11 Marine and coastal environment

Introduction

The marine environment, which includes the adjacent coastal areas supports productive and protective habitats such as mangroves, coral reefs and sand dunes. The marine environment is facing a number of pressures, arising out of the needs of people, and the multiple uses that coastal and marine areas can be put to. These pressures contribute to the depletion of marine resources and degradation of the marine environment. In the absence of good management, these pressures may result in severe stress. Chapter 17 of Agenda 21[a] lays out certain programmes for the sustainable development of the marine environment.

This chapter presents a brief overview of the institutional set-up of the marine sector in India. This is followed by a summary of the major programmes of Agenda 21 relevant to this sector, followed by highlights of the policies and programmes undertaken by the Government of India to meet the objectives of Agenda 21 with regard to marine resources. The government policies and programmes are analyzed in the context of Agenda 21 in the following section. The chapter concludes with recommendations for a cleaner and healthier marine environment.

Overview of India's marine sector

India has a long coastline of more than 7500 km. Its marine resources are spread over in the Indian Ocean, Arabian Sea, and Bay of Bengal. The exclusive economic zone (EEZ) of the country has an area of 2.02 million sq km comprising 0.86 million sq km on the west coast, 0.56 million sq km on the east coast and 0.6 million sq km around the Andaman and Nicobar islands. The east coast supports activities such as agriculture and aquaculture while a number of industries are supported on the west coast. Tourism has emerged as a major economic activity in coastal states such as Goa, Kerala and Orissa.

[a] http://www.un.org/esa/sustdev

Mangrove cover in India has been estimated at approximately 3,15,000 ha confined mainly along the east (Orissa and West Bengal) coast and Andaman and Nicobar islands. The Sunderbans in West Bengal have one of the largest mangrove forests in the world. The mangrove flora of India is comprised of 50 exclusive species belonging to 20 genera. Some of the common and economically important species include *Mugil cephalus, Hilsa ilisha, Lates calcarifer, Scylla seratta, Meretrix casta* and *Crassostrea grephoides*. According to the latest evaluation (Rao, Molur and Walker, 1999) 67 % of the mangroves and associated plant species are endangered, while 97% of the plant species are threatened. Indiscriminate cutting, reclamation for agriculture and urbanization, fuel and overgrazing by domestic cattle have severely degraded mangroves in India. The threat to mangroves in recent years comes mainly from, aquaculture and urban settlements. Sand dunes which support diverse flora are categorized as ecologically sensitive areas under the Coastal Regulation Zone notification of 1991. Coral reefs are found in the Palk Bay, Gulf of Mannar, Gulf of Kutch, central west-coast of India, Lakshadweep and Andaman and Nicobar islands. A few species of corals have recently been reported from the Maharashtra coast. A total of 50 genera and 13 sub-genera of reef-building corals are known to occur in Indian reefs representing more than half of those recorded from all over the world**.** Fisheries in the Indian marine environment comprise 15 pelagic and the same number of demersal fisheries. India is a major seafood exporting country. The annual export of fisheries is 0.4 million tonnes (mt) worth Rs 47,000 million (Pandian, 1999). Marine fishery exports in 2000 were 421,075 metric tonnes valued at Rs 63,965 million. The Indian marine production increased from 0.534 mt in 1950-51 to 2.576 mt in 1992-93. However, the growth of Indian marine fisheries has become sluggish in recent years (Acharya and Thakur, 1999) and reached a plateau at around 2.8 million tonnes by 1995-96 (MoA, 1996). While the inland sector contributed increasingly (6.2% annually since 1980-81) to the growth of fish production in India (5.21% annually since 1980-81), the growth in marine food production decreased to 2.5 % during 1990-99 from 3.73 % during 1980-90 (Krishnan Birthal, Pounusamy et al-2000). The potential harvestable yield of marine fish stock in the Indian EEZ is estimated to be 3.9 million tonnes (Devaraj and Vivekanandan, 1999; Somvanshi, 1999). About 1 million people in 3651 villages of India situated along the coast are employed in marine capture fisheries. Indian fishery also supports several ancillary activities such as boat building, processing plants etc. All these features make this an important sector from the economic and social viewpoint.

The coastal and offshore environment of India supports rich biodiversity. Bacteria, fungi, and zooplankton species are abundant. Benthic fauna consists of plychaeta (62%), crustaceans (20%), and molluscs (18%). Over 630 species of marine algae have been reported. The annual production of seaweed is estimated at 70,000 tonnes. Sea grass flora is dominated by *Thalassia hemprichii* and *Cymodocea* species. The total standing crop is estimated at 7000–8000 tonnes. The few economically important species of algae such as *Gracilaria edulia* can be cultivated on a large scale. A sea grass called *Enhalus acroides* is now a threatened species. *Dugong dugong*, a mammal dependent on sea grass for its food is also threatened.

Economic activities such as offshore drilling, aquaculture, port activities all impact the coastal ecosystem. India's external is almost entirely dependent on surface transport through its ports, except for a small quantity of high-value international cargo in volume terms, which is carried by air. For the protection, preservation and management of coastal waters and maritime zones the Central Government has formulated exclusive jurisdiction. The state governments too, have jurisdiction over the development of fishery and other living resources in the territorial waters adjoining the states. The following institutions are responsible for decision-making in the area of oceans and seas, in India.

Table 11.1 Institutions responsible for decision-making

Organization	Responsibilities
Ministry of Environment and Forests	Management of resources in the coastal water, nodal ministry with major responsibility for protecting marine environment, includes implementation of legislative measures.
Department of Ocean Development	Scientific monitoring of the marine environment, Management of resources in the high seas
Ministry of Agriculture	Development of fisheries, aquaculture, fish processing
Ministry of Water Resources	Erosion
Ministry of Defence (Indian Coast Guard)	Pollution response measures, including oil pollution
Ministry of Surface Transport	Ports, shipping etc.
Ministry of Petroleum and Natural Gas	Offshore installations, coastal refineries, pipelines etc.
Ministry of Tourism	Tourism activities in coastal regions
Ministry of mines	Mining activities in coastal regions

Marine environment and Agenda 21

The major objectives of Agenda 21 with reference to the marine environment are the preserving of ecologically sensitive areas, developing and increasing the potential of marine living resources, ensuring effective monitoring and enforcement with respect to fishing activities, improving the living standards of coastal communities, maintaining the health of the marine environment and addressing issues of critical uncertainty and climate change. To achieve these objectives, programme areas have been identified and these are discussed below.

Integrated management and sustainable development of coastal and marine areas, including exclusive economic zones

Agenda 21 urges governments to adopt an integrated policy and decision-making process to promote a balance of uses in coastal and marine areas. It also seeks to identify existing and projected uses of coastal areas and their interactions and concentrate on well-defined issues concerning coastal management. Agenda 21 identifies the need to promote the development and application of methods, such as natural resource and environmental accounting, that reflect changes in value resulting from uses of coastal and marine areas, including pollution, marine erosion, loss of resources and habitat destruction. It seeks to provide relevant information and opportunities to concerned individuals, groups and organizations for consultation and participation in planning and decision-making.

Marine environmental protection

To address the potential for degradation of the marine environment from a wide range of activities, Agenda 21 calls for the adoption of a precautionary and anticipatory approach to development planning. It encourages the integration of marine environmental protection into relevant general environmental, social and economic development policies and the adoption of economic incentives to apply clean technologies. Agenda 21 also stresses the need to improve the living standards of the coastal population.

Sustainable use and conservation of marine living resources of (i) the high seas and (ii) those under national jurisdiction

Sustainable use of marine living resources is a concern strongly expressed in Agenda 21. Marine living resources provide food and livelihood to coastal communities. Adequate knowledge, use of new technology and good regulatory measures are necessary to manage and conserve these resources. Agenda 21 aims at developing and increasing the potential of marine living resources to meet human nutritional needs, maintaining or restoring populations of marine species at levels that can produce the maximum sustainable yield, promoting the development and uses of selective fishing gear and practices that minimize waste in the catch of target species and minimize by-catch of non-target species. It also urges governments to ensure effective monitoring and enforcement with respect to fishing activities, protecting and restoring endangered marine species, preserving habitats and other ecologically sensitive areas and promoting scientific research with respect to marine living resources in the high seas. It emphasizes the need to take into account traditional knowledge and interests of local communities, small-scale artisanal fisheries and indigenous people in development and management programmes.

Addressing critical uncertainties for the management of the marine environment and climate change

The marine and coastal environment is vulnerable to the uncertainties of climate change. These changes may cause significant damage to the coast and inhabitants of nearby areas. In order to develop a good response strategy and reduce uncertainties, it is necessary to collect data systematically on various marine environmental parameters so that future conditions can be medicated. Agenda 21 seeks to promote scientific research on and systematic observation of the marine environment; promote exchange of data and information resulting from scientific research and systematic observation as well as from traditional ecological knowledge and ensure its availability to policy-makers and the public at the national level and cooperate with a view to the development of standard inter-calibrated procedures, measuring techniques, data storage and management capabilities for scientific research on and systematic observation of the marine environment.

Strengthening international including regional, cooperation and coordination

Agenda 21 recognizes the role of international cooperation in supporting and supplementing national efforts and stresses the need to improve coordination

and strengthen links among national and international institutions. It emphasizes the need to integrate relevant sectoral activities addressing the environment and development in marine and coastal areas at the national, sub regional, regional and global levels, as appropriate; promote effective information exchange and institutional linkages between bilateral and multilateral national, regional, sub-regional and inter-regional institutions dealing with environment and development in marine and coastal areas; promote within the United Nations system, regular intergovernmental review and consideration of environment and development issues and promote the effective operation of coordinating mechanisms for the components of the United Nations system dealing with issues of environment and development in marine and coastal areas, as well as links with relevant international development bodies.

Sustainable development of small islands

Small island developing states and islands supporting small communities are considered as a special case in Agenda 21. They are ecologically fragile and vulnerable. They are rich depositories of biodiversity as they shelter some unique species of flora and fauna. Agenda 21 urges governments to adopt and implement plans and programmes to support the sustainable development and utilization of their marine and coastal resources including meeting human needs, maintaining biodiversity and improving the quality of life for island people and adopt measures, which will enable Small Island developing states to cope effectively, creatively and sustainably with environmental changes and reduce the threats posed to marine and coastal resources.

Review and analysis of initiatives for protection of marine and coastal environment in India

Highlights of major initiatives

In order to protect its marine environment, the Government of India, even before 1992, had initiated a number of programmes. These acquired a new significance post-1992. To meet the objectives of Agenda 21, continuous monitoring of ongoing projects, acquiring of new technology and implementation of already-existing policies are being actively carried out. The following section highlights the major policies and programme areas of Agenda 21 that relate to marine resources, assesses the achievements, and identifies the areas that remain of concern. Table 11.2 highlights the major policies and

programmes adopted. The developments in policies post-Rio reflect responses to the changing international scenario, where there is a recognition that development needs to be attentive not only to the environment, but also to the people who have a stake in any such development.

Table 11.2 Highlights of major policies and programmes

Year	Relevant Acts, programmes and policies	Salient features and Amendments
1897	Indian Fisheries Act	Offers protection to fisheries against explosives or dynamites
1908	Indian Ports Act	Enactment relating to ports and port charges. Provides for rules for the safety of shipping and conservation of ports
1950	Coast Guard Act	Provides levying of heavy penalties for the pollution of port waters In 1993, Coast Guard under Ministry of Defence, made directly responsible for combating marine pollution. National Oil Spill Disaster Contingency Plan, formulated in 1996, under Coast Guard Act lays down action to be taken in the event of oil spills
1958	Merchant Shipping Act	Control of pollution from ships and off-shore platforms
1972	Wildlife Protection Act	Offers protection to marine biota Creates conditions favourable for *in situ* conservation of fauna and flora.Amended in 1991 to prohibit fishing within the sanctuary area Gahirmatha, annual mass nesting place for Olive Ridley turtle, an endangered species, accorded the status of marine sanctuary in 1997. Amended in 2001 to include several species of fish, corals, sea cucumbers and sea shells in Schedule I and III Whale shark placed in schedule I
1974	Water (Prevention and Control of Pollution) Act	Control of pollution from land-based sources includes tidal waters , unlike many other countries and has jurisdiction upto 5 km in the sea

Year	Relevant Acts, programmes and policies	Salient features and Amendments
1976	Maritime Zones Act	Describes various zones such as territorial waters, EEZ, Continental shelf etc.
1978	Marine fishing Regulation Act	A model act, which provides guidelines to the maritime states to enact laws for protection to marine fisheries by regulating fishing in the territorial waters The measures include: regulation of mesh size and gear, reservation of zones for various fishing sectors and also declaration of closed seasons. Laws framed and amended from time to time by different maritime states Coastal states ban fishing during closed season Different closure period for different states
1980	Forest Conservation Act	Protection to marine biodiversity
1982	Coastal Pollution Control Series (COPOCS programme)	Started in 1982 by CPCB Aims at assessing the pollution status of coastal waters
1986	Environment Protection Act (EPA)	Under this, the Coastal Regulation Zone 1991 has been notified. Standards for discharging effluents are listed
1991 (under EPA, 1986)	Coastal Regulation Zone Notification	Regulations on various activities in coastal zone. Classifies coastal zone into four categories specifying activities permitted and prohibited in each category Offers protection to backwaters and estuariesAquaculture was allowed as foreshore activity. The Supreme Court in 1996 banned all the aquaculture activities, except traditional and modified traditional, in the coastal zone upto 500m in most places. Aquaculture Authority was formed
1991	Deep Sea Fishing Policy	Allows foreign fishing vessels into Indian waters beyond 12 nautical miles. Protests from local fishermen Charter and leasing operations of foreign trawlers suspended in 1997 No granting of new licences to joint venture companies operating in the EEZ Deep Sea Fishing Policy, 1991 practically scrapped in 1997
1991	Coastal Ocean Monitoring and Prediction systems (COMAPS Project)	Being implemented from 1991 onwards Assesses the health of coastal waters and facilitates management of pollution-related issues Programme was restructured and modified in 2000-01 to include pollution monitoring; liaison, regulation and legislation; and consultancy services

Year	Relevant Acts, programmes and policies	Salient features and Amendments
1995	National Environmental Tribunal Act	This has been created to award compensation for damages to persons, property and the environment arising from any activity involving hazardous substances
1995	UNCLOS	A new international order established for oceans Provides a comprehensive legal framework for integrated treatment of issues relating to oceans and seas.
1995	Land Ocean Interaction in the Coastal Zone (LOICZ Project)	Aims to develop, on a scientific basis, the integrated management of coastal environments
1996	Coastal Zone Management Plans (CZMPs)	Supreme Court Intervention that all the Coastal states prepare their CZMPs by 1996
1997	National Environment Appellate Authority Act	Addresses appeals with respect to restrictions of areas in which classes of industries etc. are carried out or prescribed subject to certain safeguards under the EPA The objective is to bring in transparency and accountability and to ensure the smooth and expeditious implementation of developmental schemes and projects
1998	Turtle Exclusion Device (TED) mandatory in Orissa	Orissa High Court passed judgment in 1998 that all fishing trawlers be equipped with TED
1997-1998	Ocean Observation and Information Services (OOIS)	Generate reliable oceanographic data Various projects of DOD were restructured under this in
1998	Integrated Coastal and Marine Area Management (ICMAM Project)	Aims at integrated management of coastal and marine areas. Model plans for Chennai, Goa and Gulf of Kutch being prepared
Ninth Plan	DOD programme to assess living resources beyond 70 m depth	Major objectives were to have reliable and realistic information on the potential of marine living resources in the Indian EEZ for sustainable development and management and to augment sea food production and thereby the income of the coastal fishing community and the fishing industry. Initiated during the Ninth Five-year Plan for better understanding of the resources of the Indian EEZ, since the region upto 50–70 m depth is exploited almost to the maximum sustainable levels.
2000	The Biodiversity Bill	With an aim to protect and conserve biodiversity and sustainable use of its components the Biodiversity Bill is being placed in Parliament

Achievements

Integrated management and sustainable development of coastal and marine areas, including exclusive economic zones

Through the introduction of scientific research programmes and the legislation adopted, the GoI has been successful to a great extent in addressing the issue of sustainable development of coastal and marine areas. The Department of Ocean Development (DOD) was established in 1981, with an aim to implementing programmes for sustainable development of the Indian Ocean. DOD formulated the first Ocean Policy Statement (OPS) of the country, which sets out the basic principles through which the development of ocean resources is to be carried out. The OPS lays emphasis on sustainable exploitation of living and non-living resources and protection, preservation and conservation of coastal and marine environment. India is the first country to adopt such a policy.

The Ninth Five-Year Plan emphasizes the need for sustainable development and the strategy for natural resources management (including wild-life conservation and protection), in particular coastal resource conservation, with an emphasis on people's participation.

Projects introduced by the Department of Ocean Development such as the Integrated Coastal and Marine Area Management (ICMAM) aim at integrated management of coastal and marine areas. The concept of ICMAM has been adopted to facilitate the management of marine environment and biodiversity as well as for their monitoring. Decision support systems are being established for the management of critical habitats such as mangroves, coral reefs, areas rich in biodiversity, etc. under the ICMAM programme. The following activities are being undertaken under this programme.

- Development of GIS-based information systems for critical habitats containing all information necessary to prepare management plans.
- Determination of waste assimilation capacity at selected estuaries.
- Development of EIA guidelines for major coastal developmental activities and process.
- Determination of No Impact Zone for Pulicat and Coringa
- User classification of coastal zones for future developmental activities
- Infrastructure development for capacity building in ICMAM through training
- Development of model ICMAM plans for selected areas such as Chennai, Goa and Gulf of Kutch.

India also supports and participates in one of the core projects of the International Geosphere-Biosphere Programme (IGBP), the Land-Ocean Interactions in the Coastal Zone (LOICZ). This project was launched in India in 1995 for the integrated management of the coastal environment. The programme is aimed at determining the effects of global change on the coastal zone. LOICZ seeks to estimate fluxes of elements such as carbon, nitrogen, trace metals and major elements to the land and ocean. The primary objective is to improve predictive capability of changes in the coastal zone of India. The project also assesses economic and social impacts of development activities on the coastal population.

The Department of Ocean Development sponsors R&D projects in academic institutions, national laboratories and societies. These projects train and orient the scientists in specific fields in the ocean sector and deploy them in the R&D activities. Some of these scientists associate themselves with Universities and improve their academic qualifications also. The Department also provides research fellowship is carry out to doctoral and post-doctoral work to enhance their potential, knowledge and expertise. The Department sponsors short-term training programmes in specified areas. It has plans to establish infrastructure to train coastal states on the advanced tools and techniques for planning coastal zone management systems.

The Department of Ocean Development has been sponsoring research projects in different disciplines in a large number of national laboratories and academic institutions with the guidance of a Research Advisory Committee. Special grants are given to selected academic institutions to build infrastructure. Research fellowships an Research Associateships are granted for post-graduate and post-doctoral research in Marine Science in universities and national laboratories. To promote specialization in marine sciences in different universities, the Department formulated a scheme for establishing Ocean Science and Technology Cells (OSTC) in consultation with universities engaged in Marine Science research. These cells in the academic institutions will grow into Centres of Excellence in due course. So far eight OSTCs have been established.

Marine environmental protection

India’s rapid population, economic and industrial growth has created pressures on the coastal resources. Some coastal stretches in India are highly polluted with municipal waste deriving from urbanization and tourism, waste generated from industry, chemical agents from fertilizers and pesticides and silt from degraded

catchments. Untreated sewage and other non-industrial waste account more pollution than industrial effluents. Mining of sand from the sea-bed results in an increase in turbidity in the ambient water, which affects benthic organisms and primary productivity by limiting the availability of light. Aquaculture activity in some parts of India has also placed considerable pressure on coastal resources. Construction of breakwaters, which forms part of the port development, alters the sediment transport mechanisms in the coastal areas, thereby causing erosion or accretion.

A number of rules and laws regulate activities on the Indian coast. India has regulatory agencies such as the Central Pollution Control Board (CPCB) at the central level and State Pollution Control Boards (SPCB) at the state levels, constituted under Water (Prevention and Control of Pollution) Act, 1974 (for details refer to Chapter 2). The Aquaculture Authority of India has been constituted and guidelines on sustainable aquaculture development for regulating coastal aquaculture have also been developed. A National Contingency Plan has been formulated to combat oil spills in the EEZ of India with the Coastal Guard as the nodal agency.

The disposal of ship-based wastes is regulated by the Merchant Shipping Act, 1958 and by the adoption of MARPOL 73/78. Standards for discharging effluents are listed in the Environmental Protection Act, 1986. This serves as an umbrella act providing for the protection and improvement of the environment including coastal and marine areas. The effluents/discharges from various resources have to meet these standards before being discharged into marine waters.

The Coastal Zone Regulation Notification was issued in 1991 in India, under the EPA, 1986. The Notification aims at protecting and improving the quality of the coastal environment. The Notification declares the limits of the Coastal Zone and classifies it into four categories for purpose of regulation. CRZ I includes areas which are ecologically sensitive, areas of outstanding natural beauty, historical heritage or rich genetic diversity. CRZ II includes the areas that have already been developed up to or close to the shoreline. Areas that are relatively undisturbed are classified under CRZ III. CRZ IV includes the coastal stretches in the Andaman and Nicobar, Lakshadweep and other small islands except those designated as CRZ I, II and III.

The notification lays down certain prohibitions and also exceptions to prohibitions. Prohibited activities include setting up of new industries (except those which are directly related to the water front or which directly need foreshore facilities) and expansion of existing industries including fish

processing units, manufacture, handling, storage or disposal of hazardous wastes and substances, discharge of untreated wastes and effluents and dumping of municipal wastes as landfills or otherwise. Withdrawal of groundwater within 200 metres of the High Tide Line (HTL) is prohibited with some exceptions.

In most of these areas, an area of 200 metres from the high tide line (HTL) has been declared a no development zone. Several restrictions have been imposed for carrying out development in the area between 200 to 500 metres from the HTL. These measures have been adopted to protect fragile ecosystems which exists in the area and are vital for sustaining the ecological balance. Mangroves and coral reefs have been declared ecologically sensitive areas (CRZ I) under this notification and regular monitoring using satellite imagery is in progress. A state-wise Mangrove Committee has been formed for effective management of the mangrove ecosystem. Mining of corals and coral sands has been banned. The CRZ notification also offers protection to coastal communities such as traditional fishermen.

The Recycled Plastics Manufacture and Usage Rules, 1999; Municipal Soild Wastes (Management and Handling) Rules, 2000; Ozone Depleting Substances (Regulation) Rules, 2000; The Prevention and Control of Pollution (Uniform Consent Procedure) Rules, 1999, are some of the rules framed under EPA, 1986, with an aim to providing environmental protection and are relevant to the coastal environment.

Since 1982, the CPCB has been carrying out a rapid inventory annually to assess the pollution status of coastal waters of India. This programme known as the Coastal Pollution Control Series (COPOCS), comprises among other things, a) Identification of the uses of coastal water at different stretches and the best use among them; class designation of the sector or a portion thereof, and b) Identification of land-based pollutants and polluting activities and those that require immediate control.

The Coastal Ocean Monitoring and Prediction systems (COMAPS) programme was launched in 1991, by the Department of Ocean Development (DOD) for monitoring the health of India's coastal waters. The programme monitors the effect of anthropogenic activities on the marine environment periodically and assesses the impact on the marine flora and fauna in the coastal waters of India. Studies related to the waste assimilation capacity of coastal waters have been undertaken from 1997-98 onwards.

Efforts have been made to set up sewage treatment plants in all coastal states. Treated effluents are being discharged into deeper waters through

pipelines. The Government is also preparing an action plan for treatment of domestic wastes. Legislation has helped in the treatment of industrial wastes. In India, the Water (Prevention and Control of Pollution) Act includes tidal waters, unlike some other countries. The Act is applicable upto 5 km into the sea. Though the discharge of effluents from small-scale industries is still a problem, efforts are being made to set up common treatment plants. This will help in minimizing the load that is discharged to the sea.

Sustainable use and conservation of marine living resources of the high seas and under national jurisdiction

To address the concern for conservation of marine living resources, in some marine areas which support high biodiversity, such as the Gulf of Mannar and Wandoor (Andaman) have been declared as marine national parks, while some other coastal areas such as the Malvan coast (Maharashtra) and the Gulf of Kutch (Gujarat) have been declared marine sanctuaries. The Gahirmatha beach (Orissa) where mass nesting of the endangered Olive Ridley turtle takes place was accorded marine sanctuary status in 1997. Five species of marine turtle are found in Indian coastal waters. These are the green sea turtle *(Chelonia mydas),* Olive Ridley *(Lepidochelys olivacea),* loggerhead (*Caretta caretta*), leatherback sea turtle (*Dermochelys coriacea*), and hawksbill turtle (*Eretmochelyx imbricata*). Except for the Loggerhead, the other four species nest in India. The Bhitar Kanika Wild Life Sanctuary is another globally important site for nesting for the Olive Ridley turtle. A total of 32 critical habitats which include the Gulf of Kutch, Gulf of Khambat, Gulf of Malvan, islands off Karwar, islands off Kochi and Lakshadweep islands have been identified in India. Such measures offer protection to the flora and fauna of the region and help prevent any damage to the marine ecosystem. The Indian Coast Guard is empowered to prevent capture of endangered marine species under the Wild Life (protection) Act, 1972. A number of threatened marine species have been placed in Schedules I and III of the Wild life (Protection) Act, 1972. Some of these are the whale shark, sea horse, sea cucumber, sea shells and different types of corals. The most important of these is the whale shark, which is placed in Schedule I.

To protect and conserve biodiversity, the Biodiversity Bill, 2000, at present with a new set of recommendations, is being placed in Parliament. The details of this Bill are discussed in the Chapter on Biodiversity.

Various studies are being carried out for the assessment of marine living resources in India. These include marine environment and productivity studies carried out in the waters of the Andaman islands and the Arabian sea, fishery

resource surveys along the continental slope, studies on the deep scattering layer, toxic algal blooms, benthic productivity and harvest technology. The Fisheries Survey of India regularly assesses fishing resources upto 50-70 m depth. The Department of Ocean Development initiated a programme to assess the marine living resources beyond 70 m depth within the Indian EEZ in 1997-98. There are plans to encourage sea ranching and mariculture in order to increase marine production. The technology for generation of Potential Fishing Zone (PFZ) information and retrieval of Sea Surface Temperature (SST) data help assessing fishing zone information.

India is a major exporter of seafood. The export of marine products from India has gone up by 28% quantitatively and 19% in terms of value during the last financial year. According to the marine Products Export Development Authority (MPEDA), India exported 440,473 tonnes of seafood valued at $1.4 million dollars in 2000-01 as against 343 031 tonnes valued at $1.2 million during 1999-2000. Frozen shrimp (70%), fish, cuttlefish and squid are the major export earners and account for 92.64% of the total exports. Japan is the major market (40% in terms of value and 16% in terms of quantity) followed by Europe. China is the largest single importer of Indian seafood in terms of quantity.

Aquaculture activity got a boost in the early 1990s in the coastal parts of India on account of economic liberalization policies initiated by the GoI. The increased production was both a result of increased area under expansion and increased productivity. Coastal aquaculture in India is mainly related to shrimp farming. The contribution of cultured shrimps to the total shrimp export increased from 48.78% in 1988-89 to 75.07 % in 1998-99. However, it suffered a setback with the Supreme Court declaring it contrary to the CRZ notification and banning all aquaculture activities, except traditional and improved traditional within upto 500 m of the High Tide Line (HTL) in most coastal areas.

The government has made extensive efforts to promote investments in the fisheries sector. Infrastructural facilities for handling, preservation, processing and marketing of fish have been improved. A number of ice plants and storage facilities have been created. Fishery harbours with berthing facilities and road links to fish landing centres have been set up. The Government of India has organized training programmes for people from different sectors. Financial assistance in the form of loans and subsidies is offered to small-scale farmers (aquaculture), trawler owners or for any small fishing craft. A number of programmes have been undertaken by fishermen's organizations to educate active fishers. They are encouraged to form fishery cooperatives for proper

exploitation of fishery resources. The government has also introduced a few welfare schemes for fishermen. A free Group Accident Insurance Scheme has been introduced as a measure to provide social security.

To prevent overexploitation of fish stocks and protect the interests of coastal communities, the following legislation / rules / acts are in force in the country.

- The Maritime Zones of India (Regulation of fishing by Foreign Vessels) Act, 1981 provides regulations for foreign fishing vessels operating in Indian waters. The Coast Guard and the State / UT Police has been authorized under the Act to apprehend and prosecute unauthorized foreign fishing vessels / crew for fishing / poaching in Indian waters.
- The Marine Fishing Regulation Act (MFRA), 1978. Consistent with the guidelines contained in the MFRA, 1978, which is a model act, providing guidelines to the maritime states, legislations have been encated and enforced for regulating fishing and conservative measures in territorial waters. Such state enactments provide for regulation of mesh size to avoid catching juvenile fish, regulation of gear to avoid over-exploitation of certain species, reservation of zones for various fishing sectors to provide exclusive rights to traditional fishermen to fish unhindered in near-shore areas and also for declaration of closed seasons during the fish-breeding period to avoid catching of young juvenile fish.

These state enactments, have been provided with a view to protecting fisheries and assisting traditional fishers provide zonation within which activities such as mechanized fishing, are prohibited.

In the states on the south east coast i.e. Tamil Nadu and Andhra Pradesh the zonation is 3-6 nautical miles from the coastline. On the west-coast and the north east coast i.e. Orissa and West Bengal, an area up to 7-10 nautical miles is earmarked for traditional fishers.

The Government of India constituted a committee in March 1995 to review the Deep-Sea Fishing Policy of 1991. On the basis of the recommendations of this Committee, the policy was revoked and no new permits, extensions or renewal of fishing permits under the above policy are being given. The Government has had this matter examined and is now in the process of drafting a new policy.

The fishery survey of India has studied the availability of tuna in the EEZ. Tuna resources are estimated at between 220,000 and 250,000 tonnes per annum.

The current level of exploitation is about 10,000 tonnes per annum, most of it coming from the Lakshadweep archipelago.

The scientific community in India has also focused on deriving biologically active compounds from marine organisms. The National Institute of Oceanography has identified a marine microbial strain for bio-bleaching in the paper industry. A mangrove fungus has been successfully used in pilot studies by a paper industry and has since been patented. The research on developing potential drugs and chemicals from marine flora and fauna is ongoing.

Addressing critical uncertainties for the management of the marine environment and climate change

India has introduced some programmes for the long-term monitoring of oceanographic parameters to address the issue of critical uncertainties. These are the Sea Level Monitoring and Modelling (SELMAM) Project, National Data Buoy Programme (NDBP), Satellite And Coastal Oceanographic Research (SATCORE) Project, Experimental Ocean State Forecast (E-OSF) programme, Indian Ocean Modelling and Dynamics (INDOMOD) etc. A set of three current meter arrays at pre-selected locations along the equator in the Indian Ocean for long-term monitoring of the current structure is proposed. Various projects of the Department of Ocean Development were restructured and reoriented in 1997-98 as Ocean Observation and Information Services (OOIS) in order to generate reliable data.

Strengthening international, including regional, cooperation and coordination

India is a member of various committees of the Global Ocean Observing System (GOOS). This is a programme to collect long term systematic scientific oceanographic data at a national, regional and global level. The South Asia network of Global Coral Reef Monitoring network (GCMRN) consists of India, the Maldives and Sri Lanka. The network has commissioned four pilot reef-monitoring exercises.

During the year 1999-2000, India made contributions to international commissions and organizations such as the UNCLOS, ISBA, COMNAP/SCALOP, CCAMLR, Regional Sea Programme etc. India effectively participated in the IOC Executive Council and other meetings of IOC, IOCINDO, International Sea bed Authority, 7th UN Commission on sustainable development, XXIII Antarctic Treaty System (ATS), 2nd meeting of Environment

Protection of ATS, Commission for Conservation of Antarctic Marine Living Resources etc.

India also is actively involved in the Inter-governmental Oceanographic Commission, UN Convention on the Law of the Sea, Antarctic Treaty System, and the UNEP Regional Seas Programme. Scientific and technical bilateral cooperation with other nations, e.g. Russia, Germany, Republic of Korea, Argentina, Peru, Italy and others, has been established. India has also ratified the International Convention for the Prevention of Pollution from Ships (MARPOL Convention 73/78). Some of the other international conventions on environment ratified by India are the International Convention for the Regulation of Whaling, International Plant Protection Convention, 1951, Cconvention on Facilitation of International Traffic, 1965, International Convention on Loadlines, International Convention on Tonnage Measurement of Ships, International Convention on Civil Liability for Oil Pollution Damage, 1969, Special Trade Passenger Ships Agreement, 1971, International Convention on Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971, Convention on the International Regulations for Preventing Collisions at Sea, 1971, as amended (COLREG 1972), International Convention of Safe Containers, 1972, Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973, International Convention for the Safety of Life at Sea, 1974, Framework Convention on Climate Change, 1992, Convention on Biodiversity, 1992. India is also a signatory to the Convention of Wetlands of International Importance, protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, Vienna Convention for the Protection of the Ozone Layer, Convention on Migratory Species, Basel Convention on Trans-boundary Movement of Hazardous Substances, Montreal Protocol on Substances that Deplete the Ozone Layer.

Sustainable development of small islands

The Andaman and Nicobar Islands and Lakshadweep archipelago are the major islands in India. Special emphasis on island development was given in the Ninth Five-Year Plan programme proposed by the DOD. This includes a programme on lobster resource enhancement, which has been implemented from 1998 onwards. The GoI has initiated a number of steps for sustainable development of these small islands:

- Under the CRZ Notification, 1991 of EPA (1986), these islands are classified as a separate category (CRZ IV). Prohibitive activities include mining of

corals in the coral reef area along with other restricted and regulated activities.

- An Island Development Authority (IDA) has been constituted. It was directly under the chairmanship of the Prime Minister earlier but the deputy chairman of the Planning Commission is the current Chairman of the IDA. It takes up measures for ensuring sustainable development of the islands on scientific lines.
- The Andaman and Nicobar Integrated Development Corporation has been set up to undertake sustainable development in an integrated manner.
- An Island Development Programme is being implemented at the National Institute of Ocean Technology, Chennai. This programme aims at the transfer of technology in the area of marine living resources so that the island community can avail of socio-economic benefits.

Concerns

As in the other parts of the world, coastal areas in India are increasingly under pressure from anthropogenic activities. The major areas of concern are overexploitation of coastal resources and the impact of land-based activities and ship traffic. A number of issues arise in the management of India's marine environment, despite the programmes in place. These can be listed as follows.

- Sustainable use and conservation of marine living resources has been the central concern of Agenda 21. Over the last 25 years there has been a considerable influx of non-fishermen communities into the fishing sector. Entry of more people tends to encourage over exploitation though, in the Indian Ocean this is not as alarming as in some other parts of the world. Nevertheless, it is noted that though the marine production has not exceeded the maximum sustainable yield (MSY), fishery resources in India's coastal waters in the 50-70 m depth are almost fully exploited (Devaraj, 1996; Somvanshi, 1997; Biradar and Thakur, 1999; Zingde, 1999; Devaraj and Vivekanandan, 1999). Inappropriate exploitation patterns such as concentration of fishing efforts in coastal waters is having a detrimental effect on Indian fisheries (Devaraj and Vivekanandan, 1999). In addition, marine pollution has led to a degradation of the marine resource potential and marine biodiversity. Some of the species are over-exploited and endangered. The Government of India is cognizant of these and is taking measures to protect the marine environment against overexploitation of its living resources and pollution. However, strict implementation of government policies is needed.

- The following issues deserve immediate attention. Pollution from use of persistent organic pollutants (POPs) such as DDT for crop protection and the issue of adoption of a legal instrument on the control of POPs.
  - The effect of antifouling paints used on ships on marine organisms and the adoption of the ban as targeted for the year 2006 by the IMO
  - Transfer of exotic species through ship fouling and ballast water
  - A need for providing adequate and appropriate support from developed countries to ocean-related capacity-building in developing countries
  - A need for some form of international involvement in the management of the high seas fishery resources, as observed by the UN Conference on Straddling and Highly Migratory Fish Stocks.
  - The release of persistent hydrocarbons through ship traffic and their effect on global warming and climate change
  - Policies for coastal aquaculture, keeping in view socio-economic and environmental aspects, need to be framed.

Studies on these aspects have been initiated in institutions of the DOD.

- Weak enforcement of rules and laws and a fragmented approach towards the implementation of government policies is a serious concern. Difficulties in enforcement stem from conflicts between stakeholders such as the corporate class and the traditional communities, foreign operators and local fishers, between different departments or agencies of the governments and even between state governments and the central government.
- The Notification on Coastal Regulation Zone (CRZ), 1991, ensures protection to the coastal zone. However, a number of problems occur in its enforcement. A committee was appointed, headed by B B Vohra to examine certain issues related to coastal ecology and CRZ notification. Some of the recommendations were accepted while some others were modified and incorporated by an amendment in 1994 to the CRZ Notification.
- A good deep-sea fishing policy is awaited. The deep-sea fishing policy introduced by the GoI in 1991 did not work due to lack of patrolling and weak enforcement. Traditional fishers protested against the foreign vessels fishing illegally within the area reserved for traditional fishers. As a result of these protests, the deep-sea fishing policy of 1991 had to be practically scrapped in 1997. In order to relieve the pressure on coastal fisheries, deep-sea fishing has to be encouraged.
- Promotion of coastal shelterbelt plantations for prevention of natural calamities is necessary. Coastal communities need to be protected against

natural calamities and the damage caused. GoI realizes the role of ecologically protective areas, such as mangroves, as receptacles of storms and flood water and the protection they offer to coastal communities during natural calamities. This concern is addressed in the Approach Paper to the Tenth Plan (Planning Commission, 2001).

- Protection of the interests of various stakeholders can be ensured only by their involvement in the policy-making process. This aspect is central to the process of ensuring better policies as well as the equally important issue of their effective implementation and enforcement.

Towards a healthier marine environment

The Government of India has given considerable attention to commitments under Agenda 21 with regard to the marine environment. The Government has been successful in collecting scientific data in various fields of oceanography. What is required now is to recognize the linkages between the health of the environment and anthropogenic activities, through a more detailed study of the processes involved, their linkages with the social system and a greater use of inputs from the social sciences. Because of the multiple uses to which coastal areas can be put, the major challenge in coastal management is resource-use conflict in coastal areas. Such conflicts of interest arise between traditional and development cultures, between different users, between the small, medium and large fishermen and between the coastal community and the polluters (Mehta, 1999). These conflicts can be meaningfully resolved through an integrated approach that assimilates inputs from various disciplines and a greater use of multi-stakeholder consultation at all levels.

Agenda 21 highlights the need for proper exploitation and conservation of marine living resources. At present, 90% of the fish potential upto depths of 50 m is being tapped. There are no significant fishing efforts beyond this depth, especially beyond 100 m. Attempts need to be made to encourage deep-sea fishing. It is estimated that 0.5 m of the unexploited stock in the deep-sea are tunas which undergo transoceanic migration. In order to exploit these stocks, it is necessary that the neighbouring countries share information on the biological characteristics and their distribution. The deep-sea fishing policy of the GoI has to take into account the interests of traditional fishermen, whilst increasing marine production. The Murari Committee also recommended this. The new deep-sea fishing policy will address these issues.

The following issues call for international cooperation and some of these were discussed at the in the seventh session of UN Commission of Sustainable Development (CSD):

- With respect to imposing a ban on use of persistent organic pollutants (POPs) such as DDT, transfer of the expertise and technology, to developing countries such as India, to develop insecticides / pesticides which are eco-friendly is necessary. No viable and affordable alternatives to POPs, which have an effective role in the control of harmful microbes, are available as yet in India. Hence keeping in view the usefulness of the POPs in public health programmes and food security, a legal instrument banning POPs need to be reviewed.
- The effect of antifouling paints used on ships on marine organisms is being studied in India. The harmful effects of antifouling paints such as change of sex in Gastropoda, shell thickening, imbalances in growth and the reproductive stages and, on larvae in oysters and mussels and on primary productivity are well known. Regulations controlling the use of harmful paints and a proper plan for eliminating / phasing them out need to be developed. Development of such a regulatory framework under the International Maritime Organization is expected on favourable and preferential terms the developing countries.
- There is no data yet on the transfer of exotic species through ship fouling and ballast water. This issue has been addressed recently by the DOD through scientific studies.

Coastal management strategies also need to consider the socio-economic and cultural aspects of the coastal population, besides environmental issues. Such a need to improve living standards of coastal population is emphasized in Agenda 21. Adequate financial credit and banking facilities need to be provided to fishermen for upgrading their technology and improving their financial position. It is also necessary to provide alternative means of livelihood to the family members of the fisher community so that the pressure on coastal fishing does not increase further. Ecological know-how in the preservation, conservation and exploitation of marine living resources is necessary. *In situ* gene banks and more area for marine sanctuaries and parks is necessary to preserve the biodiversity of marine fauna and flora. At the same time, the interests of coastal fishermen and their employment in the fishing industry have to be protected.

A healthier marine environment needs integrated policy approaches, which involve scientific disciplines to address the complexity of the interaction between the social and natural systems in the coastal and marine environment. The need for a single administration to deal with governmental responsibilities for policy implementation is recognized and the GOI is taking steps to initiate programmes which involve inter-departmental collaboration.

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