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Planning and Management of the Coastal Zone in India—A Perspective

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Abstract *India's coastal zone has, since ancient times, played a very significant role in socioeconomic, political, and defense developments. For a developing country like India with a vast coastal zone, there is a need for establishing one Central Coastal Zone Management Authority at the national level and a suitable agency in each of the maritime states for properly coordinating and implementing the coastal zone management program of the country. It is necessary to consider all major uses of the coastal zone, relevant to its physical, chemical, and biological regimes, as well as man's socioeconomic and political systems. The goals must be clearly specified and policies with necessary built-in legislative powers should be framed for implementation. Most recent advances in ocean science and technology are to be used to resolve any conflict that may arise in the interactive uses of the coastal zone and implementation of public goals. Engineering and management techniques should be evolved and applied in planning and implementing the specific goals.*

Keywords Coastal Zone management, India

Introduction

India has an extensive coastline of about 7500 km and a vast Exclusive Economic Zone (EEZ) of more than 2.1 million km², which includes the Andaman and Nicobar islands (Figure 1). The EEZ of India equals about 66% of its land area and about 4.2% of the Indian Ocean area. India has 12 major ports, 16 intermediate ports, 78 minor ports, and more than 200 fishing harbors/facilities. Main uses of the coastal zone include construction and maintenance of ports and harbors, transportation, extraction of living and non-living resources, land reclamation, commercial and industrial development, agriculture, human habitation, military defense, aesthetic appreciation, and ecological use as well as waste disposal.

The predominant physical feature of the coastal zone is the shoreline where land, sea, and air meet to form a triple interface. Any use of the coastal resources would modify the coastal environment. Despite the importance of the coastal zone for national development, a coastal zone management policy and its implementation strategy have not yet been clearly defined in India. There could be several reasons for this, including the low level of governmental and public awareness of the problems involved and the shortage of trained manpower. The main problem of coastal zone management in devel-

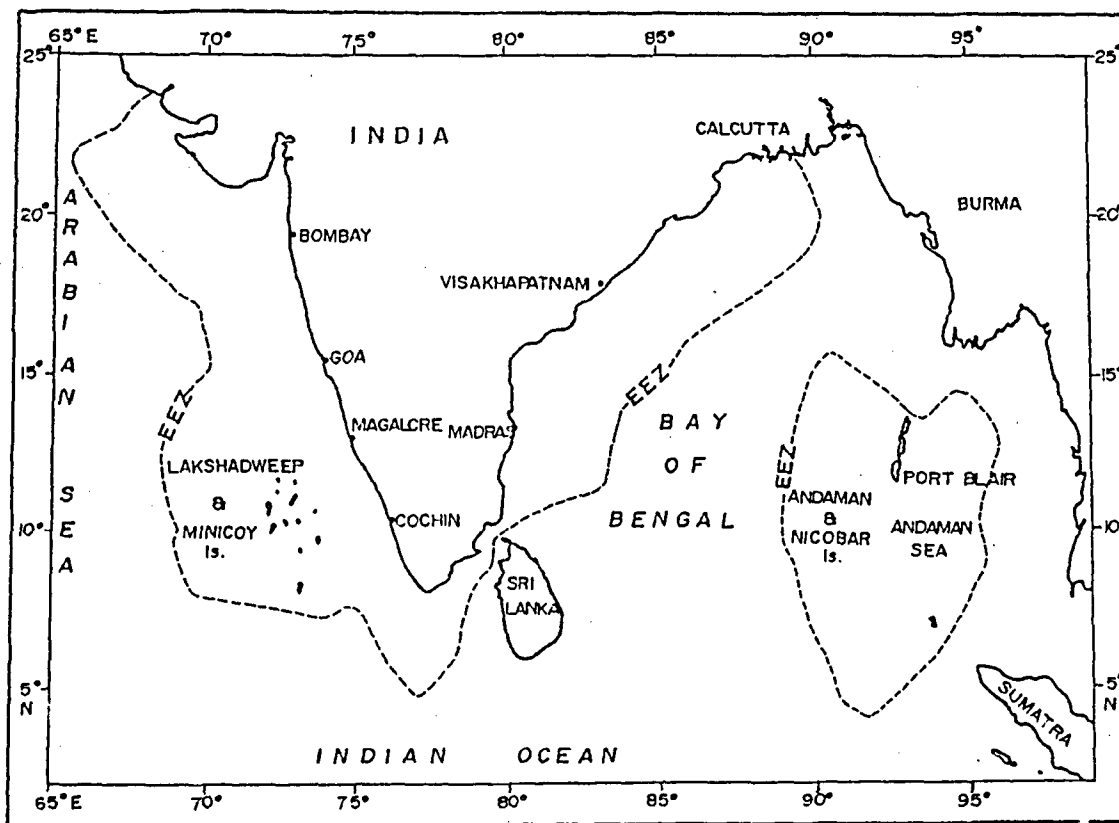


Figure 1. The Exclusive Economic Zone of India.

ing nations concerns the quality of the data base on which management decisions can be based. There is a need to collect various types of data required by decision makers and to interpret the already available scientific information for the government and the general public.

Coastal Regimes of India

Through ancient times, the topography and geology of the land have governed the pattern and intensity of human activity. The physical regime of the Indian coastline is characterized by different types of coastal and shore features like promontories, sandy spits, barrier beaches, embayments, estuaries, and offshore islands. These characteristic features are the results of the geological and geomorphological history of the coastline.

West Coast of India

A large portion of the west coast of India is dominated by a scarped slope resulting in a well-drained, flood-free hinterland with high potential for locating hydroelectric projects. In certain sections, however, such as Gujarat on the northwest coast of India, the coastal zone is marked by low land, free from rocky or scarped terrain. This has resulted in numerous roads, railways, and rivers interconnecting the shorezone with the inner parts of the country (Ahmed 1972).

East Coast of India

The east coast of India, as a whole, is marked by a wider and flatter coastal strip with easier relief. It is, therefore, better cultivated and more densely populated and is characterized by coastal highways, railways, shore-parallel navigation canals, better connections between the shore and the interior land, and a relatively large number of medium and minor ports (Ahmed 1972).

Offshore Islands

The tropical islands of the Andamans and Nicobars are clad with dense forests from the shores to the hills' summits. The coastal zone here is marked by a dominantly rugged terrain and a north-south faulted structure (Ahmed 1972). The Lakshadweep group of islands are characterized by extensive coral reef systems with lagoons and considerable vegetation along the shore zone. One important feature of the offshore islands is the presence of a negligible continental shelf and the dominance of coral reef communities. These complex biotic communities protect the shores by regulating the force and direction of approaching waves. They produce the sand for the beaches through abrasion of the calcareous reef structure and provide an enormous recreational resource.

Coastal Zone Management in India

Though India has enacted comprehensive environmental protection laws to control water and air pollution, the country has yet to formulate a national coastal zone management policy in conjunction with its nine maritime states. The Central Beach Erosion Board was constituted by the government of India in 1971 with the following functions (Nayak 1982):

- To organize a coordinated program of collection, compilation, evaluation, and publication of data relating to various natural phenomena and coastal processes that affect the coastline through central and state organizations.
- To arrange general investigation, studies, and research.
- To lay down general design principles and construction techniques for anti-sea erosion measures for the guidance of the state authorities.
- To review from time to time the performance of works carried out by the maritime states and evolve improved design and techniques based on such experience.
- To render technical advice on specific problems at the request of the states.
- To draw up a program of training for the personnel engaged in coastal engineering.
- To suggest other steps necessary in tackling the problem of coastal erosion in an economic and coordinated manner.

The Central Beach Erosion Board, realizing the complexities associated with the conflicting and multiple uses of the coastal resources, has proposed the establishment of a Coastal Zone Management Authority in every maritime state of India.

The Department of Ocean Development of the Government of India, through its high level policy-making body called the Ocean Science and Technology Board (OSTB), could evolve a national policy with an appropriate mechanism and strategy for managing the vast coastal zone of India in coordination with the Central Beach Erosion Board and other concerned bodies and organizations. Realizing the unique role played by the off-shore islands and their special nature, the government of India constituted a separate national committee in 1986 for the development of the islands of Andamans and Nicobars as well as the Lakshadweep group of islands.

Goals of Coastal Zone Management in India

In the coastal zone management program, one has to bring all of the main uses of the coastal zone—both present and future—into proper relationship with its physical, chemical, and biological regimes and also with man's socioeconomic and political systems. The following are the major goals of a coastal zone management program; the degree of emphasis may, however, vary from one region to the other (Nayak 1983).

- To examine and critically appraise the current statutory role and jurisdiction of central, state, and local agencies in managing the coastal zone.
- To prepare a complete inventory of uses and activities that take place in the coastal zone, to determine their contributions to the state economy, and to evaluate them in terms of economic criteria and environmental impact.
- To integrate conservation principles into planning processes for development in the coastal zone.
- To promote necessary and desirable development in the coastal zone in keeping with the intrinsic environmental features of specific coastal regions.
- To restrict ecologically harmful development in the coastal zone and to ensure that major development is concentrated as much as possible at certain specific coastal regions.
- To strictly control development in as yet undeveloped areas so as to retain the natural character of the coast as far as possible.
- To ensure that ecologically sensitive coastal features such as coastal lakes, estu-

aries, lagoons, marsh and wetlands, backwaters, mangroves, bays, dunes, beaches, rocky shores, and reefs, as well as offshore islands, are protected as much as possible.

- To promote public education so as to obtain voluntary collaboration and cooperation of all concerned in the implementation of coastal zone management programs.

Suggested Approach for Coastal Zone Management in India

Taking into consideration the unique socioeconomic and political system of India, each coastal district can be considered a unit to promote coastal zone management (CZM) at the local level. State government can set up effective coastal zone management committees for each coastal district. The chairman of such a CZM committee should be the administrative head of the district, the deputy commissioner. Representatives from local academic institutions; state departments of fisheries, tourism, forestry, and minor irrigation; coastal residents; local interest groups; environmental protection groups; and members of the Legislative Assembly and members of Parliament from the coastal constituencies could compose this committee. These local committees should hold frequent meetings, seminars, workshops, and public hearings to educate the planners, administrators, and coastal residents on specific issues concerned with coastal developmental problems before arriving at nature-friendly solutions to such problems in the larger interest of the society. The local CZM committee can also decide about adequate financial or other compensation to local residents who are affected by the coastal problems associated with coastal erosion, harbor development, or public facilities for recreation, tourism, and industry.

Broad-based central and state Coastal Zone Management Authorities (CZMA) should be set up that would take up all matters pertaining to coastal zone development, including that of the functions of the existing Central Beach Erosion Board, Anti-Sea Erosion Committees of the coastal states, and the Central and State Pollution Control Boards. These CZMAs should develop a comprehensive national policy with statutory regulations for managing and administering all developmental activities in the coastal zone. District-level CAM committees should be given necessary authority and statutory power to plan and implement coastal developmental programs in each of the coastal districts in accordance with the policies laid down by the Central and state CZMAs.

The state and local administrative structure in the country is not yet geared to meet the challenges of managing the coastal zone, considering the multiple uses and developmental pressures on the delicate coastal ecosystem of India. Piecemeal approach is still being pursued in the absence of a comprehensive national and state level CZM policy (Nayak 1982, 1983). There is, however, considerable awareness among the planners, policy makers, researchers, politicians, local leaders, environmentalists, and coastal residents of the problems associated with coastal development and the need to preserve the natural balance in the coastal ecosystem. Adequate scope therefore should be provided through seminars, workshops, and discussions to improve the understanding between the various interests groups before a nature-friendly solution is found to a coastal problem. General comprehensive policy laid down by the central and state CZMAs should provide a base for solutions to local problems conceived by the district CZM Committees. The recommendations of these local committees should however be scruti-

nized and approved by the state and central CZMAs before implementation of the scheme.

With regard to environmental and pollution control, adequate information on which to base decisions is generally being gathered. But in the case of coastal zone problems, considering the interactive uses, conflicting demands, and developmental pressures exerted by different interest groups, it is generally felt that adequate data are neither available nor collected for decision making. Efforts are therefore being mobilized with the help of local academic and R&D institutions, relevant government departments, resource users, and appropriate central agencies to collect necessary data and information. A mechanism can be developed through the coordination of the central, state, and local administrative systems of the government, for gathering the requisite data base (Schneidewind 1972; Nayak and Chandramohan 1986).

Scientists and engineers in the country can play a significant role in providing necessary scientific input to the planners and policy makers for evolving various CZM programs and their implementation.

There should be a comprehensive CZM policy for the country as a whole that serves as the basis for all the coastal states. District-level CZM committees, in coordination with the state-level CZMAs, can then effectively deal with individual cases. In the decision-making process the public and resource users, through the district-level CZM committees, would play an important role.

A Coastal Zone Management Program

Figure 2 illustrates diagrammatically various steps that may be followed while evaluating the need as well as the feasibility of preserving or enhancing a given coastal resource and for developing and implementing a plan for doing so.

For boating, sports fishing, hunting, and other types of recreation, similar procedures can be adopted for decision making. For aesthetic appreciation, a length of extensive, undisturbed shoreline, observable from reasonably accessible viewpoints, would be required. For other non-scenic forms of aesthetic appreciation, such as historical and cultural sites, requirements of the shore area can be estimated.

The need for more reclaimed land near the shore to satisfy residential, commercial, and industrial development demand will undoubtedly not coincide with the need for wetlands to satisfy the demands of commercial and sports fishing, hunting, and ecological balance. Some tradeoffs based on scientific knowledge and the relative significance of the individual demands should be made here. Some apparent incompatibilities might be mitigated by, say, judicious application of engineering and management techniques. Public expression, fully exposed to the significance of the choices involved, is most important under such situations (Edwards 1985; Clayton 1985).

Techniques for Achieving the Goals

Both engineering and management techniques are useful in preserving and enhancing the coastal resources thereby achieving intended goals. Engineering techniques can accomplish this by influencing the physical interface of land and water by man-made structures. Management techniques can accomplish this by influencing people in their use of the coastal zone. To satisfy the need for more public beach, engineering techniques might be employed to stabilize an existing beach against erosion or even to create a new

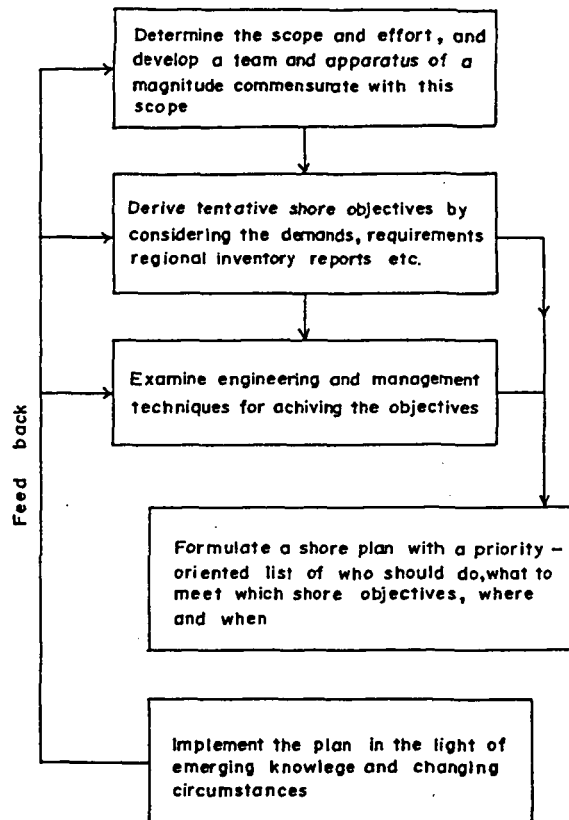


Figure 2. A shore management procedure.

beach. Management techniques might be employed to acquire more beach or to improve access to the existing beaches.

For achieving goals that call for stabilizing a shore, the following engineering techniques might be helpful.

- Beach nourishment
- Dune stabilization and vegetative cover
- Breakwaters, jetties, and groins
- Bulkhead, revetments, seawalls, and dikes

When an objective calls for developing the shore by modifying existing shore conditions, the techniques listed below can be considered. Most of the techniques considered under shore stabilization above can also be applied here with some modification.

Ditching and diking: These techniques can be used to enhance marshy beaches and bay shorelands for a variety of purposes that are not always complementary. Waterfowl habitats can be created or enhanced by diking off saltwater to create freshwater impoundments. Ditching can open up fish accesses to wetland areas, which are valuable as food sources and as spawning and breeding areas.

Dredging and filling: Dredging can enhance navigation, boating, and water circulation by deepening the water courses. Filling can provide additional shoreland. A combination of dredging and filling can improve the shoreline for development purposes.

Upstream dams and water diversions: When used for flood control, navigation, low-flow augmentation, sediment control, and stabilization of salinity gradients, these devices usually enhance or do not appreciably affect the shoreline uses in developed urban areas, which are often situated at river mouths. When they dampen out the extremes of high and low freshwater inflow, they may benefit some marine species and harm others. When they reduce sediment flow, they may improve water quality, reduce shoaling tendencies, and protect benthic life from being smothered occasionally, but they may also reduce the supply of nutrients beneficial to this life.

Whenever river-borne sediment contributes significantly to the natural replenishment of beach sand, upstream dams and water diversions can cause shoreline erosion at the river mouths. The flow patterns may also be changed, thereby altering the erosion and accretion patterns. Solutions to shore problems occurring near the river mouths should, therefore, consider what effect these upstream projects might have on the shores.

Cyclone barriers: When the objective is to protect highly valued urban property and minimize human suffering and possible loss of life caused by inundation, etc., cyclone barriers might have special applications.

Management Techniques

Management techniques are useful in fulfilling the goals by influencing people in their uses of the coastal zone. Like engineering techniques, each management technique has its own capabilities, limitations, and side effects that should be carefully considered before adopting it. In applying management techniques, a governmental agency has to satisfy the following tests.

- Authority to support its actions must be legally delegated to it.
- The action must be in pursuit of the goal appropriate to the agency's level of government.
- The action must help reach the intended goal.
- All individuals subject to a regulatory system must be treated equally.
- Private property must not be acquired without compensation.
- Decisions must be made in accordance with procedural requirements of a full and impartial hearing whenever private interests are affected.

Basic management techniques for the coastal zone do not differ essentially from techniques employed for land use management elsewhere. However, their application is often of special importance along the shore because of some complex and unique natural and human interactions there as a result of

- the common use of water areas for a wide variety of purposes such as navigation, fishing, recreation, effluent disposal, etc.
- the multiple uses of the shoreline, which depend on the condition of the adjoining land and water areas.
- the dependence of offshore living resources on estuarine ecology.
- the very high cost of land along the shore, especially near coastal cities.
- a changing shoreline caused by erosion or accretion as a result of varying forces of the sea.

Environmental Data for Coastal Development

The greatest problem for coastal zone management particularly in India is with the quality of the data base on which management decisions can be based. Various types of data bases are necessary to make appropriate management decisions (Schneidewind 1972). There is a need to collect various types of data required for decision makers and to interpret already available scientific information for the government and the general public. Coastal zone data systems are required to support the following functions:

Research: Collection, analysis, interpretation, and synthesis of data.

Planning: Number, type, characteristics, and condition of coastal resources. Planning is to be continuously supported by complete inventories of existing coastal resources and auxiliary data such as population; facilities; users; natural resources (beaches, parks, and animal life); equipment (recreational boats, fishing boats, diving gear); economic indicators (revenue and costs); geography, topography, physical, chemical, and biological characteristics; status of coastal zone activities (harbor construction, shore stabilization, beach resort construction, etc.); status of coastal zone resources and facilities (beach erosion, storm damage to coastal structures, etc.).

Development and implementation: Highly specific data would be needed for this purpose, whereas more general statistical data may be adequate for the planning phase.

Operation and management: Once a project is put into operation, it must be managed and/or regulated. In progressing from the first phase of research to the last, namely operation and management, the need for raw environmental data becomes progressively less. Requirement for environmental data, however, would increase at the management stage if there is a need to monitor the implemented project.

Ocean Engineering and Technology

The challenge of attaining the goals of coastal zone management lies in resolving conflicts and receiving a major contribution from engineers (Nayak 1983). Engineers are asked to bring certain changes to the coastal zone, control its environment, and construct major structures in this important zone. The extent to which they can successfully do this will depend on the state of engineering technology.

Ocean engineering and technology have been rapidly developing in the world. Engineers concerned with Indian coastal zone planning and development should, therefore, be acquainted with up-to-date, state-of-the-art technologies and adapt them to given situations for deriving functionally efficient, structurally sound, and cost-effective designs, construction techniques, and operation procedures.

Conclusions

The coastal zone in India is subjected to multiple uses, thereby leading to conflicting demands for the exploitation of various resources by different interest groups. Nearshore oceanography is an especially interesting and complex field because it encompasses an interface of water, land, and air, and each, in turn, influences the other.

Despite the importance of the coastal zone for the socioeconomic and political developments of the nation, comprehensive coastal zone management policy and its implementation are yet to be organized in India. Because the systems exist and operate in a physical world of finite space and resources and because they perform at the direction of

purposeful humans, conflicts are bound to arise, particularly in the coastal zone. It is important to understand and evaluate what level of human intervention, in the name of planning and development, can be tolerated without destabilizing the coastal ecosystem.

A national Coastal Zone Management Authority needs to be established at the center with a suitable agency in each of the maritime states to ensure proper interaction among various government agencies, voluntary organizations, and developers, as well as the public. The public goals and a master plan should be clearly defined for a given coastal area, and suitable policies with legislative powers should be framed to implement such goals without leaving room for ambiguities or conflicts. Public participation should be encouraged in the decision-making process to avoid conflicts.

The engineering techniques would physically change the interaction between the land and the sea, and the management techniques are to be employed to influence the people in their uses of the coastal zone. One of the most important aspects of an effective coastal zone management program is the utilization of the most recent advances in ocean science and technology as the basis on which planning and development of a given coastal segment should be undertaken. This necessitates close working of planners and policy makers with scientists from many disciplines to ensure that recent discoveries or findings in science and technology are integrated into wise resource management.

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