•		•	•	
Lagoons	•	•		•	•	•	•	•	•		•	•	•	•	•	•		•		•	•		•
Deltas		•	•			•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
Estuaries		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•		•
Coastal Wetlands		•		•		•	•	•	•	•	•	•	•	•	•	•		•		•	•		•
See page numbers	9	24	40	49	61	78	84	93	104	112	119	131	145	155	163	174	182	194	200	204	213	217	229

Source : Snedaker and Getter (1985)

qualitative information. Many database programs are on the market for use on micro computers that are designed to store both quantitative and qualitative information in the cells of multidimensional matrices.

The following matrix (Table 2.5) juxtaposes ecosystems with activities in the coastal zone. Since two interactions are presented as to the importance of various ecosystems as a location for fishing, shrimp culture, and oyster culture and as a source of nutrients for each of these activities.

TABLE 2.5 Ecosystems and activities in the coastal zone

Location / Source of Nutrients	Upland	Mangroves	River	Estuary	Mud flats	Bay	Sea
Fishing	++	+ / ?	+ / +	+ / ++	+ / ++++	+++ / ++	++ / +
Shrimp Culture	+	+++ / ?	+	++ / +	++	+	?
Oyster Culture	+	?	++	? / ++	+++ / ++	++	?

Matrices can be used to help understand systems. For example, environmental functions can be juxtaposed against environmental functions to form a matrix. Each cell in such a matrix can be used to indicate how augmenting or diminishing one function through environmental management affects the other functions. While matrices can be quite helpful in organizing information about interactions within systems, the limits of matrices are quickly reached. First, the information in each cell only indicates the 'first-order' interaction, the direct effect of one function

on another rather than the final effect after all of the impacts in the system affecting each other have reached an equilibrium. Second, how one environmental function is changed affects how it interacts with all the other functions. One soon begins to find that a whole new matrix is needed for each type of disturbance to the system. In summary, the interactions within environmental systems or between economic activities and environmental systems cannot be represented like the input-output tables of economic activities where everything is measured in dollars and relationships can be assumed to be linear.

Even though matrices cannot be used to functionally model ecosystems or economic and environmental interactions for planners, they do offer numerous possibilities for ordering and conveying information. Tables 2.6 and 2.7 give a good demonstration of how matrices can be linked to show serial cause and effect relationships. Linked matrices have some of the advantages of matrices and some of the advantages of network diagrams.

PLANNING APPROACHES

Apart from an armoury of techniques the planner has several approaches which can help him to minimize the adverse impacts of development on the coastal zone :

Avoidance - This is perhaps the most obvious. Developments which do not have an overriding need to be located in the coastal zone can be located away from coastal ecosystems. It should be noted that there are special risks attached to development in any shorelands within reach of coastal storm or flood tides. On the open coast, the risks are mostly involved with the direct impact of storm driven waves whereas in estuaries the risks are due to storm-induced high waters.

The open coast is a risky place to locate human settlements and huge public and private investments to stabilize and

TABLE 2.6 Development activities that can adversely effect selected important coastal tropical ecosystems

Development Activity	Marshes	Deltas	Estuaries	Mangrove swamps	Seagrass beds	Coral reefs and lagoons	Beaches	Islands
	Type of Ecosystem							
Agriculture and farming		●	●	●	o	o		●
Feedlots, ranching, and rangelands	o	o		●	o	●		●
Forestry		o		●				o
Aquaculture and mariculture	o	o	●	●	●	o		
Nearshore-catch fisheries		o	●	o	●	●		o
Dredging and filling	●	●	●	●	●	●	o	o
Airfields	o	o	o	o	●	●	●	●
Harbors	●	●	●	●	●	●	o	●
Roadways and causeways	o	●	●	●	●	●	o	o
Shipping		●	●	o	o	o	o	o
Electric power generation	o		●	o	●	●	o	o
Heavy industry (onshore)	o	●	●	●	●	●		●
Upland mining	o	●	●	o	●	●		o
Coastal mining	o	●	●	o	●	●	●	●
Offshore oil and gas development		o	o	●	●	●		●
Military facilities, training, and testing	o				●	●		●
Land clearing and site preparation	o	o	o	o	o	●	●	●
Sanitary sewage discharges	o		●	o	o	●		●
Solid waste disposal	●	o	o	●			o	●
Water development and control	●	●	●	●				●
Shoreline management and use		o				●	●	●
Coastal resource uses	●	●	o	●	●	o	●	●

● Significant adverse effects likely

o Adverse effects possible

Source : Maragos et al (1983)

TABLE 2.7 Linkage between development activities, their physical consequences, and responses by ecosystems (notes provide explanations of the technical terms and interrelationships)

II. PHYSICAL CHANGE

I. DEVELOPMENT ACTIVITY...CAUSES	Temperature 1	Dissolved oxygen 2	Nutrients 3	Salinity 4	Hydrology/oceanography 5	Siltation/sedimentation 6	Water pollution/toxic subs. 7	Pathologic substances 8	Physical disruption 9	Soil erosion 10	Debris and solid wastes 11	Change in cover 12	Overexploitation 13	Disruption of migration 14	Disturbance of behavior 15	Overloading/encroachment 16
MANAGED ECOSYSTEMS Agriculture and farming						↓	↓			↓		↓				
Forestry						↓			↓	↓	↓					
Ranching and feedlots		↓				↓		↓		↓		↓				
Aquaculture and mariculture			↓		↓				↓			↓				
Nearshore-catch fisheries							↓		↓				↓			
CONSTRUCTION AND TRANSPORTATION FACILITIES Dredge-and-fill activities					↓		↓		↓					↓		
Airfields									↓			↓			↓	↓
Causeways and highways		↓			↓	↓			↓					↓	↓	
Harbors				↓	↓	↓	↓		↓							
Shipping							↓				↓					
INDUSTRIAL AND RELATED DEVELOPMENT Military facilities						↓	↓		↓	↓		↓			↓	
Electric power generation	↓						↓								↓	
Heavy industry	↓	↓	↓	↓			↓	↓								
Offshore gas and oil development	↓				↓	↓	↓		↓							
Coastal mining			↓			↓	↓		↓							
Upland mining			↓			↓	↓		↓							
URBAN AND RESORT DEVELOPMENT Sanitary sewage discharges		↓	↓				↓	↓								
Solid waste disposal							↓	↓	↓		↓					
Water development and control				↓	↓											
Shoreline management and use					↓	↓			↓	↓				↓	↓	
Land clearing and site preparation						↓			↓		↓				↓	
Coastal resource uses													↓	↓	↓	
III. ECOLOGICAL RESPONSE																
Biological displacement/change in species composition 17	→	→	→	→	→	→	→	→	→	→		→	→	→	→	
Lowered species diversity 18	→	→	→	→	→	→	→		→			→	→			
Reduction of standing stock 19	→	→	→	→	→	→	→		→		→	→	→	→		→
Reproduction/recruitment failure 20	→	→	→	→	→	→	→	→	→			→	→	→	→	→
Overutilization of selected species 21													→			→
Smothering of sedentary species 22						→			→	→	→					
Mass kills 23	→	→		→	→		→	→								
Respiratory stress 24	→	→				→	→									
Inhibition of photosynthesis 25	→	→	→	→	→	→	→									
Food chain concentration 26							→	→								
Diseases of stocks 27							→	→								
Habitat modification/destruction 28					→	→			→	→	→	→				

THAT RESULTS IN

Source : Maragos et al (1983)

Table 2.7 Continued : Explanatory notes

1 The rate of metabolism, physiological responses, and biochemical reactions in organisms are largely controlled by temperature, and tropical organisms live near their upper lethal temperature limit. Each organism has an optimal temperature range.

2 All organisms, aquatic or terrestrial, require dissolved oxygen for respiration, and each species has a preferred range of oxygen concentration.

3 Nutrients and fertilizers (such as phosphate, nitrate ammonia) that are normally limited in concentration but which plants require for food production. Nutrient concentrations often control the rate of productivity.

4 Each species is normally adapted to a narrow range of salinity (the proportion of dissolved salts in water) because of physiological and osmotic requirements.

5 Each species or distinct ecological community will have a preferred range of water circulation, wave actions, and water residence times.

6 Siltation and sedimentation can change the type of bottom, reduce light, clog pores, disrupt movement, and/or reduce respiration due to burial.

7 Certain substances are toxic, lethal, or stressful to particular organisms at particular concentrations.

8 Pathogenic substances lower the health or introduce disease to organisms.

9 Burial or removal of bottom habitat physically destroys bottom-dwelling life or changes communities.

10 Plant and vegetation communities have specified soil requirements. Eroded soils also serve as sources of disruptive sediments.

11 Debris and solid waste changes bottom habitat and can introduce toxic substances.

12 Changes in bottom cover (vegetation, corals, algae, etc.) of important or dominant species can affect the entire community.

13 Overexploitation is the removal of species (fish, wildlife) from populations at a rate faster than the population can maintain itself.

14 Physical barriers (dams, causeways, roads, etc.) can block the flow of water and the migratory routes used.

15 Introduction of changes to the environment - most notably oxygen, light, and temperature - can cause organisms to avoid or become attracted to the changed environment.

16 Excessive exposure to environmental effects (noise, dust, saltwater, sediment) will cause stress to organisms and changes to communities.

17 A response manifested in the loss of certain species or the introduction of others.

18 A community response resulting in lowered total number of species or reduced proportions of rarer species.

19 A reduction in the total size of an existing population of organisms of the same species.

20 Population reduction caused by reduced viability of eggs, reproductive activity, or the ability of new juvenile members of the population to survive to sexual maturity.

21 Selective overexploitation of dominant or important species that indirectly affects other species in the community.

22 Sedimentation to a sufficient extent that results in permanent or prolonged burial of bottom organisms.

23 Introduction of pollutants or drastic temporary environment changes that exceed the lethal limits of a major proportion of the population of the community.

24 Changes that result in lower dissolved oxygen concentrations or in lowered ability of organisms to acquire oxygen from respiration (e.g., burial, clogging of gills and lungs).

25 Reduction in the factors that control photosynthesis including changes in light, carbon dioxide, water, nutrients, and introduction of photosynthetic inhibitors.

26 The progressive accumulation of toxic substances within the tissues of organisms as they move up the energetic food chain from plants and herbivores to carnivores.

27 Changes that lower the health and tolerance of organism to resist disease.

28 Changes to a sufficient degree that destroy or modify environmental conditions upon which important or dominant organisms depend.

safeguard inhabited beaches with structures have not always been successful. Avoidance is the best course of action.

Estuarine areas do not receive the same wave and wind forces as beaches do but they too suffer persistent erosion and the building of structures near the bank edge should be avoided. Buildings should be set back some distance to allow the area between the bank and the building to be left as a naturally vegetated buffer area. Where bulkheads are required and feasible they should be built behind the tideland or wetland vegetation. Moreover buildings are best built on piling with the main floor above the 100 year flood level.

Mitigation/Amelioration - Some impacts are inevitable and must be reduced by treatment, dilution, optimal siting, containment and other controls. For example, for sewage treatment coupled with ocean outfall into open coastal waters downcurrent from coral reefs can reduce the ecological effects of discharge to insignificant levels.

Compensation/Enhancement - In some cases, significant adverse impacts cannot be avoided e.g. the only feasible location for a port may be within a coastal marsh. The approach here is to compensate for the loss of a calculated quantity of significant habitat by restoration or the creation of opportunities for the same habitat (or other ecosystems) elsewhere.

Remedial - Developments that occur without proper planning and accurate environmental assessment may cause adverse impacts that could have been avoided through use of an alternative design or site. The planner in this case can stipulate that significant unforseen impacts be

rectified after a post development environmental impact assessment provides details of the extent and strength of the impact.

Institutional and Legislative - The planner also has available other institutional approaches to protect coastal ecosystems from unnecessary or unwarranted development. Some of these include resource conservation practices (controls on the taking of fish and wildlife); critical or vital area designation (fishery reproduction zones, habitats for rare or endangered species etc.) water quality standards (to control the quality of receiving waters and effluents to protect coastal ecosystems).

Moreover there are a number of Thai legislative enactments which can be appropriate for controlling the use of coastal resources such as the City and Town Planning Act of 1975, Minerals Act of 1967, Petroleum Act of 1971, Fisheries Act of 1947, the Forest Act of 1971, Environmental Quality Act of 1975, Wild Animals Reservation and Protection Act of 1960, the National Park Act of 1961, and the National Forest Reserves Act of 1964. Those who are concerned with coastal development planning and management must become familiar with these and know their appropriateness and strengths to deal with a particular coastal problem or opportunity.

Section 3. Environmental Assessment and Economic Valuation

Introduction

Environmental assessment entails strategic investigations at the initial stage of planning. The assessment focuses on the abilities of environmental systems to support different types and levels of development and to respond to alternative forms of management. The assessment process includes an evaluation of the current uses of coastal land and water resources and the effects of these uses on the resources. The assessment of what is possible, what is currently taking place, and the objectives of development form essential information for the planning process.

Environmental impact analysis (EIA) is already practiced in Thailand. EIA is required for specific projects in a development program between the time a project has been identified and designed and the time it is approved. EIA can be used to improve the design and operation of a project. In some cases, EIA can lead to an alternative site for a project. In rare cases, a project might be abandoned because of excessive environmental problems which can not be reduced. The EIA process has led to a greater awareness of environmental systems, of their vulnerability to development projects, and of how to design projects with fewer impacts. Whereas EIA basically addresses how the environmental impacts of development can be reduced, environmental assessment addresses how environmental systems can assist development.

More emphasis should be placed in Thailand upon the use of environmental assessment at an early stage in the planning process. The environment should be seen as a source of sustainable development rather than as a constraint to economic development or simply as a location for development. This manual, therefore, focuses on the application of environmental assessment as a means of defining coastal resource development opportunities and management measures to promote

multiple purpose, sustained use. These sustainable multiple use possibilities provide a sound alternative for assessing the advantages and disadvantages of development where exclusive uses or the conversion of natural ecosystems are planned.

Ports and harbors are good examples of activities which must locate at the coast and which normally require the major alteration of natural systems. A clearer understanding of the benefits from alternative locations for such activities can be gained once a broad evaluation of the coastal zone has been carried out. A broadly based environmental assessment of resource development opportunities at the planning stage provides excellent background information to the subsequent, more narrowly focused, environmental impact analysis.

It should be stressed that an objective assessment of a coastal zone and how it functions is required before judgements are made concerning major programs or individual forms of development. This lesson has been learned during the process of the Eastern Seaboard Development Project. The wholly inadequate environmental assessment in the consultants' reports has led to recommendations which are not trusted and to delays in the implementation of even the acceptable parts of the plan until an environmental evaluation is conducted.

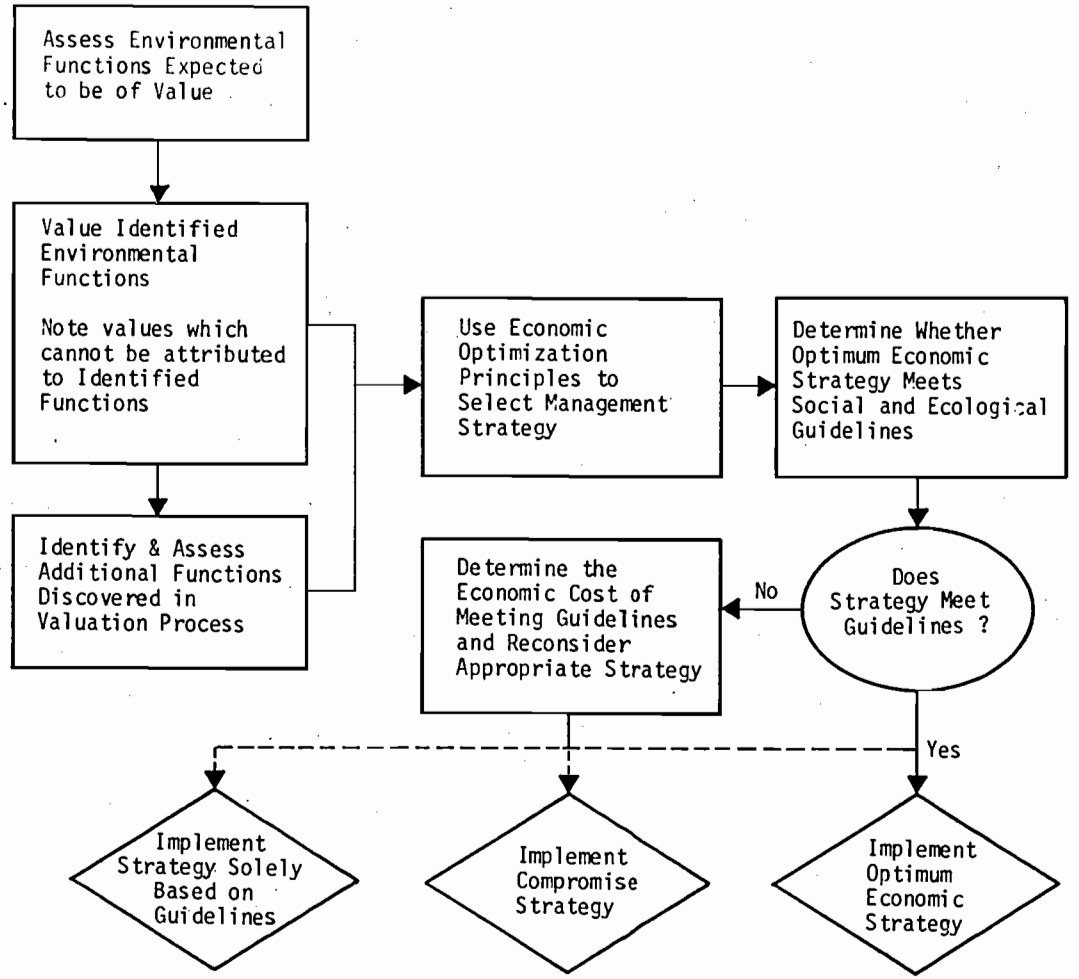
While the geographic area of a coastal zone may be extensive, the cost and time involved in gathering information for an environmental assessment need not be great. Tools such as remote sensing using satellite and aerial photographic information can cut the cost and time involved in field surveys. Base maps and detailed resource inventories of mangrove and mudflat are already being produced in Thailand and can be further extended and refined to deal with other resources. By adopting existing information such as soil surveys and conducting field spot surveys, by interviewing knowledgeable researchers, and by collating information already collected for the provincial coastal development plans, much of the basic information required could be codified and incorporated into a broad environmental assessment. However, stress must be placed upon the collection and collation of

information for management purposes rather than the production of 'laundry lists' of data on hectares of mudflat, etc. Economic valuation complements environmental assessment. Figure 3.1 suggests how environmental assessment and economic valuation interrelate. Environmental assessment identifies functions for economic valuation. The environmental scientist, for example, may ask the economist to investigate the value of a nutrient flow from a mangrove to a fishery. The economist, on the otherhand, in his investigation of the fishery, may suggest to the environmental scientist that a nutrient flow appears to be very valuable and the factors influencing it need assessing so that they can be managed. For example, a preliminary economic analysis of oyster production in Ban Don Bay, Surat Thani Province indicated that the nutrient flows to a hectare of oyster production are very valuable. The high value indicates that this environmental function deserves better understanding for appropriate management. Economic valuation is described later in this section even though it can be initiated at the same time as the environmental assessment.

Basic Steps in Environmental Assessment

1. *Define the Coastal Zone.* The definition of the coastal zone for a particular area should be broad enough to contain the major coastal ecosystems which will be the subject of management and development plans. Definitions of coastal zones are often a compromise between ecological and administrative units. The precise definition of boundaries is not particularly important so long as attention is paid to factors that will influence coastal resource management such as upland forest conversion and consequent potential impacts upon downstream coastal areas. It is not necessary to include whole watersheds in the coastal zone boundary, however, discussions between the Land Development Department divisions responsible for

FIGURE 3.1 The process of assessment, valuation and selection of a management strategy



upland and coastal management should be encouraged so that coastal plans are not disrupted by upland development.

2. *Divide the Coastal Zone into Smaller Units.* These units should be based upon landforms (e.g. flood plains) or major ecosystem types (e.g. mangrove, coral reef). The objective is to provide a preliminary assessment of the distribution, areal extent, and basic functions provided by the components of the coastal zone. Remote sensing materials, existing surveys, field studies, and reports all form sources of information which can be used to identify and map major coastal features.

   The landforms and ecosystems provide practical units for the identification and analysis of land and water resources. Within each unit, information should be collected on : a) the functions that the component landforms and ecosystems serve, b) the goods (wood products, fish fry) and services (nutrient exchange, control of erosion) they provide, and c) factors which influence their development and which form the elements for management controls and the investments required to exploit coastal resources on a sustainable basis. Use matrices and checklists, pp.37-45.

   The analysis should define development opportunities and constraints and the corresponding management actions required to achieve the desired development. With this primary objective in mind, characteristic features of the landforms and ecosystems including climate, soils, topography, hydrologic conditions, vegetation, and other bio-physical factors are identified. The structure and function of the ecosystem types are also analyzed to a) provide an understanding of how the bio-physical factors are related, b) to identify features of the systems which are critical to the maintenance of their ability to continue

to produce goods and services, and c) to identify how the component ecosystems are interrelated.

A series of basic management purposes are served by the initial inventory and subdivision of the coastal zone into broad landform and ecosystem units, namely :

i. Landforms and ecosystems can act as management units or can be aggregated to form larger management and planning units;

ii. As bio-physical systems, they form logical units for the collection of data and organization of information;

iii. Uses of the landforms/ecosystems can be defined in terms of their dependence upon the bio-physical functions of, and goods and services provided by, coastal ecosystems. These uses can be classified according to their dependence and their mutual compatibility to form the basis of multiple use strategies which attempt to maximize the full economic development potential of coastal systems;

iv. The potential uses which can be identified for individual management units (ecosystems) help to identify the agencies responsible for the management of these units (e.g. mangrove-Royal Thai Forestry Department) and the agencies which have an economic interest in the goods and services provided (mangrove-fish fry-Department of Fisheries). These agencies form the nucleus for discussion on how to integrate development interests and how to manage systems accordingly; and

v. The factors which control the functions of ecosystems condition management approaches and influence levels of investment required to promote their development. The ecosystem units act as building blocks for the creation of coastal development strategies and management plans.

3 *Identify and Classify Existing Activities.* This classification is based upon the dependence of different activities on the natural functions of coastal ecosystems and the compatibility between different forms and intensities of use. Some of these activities will be directly dependent upon the natural functions of ecosystems (wild fry collecting of Chanos Chanos from mangrove used to stock brackish water ponds). Others benefit, but do not directly consume, ecosystem goods and services (protection of inland agriculture or aquaculture from storm surges by mangrove, tourism based on fine sand beaches and exotic coral reefs).

Listing uses into the following four classes may prove useful.

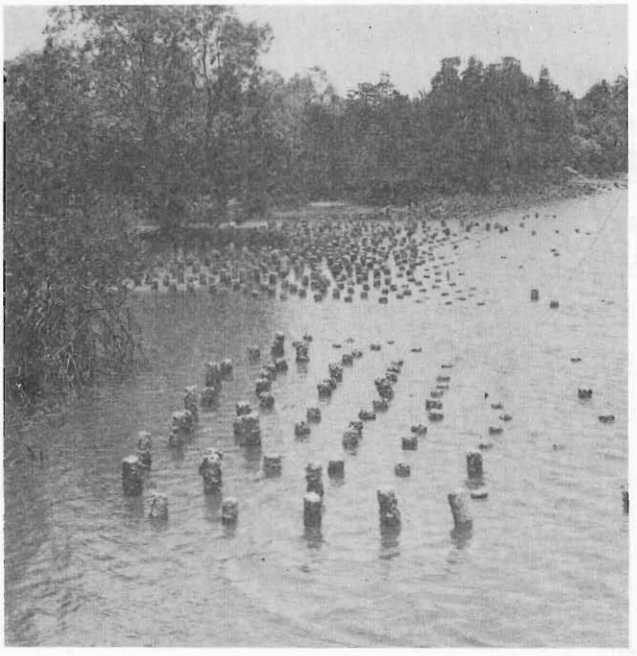
i. Uses which are dependent upon the functions and/or goods and services of coastal resources and which do not conflict (e.g. erosion control, fish nursery, tan bark collection);

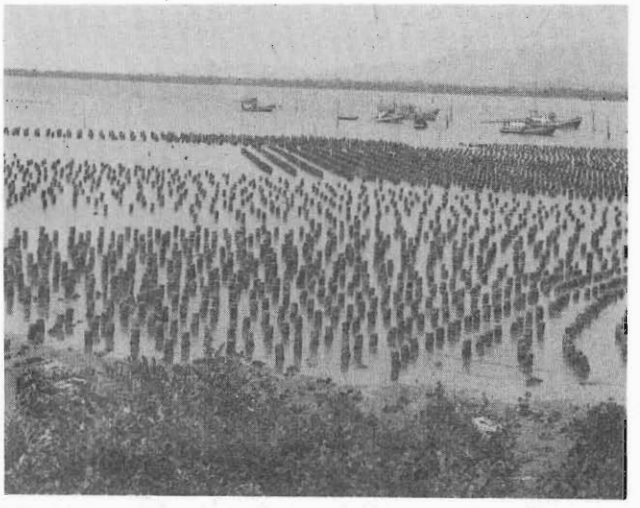
ii. Uses which are directly or indirectly dependent but which will conflict unless controls over the level and/or timing of use are implemented (coral reef fishing, coral mining, tourism);

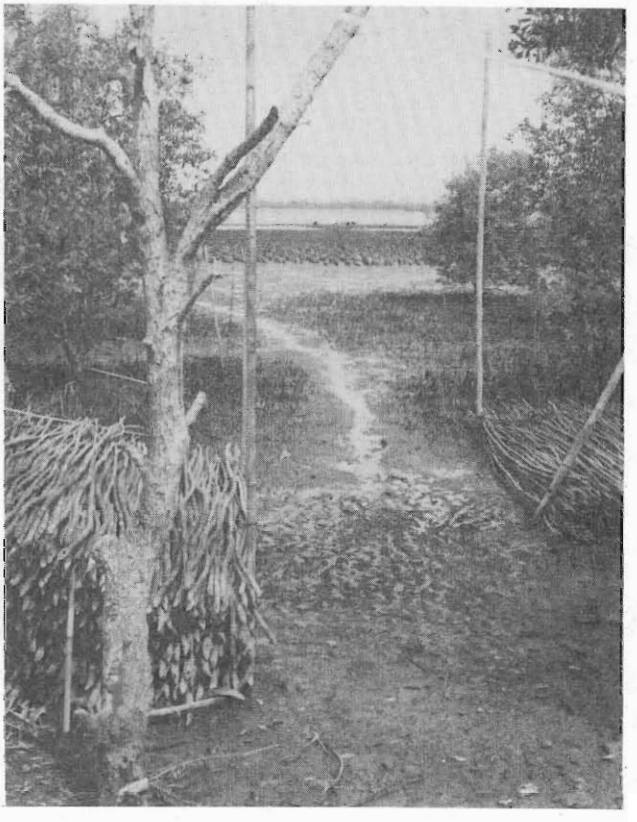
iii. Uses which are dependent and which require major controls over all other uses (habitat for endangered species vs. forestry in mangrove); and

iv. Uses which are not directly dependent upon the functions or goods and services but require major alteration of the natural system and controls over other potential uses (salt or fish ponds).

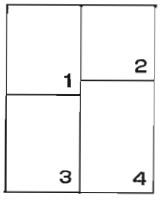
4. *Identify the Condition of the Ecosystem and Possible Uses.* The condition of the ecological system is also an important variable to include in the assessment. If a coastal area has largely been converted to major single purpose uses,







Sustainable development of mangrove resources requires the adoption of multiple use practices :



1,2 Oyster farming in mudflats adjacent to the mangrove forest

3. Nypa palm leaves used for making roofing material

4. Firewood

the natural functions and the areal extent of the natural ecosystems will have been severely affected. In areas where resources are largely undeveloped, the condition of the ecosystems may be affected by pollution or changes in the seasonality of water flows due to upstream land management practices or dams. These factors will reduce the ability of the systems to support both single purpose and multiple use/purpose forms of development.

Coastal environments support more than one use at a time or over different seasons. This feature can be expressed as the multiple use potential of coastal resources. For example a mangrove can provide economic goods such as fuelwood, charcoal, tan bark, fish trap poles, timber, mangrove crabs, fish fry, and environmental services such as coastal erosion control. All of these, and other goods and services can be supplied by the mangrove if it is carefully managed. Management implies the control of factors which might damage the mangrove such as the interruption of fresh water flows or of tidal flushing. Management of activities which extract goods from the mangrove is also required if over-exploitation of one good is not to detract from other potential uses.

Assessment of the multiple use potential helps to define the economic and social significance of coastal resources. It is also a tool in assessing the trade-offs associated with alternative development strategies. For example, managing a mangrove for the maximization of forest products may reduce other uses such as mangrove crab collection. Conversion of the mangrove would foreclose all renewable resource development opportunities and the potential value of those opportunities can be accurately expressed in terms of single use (conversion) versus multiple use.

Multiple use potential is also a useful measure of the ability of coastal resources to meet multiple objectives

in management strategies. For example, the objectives of conserving coastal fish stocks through maintenance of nutrient exchange processes in estuaries, protecting coastal areas from wind and wave forces, and providing community forestry opportunities can all be fulfilled by multiple use/multiple objective mangrove management.

A basic objective of this stage of the assessment is to define the levels of management required to promote the development of compatible use. The level of management required is a function of the mix of uses and the level of control and investment required to support increasing intensities of use and/or to ameliorate, mitigate, or compensate for conflicts to achieve sustainable development.

5. *Identify the Undeveloped Multiple Use Potential.*
The existing use provides a measure of the level of multiple use potential which remains undeveloped. The intensity of use is an important factor. If there are very intensive forms of use, the remaining multiple use potential will be reduced. The multiple use potential classification developed in step 4 provides both a checklist and a basis for comparison when assessing existing uses and the condition of the coastal area. The difference between the potential for multiple uses and the assessment of existing uses and conditions provides a realistic assessment of the remaining undeveloped potential.

Multiple use potential can be increased through management interventions to a) reduce current pressures and conflicts, b) improve environmental conditions and c) create a new mix of uses. The degree of management effort and the costs involved can be measured and assessed in terms of the costs and benefits which can be derived through alternative management strategies.

The UNESCO Handbooks on Coral Reefs and Mangrove Area Management and other reports listed in the bibliography provide very useful information on the structure, function and uses of coastal ecosystems. These materials provide basic checklists to help in the identification of major features of the coastal areas, potential uses, factors which reduce their productivity, and principal management considerations. The coastal zone should be assessed with reference to these materials both to avoid the omission of major factors which are not immediately evident to the observer and to help identify potential uses which can be developed.

Highly detailed, expensive and time consuming analyses of the coastal zone are not required. To attempt surveys which are too-detailed or in-depth ecological analyses would lead to delays. Specific data frequently become outdated. This level of detailed examination should be reserved for critical questions identified by the inventory and mapping process and for the more detailed analyses of the environmental impacts of specific projects.

The five step process which has been described provides a methodology for determining the use potential of coastal zones based upon the sustained management of renewable resource opportunities. A basic premise embodied in the methodology is that multiple use will normally generate greater social and economic welfare than single purpose uses. Where multiple uses must be foregone due to overwhelming arguments for the exclusive use or conversion of coastal resource systems, the methodology helps to create the baseline data to evaluate what is gained and what is lost. While many such choices will have to be made, the methodology will help planners and decision makers evaluate alternative locations and evaluate the benefit from measures to ameliorate, mitigate, and compensate for the new development.

The methodology can also be used to appraise the present state of management for a given coastal zone resource. If the current uses and management practices are not creating desirable levels and mixes of activities, the benefits to be derived from management intervention to improve existing conditions can be assessed. Finally, the methodology provides a reasoned basis for classifying coastal resources and geographic areas by the nature and degree of desirable multiple uses. This is more sophisticated than the more traditional 'development', 'conservation', and 'preservation' classification. All three levels of use are embodied in the multiple use classification. Rather than suggest rigid geographic zonations the 5 step methodology defines a continuum of desirable uses. Both preservation and exclusive uses can be accommodated and their management implications can be clearly demonstrated.

In real life there is no such thing as absolute preservation, nor is there a truly single purpose and exclusive land or water use. Neither is it desirable to seek such absolute states. It is feasible to choose to restrict the use of a pristine mangrove to allow the management of the habitat to save a rare or endangered species of plant or animal. Such restrictions will, by the very nature of having to manage a living system, provide for the continued functioning of the system and the continued generation of the goods and services which can be utilized without detracting from the protection of the endangered species.

This more realistic notion of controlled use will help to promote wise use of resources (conservation) while allowing for both exclusive use and preservation. All these uses can be accommodated within a development oriented multiple use based classification.

Environmental Impact Analysis

We have focused upon the use of environmental assessment as a tool in defining and developing coastal resource development

opportunities and management guidelines. This presents a forward looking assessment which helps in the planning process and is intended to guide public and private investment.

Environmental impact analysis (EIA) comes at a later stage in the development planning process and forms a tool for examining the potential effects of specific development projects or even programs. The EIA process can successfully build upon the more broadly based environmental assessment outlined above. Due to the more limited geographic area or range of possible locations in which specific projects can be developed, it is possible to carry out a more detailed analysis of the environmental aspects of the project and to consider alternative locations. The project can also be rigorously defined and its locational and resource requirements specified very exactly. This helps to narrow down the potential analysis and therefore the commitment of manpower and funds. A reasonable period of time can then be justified without necessarily detracting from the ultimate benefits the project could generate.

It should be stressed that the EIA process is a means of promoting development and reducing avoidable environmental damage and the loss of resource development options. The EIA process has received considerable attention in Thailand and the reader is referred to the NEB Guidelines on EIA and the supplementary EIS guidelines for developments in the coastal zone (NEB, 1979). A number of texts have been prepared on the subject outside of Thailand, some of the most useful are listed in the bibliography to this manual.

While this manual is being drafted, a framework for environmental impact analysis of the eastern seaboard project is being conducted with the assistance of the United States Agency for International Development. The reader is referred to this work as it represents a major example of coastal EIA in Thailand.

Economic Valuation

The physical productivities of environmental functions can neither be summed together nor adequately compared. In physical terms, a hectare of mangrove each year might produce 650 kg. of charcoal, provide habitat for 3,000 shrimp fry, and entertain visitors passing through in boats for 100 person-hours. What does the mangrove as a whole contribute and which of these individual functions are the most important ? Economic valuation of the individual functions converts the physical productivities to monetary values that can be summed as well as compared.

The market puts monetary values on some environmental functions already. A good paddy field might rent for twice the price of an average paddy field and for four times the price of a poor paddy field. The differences in the rental rates reflect the differences in the productivities of the soil, distances to market, security of water supply, adequacy of drainage, and other environmental factors which make a paddy productive. There is not, however, a one to one relationship between rental rates and rice produced because production also entails the use of labor, equipment, and materials which also command a price. If the market system is working well - the user is advised to refer to a principles of economics text with respect to this concept - the differences in rental rates for different quality paddies indicate the differences in the value of the environmental services available. The differences in the rental rates of a paddy field and a coconut orchard can also indicate the relative importance of the economic value of very different environmental services. Furthermore, the value of the environmental services associated with a hectare of paddy and of a hectare of coconut can be added.

Unlike the services of soil and other functions of agricultural ecosystems, only a few of the services of coastal ecosystems are rented or sold. It is difficult for technical reasons to own a capture fishery or a nutrient flow and for legal reasons to own a beach. For such

environmental functions, there are no private owners who can command a price for their use. "Non-ownership" takes many forms with somewhat different consequences for management. With respect to valuation, however, the distinctions in the form of non-ownership are relatively unimportant. The techniques of valuing non-market environmental functions are defined by the type of data available (Dixon, 1984).

The role of environmental valuation in the overall process of assessment and the selection of a management strategy are illustrated in Figure 3.1. A simple taxonomic system -- categorizing environmental services with respect to whether they are marketed or non-marketed and whether they occur on-site or off-site -- has proven to be helpful. For a mangrove, for example, the various environmental services can be classified quite effectively in Figure 3.2 (taken from Section IV, Hamilton and Snedaker, 1984). The taxonomy helps organize an environmental valuation so that services are not forgotten. Since not all services can be effectively measured, the taxonomy helps the economist keep in perspective those valuations that are possible.

Estimates of the economic value of some environmental services can be made. Such values, however, must always be presented as partial and interpreted carefully. Thus, before the techniques are reviewed, some important general warnings are in order.

GENERAL PROBLEMS IN VALUATION

Market Fluctuations. Market prices reflect short term equilibria between numerous factors affecting supply and demand. Moderate changes in the price of a marketed good can have profound effects on the apparent value of environmental services associated with the production of the good. When the demand for rice on the international market is low, paddy can be rented very inexpensively; when the demand is high, the rental rate increases dramatically. The purchase price of paddy is more stable because it stems from a weighted average of expectations of future rice prices.

FIGURE 3.2 Relation between location and type of mangrove goods and services and traditional economic analysis

		Location of Goods and Services	
		On-site	Off-site
Valuation of Goods and Services	Marketed	1 Usually included in an economic analysis (e.g., poles, charcoal, woodchips, mangrove crabs)	2 May be included (e.g., fish or shellfish caught in adjacent waters)
	Nonmarketed	3 Seldom included (e.g., medicinal uses of mangrove, domestic fuelwood, food in times of famine, nursery area for juvenile fish, feeding ground for estuarine fish and shrimp, viewing and studying wildlife)	4 Usually ignored (e.g., nutrient flows to estuaries, buffer to storm damage)

Source : Section IV, Hamilton and Snedaker, 1984

Valuation should be done in terms of current prices, recent average prices, and high and low prices forecast for the future. Valuation does not result in one right or best estimate. Valuation must reflect the uncertainty of the future.

Private vs. Public Values. The valuation of non-marketed environmental goods and services necessarily relies on prices generated by the private market system. The value of nutrients from a mangrove lined estuary enriching a shrimp pond can be determined from the price of equivalent nutrients purchased in the market. But are these market prices appropriate ? Might the production of the nutrients purchased in the market depend on the use of fertilizers, pesticides, and other materials with unpriced environmental consequences ? If energy markets are distorted due to uncompensated environmental impacts, what is the true value of charcoal ?

Similarly, the value of environmental services from a public perspective should not simply be based on private expectations of future prices. In countries around the world, the private sector expected resource prices to continue down during the 1970s, but in fact they went up. The private and the public sector then extrapolated the rising prices of resources during the 1970s into the 1980s. In fact they went down.

The Treatment of Time. Most valuation analyses will have to contend with problems associated with variations in returns and expenditures over time. Environmental systems in a steady state, producing the same services each year which can be utilized with the same amount of capital and labor each year pose no problems. But when environmental system transformations are being analysed, such as the building of a dam or regeneration of a mangrove forest, an investment is made during construction or planting. A number of years elapse, furthermore, before the reservoir fills and a new hydrologic pattern is established or the mangrove attains a stable flow of environmental services.

Economists weigh future benefits and costs with current benefits and costs through discounting by the rate of interest (Hufschmidt et al 1983). Quite simply, a baht today is worth one plus the rate of interest times a baht next year because today's baht put in a savings account increases at the rate of interest. There is not simply one rate of interest in the private sector, however, and there is even less agreement on the appropriate rate of interest for use by the public sector. Disagreement over the appropriate rate of interest directly translates into disagreement over valuation and optimal management.

The market price of land is equal to the sum of the discounted expected rents that can be earned in future years. When these rents are the same each year, the discounted value is equal to the rental rate divided by the rate of interest. Thus a resource or environmental service that earns 1,000 baht per year would have a sale price for its use during all future years of 10,000 baht when the rate of interest is 10% and 20,000 baht when the rate of interest is 5%. Interest rates have varied dramatically over the past decades and affected perceptions of land values accordingly.

When only the optimal management and use of a given resource is being considered, the use of low interest rates favors the conservation of the resource because the benefits of maintaining the resource for use in the future are only discounted a little by the low interest rate. High interest rates, on the other hand, favor depletion, or greater use in the present and lower use in the future, because high interest rates indicate that future benefits have relatively little weight relative to present benefits.

When the transformation of a resource is being considered, high interest rates make the transformation less attractive for the investment costs of the transformations must be weighed with highly discounted future benefits of the transformation. Low interest rates favor the transformation for the same reason if there are indeed net benefits from the transformation when all factors are considered. Thus low interest rates favor the future but may also lead to mistaken investments in

environmental transformations (Fisher, 1981; Krutilla and Fisher, 1975; and Wantrup, 1951).

The substantial variation in interest rates during the past decades has affected land values and perceptions of appropriate resource management in the private sector. Public resource managers should protect the long term productivity of environmental systems, avoiding transformations or management decisions based on short term changes in the rate of interest. They should respond to short term private decision making with respect to public resources and modify it as possible.

As in the case of the other warnings, the only solution is to undertake multiple valuations. Alternative interest rates should be considered when weighting over time appears to be an important issue.

TECHNIQUES OF VALUATION

The following techniques are described in greater detail in Hufschmidt et al (1983).

(1) Residual Return Method. In some cases an environmental service, in conjunction with labor, capital and other inputs, will produce a marketed product but a market does not exist for the environmental service itself. For example, the right to culture oysters on mudflats is controlled by the Department of Fisheries. The value of the rights is not observed, or at least not frequently, in a market. The value derives from the rich flow of nutrients to the mudflats which further multiply in the shallow waters. For Ao Ban Don, Surat Thani Province the flow of nutrients to a single hectare of mudflats was determined to have a value of between 600,000 and 1,000,000 baht per year. The valuation was simply made by deducting fair returns to capital and labor and the costs of purchased inputs from the annual revenues. See Worked Example 1 which follows.

In some cases land values or rental rates will be observed for two areas that are similar except one has the advantage of an additional environmental service. The additional value of the land with the additional environmental service can then be attributed to the service. The value of access to a beach, for example, may account for the differences in the rental rates or sales prices of otherwise similar parcels of land.

WORKED EXAMPLE 1

Economic Return of One Hectare of Mudflat Oyster Culture
Ao Ban Don - Surat Thani Province

Estimates for Total Revenues

Method 1

500 oysters/day x 300 days/year x 6 Baht/oyster = 900,000 B/year

Method 2

10,000 posts x 20 oysters/post/year x 6 baht/oyster = 1,200,000 B/year

For estimates of total expenditures see Table 3.1

TABLE 3.1 Estimates for total expenditures (฿1000s) 12% interest

Item	Capital Start up	Costs Start up	Interest During Construction		Total Capital Costs	Annual Interest	Maintenance & Depreciation	Total Annual Costs
	Year 1	Year 2	Year 1	Year 2				
Posts & Fences	300		36.0	36.4	372	44.6	30	75
Guard House		50		6.0	56	6.7	5	12
Boat	30		3.6	3.64	37	4.5	6	11
Planting	60		7.2	7.28	74	8.9	-	9
Total					539	64.7	41	106

Estimated Annual Capital Costs (Baht)	100,000	
Estimated Annual Labor Costs (3 man years)(Baht)	90,000	
Estimated Annual Cost of Supplies (Baht)	10,000	
Estimated Total Expenditures (Baht)	200,000	± 25%

Annual Net Return (1000S)

	Revenues	
Expenditures	Low = 900	High = 1,200
High = 250	650	950
Low = 150	750	1,050

Results

The preliminary analysis indicates net returns per hectare are between 650,000 and 1,050,000 baht per year (or approximately 24,000 and 39,000 U.S. dollars).

Other Evidence

An analysis of oyster production in Chanthaburi Province on the Eastern Seaboard undertaken by TISTR in 1980 determined that revenues from oyster production were approximately six times as large as expenditures. The above rates for Surat Thani Province are in this range also. Though the ratios are about the same, both revenues and expenditures per hectare are much lower in Chanthaburi because smaller, lower priced oysters are cultured and the intensity of development and management are much lower. The annual net return per hectare in Chantaburi was estimated to be only 53,000 baht.

Interpretation and Extension of the Analysis

1. Though the numbers are preliminary they are more than adequate to indicate that the environmental functions that support one hectare of oyster culture in the mudflats of Ao Ban Don are very valuable to extremely valuable.

2. The economic valuation justifies further investigations to identify how the environmental functions that support oyster production can best be maintained and utilized. The following questions should be pursued vigorously.

(a) What are the sources of the nutrients to oyster culture ? What proportions of the nutrients depend on nearby mangroves, distant mangroves, upland agricultural use and delivery by the river, and the productivity of the sea and delivery by littoral currents ?

(b) What are the major activities that might enhance or threaten this nutrient supply : mangrove transformations, upland water development projects, harbor development, coastal pollution, or competition for the nutrients through shrimp aquaculture ?

(c) What are the constraints to expanding oyster culture ? A system with such large net gains on the average undoubtedly has further gains on the margin. How should this margin best be extended ? What is preventing its extension now ? How will the costs of production increase as the supply is increased ? How fast will the market price of oysters decrease as supply is increased ? What changes in processing, marketing, and transport might expand the market for oysters ?

3. The economic questions posed above and their importance can be illustrated and extended as shown below in Figure 3.3.

At a production level of Qo oyster/years, producers receive 6 Baht/oyster. Production costs at this level of output are only 1 Baht/oyster. Total revenues received by all producers per year are currently 6 Baht/oyster x Qo oysters/year or 6 x Qo Baht/year represented by the areas b + c + d. Area d represents costs of production while areas b and c are net return attributable to the productivity of the ecosystem. Area a stems from the higher price producers would have received if the quantity supplied had been lower. This area represents a "transfer of happiness" to consumers through the lowering of the price

as supply increases. It can also be attributed to the productivity of the ecosystem.

If production were to increase, costs of production per oyster would probably increase perhaps as illustrated by the supply curve S. Production costs per oyster would increase as nutrients become less available to each oyster because of the increased competition for the nutrients and as mudflats which were physically or biologically less suitable are brought into production. Similarly the willingness to pay for additional oysters would decrease perhaps as illustrated by the demand curve D. Price Pe and quantity Qe represent the market equilibrium. Total revenues are now c + d + f + g, costs are d + g, leaving net returns received by producers equal to c + f. Area b that used to be received by producers has now been "transferred" to consumers through the lower price for oyster. Similarly consumers have also gained area e. At the new equilibrium price and quantity, society as a whole is better off by areas e and f through better utilization of the environmental functions that support oyster production. Producers of oysters, however, may or may not be better off depending on whether area b is actually greater than area f. Current producers will undoubtedly be worse off due to the price decrease unless they are also the ones given the rights to expand production, a politically expedient solution that is unlikely to be considered equitable.

If the environmental functions that support oyster are not maintained, the costs of production per oyster will increase. This would be represented by a upward shift in the supply curve S to S1 such as illustrated in Figure 3.4.

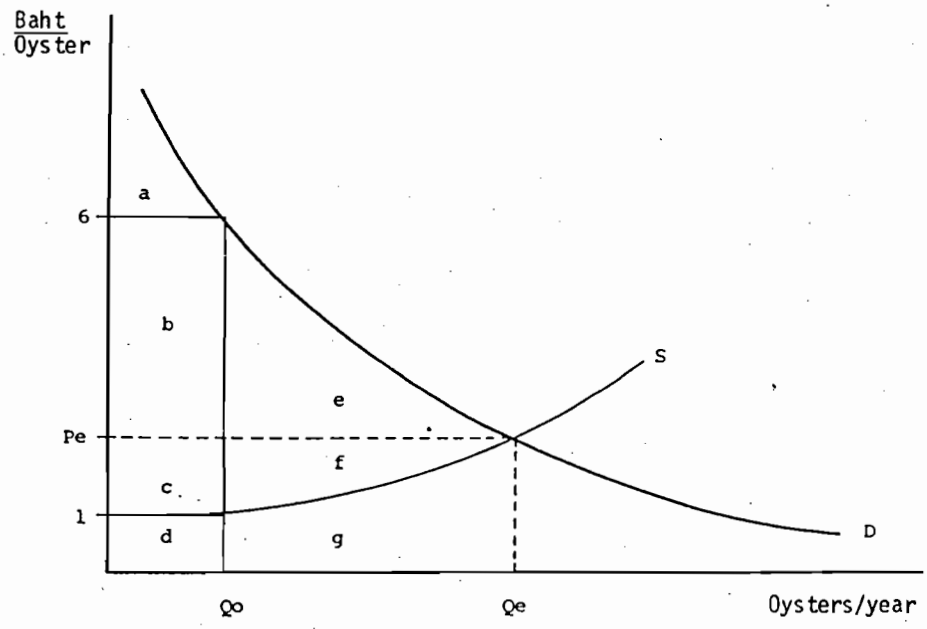


FIGURE 3.3

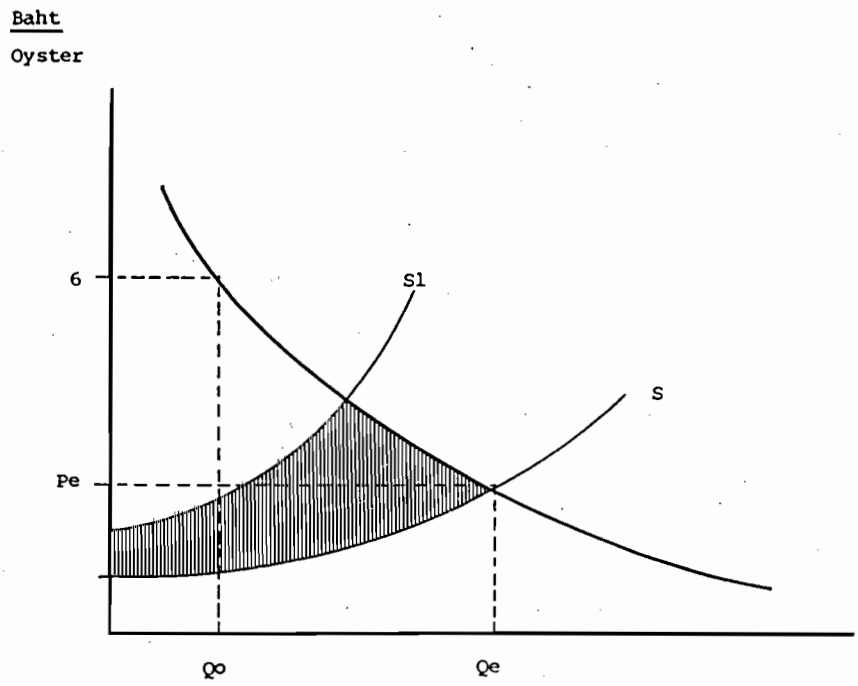


FIGURE 3.4

The costs of not maintaining the environmental functions are a loss of the returns to these functions represented by the shaded area. Note that, as illustrated in this case, most of the losses would not be realized today with the presumably inefficient utilization of the environmental functions. Efficient utilization of environmental functions and maintenance of environmental functions are typically complementary activities, each enhances the value of the other.

Conclusions

A straightforward economic analysis indicates that the environmental functions which support oyster culture range from valuable to extremely valuable. This finding justifies both the ecological research necessary to identify and protect these functions as well as further economic analysis of oyster production and marketing. Economic analysis has identified important environmental and planning questions and provides a framework for their pursuit.

(2) The Travel Cost Approach. The coastal zone is one of the most important locations for tourism development but other economic activities compete for the scarce environmental resources. Economists have sought methods to explore this question of competing activities and to determine the value of one use as opposed to another. These analyses help when decisions must be made about committing resources to preserve an existing tourism site or create a new one. Because users of tourism sites frequently pay nothing or at most nominal admission fees, the revenue collected for use of these facilities is not a good indicator of the value of the site or the willingness of users to pay. The travel cost approach is one attempt to provide an estimate of this. An application of this approach to Ko Samui, in Surat Thani Province follows .

WORKED EXAMPLE 2

Ko Samui, an island in the Gulf of Siam is famous for its beautiful beaches and rural atmosphere. Recreation development to date has been moderate. Tourists stay in simple bungalows and eat in open air restaurants along the beaches. The absence of large hotels, fancy restaurants and night clubs, and related ways to 'spend money' means that Ko Samui contributes relatively little to gross national product. Yet Ko Samui is recognized as a special place by Thais. During 1984, an estimated 117,278 Thais visited the island. There is considerable interest in predicting future numbers of visitors. In an earlier analysis, TISTR predicted there would be a total of 160,760 Thai visitors in 1995. It would also be interesting to know the value of the tourist experience. In this analysis, the travel cost approach is used to estimate the demand for tourism on Ko Samui. The analysis is preliminary. It demonstrates the travel cost approach but the results, because they are based on inadequate data, should be interpreted carefully.

A full elaboration and additional references to the travel cost approach are presented in Hufschmidt et al (1983). The technique utilizes the responses of visitors to different costs of travel to determine their willingness to pay for the recreation experience itself. For example, suppose 10,000 people from a population of 1,000,000 living at a distance with a travel cost of 100 Baht visit a recreation area and 5,000 people from a population of 1,000,000 living a distance of 200 Baht visit the area. Then if 100 Baht were charged for the visit per se, the people in the closer region would have to pay a total of 200 Baht and would probably respond as the people in the more distant region had responded, only 5,000 rather than 10,000, would choose to visit the area. The staff of TISTR interviewed approximately 1,000 visitors to Ko Samui during three different periods of 1984. These interviews indicate that the Thai visitors come from the different regions as shown in Figure 3.5 Travel costs are estimated on the basis of the fare for an air-conditioned bus from the largest city in the region plus the ferry fare, see Table 3.2.

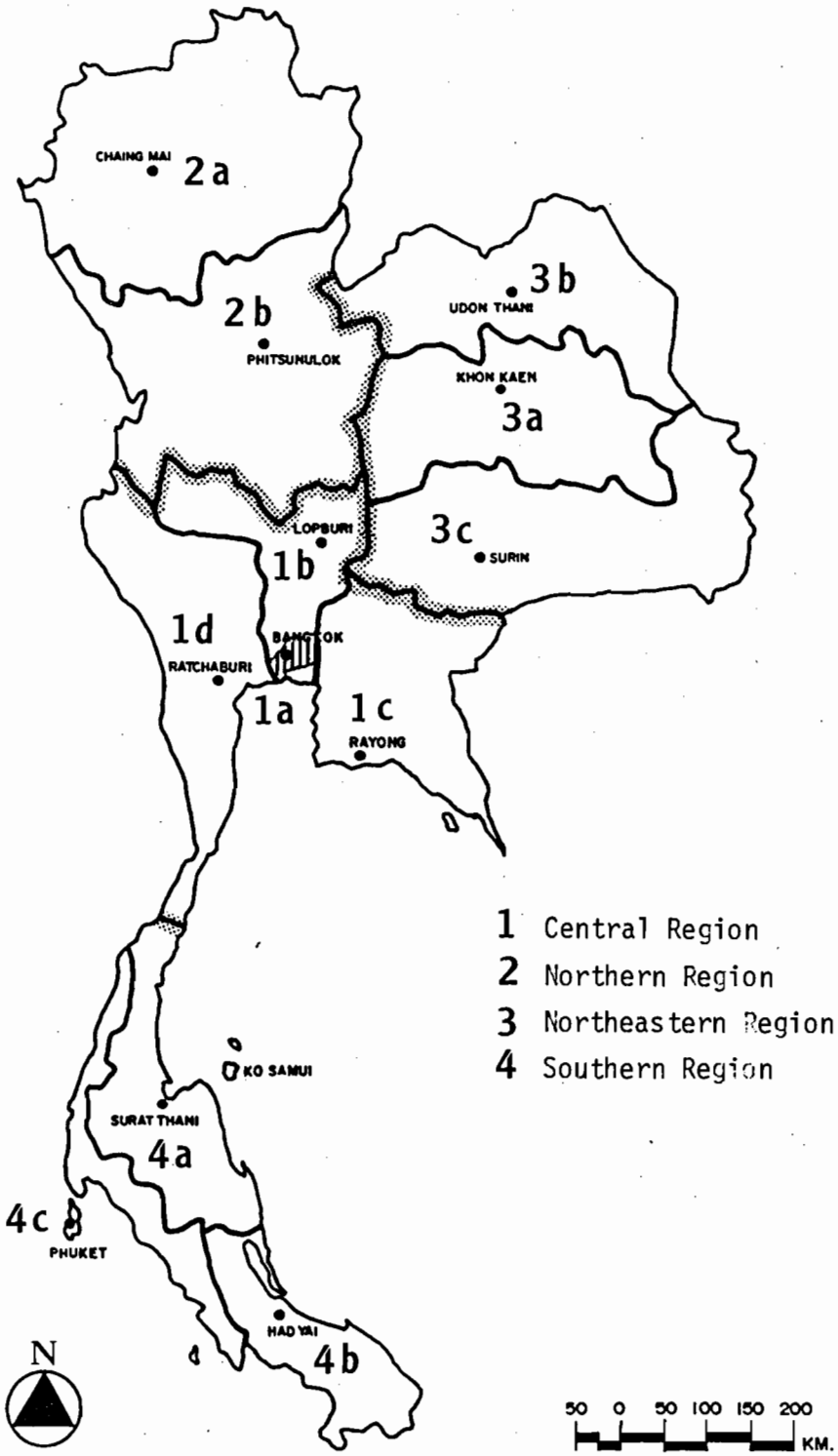


FIGURE 3.5 Regional divisions for travel cost method

TABLE 3.2 Origins of visitors and their travel costs

	Number of Visitors	Population 100,000s	Visits per 100,000	Travel Cost	Per Capita Income
(1) Central					
(a) Bangkok	67,951	53.3	1,275	560	45,983
(b) Central	4,946	35.6	139	712	17,099
(c) Eastern	5,476	35.0	156	690	31,691
(d) Western	2,188	31.8	69	520	24,282
(2) Northern					
(a) Upper	5,477	45.8	120	1,040	10,684
(b) Lower	1,642	48.7	34	810	12,002
(3) Northeastern					
(a) Central	3,295	53.4	62	866	5,992
(b) Upper	0	41.9	0	942	7,056
(c) Lower	1,642	68.7	24	870	6,018
(4) Southern					
(a) Upper	12,056	22.2	543	160	10,000
(b) Lower	10,414	24.8	420	280	11,453
(c) West Coast	2,193	12.3	178	260	25,160
Total	117,280				

The visitation rate per 100,000 inhabitants in each of the 12 regions varies from 0 to 1,275. The differences in visitation rate can be expected to be due to travel costs, the levels and distributions of income, the assessibility of other beach recreation to the inhabitants of the region, and additional factors such as the proportion of residents living in large cities. The following analysis attempts to explain the visitation rate solely in terms of the travel cost and average income for the region. Parameters to the following equation were estimated by multiple linear regression.

$$Y = aX_1^{b_1} X_2^{b_2}$$

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2$$

where

Y = visits per 100,000 for the region

X_1 = travel cost from the region

X_2 = per capita income in the region

$$\ln Y = 1.641 - 1.414 \ln X_1 + 1.248 \ln X_2$$

$$Y = 5.165 \; X_1^{-1.414} \; X_2^{1.248}$$

$$R^2 = 0.52$$

The negative sign to the coefficient b_1 indicates that the visitation rate goes down as the travel cost goes up. The coefficient b_2 indicates that the visitation rate increases with income. The rate of increase is more than proportional; it is to the power of 1.248.

The estimated relationship can be used to determine how the visitation rate would change if visitors were asked (or required) to pay for the experience of visiting Ko Samui. The analysis assumes that visitors would respond to a fee the same way they now respond to travel costs. The exercise is not undertaken with the intent of actually charging people. The analysis indicates how much people would be willing to pay for the Ko Samui recreation environment.

The following formula determines points on the demand curve :

$$Q = \sum_{i=1}^{12} \alpha i \; Ni \; (5.165)(X_{1,i} + P)^{-1.424} \; X_{2,i}^{1.248}$$

Where

Q = Total number of visits at price P

P = Price

Ni = Total population in region, (100,000)

α = An adjustment factor so that at P = 0 the estimated visitation rate and visitation rate based on the sample are equal

This yields the following demand relationship.

Price	0	100	200	300	400	500
Visits / Year	117,280	48,127	38,232	31,613	26,833	23,215

Interpretation

This is a demonstration of a technique. The analysis should be based on a larger sample. The actual incomes and travel costs of the visitors should have been used in the analysis and better income information and data on the assessibility of other beach resorts for each region should have been included in the analysis.

The results can be interpreted as follows. Each year, tourists would be willing to pay up to the area under the demand curve for the recreational experience. The area under the demand curve estimated in this analysis is approximately 38.4 million Baht or about 327 Baht per visitor (See Figure 3.6).

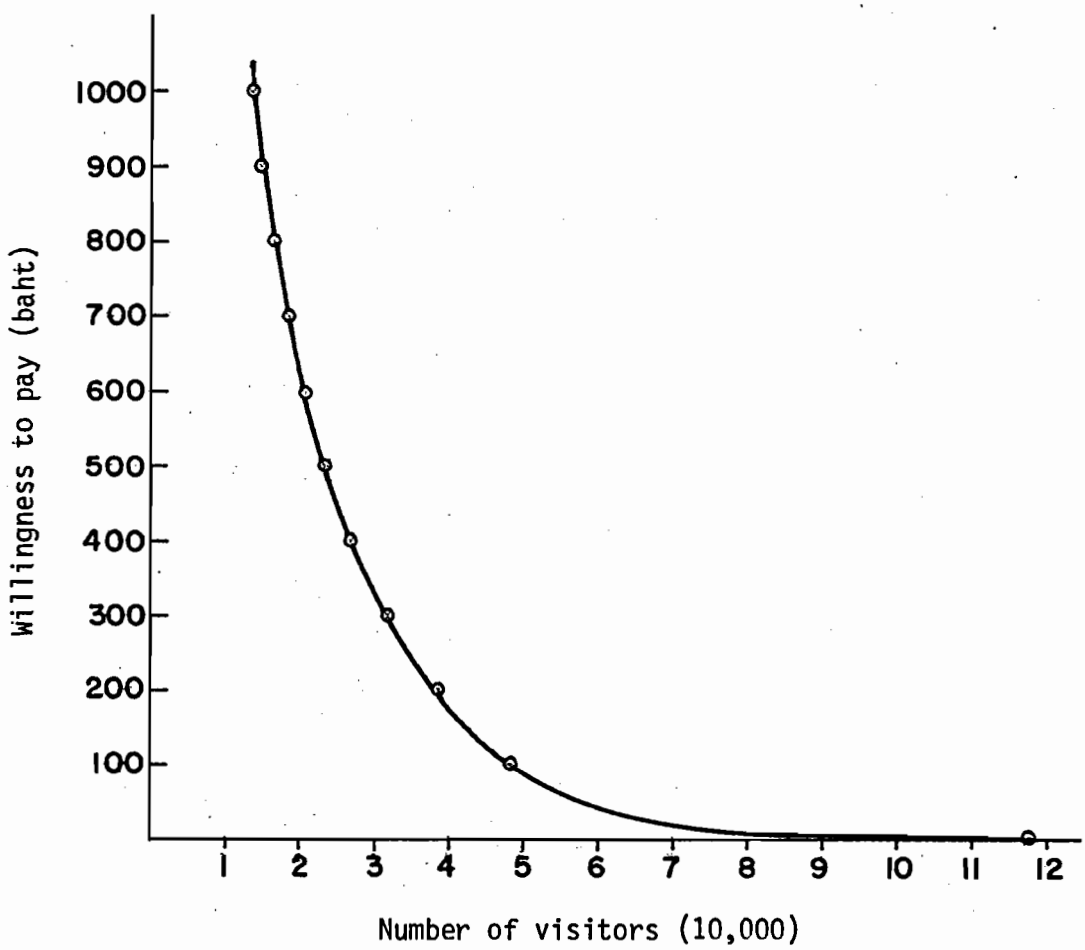


Figure 3.6 Demand curve for Ko Samui beach resort

Demand Forecasting

The estimated relationship between visits and income can be used in demand forecasting. For example, if income increases at the rate of 4% each year and population at the rate of 2% each year in each region, then the number of visits in ten years will be :

$$Q = (117,280)(1.02)^{10}\left[(1.04)^{10}\right]^{1.248}$$

$$= (117,280)(1.219)(1.631)$$

$$= 233,240$$

The functional relationship can be used also for forecasting visits where population and income growth rates differ by region. In this case, estimates of the numbers of visitors from each region are made separately based on the population and income changes specific to the region which are then summed together. For example if the Bangkok population is projected to grow at 3% and its income to grow at 6% per year while population increases at 1.9%, and income at 3% outside of Bangkok, the number of visitors in 10 years would be :

$$(67,951)(1.03)^{10}\left[(1.06)^{10}\right]^{1.248} + (49,329)(1.019)^{10}\left[(1.03)^{10}\right]^{1.248}$$

$$= (67,931)(1.344)(2.069) + (49,329)(1.207)(1.336)$$

$$= 188,978 + 86,103$$

$$= 275,081$$

The even and uneven growth projections used in the foregoing illustration are about the same on average, but the uneven growth favoring Bangkok results in a projection of 18% more visitors to Ko Samui.

Interpretation

The foregoing projections of demand assume that the nature of the recreation experience stays about the same as it is today. And yet clearly if more people come, the recreation experience will change. The beaches will be come more crowded, more bungalows will have to be built, and probably large hotels would begin to appear which would attract a different group of tourists and dissuade those who enjoy the calm, rural

atmosphere Ko Samui now offers. It is not clear whether the changes associated with more visitors will detract from or further attract additional visitors. The projection process, however, highlights the needs and opportunities for recreation planning and management.

(3) Substitute Cost Method. Some environmental services have substitutes available in the market. Purchased feeds can substitute for nutrients naturally provided in the water supply of a shrimp culture pond. The value of firewood produced by a mangrove is the equivalent cost of fuel purchased in the market place. The erosion protection provided by a coral reef could be provided by a man-made structure whose cost can be determined.

(4) Replacement Cost Method. The value of a mangrove might be the cost of replacing the mangrove. If mangroves are being protected or replanted, whether through government policy or market forces, then the transformation of a mangrove should be offset by the replanting of an 'equivalent' mangrove elsewhere. The cost of this replanting or replacement is the value of the mangrove. The cost must include the cost of planting and the interest on that cost until the new mangrove is as productive as the existing mangrove. In some instances, again due to either market forces or government policy, it may not be appropriate to replace the mangrove now but one can forsee that there is a likelihood that the mangrove should be replanted in the future. The value of the mangrove is then the replacement cost which must then be weighted by the probability of future replanting.

The replacement cost approach quite appropriately puts very high values on environmental features which are difficult to replace or which grow very slowly. Due to the low success rates of regenerating mangrove, their replacement cost is high. Due to the slow growth rates for coral, their replacement cost is also very high. A review of the economics of mangroves with attention to replacement cost arguments follows.

Mangroves and Coastal Zone Planning: An Economic Perspective

Most of Thailand's mangrove forests, except those on the West Coast, have been deliberately transformed. The history of mangrove transformation suggests several hypotheses to economists. The first hypothesis is that mangroves have lower economic value than the condition to which they have been transformed. The second hypothesis is that mangroves, from an economic perspective are like mineral resources; they can be economically exploited once but not profitably managed for sustained yield. The third hypothesis is that at least some and perhaps many of the benefits of mangroves occur 'off-site' and cannot be 'captured' by those who decide on the mangroves' management or conversion. These hypotheses are not mutually exclusive. Mangroves probably have been transformed for different combinations of the three hypotheses in different places.

Regardless of which hypothesis or combination thereof is correct, some mangroves should be maintained in each coastal region for species and ecosystem preservation for scientific research, as 'store houses' of species and genetic characteristics which might become of practical value in the future, and for their aesthetic and educational value (Bishop, 1978). Beyond this basic planning guideline, however, the three hypotheses suggest different planning approaches to mangroves. If the first hypothesis is true, independently of the third, then the conservation of additional mangroves beyond those designated for preservation would be economically inefficient. If the second hypothesis is true, again independently of the third, then coastal zone planners might address whether mangroves are being converted at the appropriate rate over time and designate areas for conversion at later dates accordingly. If the third hypothesis is true, then there is a strong economic rationale for coastal zone management plans to designate mangroves as conservation areas and to indicate an appropriate institutional framework to assure and enforce the designation.

There is an extensive literature on mangroves that has been summarized for coastal zone planners and managers (FAO, 1984); Hamilton and Snedaker 1984; and for Thailand, Adulavidhaya, et al, 1982). There

seems to be a consensus amongst those concerned with coastal management that the remaining mangroves should be conserved to the extent possible (NPS, 1985, TISTR or NEB or National Mangrove Committee). The characteristics of mangroves and their management have not been adequately studied however to distinguish between the three hypotheses suggested to economists or otherwise indicate in what ways planning can best lead to mangrove conservation.

The mangrove management literature supports the third hypothesis, attributing benefits to the mangrove from nutrient supply to coastal fisheries and habitat for immature fish and shrimp. These benefits are captured off-site by the fishing industry rather than by mangrove owners. There are, however, no studies of nutrient transport from mangroves in Thailand or, apparently, elsewhere. If a significant portion of the nutrients contributing to the return to oyster farming in the bay at Surat Thani comes from the nearby mangroves, then mangroves may be quite valuable indeed. There is little scientific evidence at this time, however.

The lack of scientific knowledge about how mangroves function is reflected in the few attempts to date at economic analyses. An analysis of mangroves in Thailand (FAO, 1982) indicated that the value per hectare per year ranged from 800 to 11,000 baht from charcoal production and 800 to 3,000 baht for fish production within and beyond the mangrove. Estimates of the productivity of mangroves to fisheries production range from U.S.$ 30 in Thailand to 1,975 in Queensland, Australia (reported in Hamilton and Snedker, 1984 p.115). This range reflects the scientific uncertainty far more than the possible differences in mangrove ecosystems between countries.

If mangroves could easily be reestablished, there would be little reason for coastal zone management plans to try to reduce the rate at which mangroves are currently being converted. In fact the costs of replanting mangroves seems to vary from as little as 1,200 Baht/hectare in Malaysia to astronomical amounts in the United States. The success rate is also highly variable with numerous replanting

attempts reporting less than 10% survival after 1 year with only one reporting 80% survival. While much has been learned through past attempts and guidelines for re-establishing mangroves have become more specific, both the cost and the uncertainty of replanting remain quite high (Hamilton and Snedaker, 1984, p.102-108). Thus if mangroves do have important off-site benefits, the high and uncertain costs of reestablishing mangroves justifies the protection of existing stands.

These findings indicate that considerable basic research is needed on the ecology and the economics of mangroves. In the absence of research findings on basic factors, coastal zone planning for mangroves cannot be 'fine tuned' and a 'safety first' policy justifies quite strict controls. Where activities such as tin mining are probably justified in mangroves, re-establishment of the mangrove system may neither be reasonable because of the high costs nor enforceable due to the uncertain success rates of replanting. These findings suggest that activities such as tin mining should be prevented in what appear to be more important mangrove areas and fines should be established for mangrove destruction that are sufficiently high to reflect the loss of the services of the mangrove system. The fines might be paid into a fund for coastal ecosystem rehabilitation and enhancement.

The Economic Optimum Combination of Activities

Mangroves can be managed to produce more charcoal or better fisheries. Estuaries and bays can be managed for more fish or more shipping and industrial waste discharge. If values can be put on each of the functions and if the relationships between the environmental functions are known, an optimum economic mix between the functions and their related activities can be determined.

This optimum mix is illustrated in Figure 3.7 for a mangrove with respect to charcoal production (on the X axis) and nutrient and habitat provision for fish (on the Y axis). The curved line identifies the combinations of these two services which are environmentally possible

through good management (the production possibility curve in economic terminology). The straight line has a slope determined by the ratio of the values per unit, or prices, of the two environmental services (the price line in economic terminology). The point (C, N) where the possibility curve and price line are tangent represents the optimum mix. At this point, giving up some of one environmental service for more of the other will reduce the total value of the combination of services. Point (C, N) maximizes the value of the two services together.

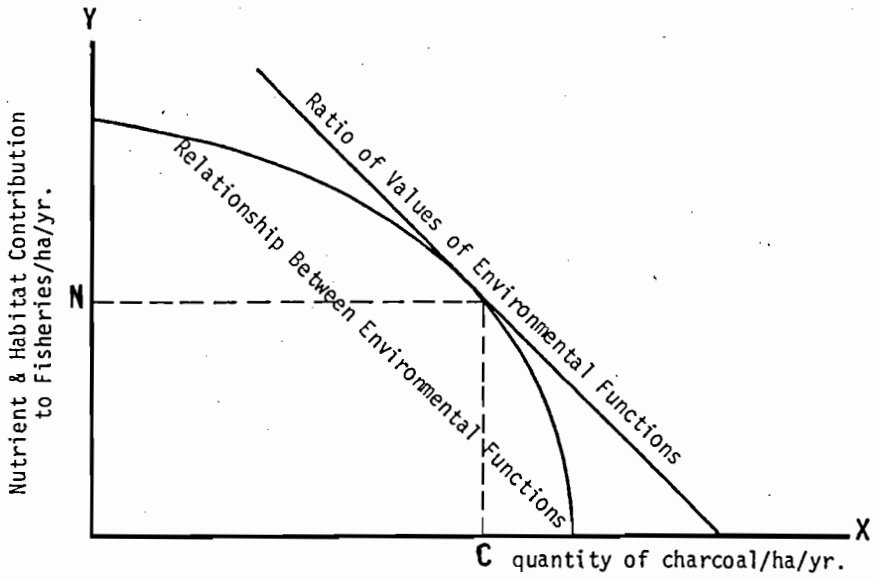


FIGURE 3.7 Optimum mix for a mangrove

Like all economic arguments, the foregoing must be used with caution. One must be sure that all functions are being considered, that appropriate values are used, that the possibility of switching to different mixes of functions is kept open over time, etc. Indeed the list of precautions is so long that one must argue that the foregoing framework should only be used in conjunction with other environmental management principles. This is illustrated in Figure 3.1 where the

strategy selected through economic optimization is compared with ecological principles and social objectives of development before adoption.

Economic criteria for optimization suggest that management should respond to changes in market forces, pushing ecosystems one way and then another to whatever extent maximizes their value as prices change. The functions of environmental systems, however, have evolved over millenia. Management, beyond protecting the functions from external forces, inevitably entails pushing the environmental system in a direction favorable to the production of goods and services desired by people. Even small 'pushes' inevitably modify the functions, while larger pushes eventually result in the loss of some functions. Every management change toward a different mix of environmental goods and services, furthermore, results in additional losses. The losses may be irreversible or, if reversible, very expensive to reverse. This means that there is a strong case for sustained, multiple use, for pushing the environmental system a little bit, and steadily, in several directions to obtain multiple products and services while avoiding large or frequent changes and the costs of replacing services in the future. Other arguments which combine economic and ecological reasoning for development decisions affecting the use of complex systems are presented in Norgaard and Dixon (1984).

Section 4. Major Coastal Eco-Systems

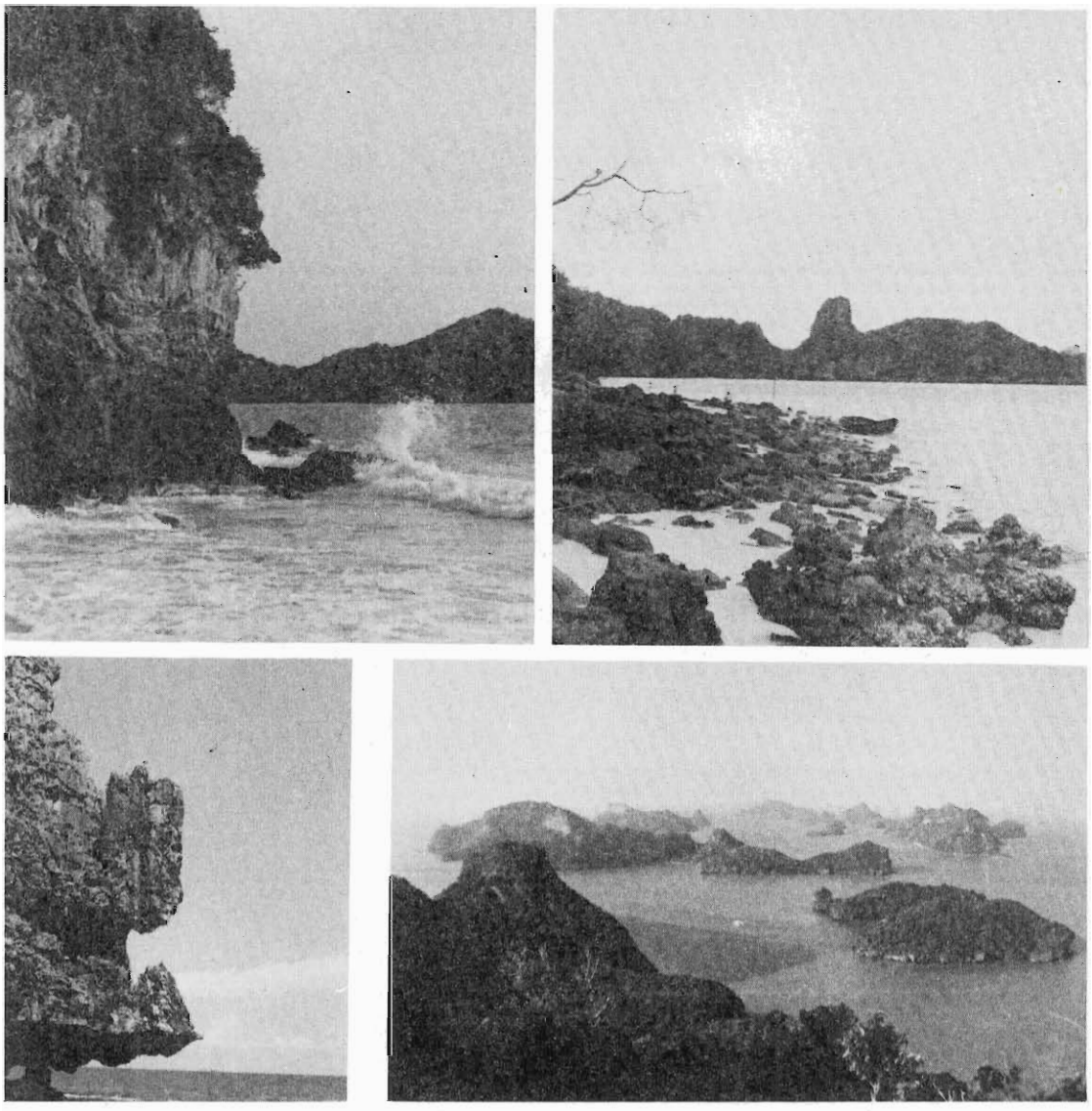
Introduction

The coastal zone has great development potential but its planning and management must be based above all on a consideration of whether or not development proposals are sustainable on a long-term basis. If sustainable development is to be achieved then it is essential that a multiple resource use strategy is adopted where possible. Non-use of course should also be considered as one alternative as in some cases it may be the best option.

Islands

Islands are created by geologic processes - by changes in the sea level or the eruption of volcanoes. For many small islands, such as those found in Thai waters, the entire area of the island can be considered to be the coastal zone. Thus the planning and management of these is of crucial significance for coastal resources.

When discussing the island ecosystem three major features must be taken into account. Their degree of geographic isolation, their size and their age. These features are very important from a bioecological point of view as they determine the number of species that can reach the island, the population size, and the age of the climax communities found on the island. Moreover it is well-known that islands are particularly vulnerable to natural phenomena such as typhoons, subsidence etc. and coastal management and planning efforts should give careful consideration to the likliehood of their occurrence.



Ang-Thong National Marine Park, Surat Thani Province

Functions

- Seabird nesting area
- Nesting populations of sea turtles and to a lesser extent for rare seals and other marine mammals
- Serve as gathering places for fish

Major management factors

- To establish upper limits for their permanent human populations where possible and for tourists
- To intergrate protected habitats into the economy of the islander so that islanders have a vested interest in protecting and conserving them

Major uses

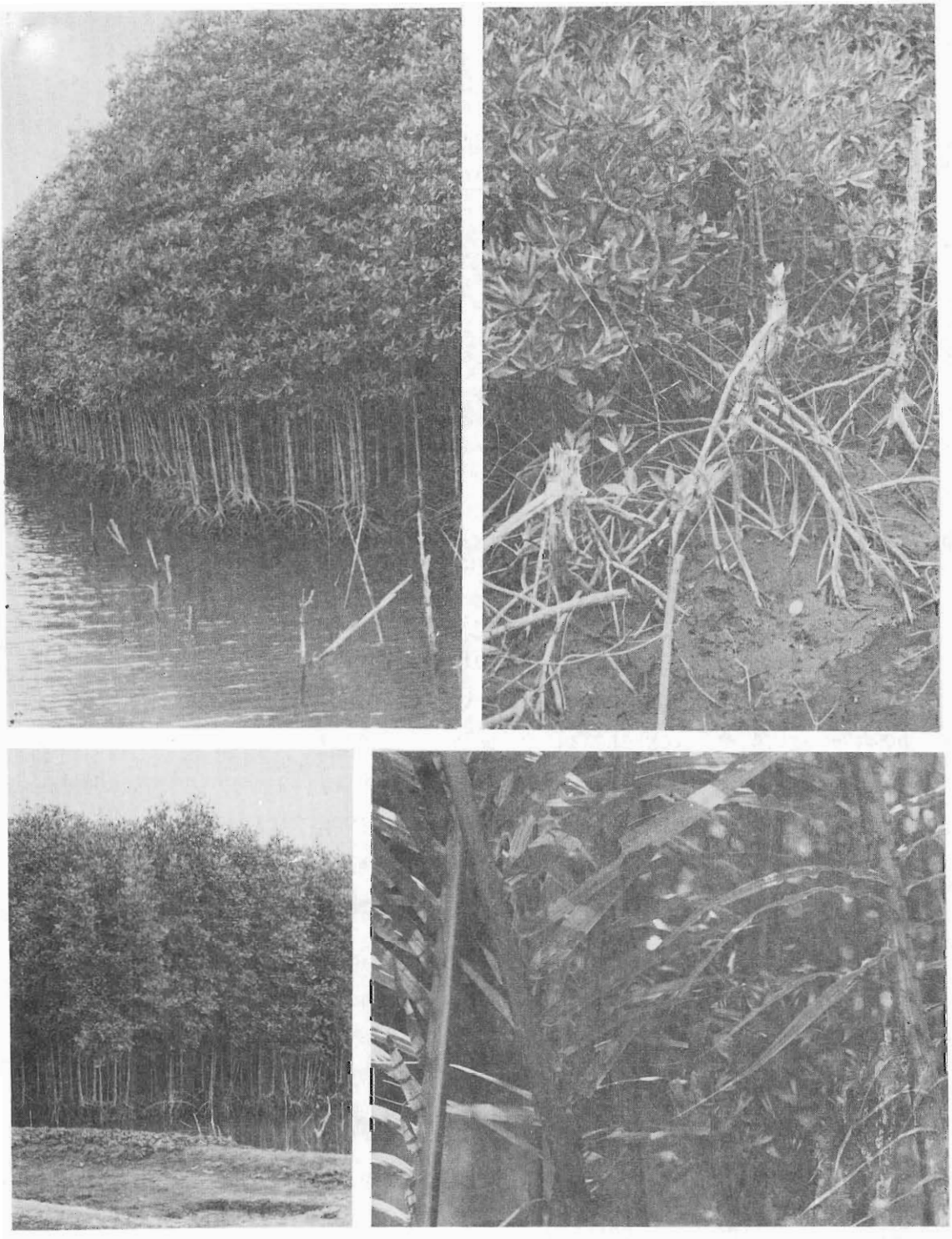
- Recreation and tourism
- Widlife sanctuary
- Protecting some marine and coastal species, such as turtle

Conflicts in use

- Tourism/wildlife sanctuary

Sustainable multiple use opportunities

- Wildlife sanctuary, turtle islands and national park



Mangrove Forest

- Tourism and recreation (not-intense) and national park (on other part of island)

Management measures required to foster/promote sustainable multiple use

- Education and interpretation
- Monitoring
- Access to the island
- Zoning

Mangroves

Mangroves are salt tolerant forest ecosystems of the tropical and subtropical intertidal regions of the world. They are complex and fragile ecosystems composed of many varieties of plants and various kinds of both aquatic and terrestial animals. The structural characteristics of mangroves vary from place to place or country to country depending upon geographic conditions, soil and water properties, topographic relief and climate condition. Mangrove forest has many species and families which are normally species of Rhizophora associated with other trees and shrubs.

Function

- Important for energy and food source
- Wildlife sanctuary
- Protecting coastal lines
- Erosion control

- Wastewater cleanup
- Barrier against tidal bores and cyclone

Major management factors

- Freshwater discharge dilutes seawater, salinity level is a principle determinant of type and abundance of species.
- Tidal range is the most important factor to mangrove forest because salinity will be intergraded in zones which effect the mangrove's growth.
- The pollution in coastal areas resulting from industrial waste discharge, municipal sewage release, agricultural waste, sedimentation and oil dispersion effect mangroves and aquatic living resource.
- Coastal mangrove forests are a significant source of wood and wood products for both domestic and commercial uses. Mangrove forest products are a major subsistence source of construction materials and fuel for coastal populations.

Major uses of mangrove system

- Wood products
- Fuel
- Construction
- Wild fry supply
- Textiles and leather
- Food, drugs and beverages See Appendix 3 for a more complete list

Conflicts in use

- Tin mining in mangrove

Sustainable multiple use opportunities

- Wood products, wild fry supply, tannin

Management measures required to foster/promote sustainable multiple use

- Control shrimp pond, strip timber use and etc. by regulation and law
- Maintain the topography and character of the forest substrate and water channels
- Maintain the natural temporal and spatial patterns of surface and groundwater salinity
- Perpetuate the natural pattern and cycles of tidal activity and freshwater runoff
- Maintain the natural equilibrium between accretion, erosion, and sedimentation

Tidal Flats and Seagrass Beds

Tidal flats are the landforms created by energetic tides. The fluctuation of low and high tides denude the shallow sea floor. Tidal flats are exposed at low tide and submerged with high tide. Littoral currents spread the laden sediment in the estuarine environment along the shore and it settles out in less turbulent water to form mudflats, etc. Tidal ebb and flow, which might be thought to be comparable to a river that symmetrically reverses direction regularly

actually causes a net shoreward transfer of mud. During the slack-water intervals when each tide reverses, mud begins to settle. Mud on the shoreward, shallow edge of the flood tide reaches the bottom and coheres, resisting current erosion on the ebb, or outward, tide. However, at the end of the ebb cycle, mud that moves seaward and settles an equal distance has not yet reached the bottom, so it is carried shoreward again by the next flood tide. This tendency to move mud into shallow, quiet water, while waves stir and winnow all the mud out of the surf zone, explains why beaches of clean, well sorted sand are so-commonly backed by intertidal mud flats, or mud lagoons.

Seagrasses are halophytic plants that occur in the shallow water of temperate and tropical waters. They provide substrates consisting of leaves and leaf detritus to fish, shrimps, crabs and other benthic animals. Seagrass communities are also noted for their ability to trap and bind sediments which militate against the erosion of the shallow sediments. The abundance of seagrasses on the shallow gradual sloping continental shelf are known as seagrass beds.

Functions

- Coastal stabilization
- Barrier to wave currents
- Disposal and deposition grounds
- Nursery ground for larvae and juveniles
- Sanctuary grounds
- A major habitat and food resource for nearshore fish, marine reptiles and mammals
- Breakdown or organic matter and soluble nutrients
- Spawning areas

Major management factors

- Amount of sediments from laden water should be enough to sustain fertility of tidal flat and sea-grass beds
- Organic and inorganic nutrients should be suitable to habitats
- Cleaning the waste products by flushing water
- Control of the disposal of pollutant and toxic compounds at a safe level for organisms.
- Control of dredging to minimize siltation and turbidity

Major uses

- Fishing grounds
- Transport routes
- Nursery grounds
- Mariculture ground for oyster, clam, mussels, cockle, pearl
- Pen and cage fish farming
- Tourist resorts, aesthetic value
- Green manure
- Chemicals
- Fodder

Conflicts in uses

- Transport routes/mariculture
- Green manure, chemicals, fodder/fishing ground/nursery ground

Sustainable multiple use opportunities

- fishing ground/tourist resorts/mariculture
- green manure/chemical/fodder/transport route

Management measures required to forter/promote sustainable multiple uses

- Dredging should be away from seagrass bed to ensure that siltation does not spoil the area, silt barrier and circulation of tidal currents should be emphasized and studied
- Engineering works should be designed to minimize either erosion or deposition in nearby seagrass beds
- Prevent the wastes from industrial effluents, high-temperature water discharges, bilge water from reaching tidal flats and seagrass beds
- Dumping of dredge spoil on tidal flats should be prohibited
- Mesh size of nets should be regulated
- Bottom trawling should be prohibited
- Shipping routes should be located away from seagrass beds
- Diversion of upstream water inland should ensure that the amount of flushing water is sufficient to sustain the coastal salinity regime
- Oil spill contingency plan should be created to prevent or manage accidental hazard

Estuaries and Deltas

Estuaries are part of the coastal area where the riverine and

marine waters meet together at the mouth of the rivers where the freshwater discharges to the open sea. The piling up of carried sediments at the mouth of the river creates deltas of various sizes and shapes according to the amount of silt-borne discharges accompanied with the magnitude of alongshore currents. Deltas are highly productive and fertile soils have been very attractive for human settlements since prehistoric periods. Fishing in estuari... environments is popular and easy so over-harvesting in these areas are very common, especially when there is a lack of appropriate control and management.

Major Functions of Estuaries and Deltas

- Spawning, nursery and feeding grounds
- Transportation arteries
- Transports nutrients, propels plankton
- Cleanses the system of pollutants by flushing away the waste products
- Controls salinity
- Shifts sediments, creates mudflats
- Barriers to wind and wave actions
- Sites of mangrove, marsh and seagrass beds

Major management factors

- Freshwater discharges

  Salinity, the vital factor to the ecosystems of living habitats, is controlled by freshwater from watershed areas. Riverine water not only dilutes the salinity but also supplies nutrients and sediments to the estuarine ecosystems.

- Tidal range

  Tides create energy to the ecosystems e.g. the intrusion of seawater upstream inland enhances the complete life-cycle of young fry. Low tide exposes the mudflats to the sunlight and thus enhances the growth of benthic algae which is the food of benthic animals.

- Waste-disposal control

  Wastes from urban settlements and industries can damage ecosystems. Pollution causes pervasive and continuous degradation, evidenced by the gradual disappearance of fish or the decline in the carrying capacity of the system. The contaminants in the form of chemicals or organic wastes create a hostile environment that drives away fish, prevents reproduction, or undermines the food chain.

Major uses

- Human settlements
- Fishing grounds
- Mariculture
- Transportation routes
- Industrial sites, ports and harbors
- Tourist resorts
- Value for scientific research
- Agricultural production
- Salt production
- Aesthetic and recreational value of the natural landscape

Conflicts in use

Many alternatives itemized above have some conflicts in use such as :

- Industrial factory with mariculture
- Ports and harbors with mariculture
- Salt pan with agriculture

Sustainable multiple use opportunities

- Industries with harbour and ports
- Fishing ground with mariculture
- Tourist resorts with fishing ground and mariculture
- Salt pan with mariculture

Management measures required to foster/promote sustainable multiple uses

- Reduce the waste products from urban settlements and industries to control the effluents that are released into estuarine water by special treatment and regulation. Also, wastes can be piped offshore and safely diffused into deeper ocean waters. Both remedies are expensive and may therefore require considerable sacrifice; but in most cases the cost can be justified on a long-term basis
- Avoid locating chemical plants with irremediable toxic discharges on estuaries. Otherwise require extensive treatment facilities
- Avoid blockage of water circulation. Structures should be located away from critical points in estuaries where

important current flow could be affected, or if structures must be located in these locations, they should be elevated on piles, instead of built on solid fill

- Select location for the removal and deposit of dredged material to avoid adverse effects on vital habitats. The season when dredges are allowed to operate should be controlled to reduce the spillover of dredged materials during biologically productive cycles
- Enforce and restrict the open water release of ship oils, bilge waters, and sewage wastes near coastal ecosystems
- Activities in recreational or visitor destination areas near or within sensitive coastal habitats should be regulated to prevent disturbance to sensitive species

Beaches

Beaches consist of accumulated, unconsolidated sediments transported to shore and moulded into characteristic forms by wave-generated water motion. Beaches are located between the lowest seaward tide level and the inland limit of the average highest storm waves, exclusive of catastrophic storm events. The landward limit is usually defined by a coastal cliff, a foredune ridge, or, by some physical man-made structure. The unconsolidated sediments range in size from rock fragments to fine-grained sands and mud. The general composition of beach materials tends to vary with latitude, but the processes that create and maintain beaches throughout the world are similar.

Beaches are not stable entities, but rather are dynamic landforms that are constantly subjected to erosion and/or accretion. The changes on a beach are responses to processes acting from outside ~~the~~ beach itself. These include offshore shoals and currents as well as inland dune systems which effect the beaches' erosional and depositional

cycles. Differences in beach form (or type) and position reflect the local balance or imbalance between deposition and erosion. It is found that erosional forces tend to dominate the accretional forces.

Functions

- Beaches act as a border of the coastline
- Habitats for unusual plants and animals
- Provide the energy base to support the beach's diverse populations of deposit and filter-feeding consumers
- At highest level of food web, beaches serve as energy sources for many species of coastal birds and fish

Major management factors

- A flat to moderately sloping, nearshore coastal shelf
- Having a source of unconsolidated material
- Force (tides and waves) a mechanism to replenish the beach and maintain beach profile
- Wave climate (seasonal frequency, amplitude, and wave length, or distance between two successive waves)

Major uses

- Beach sand serves as a major source of construction aggregrate
- Mining of place deposits : minerals, heavy metals
- Tourist attraction
- Construction of ports, wharfs or piers over the beaches

- Spawning ground for turtles
- Habitats for many plants and animals
- Source of food for humans

Conflicts in use

- Overexploitation by sand mining (for construction)
- Construction of ports over the beach decrease the aesthetic value of beaches
- Activities which affect the source and transport of beach-building materials accelerate the erosional balance. Factors which promote beach erosion are :

  1) river dams, barrages, and diversions that either trap sedimentary materials, thus preventing their entry into the coastal zone, or reduce the river water's transport power

  2) poorly designed coastal engineering works that alter longshore currents or wave forces and lead to undesirable erosion and deposition patterns

  3) coastal dredging and dune mining projects that remove beach-building materials from the longshore transport processes

Sustainable multiple use opportunities

- Tourism/human settlement/agriculture
- Spawning ground/source of food for humans
- Tourism/spawning ground/food

Management measures required to foster/promote sustainable multiple use

- Site specific studies may be required at many localities to assure wise planning decisions
- Develop a setback line before construction begins
- Where a major obstruction to longshore sand transport is built, allow for an adequate sand - bypassing system
- Use soft solution rather than hard solution to solve beach erosion problems i.e. nature-synchronous techniques
- maintain a prominent foredune ridge
- Don't mine the sand from dune, beach, or nearshore if it is valuable for tourism, recreation, or wildlife habitat
- If storm alters the beach, let the normal beach cycle return the sand

Coral Reef

Coral reefs are some of the world's most complex and productive marine ecosystems, occuring along shallow tropical coastlines, continental shelf areas and islands where the waters are oxygenated, clear and warm, and free from suspended sediments, excessive freshwater runoff, and pollutants. Corals are colonies of small animals, and each living unit of the hermatypic corals (reef-building corals) contains algal populations within its own tissues which are capable of photosynthesis, thus providing an energy source for both the coral and the algae. The actual reef consists of a large and rigid structural mass of calcium carbonate formed by hermatypic corals, which themselves have relatively slow growth rates ranging between one-tenth and ten centimeters per year in length. The large and diverse animal populations associated with the reef are supported both by the net primary production occurring on the reef

and by the organic materials (including plankton) that are continually brought to the reef by marine currents.

Functions

- Supports and maintains large animal biomass (estimated between 490 and 1,450 kilograms/hectare)
- Provides the habitat for a large number of sessile and mobile organisms for breeding, spawning, nursery, feeding, foraging and preying
- Filters the waters that circulate over and within a coral reef (maintains quality of coastal water)
- Acts as a shock absorber to weaken wave forces, thus minimizing erosion and coastal hazards behind the reef, protects land, islands and beaches
- Repairs its own reef structure
- Produces white sand for beaches and small islands

Major management factors

- Tidal range. The occurrences of the low tide for many hours causes some parts of the reef to be exposed to the air and heat from sunlight. This will destroy some sensitive corals
- Excessive freshwater inflows reduce the salinity
- Waterborne sediments interfere with filter mechanisms of reef organisms
- Temperature extremes may be beyond the thermal limits of the coral
- Pollutants e.g. agricultural biocide, may enter local waters

- Breakage caused by cyclonic storms, boat anchors, reef fishing gear, explosives used in illegal fishing practices
- Excessive nutrient loading stimulates the excessive growth of algae which covers and kills the coral organisms. The bloom of phytoplankton can shade the reef and reduce the rate of photosynthesis
- Overharvesting of coral for souvenirs, ornaments, other products (e.g. drugs, fertilizers, cosmetics), building material

Major uses

Two types of uses of coral reef are

a. Extractive uses

- Source of food. Marine fishery supported by the reef system are estimated to be as high as five tons/square kilometer
- Building materials (coral mining)
- Coral harvesting for precious or semi-precious jewel value and aesthetic appearance of interest to tourists
- Collecting of aquarium fish

b. Non-extractive uses

- Aesthetic value (Recreation purpose) - tourism
- Shelters harbours and acts as a breakwater for shore protection
- Scientific reserve for education

Conflicts in use

- Mining of coral reduces its ability to act as a buffer (or shock absorber) to stormwaves which can result in increased coastal erosion and hazards
- Mismanagement of upland areas create high rates of erosion which increase sediments on the coral reef
- Siltation and sedimentation created by mining, dredging, filling and related construction activities
- Discharge of large volumes of fresh water as may result from river diversion, domestic sewer outfall, and storm-water runoff including pollutants, spilled oil, industrial wastewater and domestic sewage which degrade the water quality
- Destructive fishing :- use of explosives, poisons and non selective traps
- Over-exploitation of selected coral species for tourist market such as for ornaments or semiprecious jewelry
- Collection of exotic species for sale in the marine aquarium market
- Tourist visits to reef system can result in breakage from boat anchors and souvenir collection

Sustainable multiple use opportunities

- Tourism/shoreline protection
- Coral mining/fertilizer/pharmaceuticals/collecting some fish
- Tourism/food production

Management measures required to foster/promote sustainable multiple use

- Seek alternative sources of construction aggregrate and calcium carbonate (for lime and cement) to relieve pressures on coral reef
- Do not undertake dredging or other activities that disturb the sediments and create silty water near or upstream from coral reefs. If possible, sediment containment (pipes, settling ponds, curtains) should be applied to take sediment away from reef. Initiate monitoring program to regulate mining activities to acceptable water - quality standards
- Avoid introduction of pollutants and excessive nutrients into the reef environment. Proper siting of industries including sewage outfalls, storm water drain away from influence of coral reef areas. Possible mitigation measures include treatment settling and cooling ponds, and disposal in areas seaward of the reef.
- Stop the use of explosives and poisons to harvest reef fish
- Set maximum limits on the annual harvesting of reef materials and associated fish and shellfish species - to maximum sustainable yield
- Promote and control tourism on the basis that coral reefs are valuable national assets. Control anchoring places and collection of souvenirs
- Avoid alteration of the natural salinity. Control disposal or brine waste and drainage of salt pond/excess fresh water discharge
- Avoid alteration of water temperatures such as by heated discharge water from industrial plants. Use cooling ponds
- Set sustainable maximum limits for seasonal coral reef harvesting

- The badly damaged or dead reefs areas can be used for coral mining by small-scale operators
- Enforcement by means of strict laws and regulations
- Proclaim any significant coral reef area to be a marine national park

Section 5. Management Guidelines

General Introduction

This section offers guidance for managing development activities in the coastal zone. Management advice specific to each type of development is given in each sub-section. The following general advice, taken from Snedaker and Getter 1985, in the form of questions to be asked before preceeding with development activities should also prove useful :

1) Do the plans and studies for the development activities recognize potential effects upon coastal renewable resources and provide measures for their protection ?

2) If the development activity is in an upland watershed, is due consideration given to the effects upon downstream coastal resources caused by alterations in river flow or water quality ?

3) Is consideration given to maintaining the physical condition of the land/sea transition as well as to identifying and protecting critical ecological areas, such as wetlands, seagrass beds, fish/shellfish nursery areas, etc. ?

4) Are suitable precautions taken to avoid the discharge of pollutants and excessive nutrients into coastal waters, such as industrial wastes and municipal sewage ?

5) Is sufficient attention given to maintaining the following :

   - Ambient-water salinities
   - Ambient-water temperatures
   - Natural patterns of tides and water circulation
   - Natural patterns of freshwater inflow
   - Existing clarity and transparency of water

Agriculture

Introduction

Coastal areas are attractive for two types of agricultural activities on both the lowlands and uplands. Rice is the preferred crop in the lowland area because it can tolerate flooding and waterlogging and has a moderate salinity tolerance. Lowland agriculture crops are grown mostly in the coastal areas and estuaries just behind salt ponds and shrimp ponds. They usually are salt tolerant species. In these areas, the trees are grown on a raised base with broad field ditches in between. Upland agricultural activities include orchard fruit trees, vegetable, para-rubber and industrial crops.

Problems

1. The conversion of coastal land for agricultural use interrupts the flow of surface water necessary for the health of surrounding resource systems. Furthermore there is a low probability of success in converting coastal sediments into agricultural soil due to the danger of flooding and salt intrusion. Other problems associated with agricultural uses on former mangrove land are : acid sulfate soils; metals previously concentrated in mangrove sediments are released and may reach toxic levels which could be detrimental to agricultural production, disease, and insect damage.
2. Upland Agriculture-the withdrawal or diversion of fresh water for agricultural uses directly reduces these critical inputs to the coastal zone and can lead to problems such as a decline in fisheries production or increased salinization downstream. The increased fresh water flow associated with stream canalization can alter the hydrologic regime

in the coast, decrease salinities and degrade salinity sensitive ecosystems.

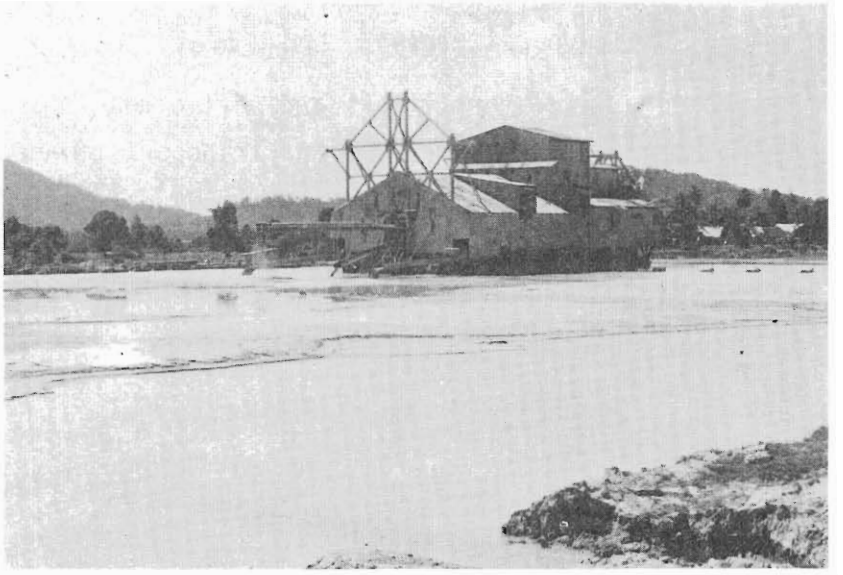
3. Other problems associated with agriculture in the upland area concerns the effect of agricultural biocides which are transported down to coastal ecosystems. These enter into marine food webs and can ultimately pose a danger for humans who eat food organisms from the affected area. Moreover soil loosened by cultivation or exposed while fallow generally erodes and can cause alterations or loss of habitat for some sediment sensitive organisms such as coral reefs. Sedimentation is also caused by deforestation, over-grazing and farming on hillsides which are too steep.

Guidelines

The demand for new agricultural land is likely to continue to increase into the future and coastal areas will be the focus of attempts at land reclamation for agriculture development.

1. Salt tolerant plant varieties should be developed
2. Water and drainage control measures should have four basic functions
   - flood control
   - saline water intrusion control
   - water table control
   - water pollution control
3. Avoid reclamation of important coastal habitats for dry land agricultural development
4. Promote only compatible wetland-dependent agriculture, such as rice or taro production, in important coastal wetland habitats

5. Plan upland farm layouts to minimize the alteration of natural drainage patterns
6. Apply and utilize fertilizers and pesticides in a manner that will minimize their loss and transport toward coastal areas
7. Do not develop acid sulfate soil areas and leave them with mangrove vegetation
8. Consider only soils above the mean sea level for agriculture to avoid salinity and acidity problems
9. Construct bunds, embankments and polders to an elevation which will protect the agricultural uses from tidal inundation during the major storms. Use meteorological data and tidal records to determine the frequency and maximum flood levels
10. Construct all drainage channels to facilitate the leaching of acids and salts from the agricultural fields and prevent formation of stagnant water or the intrusion of salt water
11. Promote good management of irrigation system : freshwater flows are capable of sustaining the agricultural crops and preventing the seepage of saline waters into the agricultural soils and must be maintained to prevent intrusion into groundwater supplies, agricultural soils, and irrigation waters
12. Whenever feasible, utilize nonpersistent biocides
13. Evaluation of the benefits of natural mangrove forest or other coastal resources and trade-off analysis should precede issuance of any permit or approval for conversion of coastal areas to agriculture



Tin Mining in the coastal zone at Phangnga Province

1 1. Bucket dredge

2 2. Tin mining in the mangrove area

Mining

1) Tin Mining

2) Sand Mining

1) Tin Mining

Introduction

Tin is one of the main economic minerals of Thailand. In 1982 233,055.77 metric tons were produced or valued at 211,010,758.41 Baht. Most mines are in the South and many tin mines are operated both on land and on the continental shelf.

Historically, the extent of tin mining in Thailand rose from about 4,000 tons/year around 1,900 to 300,000 tons/year at present, but it appears most of the richer and more accessible land deposits have been or are being exploited. Thus if the current level of production is to be maintained it will be necessary to exploit the less-rewarding land deposits and to develop offshore dredging to a higher level.

Method

Tin mining practices in Thailand are in two main groups, onshore and offshore mining.

1. Onshore Mining

   Onshore mining is done by two main methods : by use of dredge and by gravel pumps. Other methods such as hydraulicing and sluicing make up a small portion of total mining operations. In many ways the gravel pump is complementary to that of the dredging in that the ground volume required by gravel pump for economical operation is less than a tenth of that necessary for a dredging unit.

2. Offshore Mining

   Offshore mining normally utilizes relatively large-scale equipment comprising a dredge mounted on a floating

platform equipped with sophisticated gear as appropriate to withstand the adverse effects of marine operation including rough seas and corrosion. In offshore mining generally the area mined extends from the depth of about 1-25 m. or about 1-6 km. from shore.

Problems

1. Turbidity is the major problem from mechanical dredging and can have a serious adverse impact on coastal ecosystems. Onshore mining has been characterized by little attention to losses of silt, especially by the smaller gravel pump operator, nor does it appear that regulatory officials have been particularly concerned.
2. Offshore mining produces very adverse effects on the environment although these are far less visible or apparent. The damage consists literally of the complete destruction of the existing marine ecology in the dredged areas, discoloration of the offshore waters, and deposition of silts or mud on the sea bottom including deposition on beach area.

Guidelines

1. Offshore mining should be at sites of sufficiently deep water and distance from shore to prevent coastal impact.
2. A monitoring program should be developed adhering to predetermined environmental quality standards.
3. Once site selection has been completed, mining activities should be preceded by a baseline study of the locality.
4. If warranted, environmental assessments should be completed after final cessation of tin mining operations.
5. Open water slurry discharge should be prohibited and allowed only in confined upland basins.

2) .Sand Mining

Introduction

Mineral sands consist of minerals and quartz sands. The difference in weight plays a major role in the concentration of heavy mineral materials in certain locations due to the natural deposition and erosion processes which act on coastal areas. The greater weight of the heavy minerals also assists in their extraction during the mining and processing of sand deposits. Mineral sands originate from the weathering of upland rocks which produces quartz sands and their associated minerals.

Method

The mining of mineral sands involves three basic steps : (1) excavation of the mineral sand, (2) the separation of the minerals from the quartz sand and (3) the disposal of the quartz sand. Two basic techniques are used in the more technologically advanced mining operations. The first is "dry mining" where mechanical devices are used to dig the sand and to convey it to the point where the sand and minerals are separated. The second form of extraction uses a suction dredger.

Problems

1. Sediments released to the sea
2. Erosion of beaches
3. Loss or decrease of the asthetic value of the beach
4. The dredging of mineral or coral sands adjacent to coral reefs can also have an impact upon the plants and animals in the reef community

Guidelines

1. Reduce the impact of dredging to coastal zone ecosystem
2. Controls might be to prohibit the dredging within 100

meters of the reef when tides are rising or during periods of onshore current flow

3. The dredging of coral sand from reef flat areas might also be controlled through regulations based upon either the percentage of the reef flat that may be dredged per month/year and/or distances from the living coral fringe

4. Discourage sand mining from beaches

Energy

1) Oil and Gas Operation

2) Coastal Power Generation

1) Oil and Gas Operation

Introduction

As shipping is steadily increasing or will increase in both the Gulf of Thailand and the Andaman Sea it is likely that the problem of pollution of coastal waters and land will likewise increase.

Although the primary hazard is due to spills of oil and petroleum products from tankers both while at sea (i.e. due to accidents) and while loading and unloading in ports, significant spills can be expected from virtually all types of ships due to uncontrolled bilge oil discharges. Current developments along the Eastern Seaboard at Siracha, Laem Chabang, Sattahip and Map Ta Phut will most likely intensify the problems.

Problems

There are two main types of spillage which impact coastal resources, these are : acute spillage usually resulting from transportation accidents, offshore well blowouts or pipeline breaks; and chronic spillage associated with, shore-based refining and/or offloading operations. Damage may be sustained by :

- Mangroves
- Coral reefs
- Sand beaches and seashores important for tourism
- Seagrass beds
- Fishing resources
- Marine animals

Guidelines

1. As oil spillage from ships is the major cause of oil pollution in Thailand greater control of ships has to be exercised. This could take the form of fines against the ships releasing the oil and other measures to change the traditional habits and practices of ship officials
2. NEB should formulate and enforce control measures both for offshore ships and for local harbor operations
3. With the establishment of a permanent beach cleaning unit of Thailand, prompt cleanup action can be undertaken
4. A detailed fully authorized contingency plan should developed for potential spills in each harbor or other sensitive coastal areas subject to spills
5. All operations should avoid the discharge of oil and grease into the marine environment
6. Oil and gas operations and siting should maintain the integrity of the land/sea interface
7. Cleanup of oil on oiled beaches and other coastal areas should commence only after all oil has impacted the shore. Natural or manual methods are preferred
8. Evaluation and approval of offshore oil and gas development should include consideration of the direct and indirect ecological effect of onshore support facilities
9. Exploratory drilling and production should be designed and monitored to avoid blowout and spills
10. The quality of production water discharges should be sufficient to protect coastal water quality and ecosystems.
11. Postoperational ecological evaluation of offshore oil and gas sites, including the disposition of platforms and other restorative work should be required

2) Coastal Power Generation

Introduction

Electric power-generation plants are often located in the coastal zone because of the large volume of cooling water that is required. The hot water from the plant is discharged into the nearshore water to an area distant from the intake area in order to prevent recirculation.

Problems

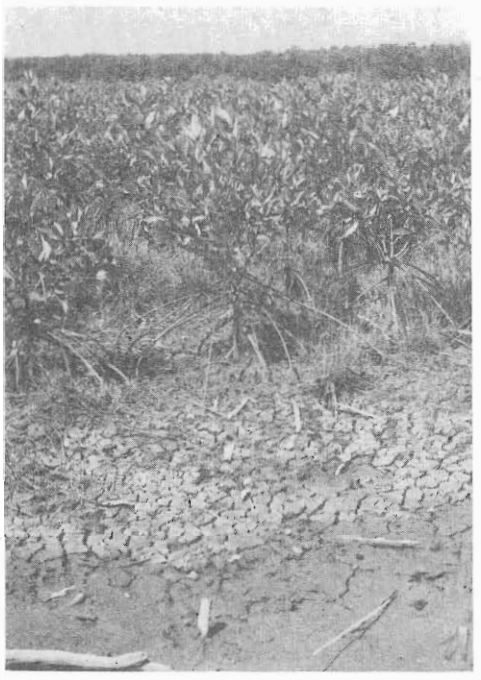
1. Chronic problems include the death of marine animals that is associated with the intake water and the discharge of heated water
2. Accident problems include the spillage or dumping of fuels; the overheating of cooling water; and reactor accidents
3. In warm-water environments, this rise in temperature is higher than the thermal tolerance limit for some marine plants and animals
4. The reactive chlorine that remains in the discharge water causes the death of the smaller organisms resident in the receiving waters

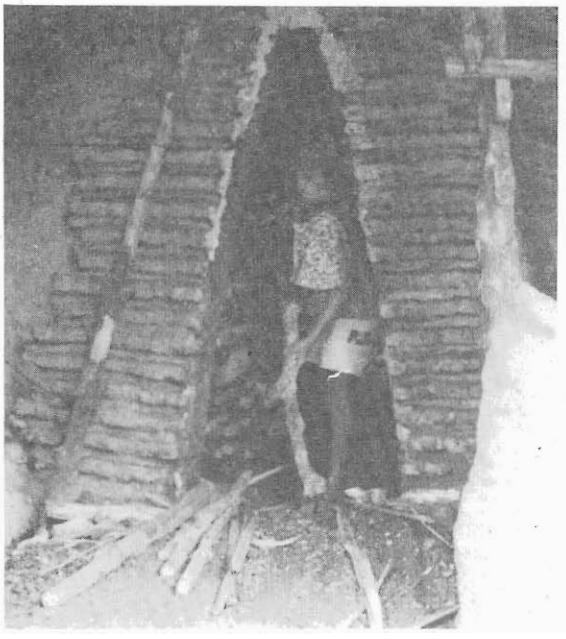
Guidelines

The major factor associated with minimizing the impact of power plants on a coastal environment is their location in relation to ecologically critical areas. The guidelines are considered to be the minimal requirements for maintenance and perpetuation of coastal ecosystems which are located near, and receive effluent from, power plants.

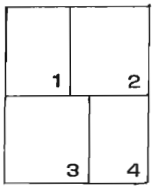
1. Power plants should only be located in estuaries and lagoons if they are designed for closed-cycle cooling
2. Coastal power plants should be sited so as not to jeopordize ecologically critical areas
3. Power plant designers should concentrate on techniques that reduce the incidence of marine-life deaths caused by entrapment, screening and entrainment

4. All operations should avoid the discharge of toxic substances into coastal waters, especially where they enter the food chain and could eventually be consumed by man
5. Locate outfalls for thermal effuents in deeper, open offshore coastal waters to ensure rapid dilution and to prevent buoyant thermal effluent plumes from impinging on the bottom
6. Whenever possible encourage the use of cooling ponds
7. Establish water temperature standards for heated effluents that do not exceed the upper lethal temperature limit for sensitive species





Charcoal production in the mangrove area :



1. Young mangrove after replanting
2. Wood waiting to be picked up for the kiln in the foreground and poles used for building in the background
3. The kiln being loaded
4. The finished product waiting to be picked up for delivery to Bangkok

Mangrove Forestry

Introduction

Because mangroves have been regarded as wastelands having little value they have often been converted to some other form of use considered to be of greater value. This approach fails to recognize the very important goods and services which are provided by the mangroves. For example mangroves provide the environmental services of storm protection, erosion control, wastewater clean-up as well as recreational and educational services. Apart from these a variety of goods are also provided such as fuel wood, construction materials, charcoal, dye, paper, etc. and crustaceans, molluscs and finfish are harvested there. See Appendix 3 for a fuller list.

Mangroves generally grow on seashores, estuaries, lagoons and at the high tide line along the tidal part of rivers. Distribution of mangrove can be divided into two main groups : Rhizophora is the dominant species which occupies the area along the edge of the forest and Nipa, Avincennia and Bruquiera which form a more distinct zone behind the band of Rhizophora.

Problems

1. Over-exploitation : Mangroves are threatened by traditional users exceeding the sustainable-yield limit in the harvest of direct products. Forestry departments often treat them only as a forestry resource and grant too many felling concessions. This conflicts with the role of the mangroves in providing other goods and services
2. Conversion. Activities such as aquaculture, fish ponds and residential development are often considered more valuable

and are increasingly taking the place of the mangrove forests

3. Both over-exploitation and conversion activities can have adverse socio-economic effects for coastal communities. Moreover many plant and animal species are now threatened with extinction in mangrove areas

Guidelines

1. Further destruction of mangroves should be prevented by halting all unjustifiable conversion activities
2. Traditional and contemporary human needs can be provided for while ensuring that the diversity of plant and animal life is protected within reserves
3. Mangroves should be managed as a renewable resource on a sustainable-use basis for direct and indirect products as well as the "free" environmental services they provide
4. Mangroves should be viewed as an integral part of the coastal zone not in isolation. Decisions concerning the use of mangroves should be made in the context of their dependence on the adjacent water catchment land use and on their important interrelationships with adjoining coastal waters
5. Impact assessments for projects in and adjacent to mangroves should be conducted on the basis of the dynamic nature of this ecosystem. Emphasis should be placed on the vital "external" processes related to the supply of both fresh and salt water, the supply of nutrients, and the stability of the substrate
6. The national mangrove data base and national plan should be regularly revised and updated

Urban Development

Introduction

Human settlements in Thailand have successive levels ranging from the primate city, Bangkok, urban growth centres, and secondary cities to towns and small coastal communities including districts (tambons) and villages (muban). People are attracted to the coast because of its many amenities but high density coastal communities have a tendency to destroy or degrade these amenities and disturb coastal ecosystems. The degree of disturbance is heightened by four main factors, namely : the increased density of development; the closer the proximity of the community to the water; extension and/or alteration of the shoreline; and the ecologic sensitivity of the shoreline. A proper assessment of environmental impacts of urban development must take into account the impact of all ancillary developments such as roads, drainage systems, sewerage, etc.

Problems

1. Nutrients in sewage wastewater can stimulate the growth of aquatic plants and can cause changes in the composition and abundance of estuarine and marine species
2. Human waste contains pathogens that can contaminate shellfish
3. Mangrove may be converted to building land
4. Building structures too close to the shoreline can cause erosion or block public access

Guidelines

1. Develop a setback line for coastal structures
2. Do not modify or destroy foredunes
3. Understand the normal beach system before altering it
4. Domestic sewage should be treated prior to discharge to minimize eutrophication and to control as far as possible the introduction of human pathogens
5. Locate human settlements away from mangrove areas

Waste Disposal and Disease Control

Introduction

Marine waters have long been considered to be convenient receptacles for the disposal of domestic, urban, and industrial wastes because of their capacity for dilution. This practice is particularly common in coastal areas due in part to the fact that large bodies of water exist nearby and alternative forms of waste treatment and disposal are not usually available. However the occurrence of certain components in discharge effluents, such as human pathogens and a variety of persistent toxic materials argues against disposal in marine waters. Organic waste from domestic and industrial sources can have the effect of depleting the oxygen in the receiving water and can result in fish kills.

Problems

The problem of pollution in Thailand has become more and more pronounced as the population increases and industrialization progresses. Thailand depends on the rich natural resources from the sea especially its fishery and mineral resources. Hence the impact from marine pollution will effect not only the future potential of fishing industry but also the economic and social well-being of the people as a whole.

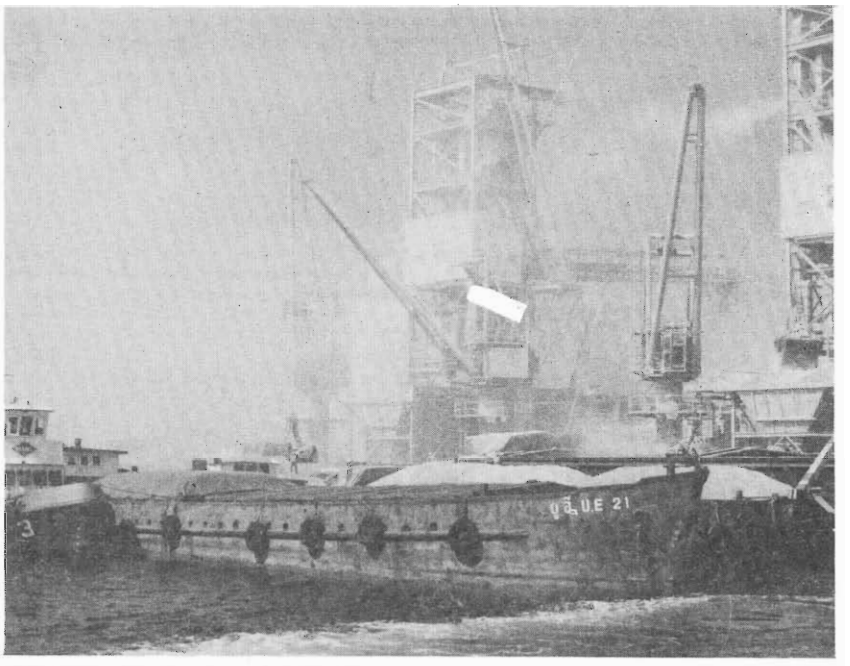
Pollution in the Gulf of Thailand is a great hazard, as evidenced by dramatically visible fish kills, and in the gradual accumulation of toxicants and other pollutants in estuary and other shallow marine waters which are the habitats not only for shellfish such as shrimps and clams but also are the reproduction areas for major finfish species of commercial fish. The decrease in the production of marine fisheries currently is in one way or another effected by water pollution.

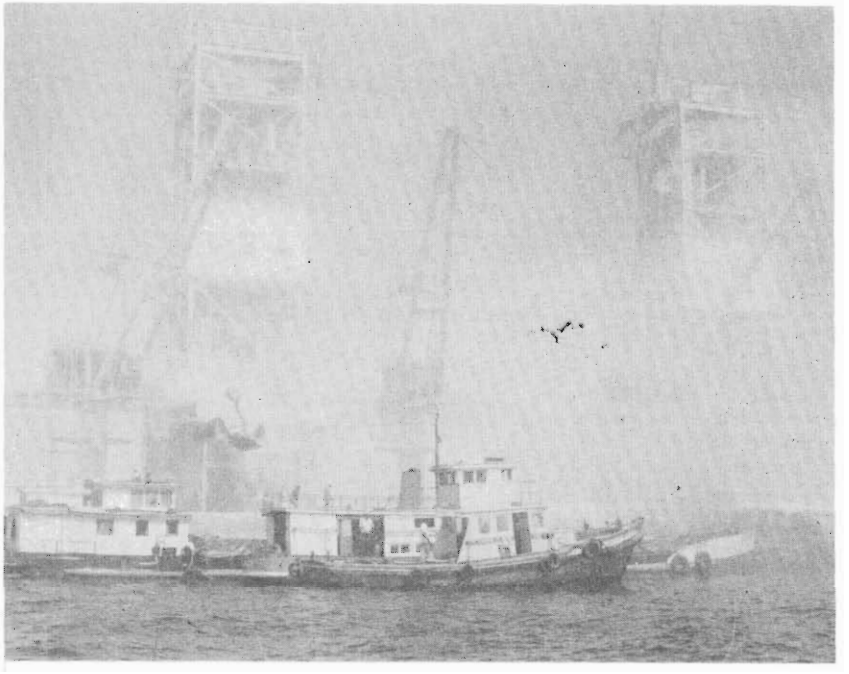
Although many human pathogens cannot survive in saline water, some find refuge in sediments and in marine organisms where they persist for relatively long periods. When present in marine animals that are consumed by man they can pose a distinct health hazard.

Guidelines

The use of natural systems for biological treatment has to be viewed with caution, but can also be one of the best and most viable options if properly designed and implemented.

1. Domestic waste should be treated prior to discharge to minimize the overfertilization of marine waters
2. Use of waste assimilation lagoons is a low-cost alternative for certain industrial liquid wastes
3. Contamination of ground water resources should be avoided, because of the potential for contamination of domestic water supplies
4. Deep-well injection of certain types of wastes is a viable alternative only where adequate technology exists to ensure that contaminants escape and secondary uptake does not occur
5. Sanitary landfills should not be located in marshes and other important coastal water habitats
6. Sanitary land fills should be located in upland areas of suitable water characteristics and soil permeability
7. The use of certain natural systems for waste assimilation and treatment is also a viable alternative but should be carefully designed and viewed with caution
8. Management of land fills should include plans for proper closure that will avoid impacts to coastal ecosystem





Some industries locate on the coast due to the convenience for bulk transportation. However they often have an adverse environmental impact as can be seen above in these scenes from the tapioca industry in Chonburi Province

Industry

1) Industrial siting

2) Salt Manufacture

1) Industrial Siting

Introduction

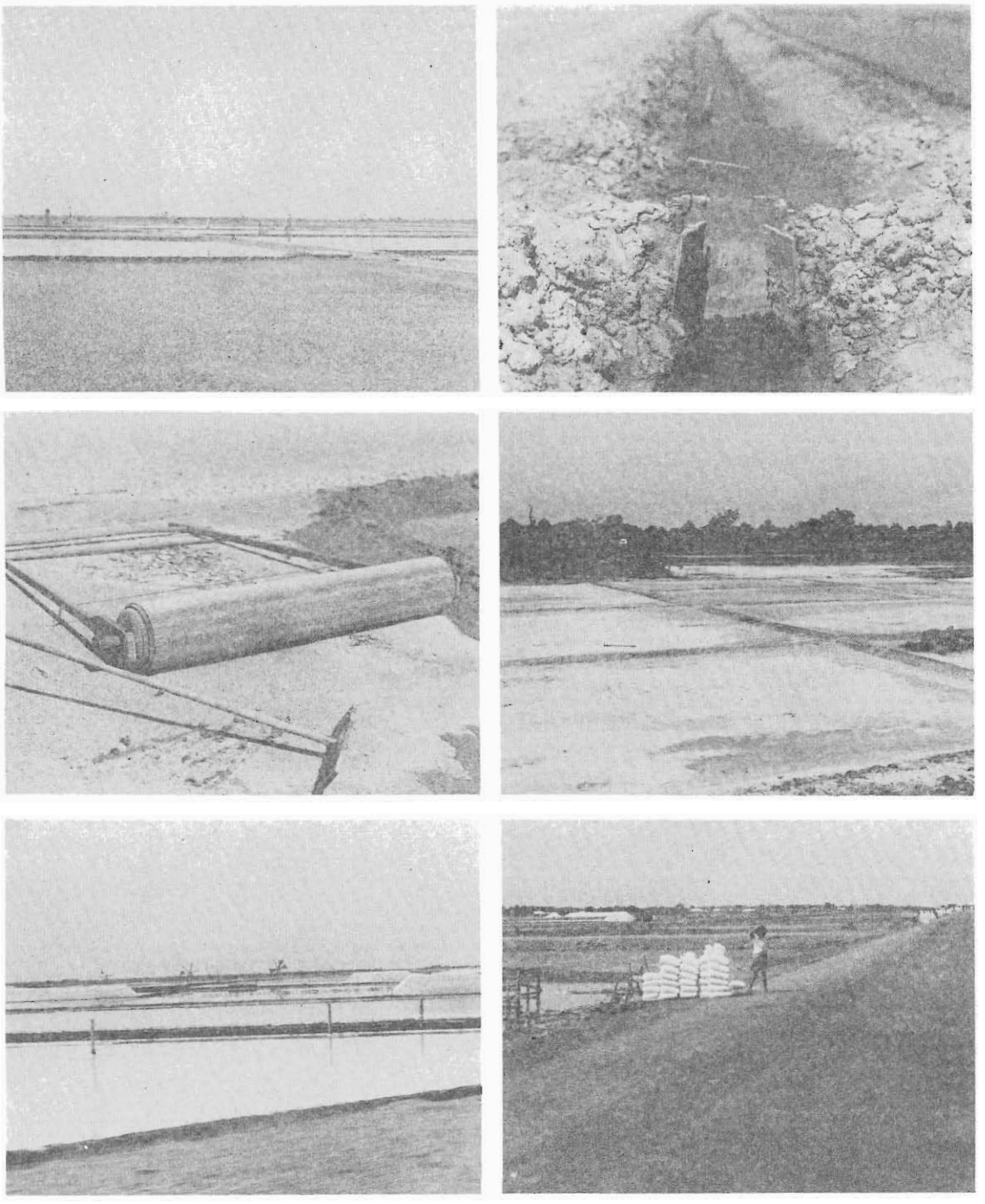
The coastal zone in Thailand is frequently considered to be the ideal location for industrial siting based on convenient access to both oceanic shipping and land-based transportation systems. As a result, many different types of industries are located close to ports and harbors for logistical and economic reasons. Many industrial plants require large quantities of water for cooling, washing the plants and diluting waste discharge.

Problem

Industrial siting in the coastal zone poses a number of problems that involve water not only directly as a vehicle for pollutant disposal, but also indirectly through the manner in which the plant site may alter natural surface-water. The water, after having been used for the aforementioned purposes, is disposed of in the nearshore environment. The primary problem with wastewater is the entrained contaminants that may have deleterious effect on coastal ecosystems. Wastewater from the plants may have toxic substances e.g. heavy metal, chlorine, oil etc. and could effect plant and animal communities in the coastal zone area and near vicinity. Large-scale release of warm-water into the sea may exceed the tolerance limits for many organisms.

Guidelines

1. Selection of industrial site should be based on ecodevelopment principle. Decision for industrial development should be made on the basis of economics and ecology.



Salt production by solar evaporation in former mangrove area :

1	2
3	4
5	6

1. A group of ponds separated by bunds
2. Typical gate used for allowing salt water into the ponds
3. Roller and rake used for preparing ground
4. Salt crystals after evaporation
5. Salt piled up waiting for collection
6. Salt being sold by the roadside in Samut Songkhram

2. The site plan for an industrial plant should provide for a wide buffer of natural land along the shoreline, except where water access requires piers and roads
3. Chosen site should be the one containing the least sensitive or valuable habitats
4. Industrial plant with high pollution discharge should not be located at the coastal zone
5. In the design phase, prior to construction, attention should be given to the natural patterns of surface-water flow and tidal inundation
6. A waste disposal system for the industrial site should be constructed
7. The production of heated water by some industries is inevitable, but its ultimate fate can be engineered to reduce environmental impact and to realize economic gain

2) Salt Manufacture

Introduction

Salt (sodium chloride) is a required component in man's diet and has a variety of other applications including its use as a preservative and as a supplement in the feeding of domestic animals.

The total area coverage by salt pan is 119,000 rai in Thailand. Half of this is in the tidal flat of Samut Sakorn, Samut Songkarm, and Petchaburi and the rest is scattered over Samut Prakarn, Chonburi, Rayong and Chachoengsao. Most salt pans are constructed on poorly drained soil comprising of a series of ponds each surrounded by bunds. They are commonly near the seashore where fresh sea water is easily obtained. In common practice these salt farms are operated only during the completely dry cycle from the months of November/December through April.

Normally, sodium chloride seawater contains a mixture of sediments, organic matter and other salts which must be removed.

Pure salt is extracted from seawater in a basic three-step sequence : settling, precipitation and crystallization. In the first step sediments and other large particles are removed through settling during the initial evaporation. Once settled, the relatively pure brine undergoes a longer period of evaporation during which time other seawater constituents such as carbonates are removed from the water through precipitation. In the final step, the continued evaporation results in the crystallization of salt which, upon drying, becomes pure salt.

Salt is extracted from highly saline mangrove sediment. At the beginning of the dry season, up to several hectares of mangrove forest are cleared and the organic-rich topsoil is removed. The deeper, more saline soil is overturned and allowed to dry, resulting in the salt concentration's being located near the surface.

Problems

The biggest problem concerning salt production is the irreversible conversion of coastal habitats, mainly mangrove-dominated environments, into pond systems. Salt production is best in an arid environment where coastal forests are uncommon. In terms of pond siting, consideration is seldom given to the natural functions and values of the supporting ecological system so conversions have often a very large impact.

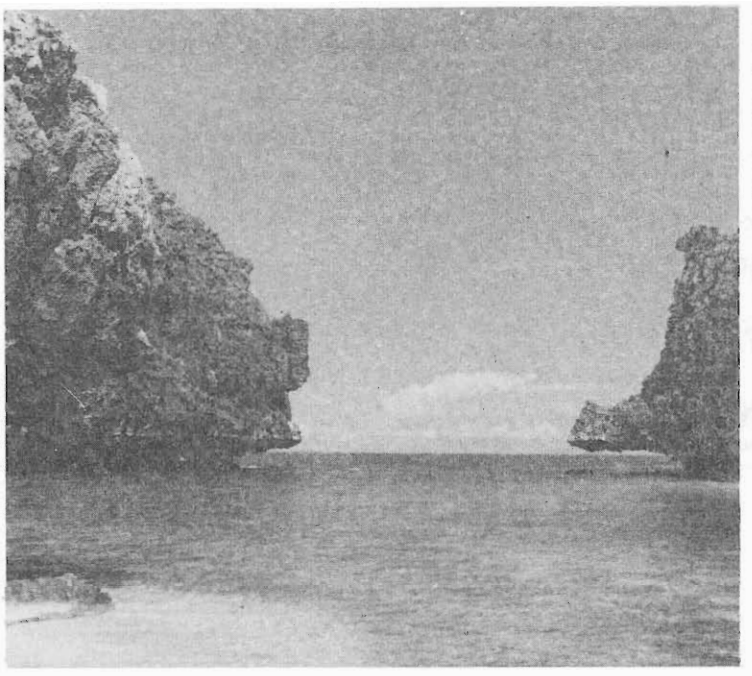
Guidelines

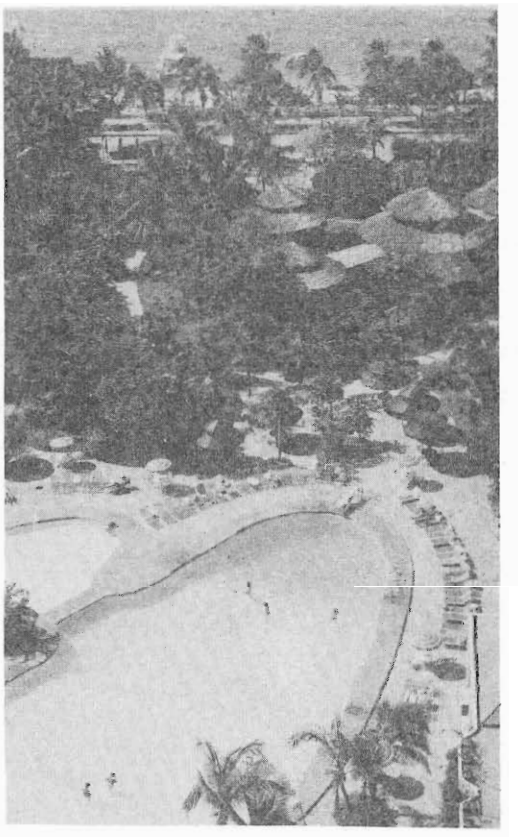
The manufacture of salt represents a significant use of the coastal zone in many near-tropical and tropical countries especially Thailand. With an increasing knowledge of compatible alternative uses of these areas, salt ponds can be developed into highly successful ventures using the following guidelines :

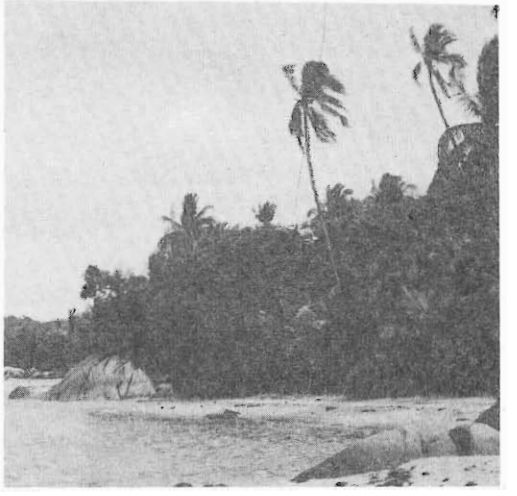
1. New salt-production ponds and the expansion of existing ponds should be planned to minimize the overall impact on coastal ecosystem

2. A national plan and protocols should be developed to encourage proper siting and efficient production techniques. Pond operators should also be made aware of alternative multiple use of the pond system

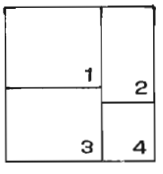
3. When ponds are abandoned, the dikes should be breeched to permit the eventual recovery of the former ponded area. Without repeated tidal and rain flushing, the loss of abandoned ponds is irreversible. New uses of abandoned ponds, for example as fish ponds should be investigated







Environmental quality is very important if the coastal zone is to contribute significantly to tourism. Management measures must aim at providing access and offering opportunities for recreation whilst maintaining the condition of beaches and other tourism resources.



1. Ang Thong Marine Park, Surat Thani Province
2. Pattaya, Chonburi Province
3. Hua Hin, Prachuab Khirikhan Province
4. Ko Samui, Surat Thani Province

Tourism

Introduction

Tourism is now one of the major economic sectors in Thailand, ranking fourth in terms of foreign exchange earning among all industries. In the tourism industry of Thailand, the attraction of ocean resorts to international tourists is growing in importance day by day.

Problems

1. Water pollution by sanitary sewage
2. Problems arising from building encroachment on beaches
   - Unsightly view of the buildings
   - Obstruction of pleasant views of the beach
   - Congestion of the beach area and blocking of roadways
   - Water pollution created by the buildings
   - Increased solid waste
3. Problem of solid waste
4. Problem from collecting coral and destroying coral reefs

Guidelines

1. Coastal tourism development should be conceived within the framwork of national, regional, and local socioeconomic development plans which assure proper integration of environmental objectives in development strategies
2. Coastal areas reserved for tourism development should be

covered by zoning plans which take into account the natural geographic and socioeconomic condition of the area

3. Site clearing, where required, should be controlled to ensure mininal impact to the natural coastal ecosystems

4. The development of accommodation facilities should be concentrated, leaving as much of the natural resource in as undisturbed a state as possible. The scale, size, and type of infrastructure should be appropriate. Structures should be set back a good distance from the beach

5. Allowances must be made for adequate waste disposal measures. Where possible, waste disposal should use existing municipal or regional collection and disposal systems. Liquid waste should not be discharged onto beaches, coral reefs, or other sensitive areas.

6. To avoid a monoceonomy, activities other than tourism should be promoted in tourism areas but these should not conflict with or degrade tourist assets

Transportation

1) Ports and Harbors

2) Roads and Rail

1) Ports and Harbors

Introduction

Ports and shipping have played important roles both in communication and cargo transportation in Thailand for many years. Most port and harbor facilities are located in regions along the coastline. There are 23 ports in South Thailand, many of which are very small fishing ports which have virtually no cargo trade. Six ports, namely Ban Don, Pak-Panang, Songkhla, Pattani, Phuket and Kantang accounted for 92 percent of all cargo passing through ports in South Thailand in 1972. Most of these ports are also fishing ports of either major or moderate significance. Other cargo ports of minor importance are Ko Samui, Nakhon Srithammarat, and Narathiwat which account for 5 percent of total cargo. Five ports, Songkhla, Pattani, Narathiwat, Kantang, and Phuket, have significant foreign export trade. Rubber is by far the most important export from these ports and accounted for 55 percent of the cargo exported from ports in 1972. Other exports included cement through Kantang and tin from Phuket.

Problems

In spite of their advantage in transportation, ports and harbors still create a number of adverse effects on the coastal eco-system.

1. Dredging and filling operations associated with ports and harbour construction can result in poor water quality, modifications to water circulation and oceanography, salinity, turpidity and sedimentation damage

2. Oil spillage or pipeline break at portsite can have serious repercussious on coastal resources such as fisheries and wildlife

3. Increased shipping can be a source of water borne pollutants and solid wastes e.g. bilge discharges and tanker washings. Passenger and cargo traffic results in the accumulation of debris

Guidelines

1. Port operation should avoid the disposal of wastes into surrounding waters
2. All port operations should avoid the discharge of oil into the marine environment
3. Open coast deep-water ports are preferred over embayments which are likely to contain an abundance of natural resources in a sheltered condition
4. Ports, harbors and water ways should be sited so as to avoid critical coastal resources, including routing around coral reefs and extensive mangrove forests and minimising the size of channels and disposal of dredge spoil
5. Ports and harbors should be planned to minimize the rise of water pollution, including the incorporation of facilities which allow the effective handing of sewage and industrial waste

2) Roads and Rail

Introduction

Industrial, commercial, and residential development in coastal lowland environments necessarily requires overland transportation facilities such as roads, railways, and bridge structures which are often over areas of open water. The transportation network links the development to inland areas and to local ports and harbors.

Problems

1. Problem of roads and railways in the coastal environment is that they cause the partial or complete impoundment of natural areas that are normally maintained by tidal flooding and surface water circulation

2. The fill material used in the construction is associated with two specific problems related to its source and the leaching that occurs when it is in place above ground. Whatever its source there are usually environmental impacts caused by removal. Moreover the fill used for the construction of roads and railway foundations may well be composed of the dredge spoils which contain numerous pollutants which have accumulated and persisted in the waterway

3. One problem that has an economic impact occurs when the design of transportation structures and the selection of the materials to be used are inadequate for use on a soft sediment base. In this case slumping and settling often occurs. This kind of structural failure problem happens when the designers and engineers have minimal experience with the technical difficulties associated with marine engineering

Guidelines

1. Road, railway, and bridge design requirements should include engineering provisions for the maintenance of natural surface-water flow characteristics according to specific performance standards

2. Fill should be free of environment pollutants which could be released by erosion and leaching

3. The technical team (s) responsible for planning, designing, and engineering capital-intensive coastal development projects should have specialists qualified not only in the relevant aspects of marine engineering, but also in coastal lowlands ecology

Capture Fisheries

Introduction

Capture fisheries refers to the areas used for the harvesting of wild populations of marine and freshwater fin-and shellfish resources whereas culture-fisheries refers to the areas used for the cultivation of populations of artificially stocked and fed aquatic animals.

With advanced fishing technology it has been possible for vessels to travel greater distances and to capture greater numbers of fish than ever before. But the supply of fish is limited and over-fishing (excessive harvesting) has occurred to the extent that the stock cannot produce maximum sustained yields. In fact overfishing in the Gulf of Thailand has depleted its water of pelagic and demersal fish. There appears to be three main contributory factors : increase in the size of the trawling fleet, the Exclusive Economic Zone (EEZ) restriction, and the indiscriminate dumping of pollutants into the inner gulf.

Between 1977-81 the Thai marine catch averaged 1.8 million tonnes a year; since then there has been a steady 10% decrease each year.

Problems

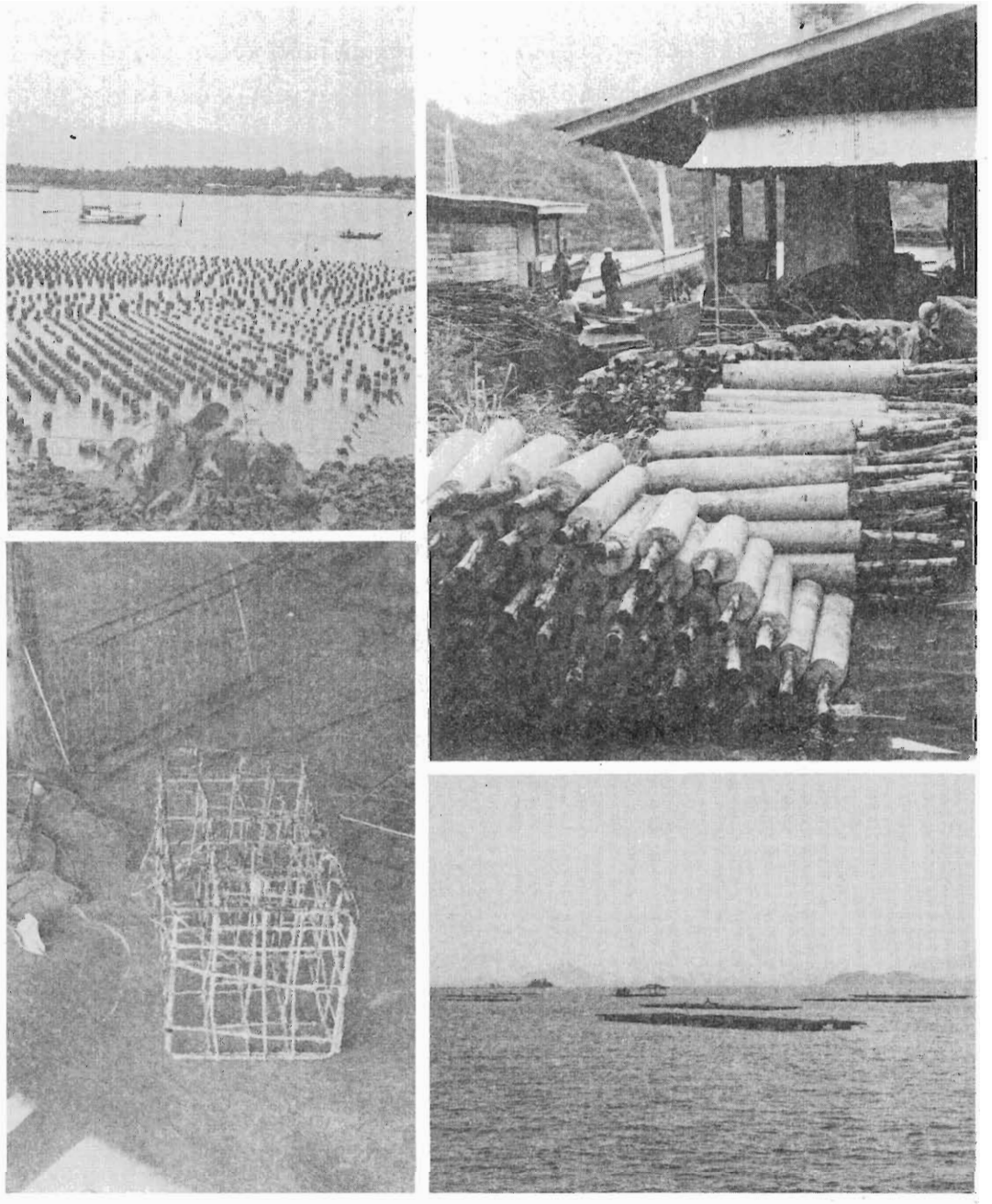
The decline in the catch from fisheries results from two main factors (a) fishing related problems such as over exploitation and (b) environmental problems such as pollution and habitat removal. This section concentrates on the environmental dimension.

Fishery resources depend heavily on estuarine and coastal waters and the degradation of these environments is directly related to the reduction in capture fishery yields. Some causes of environmental degradation are logging, agricultural practices, sewage and industrial

waste, coastal mining, urbanization, the removal of wetlands, etc. In general, these practices lead to changes in ambient-water salinities and temperatures from those optimal for economic species, especially in areas critical for spawning, nursery and foraging.

Guidelines

1. Avoid changes in ambient-water salinities and temperatures from those optimal for each fish species, especially in critical areas such as spawning, nursery and foraging areas
2. Avoid changes in the natural clarity and transparency of the water in areas which are critical for fishing resources. For example dredging or other activities that create siltation should not be undertaken near or upstream from critical fishing areas
3. Avoid the introduction of pollutants and excessive nutrients into environments that are critical to fishing resources e.g. through proper siting of industry and ocean outfalls for disposing of sewage waste water
4. Avoid changes in the natural patterns and cycles of tidal activity and freshwater runoff in areas which are critical to fishing resources



Mariculture activities along the coast :

1,2 Oyster farming in Chanthaburi Province

3,4 'cage' pearl culture in Phuket Province

Coastal Aquaculture

Introduction

Coastal aquaculture or mariculture is an important source of foreign exchange for Thailand especially through the export of shrimp. The current high world demand for marine protein has led to the expansion of existing mariculture operations throughout the coastal area of Thailand. However mariculture operations frequently experience problems and are potentially destructive to the supporting natural system.

Problems

1. Pond siting
   - direct removal of wetlands
   - the development of acid sulfate potential soils
   - inadequate or poor flushing of ponds
   - local depletion of larval and juvenile organisms for pond stocking
   - where mangroves have been cleared for aquaculture ponds their 'buffer' function is lost and during heavy rains ponds are likely to be flooded
2. Pond Management
   - Predation is a serious problem when ponds are not completely cleaned out and drawn down at the time of harvesting, thus allowing captured predators to remain in the pond. These can completely destroy the growing stock

Guidelines

1. Preference should be given to the support of intensively managed mariculture enterprises using cages or pens rather than promoting the conversion of mangrove areas to pond systems. Pond sites must be guaranteed to be suitable for sustained yield production

2. The approval and development of mariculture activities should be based on national or regional plans which take into account all other actual or potential resource uses

3. Whenever a pond system is forced to be abandoned, the impoundment dikes should be breached to permit the pond area to recover to its former status

4. Pond siting protocol should include performance requirements for the protection of the natural habitat surrounding the pond. Specifically natural patterns of surface-water flow should not be interrupted

5. In mangrove areas, the ponds should be located inland from the mangrove forests. When available, areas defined as salt flats or salt pans should be selected. Experience has shown that pond yields are often greater in these areas than in converted mangrove forest areas

6. In managed pond systems, an increased stocking of animals for growout is usually feasible. Coupled with water quality control and supplemental feeding, maximum yields can be expected

Watershed Developments

Introduction

Watershed management is the management of the natural resources of a drainage basin primarily for the production and protection of water supplies and other water based resources. It includes the control of erosion and floods and the protection of aesthetic values associated with water. The freshwater flow to the sea performs a variety of useful roles, including the delivery of terrestial sediments for distribution along beaches, the maintenance of navigable water ways by the scouring of channel sediments, and the prevention of salinity intrusion into inland areas. Bad water quality, sedimentation and siltation from upland can destroy coral reefs, seagrass and bio-activities in the coastal area. Certain upland agriculture practices are potential sources of coastal degradation e.g. use of biocides and deforestation. Other development activities which have the potential to affect the coastal environment include industrial outfall which affects water quality and coastal temperature regimes, and dam construction which reduces levels of sediment and nutrient concentration downstream. Watershed management areas are perhaps the classic case of areas which are remote from sensitive coastal systems but which can have considerable impact on them.

Problems

1. Sedimentation resulting from poor land management including deforestation, overgrazing and farming of very steep hillsides. The conversion and destruction of forest cover serves to remove a major means of soil stability and retardant to freshwater surface runoff. The forest

system serves to release moisture through evaporation, providing rain to other areas. Reduced rainfall in adjacent areas increases the chances that aridity further contributes to soil loss

2. Soil compacted by trampling has a low infiltration capacity and produces higher rates of watershed runoff

3. Overgrazing can cause problems of accelerated runoff, erosion and downstream sediment load

4. Dam construction sometime reduces natural levels of nutrient concentrations downstream, beach starvation, coastal erosion, increased salinity of estuaries, loss of biological productivities, loss of aquatic animals and reduced fish catch

5. Sea water intrusion in dry season can result from poor watershed management

6. Salinity changes frequently result from alteration in the hydroperiod, freshwater inflow, and flushing patterns through such activities as damming, dredging and bulkheading

7. Waste heat water and chemical waste from industries should have realistic contingency plans, pollution abatement equipment, and trained personnel for spill containment and cleanup

8. High fresh water demand, but only limited surface freshwater supply, so that ground water must be developed. In this situation well and pump are used for groundwater withdrawal. Groundwater pumping can exceed aquifer recharge capacity resulting in sea water intrusion into the soil. The fresh groundwater becomes contaminated with salt and is rendered unusable for most purposes

Guidelines

Good watershed management can supply water quality and water quantity for the coastal area; water-resource development should take into account the natural roles of freshwater for coastal areas.

1. Implement soil and water conservation practices to control cropland erosion and surface water runoff
2. Apply and utilize fertilizers and pesticides in a manner that will minimize their loss and transport toward coastal area
3. Require timely reforestation of logged areas especially on steep slopes
4. Have buffer strips of natural vegetation along the coastline and tributary watercourses
5. Develop water quality for drinking water for humans, domestic livestock, freshwater fish ponds, brackish-water fish ponds (water pollution control)
6. Good irrigation and drainage design is necessary
7. Water way design to limit salt intrusion (saline water intrusion control) is required
8. Avoid agricultural practices, where poorly managed lands have resulted in eroding soils; consider use of check dams, bench terraces and cutoff drains as possible means of slowing rate of soil loss
9. When dam is constructed, it may be used to regulate flow so as to simulate certain natural conditions which do not change the coastal ecosystem
10. Groundwater withdrawal should be controlled to prevent saltwater intrusion, and dewatering of surface waterbodies
11. All diversions, dams, and impoundments should be designed

to preserve the existing water quality, volume and rate of flow for marshes, estuaries, deltas, etc.

12. Water diversions should be designed to accommodate the seasonal migrations of aquatic fauna up and downstream

13. Maintain topography and character of forest soil and water channels. Avoid processes which lead to excessive sedimentation, erosion or alteration of chemical character

14. Perpetuate or maintain natural patterns of tidal activities and fresh water runoff

15. Maintain spatial and temporal (time/seasonal) patterns of salinity, avoid reduction of freshwater flow due to diversions (dam, irrigation, etc.), and withdrawal of groundwater pumping which would alter pattern of salinity

16. Maintain natural equilibrium between accretion, erosion and sedimentation

Section 6. Policies and Institutions

Policies for Coastal Resources Management and Planning

The policy for coastal resources management stated in the Fifth National Economic and Social Development Plan (1982-1986) lays emphasis on resources conservation and preservation, appropriate resource utilization and protection of resource and ecosystems from adverse effects caused by environmental exploitation. These policies for coastal resources management can be used by the relevant implementing agencies as criteria and guidelines for their development projects.

Although, the coastal land development policies are not so specific or detailed in the Fifth Plan (1982-1986), it is expected that this will be improved in the Sixth Plan (1987-1991) which is likely to emphasize the importance of the coastal area in national development.

Law and Regulations

There are many laws and regulations related to coastal resources and their development. They can be classified in 4 groups as follows :

Nature Conservation Acts

This group of Acts consists of the Wild Animals Reservation and Protection Act of 1960, the National Park Act of 1961 and the National Forest Reserves Act of 1964. These 3 Acts cover the land and the water area especially the National Park Act which also includes marine as well as forest parks. These nature conservation acts are under responsibility of the Royal Forestry Department.

Natural Resources Exploitation Acts

This group of acts consists of the Forest Act of 1941, the Fisheries Act of 1947, the Minerals Act of 1967, the Petroleum Act of 1971 and the Tourism Act of 1979. These acts are under the responsibility of a number of different agencies. The Forest Act of 1941 invests full authority in the Forestry Department for the protection and management of all forests in the country. The Fisheries Act 1947 is under responsibility of Fishery Department and its function is the control and management of fisheries. The Minerals Act of 1967 invests full authority in the Mineral Resources Department for the purpose of managing and controlling national resources utilization including survey and permission for mining operation and sale. The Petroleum Act of 1971 is under responsibility of the Petroleum Authority of Thailand and it covers the exploration and production of oil and gas. The Tourism Act of 1979 invests full authority is the Tourism Authority of Thailand in order that it might undertake investigation, planning and construction to meet the needs of national tourism development.

Environmental Protection Act

This is the Enhancement and Conservation of National Environmental Quality Act of 1975, which covers the control of quality and standards for the environment. The Office of National Environment Board (ONEB) is responsible for implementing this act and are given power to request an Environmental Impact Statement for various development projects.

Land and Water Usage Acts

Land legislation in Thailand is infinitely complex. The legislative body consists of two major areas of legislative concern, namely, land tenure and land use planning. With regards to the land tenure legislation which consists of the Land Code of Thailand of 1954,

some provisions concerning land property rights under the Civil Code of Thailand, and other three major acts of parliament, i.e., Allocation of Land for Social Justice Act of 1954, the Allocation of Land for Livelihood Act of 1968 and the Land Reform for Agriculture Act of 1975. In the area of land use planning, the City and Town Planning Act of 1975, the Formulation of Land Pattern for Agricultural Use Act of 1914 and the most recently enacted Land Development Act of 1983 constitute a legal framework for both urban and rural planning, supplemented by zoning laws embodied in a number of existing legislations, both old and new. These supplementary zoning laws are for example the Control of Building Act of 1979.

With regard to water usage, the age-old Navigation in Thai Waters Act of 1913 (NTWA) is the key legislation governing both inland and sea navigation. According to section 7 of NTWA, the term "Thai Waters" is defined to "mean and include the Thai Territorial waters and any harbours, anchorages, rivers and canals within the Kingdom of Thailand". As a party to the 1958 Geneva Conventions on the Law of the Sea and a signatory to the 1982 UN Convention on the Law of the Sea, Thailand has claimed a 12 mile territorial sea plus a 24 mile contiguous zone measured from the baseline of her sea coast since 1966. In 1969, a unilateral claim to excercise sovereign rights over the natural resources of the seabed of subsoil of the continental shelves in the offshore areas of both the Gulf of Thailand and the Andaman Sea was asserted by the Thai Government. Most recently, Thailand's claim to extend her exclusive economic zone seaward up to 200 miles was made by virtue of a royal proclamation dated 23 February 1981. Like the term "sea coast", no legal definition of "marine waters" of "sea" can ever be found in the NTWA or elsewhere in other statutory books.

In addition to NTWA, there are a number of other water usage laws, such as, the Preservation of Waterways Act of 1903, the Public Irrigation Act of 1942, the Water Works Canal Act of 1983, etc. At any rate, these laws are of little relevance, if any, to the subject of coastal zone management due to their major concern with inland waters rather than coastal marine waters.

With regard to the complete variety of Acts covering the coastal zone these can be summarized as shown in Figure 6.1. It should be noted that there are many laws covering similar areas of jurisdiction. This causes problems in practice for the implementing agencies as they are often unsure as to who should take action in any particular case.

Implementing Agencies and Organizations

The great variety of resources present in the coastal area requires many different implementing agencies to manage them according to the laws. At present, there is very little cooperation among the agencies concerned. This creates repetition and disputation leading to management problems.

With regard to the main role and the duty of each agency concerned in the coastal area, according to the law, we may divide agencies according to their chief functions into 3 different types : policy agencies, planning agencies and implementation or action agencies. There are 2 policy agencies. There are 2 policy agencies; the Office of National Economic and Social Development Board, and the Office of National Environment Board. The planning and action agencies are shown in relation to type of resource they are chiefly concerned with, see Table 6.1.

Besides, the agencies at Department level that play a role and exercise authority in coastal resources management and planning, there are also organizations established at Committee and Sub-Committee level with responsibility for policy issues and the control of operations of agencies in the coastal area. These are as follows :

1. Committee for Land Development : this committee was established by the Cabinet under the chairmanship of the Minister of Agriculture and Cooperatives. Members of the committee are Director Generals from all different Departments in the Ministry, including Secretary General

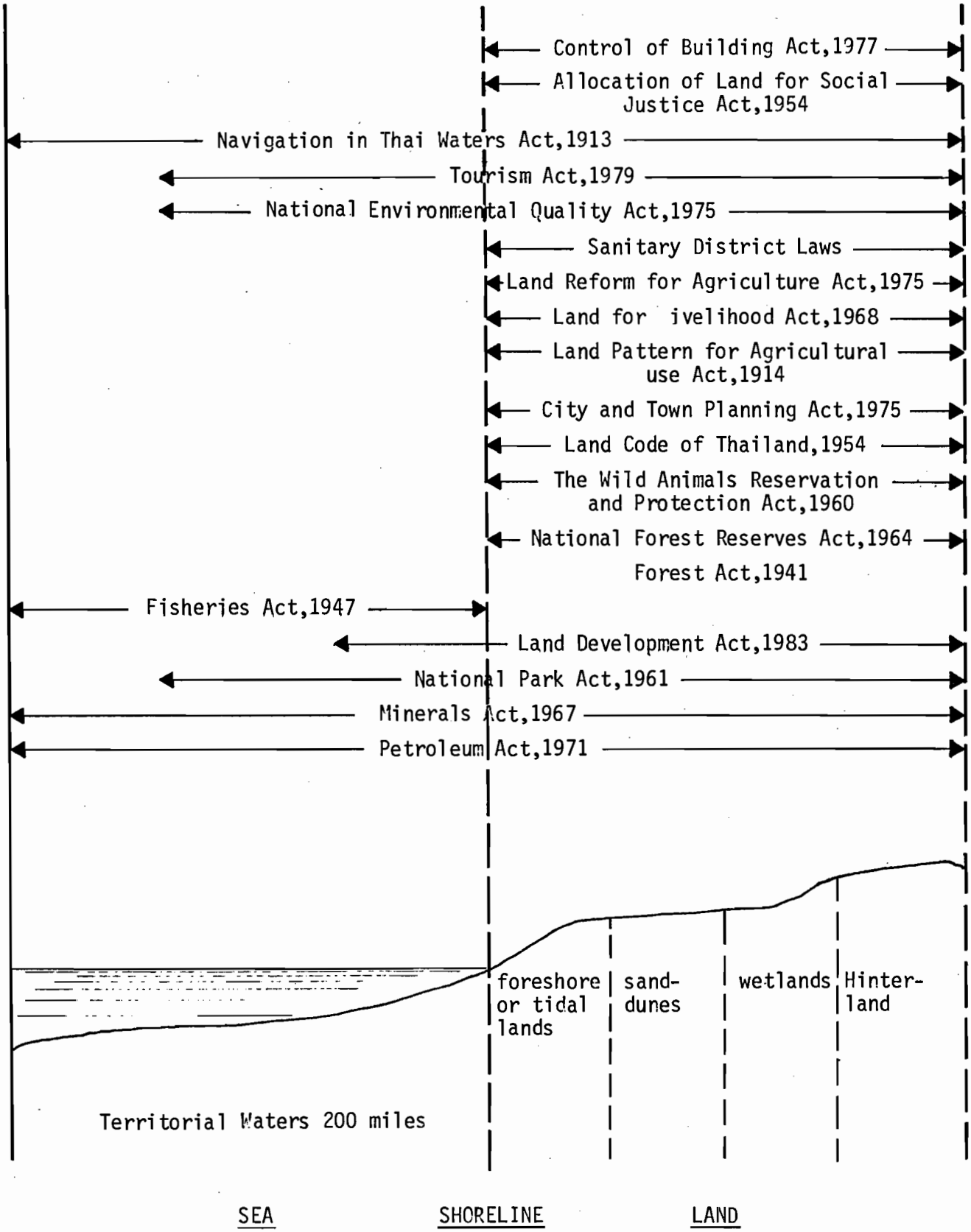


FIGURE 6.1 Legislative administration of the coastal area

TABLE 6.1 List of institutions and agencies responsible for various resources in the coastal area

Ecosystem / Major Institutions and Agencies	Mangrove			Coral Reef			Beach			Estuary			Mudflat			Island			Fishery		
	Policy	Plan-ning	Imple-ment	Policy	Plan-ning	Imple-ment	Policy	Plan-ning	Imple-ment	Policy	Plan-ning	Imple-ment	Policy	Plan-ning	Imple-ment	Policy	Plan-ning	Imple-ment	Policy	Plan-ning	Imple-ment
ONEB(1)	X	X		X	X		X	X		X	X		X	X		X	X			X	
LDD(2)		X			X			X			X	X		X			X			X	
Forestry Department	X	X	X			X					X	X						X			
Fisheries Department			X		X	X					X	X		X	X				X	X	X
Agriculture Extension Department											X	X									
Mineral Resource Department			X						X			X			X						
Harbour Department									X			X			X			X			
TAT(3)					X	X		X	X								X	X			
NESDB(4)	X	X		X	X		X	X		X	X					X	X		X	X	
National Research Council	X	X		X	X						X			X							

1. Office of National Environmental Board
2. Land Development Department
3. Tourism Authority of Thailand
4. National Economic and Social Development Board

of the Office of National Economic and Social Development Board, Director General of Land Development Department and Director General of Public Welfare Department. The Director General of Land Development is a member and secretary of the committee (Appendix 4). The major roles and duties of this committee are to deal with land classification, to establish measures for land and soil improvement and to approve the establishment of land development agencies at various levels.

2. Central Sub-Committee for Coastal Development : this sub-committee was proposed and established by the Committee for Land Development under the chairmanship of Deputy Minister of Agriculture and Cooperatives. Members are representatives from different departments concerned (Appendix 4). The representive from the Land Development Department is member and secretary of the sub-committee. The authority and duty of this sub-committee are cooperation and approval of developments proposed by the Provincial Sub-Committee for Coastal Land Development and by Provincial Sub-Committee for Land Classification and Coastal Development and any other tasks assigned by the Committee for Land Development.

3. Provincial Sub-Committee for Land Classification and Coastal Land Development : this sub-committee was established by the approval of the Committee for Land Development and located in each of the 23 coastal provinces. The provincial governor is the chairman of the sub-committee which comprises of members from various provincial and regional agencies. The representative from the Office of Land Development Department is member and secretary of the sub-committee (Appendix 4). This sub-committee has authority and duty to consider matters of land classification, land consolidation and reform for agricultural purposes, screening coastal development

projects especially those projects subject to disputes among the governmental agencies concerned or among the governmental and the private agencies. Moreover, the sub-committee has the duty of initiating and supporting research work related to coastal development, drafting master plan for coastal land use development of the province and coordinating tasks among different agencies concerned with land classification.

4. The National Committee for Mangrove Resources : this committee in under the Office of National Research Council and chaired by M. R. Chakratong Tong Yai. The members comprise of representatives from various agencies concerned with the representative member from the Office of National Research Council responsible for providing the secretary of the committee. The roles of this committee are as follows :

   - coordinating with the National Committee for Marine Science in any aspects related to mangrove resources;
   - to act as a consultant in planning and implementing academic research projects and in considering mangrove resources development problems;
   - to consider problems in utilization and conservation of the mangrove resources.

As well as a proliferation of overlapping laws and regulations there are also many different agencies involved in the coastal area and there is often a serious lack of cooperation among them. This causes some major problems as follows :

1. The Royal Forestry Department has authority in mangrove forest management, and gives official concession to private firms in forestation without regarding the impact on coastal fisheries and aquaculture which benefit from mangrove forest products and come under the Fishery Department.

2. The issue of granting concessions for tin mining in mangrove forest by the Mineral Resources Department without regard for the adverse impacts on mangrove forests and coastal fisheries which are under responsibility of Forestry Department and Fishery Department respectively. Attempts have been made to solve this problem by establishing various committees such as the Central Sub-Committee for Coastal Development and the Provincial Sub-Committee for Land Classification and Coastal Development. These committees are coordinating institutions among the implementing agencies in the coastal area and have not full authority in controlling the operations of such implementing agencies. Consequently, they are considered very unlikely to be successful in solving the problems of coastal resources utilization.

However, it is possible to achieve an effective solution to the problems. Laws and regulations related to the coastal area must be revised because the repetition and disputation problems of the implementing agencies are in fact caused by improper and ineffective laws and regulations.

Suggestions

To manage coastal resources systematically and in accordance with academic principles and to facilitate close cooperation among the implementing agencies concerned, the following recommendations are made :

1. An organization or central office for coordinating tasks related to planning and management of coastal resources should be established and the existing Central Sub-Committee for Coastal Development should be given more authority to enable it to be more successful in controlling and advising all the implementing agencies concerned in the coastal area;

2. Laws and regulations related to coastal area should be revised in order to reduce repetition and disputation. Additional laws should be enacted to cope with some specific resources such as coral reef etc.

3. Planning for development and management of coastal area should be the responsibility of the Provincial Sub-Committee for Land Classification and Coastal Land Development. But the Provincial Sub-Committee must obtain full support and help from the Central Offices on all policy issues, and issues of authority so as to enable it to achieve cooperation from the various agencies concerned.

4. A more in-depth study of the legal and institutional aspects of coastal resource management should be carried out with the agreement of the NEB and the NESDB. The study should focus on how the existing arrangements might be adapted, and on how any gaps might be filled.

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Starting with a foundation of fundamental Ecological Principles we have developed for this guidebook a number of general Management Rules and suggested a variety of constraints on coastal development activities." (P. VII)

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Appendix 1. Proclamation for Types and Sizes of Projects Requiring EIA

The National Environment Board (NEB) of Thailand is now implementing "selective projects" approach in identifying environmental impact along with mitigation measures and monitoring programs for certain projects or activities to ensure efficient utilization of natural and human resources in the economic development.

Section 17 of the National Environmental Quality Act (NEQA) of 1975, as amended in 1978, provides a power to the Ministry of Science, Technology and Energy to issue proclamation for the types and sizes of projects or activities requiring Environmental Impact Assessment (EIA) reports and measures for the prevention of and remedy for the adverse effects on environmental quality. The first proclamation has been issued on 14 July 1981 which stipulates in essence as in Table 1 below :

Table 1 Notification of Types and Sizes of Projects or Activities Requiring EIA Reports and Measures for the Prevention of and Remedy for the Adverse Effects on the Environmental Quality

Items	Types of Projects or Activities	Sizes
1	Dam or Reservoir	storage volume greater than 100,000,000 cubic meters or storage surface area greater than 15 square kilometers
2	Irrigation	irrigated area greater than 80,000 rais (12,800 hectares)
3	Commercial Airport	all sizes
4	Hotel or Resort Facilities in environmentally sensitive areas such as areas adjacent to rivers, coastal areas, lakes or beaches or in the vicinity of national parks	greater than 80 rooms
5	Mass Transit System and Expressway as defined by the Announcement of the Revolutionary Party No. 290, 24 November B.E. 2515	all sizes
6	Mining as defined by the Mineral Act No. 1 B.E. 2510, No. 2 B.E. 2516, and No. 3 B.E. 2522	all sizes
7	Industrial Estate as defined by the Industrial Estate Authority of Thailand Act, B.E. 2522	all sizes
8	Commercial Port and Harbour	with capacity for vessels of greater than 500 ton-gross
9	Thermal Power Plant	capacity greater than 10 MW.
10	Industries	
	(1) Petrochemical Industry	greater than 100 tons/day of raw materials required in production processes of oil refinery and/or natural gas separation
	(2) Oil Refinery	all sizes
	(3) Natural Gas Separation or Processing	all sizes
	(4) Chlor-Alkaline Industry requiring NaCl as raw material for production of Na_2CO_3, NaOH, HCl, Cl_2, NaOCl and Bleaching Powder	production capacity of each or combined product greater than 100 tons/day
	(5) Irons and/or Steel Industry	requiring iron ore and/or scrap iron as raw materials for procuction greater than 100 tons/day or using furnaces with combined capacity greater 5 tons/batch
	(6) Cement Industry	all sizes
	(7) Smelting Industry other than Iron and Steel	production capacity greater
	(8) Pulp Industry	production capacity greater than 50 tons/day

Appendix 2. Supplemental EIS Guidelines

1. Introduction

Of all types of land development projects, one of the most important in terms of environmental effects is any project which significantly alters the natural characteristics of coastal areas. This is because these areas, representing the interfacing of land and sea masses, are especially sensitive ecological zones. For example, most of the world's fishery reproduction, most of the world's most valuable beaches, and many of the world's most scenic areas occur in these zones. Also, because coastal zones include the sensitive estuarine areas in the discharge portions of rivers and streams, they may be drastically affected even by dam/reservoir projects constructed far upstream. Also, the bulk of the world's population and cities as well as ports/harbours are located on coastal zones, hence the pressure for economic development in these zones is generally much greater than elsewhere. Virtually all economic development projects in coastal areas will tend to exercise profound effects on their natural environmental resources, hence the most careful planning is needed to minimize or offset adverse effects.

Governmental agencies having responsibilities for controlling coastal zone development are therefore in a most sensitive position of importance in terms of ensuring preservation of critical national resources. For this reason NEB, as one of its earliest major efforts, focused attention on coastal zones including (i) preparation of Environmental Guidelines reports in 1975-76 for the areas of Pattaya, Phuket, and the Inner Gulf (References 1-4), (ii) initiation in 1976 of a project for developing a comprehensive plan of water quality control for the Songkhla Lake region, (iii) initiation in 1976 of a study program for developing practicable ways for protecting coastal zone resources (fisheries, mangroves) from the effects of silt runoff from tin mining, and (iv) initiation in 1976-77 of a number of special studies or projects for protection of coastal resources at selected sites in the Gulf of Thailand.

2. Applicable Environmental Parameters

As indicated in Section 1 above, development projects in coastal zone areas, such as ports/harbours, industrial estates, tin mining, oil pipelines, recreational resorts, breakwaters, dredging, housing projects, aquaculture projects, farming, etc., will generally involve effects on or from a great many environmental parameters. These are indicated in the summary tabulation shown in Table 1. The table shows both effects of the project on environment and vice versa. These are general indications only the precise relationships will vary widely from project to project.

3. Discussion of Specific Environmental Effects

An indication of the complexity of environmental analysis is indicated by the following brief discussion of some of the effects or impacts likely to be encountered:

(a) Physical Resources

(i) Stream Waters: Coastal projects often result in significant alterations in the natural hydrologic regimes, including rerouting of channels, paving and straightening of channels for flood control, and construction of channel obstructions and barriers. These will not only alter the flow distributions during the year (both into and from the sea) but also can result in major changes in salinity patterns and water quality

(ii) Ground Waters: The ground water resources in the project area are often developed and used for local water supply, and may be affected (both in quantity and quality) by the alterations in surface hydrology. An especially serious hazard is salinity intrusion due to excessive pumping and use of groundwater.

(iii) Air Resources: Smog and noise problems will of course result from any concentrations of industry and automotive traffic.

(iv) Beach and Other Coastal Waters: The nearshore water quality will be affected by pollutional discharges from all sorts of industrial and community wastes, and especially from tin mining.

(v) Land Uses: Beach and other recreational assets (such as sand dunes) may be encroached upon by roads, housing, and other developments. In addition to "officially-approved" projects, a common problem in Thailand is use of beach and other coastal land by squatters (including construction of sub-standard homes and rental units).

(vi) Land Alterations: Construction of breakwaters and jetties may significantly alter normal ocean sediment deposition/transport patterns, resulting in gradual removal of existing beaches and creation of new ones.

(b) Ecological Resources

(i) Aquatic Biology: Natural fisheries and all other aquatic forms (the entire configuration of fish-food chains or webs) will likely be altered, sometimes drastically, by the alterations in physical resources described above. The hazards are not only to finfish, but to shellfish, turtles, corals, and wildlife (such as waterfowl) closely associated with the aquatic ecology. Coral beds are especially sensitive to changes in light transparency. The damages to fisheries which are generally the most serious involve alterations in shallow and/or estuarine fishery reproduction zones. For environmental analyses of proposed coastal projects, in many cases evaluation of the effects on aquatic ecology may be the most difficult aspect and may require much more time and effort than for other impacts.

(ii) Terrestrial Wildlife: Development projects in rural or remote areas may sometimes have significant impacts on terrestrial wildlife including waterfowl and crocodiles.

(iii) Forests: Coastal forests, especially mangroves, are likely to be seriously affected by most development projects.

(c) Economic Development/Human Uses

As indicated by Table 1, virtually all types of existing or potential development projects will be impacted by proposed projects including transportation routes (highways, railways, navigation channels), community infrastructure (water supplies, drainage and flood control systems, sewerage systems), housing, industries, ports/harbours/fishing villages, recreational resorts, etc.

Some of the most important problems are usually in furnishing protection against (i) pollution from community, industrial, and mining sources, (ii) increase in flooding problems due to alterations in topography or construction of obstructions, (iii) interference with traffic patterns and transportation, and (iv) destruction of land values resulting from erosion due to removal of surface vegetation.

(d) Quality of Life Values

Coastal areas often include some of the most valuable areas in the region with respect to scenic and recreational values. Hazards to be evaluated include (i) damage to natural scenery caused by highways or buildings, (ii) encroachment upon and pollution of beaches and other recreational areas, (iii) damages to coral bed zones.

Another important subject area is the impact the project will have in local socio-economics, including effects on public health, on employment and income, on population and ethnic patterns, and needs for resettlement of families affected by the project.

4. Illustrative Guidelines

References 1, 2, 3, and 4 may be helpful as guidelines in planning EIS projects for development projects in the coastal areas of Thailand. They describe and evaluate situations involving most of the types of impacts mentioned in Sections 2 and 3. These include the impacts caused by harbours, shipping, mining, beach and recreational resorts, and other types of development.

References 5-9 represent selected USA publications considered to be especially valuable for coastal environmental planning.

TABLE 1

ENVIRONMENTAL PARAMETERS INVOLVED IN ANALYSIS OF

COASTAL DEVELOPMENT PROJECTS

ENVIRONMENTAL PARAMETERS	DEGREE OF IMPACT 1/				
	1	2	3	I	P
Physical Resources					
Air resources/quality	x				
Climate					x
Mineral resources					
Soils (including beach sands)		x			x
Topography/geology/seismology					x
Water quality			x		
Water quantity (hydrology)			x		
Ecological/Biological Resources					
Aquatic biology			x		
Fisheries			x		
Forest Habitat			x		
Wildlife (terrestrial)	x				
Human Use Values					
Farming irrigation	x				
Flood control/drainage		x			
Highways/streets		x			
Housing	x				
Industry	x				
Land use patterns			x		
Navigation		x			
Sewage treatment	x				
Solid waste management	x				
Water supply	x				
Quality of Life Values					
Archaeological values	x				
Community cleanliness	x				
Cultural values	x				
Employment patterns	x				
Noise problems	x				
Population density		x			
Public health	x				
Public safety	x				
Socio-economics			x		

Notes :

1/ 1 = Slight, 2 = Moderate, 3 = Heavy, I = Irreversible,
P = Environment has significant impact on project

Appendix 3. Products from Mangrove Forests

Direct Products

Uses	Products
Fuel	Firewood for cooking, heating Firewood for smoking fish Firewood for smoking sheet rubber Firewood for burning bricks Charcoal Alcohol
Construction	Timber for scaffolds Timber for heavy construction (e.g., bridges) Railroad ties Mining pit props Deck pilings Beams and poles for buildings Flooring, panelling Boat building materials Fence posts Water pipes Chipboards Glues
Fishing	Poles for fish traps Fishing Floats Fish poison Tannins for net preservation Fish attracting shelters
Agriculture	Fodder Green manure
Paper Production	Paper of various kinds
Foods, Drugs, and Beverages	Sugar Alcohol Cooking oil Vinegar Tea substitutes Fermented drinks Dessert topping Condiments from bark Sweetmeats from propagules Vegetables from propagules, fruits, or leaves Cigarette wrappers Medicines from bark, leaves, and fruits
Household Items	Furniture Glue Hairdressing oil Tool handles Rice mortar Toys Matchsticks Incense
Textile and Leather Production	Synthetic fibers Dye for cloth Tannins for leather preservation
Other	Packing boxes

Indirect Products

Source	Product
Finfish (many species)	Food Fertilizer
Crustaceans (prawns, shrimp, crabs)	Food
Molluscs (oysters, mussels, cockles)	Food
Bees	Honey Wax
Birds	Food Feathers Recreation (watching, hunting)
Mammals	Food Fur Recreation (watching, hunting)
Reptiles	Skins Food Recreation
Other Fauna (e.g., amphibians, insects)	Food Recreation

Appendix 4. Composition of Thai Coastal Zone Committees

COMMITTEE FOR LAND DEVELOPMENT

1.	Minister of Ministry of Agriculture and Cooperatives	Chairman
2.	Under-Secretary of State of the Ministry of Agriculture and Cooperatives	Vice-Chairman
3.	Secretary-General of Office of the National Economic and Social Development Board	Member
4.	Director-General of Department of Lands	Member
5.	Director-General of Department of Public Welfare	Member
6.	Director-General of the Royal Forest Department	Member
7.	Director-General of the Royal Irrigation Department	Member
8.	Director-General of Department of Agriculture Extension	Member
9.	Director-General of Department of Agriculture	Member
10.	Secretary-General of Agriculture Land Reform Office	Member
11.	Secretary-General of Agriculture Economic Office	Member
12.	Expert appointed by Government	Member
13.	Expert appointed by Government	Member
14.	Expert appointed by Government	Member
15.	Secretary-General of Land Development Department	Member and Secretary

CENTRAL SUB-COMMITTEE FOR COASTAL LAND DEVELOPMENT

1.	Deputy Minister of Ministry of Agriculture and Cooperatives	Chairman
2.	Under-Secretary of State of Ministry Agriculture Cooperatives or Representative	Vice-Chairman
3.	Director-General of Land Development Department or Representative	Member
4.	Representative of Ministry of Interior	Member
5.	Representative of the Royal Forest Department	Member
6.	Representative of Department of Fisheries	Member
7.	Representative of Department of Livestock Development	Member
8.	Representative of the Royal Irrigation Department	Member
9.	Representative of Department of Agricultural Extension	Member
10.	Representative of Department of Agriculture	Member
11.	Representative of Office of the National Environment Board	Member
12.	Representative of Lands Department	Member
13.	Representative of the Budget Bureau	Member
14.	Representative of Office of the National Economic and Social Development Board	Member
15.	Representative of Office of the Civil Service Commission	Member
16.	Secretary-General of National Mangrove Committee	Member
17.	Director-General of Department of Town and Country Planning	Member
18.	Representative of Land Development Department	Member

19.	Representative of Land Development Department	Member and secretary
20.	Representative of Land Development Department	Member and assistant secretary

PROVINCIAL SUB-COMMITTEE FOR LAND CLASSIFICATION AND COASTAL LAND DEVELOPMENT

1.	Provincial Governor	Chairman
2.	Regional Office of Forestry Department or Representative	Vice-Chairman
3.	Forest Department Provincial Officer	Member
4.	Lands Department Provincial Officer	Member
5.	Agricultural Extension Department Provincial Officer	Member
6.	Representative of Office of the National Environment Board	Member
7.	Representative of Army Area of the Royal Thai Army	Member
8.	Fisheries Department Provincial Officer	Member
9.	Director of Office of the Royal Irrigation or Representative	Member
10.	Representative of Office of the National Economic and Social Development Board	Member
11.	Representative of the Budget Bureau	Member
12.	Mineral Resources Department Provincial Officer	Member
13.	Representative of Tourist Organization of Thailand	Member
14.	Representative of Department of Town and Country Planning	Member
15.	Representative of Harbour Department	Member
16.	District officer or Representative	Member
17.	Representative of Land Development Department	Member
18.	Representative of Land Development Department	Member and secretary
19.	Representative of Land Development Department	Member and assistant

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