Marine Biodiversity in India: Satus and Issues

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Introduction

The importance of marine biodiversity can be visualized from the fact that the sea waters cover about 71% of the Earth's surface and account for 99% of volume that is known to sustain life. The diverse marine and coastal habitats harbour a wide range of biodiversity. The total number of recorded marine species (both plants and animals) is less than that of terrestrial habitats. It is because of the fact that marine diversity has not been fully understood due to logistic constraints in explorations and collection of specimen. However, it is also a fact that marine animals are more diverse than land animals at higher phyletic level. All phyla except one are found to occur in the sea. On the other hand, only about half of the total number of phyla is represented by land animals. The range of body forms and structure of marine animals are more than that of land animals. Similarly, marine plant life forms also show greater survival strategy.

Marine diversity is mostly studied in waters along the coast and around the islands. Coastal zone represents 18% of the Earth surface providing space to about 60% of the human population. It is very important bio-geochemically as it buries and mineralizes 89 to 90% of organic matter and acts as a sink for an estimated 50% of the global carbonate deposition. It has a high biological potential as it provides feeding, nursery and spawning grounds to a rich variety of marine life forms.

Status of Marine Biodiversity

Like its rich terrestrial biodiversity, India is equally rich in marine biodiversity. India's coastline which is more than 7500 km in length including those of islands of Andaman & Nicobar groups and Lakshadweep, harbours unique marine habitats which display a wide variety of marine biological diversity. The variety of coastal ecosystems along Indian coastline includes estuaries, lagoons, mangroves, backwaters, salt marshes, rocky coasts, sandy stretches and coral reefs. These marine habitats play very significant role in ecological and economic stability of the country.

The coastal waters along the East and West Coast of the country and also around the two island groups have a plethora of marine species. The marine floral diversity includes 844 species of marine alga (sea weeds) belonging to 217 genera, 14 species of sea grasses and 69 species of mangroves.

The marine faunal diversity includes a wide variety of life forum. The Indian coastal water harbours 451 species of sponges, more than 200 species of corals, more than 2900 species of crustacean, 3370 species of marine mollusks, more than 200 species of bryozoans, 765 species of echinoderm, 47 species of tunicates, more than 1300 marine fishes, 26 species of sea snakes, 5 species of sea turtles and 30 species of marine mammals including dugong, dolphins, whales etc. In addition a wide variety of sea birds can be observed around the coast.

Marine Ecosystems

The marine environment in India consists of a variety of ecosystems occurring along the coastline which borders the Indian peninsula and encircles the two major Island groups. The Indian coastline measures 7,516 km of which the mainland part measures 5,422 km and that around the two major island groups measures 2,094 km (132 km around the Lakshadweep and 1962 km around the Andaman & Nicobar Islands. The mainland coast is divided into the West Coast and the East Coast. These two coasts are significantly different in their geomorphology. The West Coast is usually exposed with heavy surf, rocky shores and headlands while the East Coast is generally shelving with beaches, lagoons, delta and marshes. The coastal zone of India exhibits a wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marshes etc. A brief description of major marine ecosystems of India is given here.

(i) Estuarine Ecosystems

Estuaries mark the transitional zone between the lower tidal region of a river and the marine environment. They are sheltered coastal water bodies which act as nutrient traps, shelter and nursery for a wide variety of marine life forms. They are very important from commercial, industrial and recreational point of view. There are 14 major estuaries on the East Coast and 16 on the West Coast. Major East Coast estuaries are Adyar, Agniyar, Corum, Edaiyur, Ennire, Godavari, Hoogly, Kallar, Kavery, Kollidam, Krishna, Rushikulya, Uppanar and Vellar. The major West Coast estuaries are Asthamudi, Amba, Beypore, Gangolli, Kali, Kaninamkulam, Korapuzha, Madovi, Mahi, Mahim, Netravathi and Gurupur, Pavenje, Periyaar, Vembanad and Zurai. The total estimated area under the estuaries in India is approximately 2 million ha (Qasim & Sengupta, 1984).

The estuarine ecosystems are under heavy anthropogenic pressures mainly due to urbanization and industrialization. Dumping of sewage, inflow of municipal waste water and industrial effluents into these water bodies are causing extensive damage to these ecosystems. The aquaculture activities around estuaries have also resulted in heavy accumulation of heavy organic and inorganic pollutants.

(ii) Lagoon Ecosystems

A lagoon is a shallow water body along the low lying coast separated from the ocean by a barrier but also connected to the ocean by one or a few restricted inlets. There are 8 major lagoons on the East Coast and 9 on the West Coast. Major lagoons on the East Coast are 1. Bende, 2. Chilka, 3. Gulf of Mannar, 4. Muthupet, 5. Muthukadu, 6. Nizampatnam, 7. Pennar and 8. Pulicat. Lagoons on the West Coast are 1. Asthamudi, 2. Ettikulum, 3. Lagoons of Bombay Coast, 4. Lagoons of Lakshadweep atolls, 5. Paravur, 6. Murukumpuzha, 7. Talapady, 8. Veli and 9. Vembanad. Lagoon ecosystems are also getting adversely affected by the urbanization, industrialization and aquaculture activities in the same ways as estuarine ecosystems.

(iii) Seagrass and Seaweed Ecosystems:

Seagrasses are monocotyledonous plants found submerged in shallow and sheltered localities of sea, gulf, bays, backwaters and lagoons. They play an important role in the conservation of many endangered species like dugong, marine turtles etc. About 14 species are reported along the Indian coast. In Andaman & Nicobar Islands, 9 species are found extensively.

Seaweeds on the other hand are found mostly on flat and rocky coastal wetlands which are submerged during high tides and subsequently get exposed during low tides. They are found in abundance on the West Coast, Andaman & Nicobar Islands and Lakshadweep, but less frequently along the East Coast. About 120 species of seaweeds have been recorded in the coastal

region of India. Seaweeds are known to remove or consume the nutrients like nitrogen and phosphorus from domestic sewage and other effluents, thus, reducing eutrophication. They contain bioactive substances and are important sources of fertilizers and many other commercially important substances.

Mangrove Ecosystems

Mangroves are salt tolerant forest ecosystems found mainly in tropical and sub-tropical inter-tidal regions of the world. They are trees or shrubs that have the common trait of growing in shallow and muddy salt water or brackish water, especially along quiet shorelines and in estuaries. They exhibit remarkable capacity of salt water tolerance.

Total mangrove area in the world is about 14 million ha (Finlyason and Moser, 1991). Of this, Indo-Pacific tropical zone and Tropical Australia have the most dominant mangroves. These regions are also important in respect of species diversity and richness of mangroves, mangrove abundance and successions. The most dominant and single large mangrove chunk of the world is situated in the Ganga-Brahmapitra-Magna deltaic regions or estuarine mouth in both India and Bangladesh (Naskar and Mandal, 1999). In India, 69 species of mangroves belonging to 42 genera and 27 families are found. Area under mangrove cover in India represents about 2.6% of world's total mangrove area. As per the latest satellite data based survey done by the Forest Survey of India (2003), mangrove cover in India is 4,461 km^2. Of this, about half of the mangrove cover is in Sunderbans of West Bengal (2,120 km^2), followed by mangrove cover in Gujarat (960 km^2) and Andaman & Nicobar Islands (671 km^2).

Mangroves protect shoreline from the action of waves, storms and cyclones, thus prevent coastal erosion. They provide shelter and breeding grounds to a wide variety of marine life forms and also act as nursery to juveniles and larvae of many marine animals. Mangrove ecosystems play an important role in the economy of people living around the coastal areas. They provide a wide variety of goods and services including wood, fuel and support for fishing, aquaculture and tourism.

Mangrove ecosystems are considered as one of the most productive ecosystems on earth, yet they are under serious threats from anthropogenic activities. Development works along the coast, urbanization, flow of pesticides and insecticides from the agriculture fields, over-exploitation, heavy tourism etc lead to degradation in these unique ecosystems.

(iv) Coral Reef Ecosystems:

Corals are tiny organisms belonging to group Anthozoa of Phylum Cnidaria. These animals are capable of secreting a massive calcareous skeleton and collectively deposit calcium carbonate to build ornate and sometimes large colonies. Concerted growth of a variety of corals in a localized habitat gives rise to a coral reef, a complex system which consists of a variety of animals including corals and plants. The combinations of shapes and colours as well as the variety of corals and other animals in a reef make it a fascinating and unique ecosystem

There are mainly three types of coral reef formations-fringing reefs, barrier reefs and atolls. In India, all three types occur. Fringing reefs are found in Gulf of Mannar, Gulf of Kachchh and Andaman & Nicobar Islands. Barrier reefs are reported on the western side of Andaman group of Islands and atoll formations are common in Lakshadweep islands. A total of 199 species of corals belonging to 71 genera are recorded from Indian Ocean (Pillai, 1996). A subsequent survey in Andaman group of islands by a team of UNDP and Indian experts in 2000-01 has indicated occurrence of more than 200 species of corals in Andaman islands alone. The total number of coral species if surveyed and identified properly may increase further.Coral reefs are among the most dynamic and productive ecosystems of the world. They prevent coastal erosion, act as primary producer and are important breeding and nursery ground for shell fish. They provide shelter to juvenile fish and larvae of many organisms. They also provide sustenance and employment to people living around.

Coral reefs are affected by both natural as well as anthropogenic threats. Natural threats include damage by storms, hurricanes, strong waves, diseases like white-band disease, predation by the 'crown of thorns' starfish and bleaching due to rise in sea surface temperature.

Coral reefs are very fragile ecosystems and sensitive to changes in surrounding environment. Therefore, increased sedimentation and siltation, oil spills from motorized boats and ships, faulty anchorage of boats and ships, destructive fishing methods, etc cause damage to reefs. Deforestation, faulty agricultural practices, sewage, eutrophication etc are also responsible for degradation of coral reefs.

Conservation issues

Conservation issues of marine biodiversity encompass a variety of issues like socio-economic, economic, environmental and legal issues as well as scientific and technological issues.

A. **Socio-economic issues:** Socio-economic goods and services provided by the marine ecosystems include food, medicines, raw materials, tourism, education, research, employment etc. A healthy marine environment in a nation can contribute significantly to the food security and employment generation. Marine ecosystems are a pool of important genetic resources. The pace of discovery of new species as well as products that are potentially useful to pharmacology, is higher for marine and microbial life than for the terrestrial organisms. Marine drugs could be used as antioxidants, antifungal, and antibiotics and to fight diseases like HIV/AIDS, cancer, tuberculosis, malaria, osteoporosis, Alzheimer's disease and cystic fibrosis (UN University, 2005). The degradation in the marine environment thus would definitely cause significant harm to human health and livelihood (Millennium Ecosystem Assessment, 2005).

B. **Economic issues:** Most of the benefits provided by the biodiversity and ecosystems are public goods and are considered as non-market goods as markets do not place any monetary value on their conservation and use (Report, 2004) and therefore there are no incentives to ensure their continued supply.

In the valuation of ecosystem and biological resources, usually only market values are taken into consideration for decision making and often discounting is also applied. Discounting is used to reduce the urge to 'focus on the current or short-term cost of conservation and to avoid disregarding future and long-term benefits of maintaining biological resources. However, there is no agreement by economists on the discounting methods to be used.

Gross undervaluation of biodiversity particularly of ecosystem services is also responsible for lack of conservation efforts. The goods and services which do not enter the marketplace are largely overlooked. Countries depleting their natural resources can appear to be experiencing economic growth, but in reality the erosion of their natural wealth is not reflected in their balance sheets (Newel and Pizer, 2001). Moreover the ecosystem goods and services that are not traded in the marketplace do not send price signals that warn changes in their supply or status (Daily *et. al.,* 1997). Therefore, in spite of the fact that the biodiversity is of great importance to society, its importance is not reflected in the marketplace and there appears to be a lack of will to allocate adequate budget provisions for its conservation. There is a need to frame policies envisaging a balance between ecosystem services and economic development.

Some of the economic options which are being considered potential tools for conservation and suitable use of marine biological diversity include 'internalizing environmental externalities', elimination of perverse incentives, imposing taxes, rewards for environmental services and property rights over 'commons'.

(i) **Internalizing environmental externalities:** The cost of environmental impacts arising out of the actions of people and companies, are often paid by everyone affected in absence of suitable regulatory mechanisms. It is important that those who exploit biological resources should pay full cost of their acts including any damage or harm that may result from the overexploitation of resources. The process of making economic actors recognize and assume responsibility for environmental

and social costs is known as 'internalizing externalities'.

(ii) **Elimination of perverse incentives:** Incentives such as subsidies to promote economic growth may discourage conservation, for example perverse subsidies in fishing industries are incentives to fishermen to overfish. The Million Ecosystem Assessment report (2005) has highlighted the need to eliminate subsidies that promote excessive use of ecosystem services and wherever possible transfer these incentives to payment of non-marketed ecosystem services.

(iii) **Imposition of taxes :** Taxes can be imposed on polluting materials, wastes, emissions and other activities that affect the environment. Revenue from these taxes would raise additional funds that could be used for conservation projects and also discourage environmentally damaging activities.

(iv) **Payments for environmental services:** Those who provide environmental services should be compensated for doing so and those who receive the services should pay for it (Pagiola and Platais, 2002).

(v) **Property rights over the 'commons' :** It is also viewed by experts that replacing open access with some form of property rights could stimulate economic measures for protection of ecosystems (Report, 2004). This will lead to creation of markets based on premise that holders of these rights would maximize the value of their resources over time, thereby optimizing biodiversity use, conservation and restoration (Policy Brief, 2005). Licences that establish a form a property rights and encourage sustainable use will result in self-regulation which will be more useful in areas beyond national jurisdiction where it is more difficult to enforce protection measures. The establishment of appropriate forms of property rights in conformity with international legal regime could also constitute a basis for the development of exchange market. Exchange markets have already been established for sulphur-di-oxide, nitrogen oxide and carbon di oxide. Similar type of markets could be envisaged for marine biodiversity conservation.

C. **Environmental issues :** Oceans are believed to contain vast energy and mineral resources and shelter major biological resources. They play a key role in biogeochemical cycles that regulate oxygen and carbon di oxide, the vital components of life on Earth. The marine diversity and ecosystems are increasingly affected by a wide array of anthropogenic activities which include fishing, pollution, introduction of alien species, waste disposal, mineral exploitation, anthropogenic underwater noise, marine debris, scientific research, carbon sequestration, tourism, laying of pipelines and cables and activities leading to climate change.

D. **Legal issues :** The struggle among the coastal states for control over marine areas led to the development of the Laws of the sea. After the Second World War, the international community approached the United Nations International Law Commission for codifying laws relating to oceans. The Commission started its on framing laws of the Sea in 1949 in the first United Nations Conference on the Laws of the Sea (UNCLOS-I) which was held from February 24 to April 29, 1958, following four conventions collectively known as the 1958 Geneva Conventions were adopted:

(i) the Convention on the Territorial Sea and Contiguous Zones
(ii) the Convention on the High Seas
(iii) the Convention on Fishing and Conservation the Living Resources of the High Sea
(iv) the Convention on the Continental Shelf

The UNCLOS-II was held from March 17 to April 26, 1960 but did not result in any agreement. In 1962, the World Conservation on National Parks considered the need of protection of coastal and marine areas. In 1971, the Convention on Wetlands of International Importance was developed and it included many coastal

marine habitats. The Convention for the Protection of the World Culture and the World Heritage adopted in 1971 included marine areas also as areas of 'outstanding universal value'.

The Governing Council of United Nations Environmental Programme (UNEP) was set up in 1972 to ensure that adequate attention was paid by the Governments to the emerging environmental problems. This was followed by a series of Conventions and Action Plans for the conservation of marine environment under the Regional Sea Programmes. A Conference was held in Tokyo in 1975 by the IUCN (International Union on the Conservation of the Nature) where the increasing pressures on the marine environment were discussed. In 1982, the IUCN Commission on National Parks and Protected Areas (CNIPA) organized a series of workshops on creation and management of coastal and marine protected areas.

The Third United Nations Conference on the Laws of the Sea (UNCLOS-III) continued from 1973 to 1982. Over160 nations participated in the 9 year convention which finally came into force on 14th November 1994. Some of the significant features of the Convention were related to the protection of marine environment. The conservation and management of living resources of the high seas is addressed in Articles 116 to 120 of UNCLOS. The protection and preservation of marine environment is addressed in general in Part XII of UNCLOS.

In the First World Biosphere Reserve Congress organized in Minske, USSR by UNESCO in 1983, it was recognized that the Biosphere Reserves Concept is potentially applicable to the marine environment and that an integrated multiple-use Marine Protected Area can represent all the scientific, administrative and social principles that define a Biosphere Reserve under the Man and Biosphere (MAB) progamme of the UNESCO.

The report 'Our Common Future' published in 1987 by the World Commission on Environment and development (WCED) highlighted the importance of marine conservation. At the same time, the General Assembly of the United Nations adopted the 'Environment Perspective to the Year 2000 and Beyond' developed by the UNEP in tandem with the WCED report.

.The Convention of Biological Diversity (CBD) which is complementary to UNCLOS in its specific objectives, was negotiated under the auspices of the UNEP. It was opened for signature in June 1992 at UN Conference on Environment and Development (UNCED) and came into force on 29 December 1993. More than 170 countries have become party to it. The three goals of the CBD are to promote the conservation of biodiversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. The subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) which advises the Conference of the Parties (COP), meets several months prior to each COP.

The first meeting of COP was held in Nassau, Bahamas from 28 November to 9 December 1994. The second meeting of COP held in Jakarta, Indonesia from 6-7 November 1995 had been important from marine diversity point of view is known as Jakarta Mandate of Marine and Coastal Diversity. Its programme of work which was sought to be implemented at national, regional and global level, was adopted in 1998 and reviewed and updated in 2004. Through it, the Convention focuses on integrated marine and coastal management, the sustainable use of living resources, marine and coastal protected areas, mariculture and alien species, and genotypes. It also provides a general element to encompass the coordination role of the Secretariat, the Collaboration linkages required and the effective use of experts, as well as enabling activities to assist Parties in overcoming obstacles to implementation.

The Programme for the Development and Periodic Review of Environmental Law for the First Decade of the Twenty First Century (Montevideo Programme III) of the UNEP (180) under the theme 'conservation and management' calls for the promotion and improvement of the integrated management, conservation and sustainable use of coastal and marine resources and ecosystems. The Programme was adopted by UNEP Governing Council by its decision 21/23 of 9 February 2001.

The UNEP Regional Seas Programme was launched in 1974 to address the increasing degradation of the

world's oceans and coastal areas, through the sustainable management and use of marine and coastal environments. New regional seas strategic directions for 2004-2007 were developed by the sixth Global Meeting of the Regional Seas Conventions and Action Plans in 2004 for providing the implementation of biodiversity related conventions such as CBD, the Convention on the International Trade in Endangered Species (CITES), the Convention on the Migratory Species, the Convention concerning the Protection of the World Culture and Natural Heritage and the Convention on the Wetlands of International Importance. The collaboration between the secretariat of the CBD and the Regional Seas Coordinating Unit of INEP currently focuses on two major activities;

(a) the development of a cooperative initiative for the management of marine alien species, also in collaboration with Global Invasive Species Programme, and

(b) the establishment of regional marine protected area networks.

The Regional Seas Programme and the secretariat of the Endangered Species Convention, the Whaling Convention, the Convention on Biological Diversity and the Convention on Migrating Species are also collaborating in Marine Mammal Action Plan.

The Indian Scenario

Owing to its long coastline and continuous increase in population in the coastal areas and islands, the marine diversity in India is facing serious anthropogenic threats. Large scale fishing, over-exploitation of marine resources, pollution and marine litter, physical alteration of watershed and coasts, land-use changes, faulty land-use practices, introduction of exotics, species invasion, increasing tourism, construction along the coasts leading to increased sedimentation, excessive use of fertilizers and chemicals in areas near coasts etc are some of the anthropogenic activities leading to degradation, fragmentation and loss of habitats and damage to marine diversity.

India is a signatory to various International instruments and conventions related to the marine environment, notable of which are the UNCLOS, IWC, CBD, CMS, Tuna Commission, International Oceanographic Commission, Antarctica treaty etc. and therefore, has an obligation to develop proper conservation and management of the marine habitat and its management. However, it appears that marine conservation efforts have not been given due importance in India in spite of the fact that about 30% of country's population is supported by the Indian coastline. The main constraints in protection and conservation of marine diversity include a long coastline, poor infrastructure available with enforcement agencies, lack of coordination among enforcement agencies, poor awareness among masses about the importance of marine biodiversity and ecosystem, inadequate information on status of marine diversity due to lack of proper survey and monitoring mechanism, no mechanism for sharing of information among the survey and research organizations, lack of effective management plans and practices, inadequate involvement of people, poor implementation of eco-development plans, inadequate funds for scientific research and management, excess tourism without study of carrying capacity of marine areas and without following ecotourism norms etc.

Main Acts and Rules to regulate the coastal and marine activities in India include Indian Fisheries Act 1899, and its amendments in 1920 and 1980, Indian Ports Act 1902, Merchant Shipping Act 1974, Wildlife Protection Act 1972 (amended in 1991 and then in 2002), Water (Prevention and Control of Pollution) Act 1974, Indian Coast Guard Act 1974, Marine Zones of India Act (Regulation of Fishing by Foreign Vessels) Act 1981 and the Environment Protection Act 1986.

There are presently only five Marine Protected Areas including four Marine National Parks and one Marine Sanctuary though there needs to be more Marine Protected Areas. Management in these Protected Areas is regulated by the Wildlife (Protection) Act, 1972 and there is no separate Regulation/Act for marine life protection. Coastal Regulation Zone notification 1991under the Environment Protection Act 1986 is an effective means to conserve coastal areas by prohibiting construction activities along the coast but its implementation has been poor in many areas. Inclusion of a number of marine animals in schedule I of Wildlife

(Protection) Act, 1972 has been done to prevent exploitation of marine life but it is learn to have compounded the problem than solving it. It has adversely affected the economy of small fisherman and artisans living on marine resources.

One must understand various aspects of coastal ecosystems- the environmental process, functioning, flow of marine resources and various conflicts before drawing a strategy of marine diversity conservation. Proper legislative measures, socio-economic analysis and integrated management practices of both marine and surrounding terrestrial areas are required to develop a sound marine biodiversity conservation strategy. Scientific research, awareness generation and involvement of local community should be an integral part of such strategy.

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