

DEGRADATION OF MARINE HABITATS AND COASTAL MANAGEMENT FRAMEWORK

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INTRODUCTION

India has a long coastline of over 8000 km with associated continental shelf of 0.5 million km² and an Exclusive Economic Zone of 2.02 million km². The coastal zone of the country with its wetlands, lagoons, mangroves, sea-grass beds, coral reefs and shallow bays, creeks and estuaries is rich in natural resources including fisheries, coastal forestry products and minerals, and offers tremendous potential for recreation, aquaculture, extraction of freshwater and harnessing of tidal and wave energies. Unfortunately, much of this wealth is often exploited in an indiscriminate or ill planned manner resulting in rapid resource depletion and irreversible environmental degradation. Major driving forces for coastal degradation include (a) high rate of growth in population leading to reclamation of coastal areas and release of wastes, (b) over-fishing due to lack of alternative livelihoods, (c) large commercial enterprises aiming at quick profit at the cost of sustainability and their insensitivity to the interests of local inhabitants, (d) ignorance about management of resource sustainability among stake holders and policy makers, (e) lack of understanding of environmental significance and importance of coastal habitats, and (f) inadequate enforcement of environmental rules and regulations.

The present paper examines the trends that have emerged concerning the status of the nearshore ecology of India in the context of development activities and the Government policies aimed at minimizing the impacts of anthropogenic interventions on the marine environment.

SOURCES OF POLLUTION

Among number of concerns regarding the coastal zone, degradation caused by disposal of domestic and industrial wastes is one of the major issues. Indiscriminate releases of untreated or partially treated wastes without considering the assimilative capacity of the waste receiving water body have resulted in pockets of polluted environs with depleted coastal resources, public health risks and loss of biodiversity. The population of India which was 345 million people at the time of independence (1947) has crossed 1 billion by the middle of 1999. over 300 million people living in the coastal zone of India are considered to generate 1.11×10^{10} m³ of sewage annually, a considerable fraction; particularly

from coastal cities and towns where sewage collection network exists, enters the marine waters. (Zingde, 1999a).

There is a high concentration of large and medium industries within the narrow coastal belt of 25 km width than the rest of the country. These industries are estimated to generate 1.35 million m³/d of liquid effluent and about 34,500 t/d of solid waste. The West coast of India is more industrialized than the East coast with Maharashtra and Gujarat having largest concentration of industries. A 1994-95 survey (CPCB 1996) revealed that out of 308 large and medium industries in the country, 233 were located along the West Coast. The industries established within the 25 km belt along the West coast generate 0.85 million m³/d of liquid effluents and 14,600 t/d of solid waste. A major fraction of the liquid effluents is released to marine areas, presumably treated, to meet specifications of the respective state pollution control board. In addition, aquaculture farms, largely concentrated in Andhra Pradesh and Tamil Nadu, generate 2.37 million m³/d of effluent.

Much of the development along South Gujarat and Maharashtra has taken place several kilometers inland from the coastline. Primary considerations for such developments in the past had been the availability of water, electricity and transport, while, environment received the lowest priority. Evidently, many industries are located near national highways and railway stations and release their effluents in nearby rivers, estuaries or creeks. Nearly 8% of industries in the country are located around Mumbai in four large industrial clusters namely, Trans Thane – Belapur belt, Kalyan-Ulhasnagar-Ambarnath belt, western bank of Thane Creek and around Patalganga and Amba Rivers. Evidently, Ulhas, Patalganga and Amba rivers as well as Thane Creek are the recipients of a variety of wastes (Zingde, 1999a).

Recent major industrial development in Gujarat is along the southern Gulf of Kachchh, at Dahej and at Hazira on the northern bank of the Tapi estuary. The industrialization along the Gulf of Kachchh is of considerable concern because of high ecological sensitivity of the region, and hence needs special attention. Availability of relatively deep waters near the southern shore and protection from the monsoon waves has made the Gulf attractive for the import of crude oil

through Very Large Crude Carriers (VLCCs) and unloading the cargo via Single Point Mooring (SPM) systems to shore-based tank farms. Four SPMs with a potential to handle about 50 million t/y of crude oil are already operational and a few more are being considered. The traffic of crude oil is projected to increase from the present 40 million t/y to over 70 million t/y by 2007. With this, the traffic of VLCCs is expected to go up to roughly 500 per annum by 2007 apart from the traffic of the tankers carrying petroleum products. This multifold increase in traffic of crude oil and its products enhances the risk of oil spills due to tanker accidents, hose ruptures, sub-sea pipeline leakage, operational discharges etc. If a large spill occurs, the Gulf ecology particularly of the intertidal and subtidal nearshore habitats will be under high risk (Zingde, 1999b). As a matter of fact the waters around the entire coast of India have become vulnerable to oil pollution due to increasing transport of crude oil and its products as well as enhanced oil exploration and production activities on the shelf.

The rivers along the coast of India discharge about $1.56 \times 10^{12} \text{ m}^3$ of runoff annually to the seas transporting a wide range of pollutants of terrestrial origin. The transport of fertilizers through land runoff is expected to have increased substantially with the enhancement in its consumption. The progress made in the agricultural sector in India in the last four decades has been one of the biggest success stories. The agricultural production increased from 50.82 million t in 1950 – 51 to 208.07 million t in 1999 – 2000 with the sown area increasing from 97.32 to 123.06 million ha over the same period. The use of fertilizers and pesticides played an important role in this success. The total fertilizers and pesticides played an important role in this success. The total fertilizer consumption in India that was less than 0.1 million t/y in 1950s, increased dramatically in 70s and thereafter, with the consumption in 1999 – 2000 estimated at 18.37 million t. The use of nutrients, particularly nitrogen, per unit of gross cropped area increased from 0.55 kg/ha in 1950s to more than 90 kg/ha in 1998 – 99 (Zingde, 2001). It is well established that a considerable fraction of nutrients applied on land, particularly nitrate, is washed to the sea through river runoff thereby increasing the productivity potential of the marine area that, in the long run, can considerably modify the marine ecosystem (GESAMP 2001).

The consumption of pesticides (insecticides, herbicides, fungicides, bactericides, and rodenticides) also increased phenomenally – from 5000 t in 1950 to over 84,000 t in 1998 – 99. Today India is the largest manufacturer of basic pesticide chemicals among the South Asian and African countries next only to Japan and along with China accounts for more than 10% of the total world production. Of the persistent chlorinated pesticides, DDT and BHC have been widely used in the country till recently. Their indigenous production began in 1954 though they were used since 1948 for malaria

(DDT) and Locust (BHC) controls. The use of BHC that formed 20-30% of the total production of pesticides in the country during 1995 – 97 was banned in 1997 and the use of DDT has been restricted largely to malaria control. Evidently, the production of DDT declined from 6000 t in 1995 – 96 to 3400 t in 1999 – 2000. It is feared that indiscriminate use of DDT and BHC in agriculture/malaria control has caused dangerously high levels of pesticides in the food chain (Zingde, 2001). As in the case of fertilizers, a fraction of pesticides applied on land is transplanted to coastal waters through runoff (GESAMP 2001).

Another source of nuisance particularly on the beaches near cities and towns in India is the discarded plastic materials. The consumption of plastic, which was negligible in 1950s, has gone up exponentially to 2.2 million t in 1997 – 98 (Zingde, 2001).

STATUS OF COASTAL ENVIRONMENTAL QUALITY

A fairly comprehensive database has been generated for the coastal water quality through the national program 'Coastal Ocean Monitoring and Prediction Systems' under which openshore waters up to a distance of 25 km from the shoreline are monitored at pre-decided transects. Independent site specific investigations at a number of locations have also been carried out along the coast by several other agencies. An assessment of the available results indicates that the openshore waters, about 1 km away from the shore, are clean and healthy except in some isolated pockets around coastal cities where degradation has spread a few kilometers further. Several inshore regions such as estuaries, creeks and bays however, have been degraded to a varying degree depending on the fluxes of pollutants they receive and their flushing characteristics. Domestic wastewater is the major source of pollution though industrial emissions also contribute locally in some instances (Zingde 1999a).

Inshore waters of Mumbai and region around, particularly Versova Creek, Mahim Creek, Ulhas estuary, Thane Creek and Patalganga estuary, are the examples of highly degraded environment because of anthropogenic perturbations. Several other inshore waters also reveal varying degrees of ecological deterioration. These include Veraval, Porbandar and Visakhapatnam harbours, Mahi, Mindhola, Purna, Par, Ambika, Auranga, Kolak, Damanganga, Ulhas, Savitri, Kundalika, Vashishti, Ashatmudi and Ennore estuaries, interior Kochi Backwaters and coastal waters of Chennai. Excess organic loading, often associated with the release of untreated or partially treated domestic wastewater, is largely responsible for this degradation. These waters are characterized by abnormally high and tide dependant levels of $\text{PO}_4^{3-}\text{-P}$, $\text{NO}_3^{-}\text{-N}$ and $\text{NH}_4^{+}\text{-N}$, Variable DO falling to zero at low tides in some instances and abnormally high and tide dependant populations of pathogens (Zingde 1999a).

Marine sediments of the Indian coast are by an large free from gross contamination by heavy metals such as Co, Ni, Cu, Zn, Pb, Cd and Hg (NIO 1997) though a few localized areas have been reported to have accumulated trace metals. Some examples are: Cr and Hg in Par estuary, Hg in Mindhola estuary, Cr, Cu, Zn, Pb, Cd, and Hg in Ulhas estuary (Sahu and Bhosale, 1991) and Ni, Cu and Zn in Visakhapatnam harbour (Satynarayana *et. al.*, 1994). Mercury levels of 60 ppm. have been found (Ram, 1999) in the surficial sediment of the interior Ulhas estuary which progressively decrease in the seaward direction with the sediment of the mid-estuarine segment sustaining the concentrations of about 0.6 ppm and the baseline (0.1 ppm) is attained several kilometers off in the sea from the mouth of the estuary. Caustic soda industry is considered to be the major source of Hg to the marine environment.

Except in a few cases of elevated concentrations of some toxic metals in marine organisms localized to a few wastes receiving sites, the commercial fish and shellfish is free from heavy metal contamination. Uptake of DDT and Aldrin by marine organisms to levels to cause concern is also not indicated though the results are not exhaustive (Zingde, 2001). The levels of petroleum hydrocarbons in water (<20µg/l) as well as sediment (<10 ppm) in some port areas though show a marked enhancement as compared to those at the openshore regions, they do not reveal serious accumulation (Chokshi, 2002).

Although long-term data on nutrient levels in coastal waters is not available, the concentration of NO_3^- N is considered to be increasing at least along the north west coast of India due to the load transported by rivers which drain agricultural areas in the hinterland (Zingde, 1999a).

STATUS OF MANGROVES

The mangroves are wide spread along the Indian coast. Gangetic Sundarbans occupying an area of 2067 km² is the largest single block formation of mangroves in the world annually yielding 30,000 t of fish, crab and prawn. It is estimated that over three-fourths of India's commercial fishing in the Ganga-Brahmaputra estuary is dependent upon the health of mangroves. Mangroves of the A&N Islands are the second largest in India. The other prominent mangrove formations are in the deltaic areas of Mahanadi, Godavari, Krishna and Pichavaram and Puthupet on the East coast. Mangroves, though to a lesser extent, also occur along the West coast in the states of Gujarat, Maharashtra, Goa, Karnataka and Kerala. The total area under mangroves along the Indian coast is estimated at 4460 km² (Nayak, 1998).

Overexploitation and unsustainable demand has resulted in considerable degradation of mangrove areas though exact estimates are not available. Mangrove

formations along the Gujarat coast have declined from 165.2 km² in 1992 to 128.9 km² in 1998 when mangroves of the Kachchh District are excluded. Significant improvement from 601.8 km² to 938 km² over the same period has been reported in the mangrove formations of the Kachchh District probably because these areas are remote and not easily accessible (Bahuguna *et. al.*, 1998). It is feared that the area under mangroves around Mumbai areas has dwindled by 35% in the last 25 y and only about 20 km² of mangroves exist today.

STATUS OF CORALS

The major coral formations are around the Lakshadweep (816 km²) and A&N Islands (960 km²) as well as in the Gulf of Mannar (94 km²) and the Gulf of Kachchh (460km²). Many of these areas are under anthropogenic pressure due to mining, dredging, fishing, coral collection and recreational activities. The coral reefs of the Gulf of Kachchh have been degraded to a considerable extent with the deposition of mud over reef. Localised reef areas of the A&N Islands also have mud deposits. These deposits of mud on reefs are as a result of mangrove deforestation. A study conducted in the Lakshadweep and Andaman Islands as well as the Gulf of Kachchh indicates that disease, predation and stress are the major factors of coral mortality (Ravindra *et. al.*, 1999).

STATUS OF MARINE FISHERY

The progress and the problems of marine fishery of India have been reviewed by Devraj and Vivekanandan (1999). The marine fish production in India is exclusively from the capture fisheries, barring an annual production of about 0.7 million t of brackishwater prawns through aquaculture. However, the production from inshore waters (<50 m depth) has reached the catchable potential (2.2 million t/y) and scope for further increase in production from nearshore waters is limited. Inappropriate exploitation patterns of concentrating 80% of the total fishery effort in the nearshore areas and over-dependence on trawlers is feared to have become counter productive. The catch rate of fishing vessels in several fishing centres is on the decline leading to an increase in competition and, often, conflicts between different fishing fleets.

Among other factors, the trawlers are also responsible for declining population of the Olive Ridley sea turtles, an endangered species, which nest along the east coast of India, due to incidental capture of adults in fishing nets (Pandav *et. al.*, 1998). The rookery at Gahirmatha in Orissa has been the largest in the world with annual nesting of 0.1 to 0.5 million turtles. Intense patrolling along the coast to prevent unregulated trawling in order to provide the turtles safe passage in recent years has shown signs of recovery.

With active encouragement by the government, shrimp culture boom was witnessed during early 1990s. Unfortunately, the developments were unplanned and basic norms with regards to water treatment, use of antibiotics, seed quality, pond fertilization, effluent disposal practices etc. were flouted. The cumulative effect of this negligence was the severe outbreak of white spot disease in 1995 that wiped out the crop in majority of aquaculture farms. Since then though the virulence of the virus seems to have declined, sporadic mass mortalities occur locally. To add to the woes of the farmers there were allegations of contamination of drinking water and salinization of agriculture areas resulting in major legal problems which effectively crippled the industry (BOBP, 1998).

COASTAL ZONE MANAGEMENT FRAMEWORK

From the foregoing discussion it is evident that the coastal zone of India is under considerable pressure and it is inevitable that these pressures will continue to increase, intensifying the conflicts among different sectors, with passage of time. Hence, for proper appraisal of projects planned in the coastal zone, the government has issued several directives aimed at planned management of the marine coastal areas, though approach towards ICZM is yet to crystallize clearly.

The most important of the regulatory framework is the Coastal Regulatory Zone Notification promulgated in February 1991 with modifications from time to time. Under this notification, the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 m from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL are declared as CRZ. In case of rivers, creeks and backwaters, the distance should not be less than 100 m or the width of the water bodies whichever is less. Development activities within 100-500 m from the HTL (as applicable) are classified into 4 CRZ regions as follows : CRZ (I) (i): Areas that are ecologically sensitive and important, such as national parks, marine parks, sanctuaries, reserve forests, wild life habitats, mangroves and coral reefs; areas close to breeding and spawning grounds of fishes and other marine life; areas of outstanding natural beauty; historical heritage areas; regions rich in genetic diversity etc. CRZ (I) (ii): Areas between the LTL and the HTL. CRZ II: The areas that have already been developed up to or close to the shoreline. CRZ III: Areas that are relatively undisturbed and those which do not belong to CRZ I and CRZ II. CRZ (IV): Insular stretches of Andaman & Nicobar and Lakshadweep Islands and other Islands. Norms for development or construction activities in different categories of CRZ are specified in the notification. The activities declared as prohibited within the CRZ include (1) setting up of new industries and expansion of existing industries, except those directly related to water front or

directly needing foreshore facilities : (2) manufacture or handling or storage or disposal of hazardous substances except in certain port areas; (3) setting up and expansion of fish processing units; (4) setting up and expansion of units/mechanism for disposal of wastes, except facilities required for discharging treated effluents into the water course; (5) discharge of untreated wastes; (6) dumping of city or town waste; (7) dumping of ash or any other wastes from thermal power stations; (8) land reclamation, bunding or disturbing the natural course of sea water except in certain cases; (9) mining of sand, rock and other materials; (10) harvesting or drawl of ground water; (11) any construction activity between the LTL and HTL, except facilities for carrying treated effluents and wastewater discharges into the sea and facilities for carrying seawater for cooling purposes, oil gas and similar pipelines, and (12) dressing or altering of sand dunes, hills and natural features. The notification also lists the activities which are permissible but regulated. The government has set-up a National Coastal Management Authority and State Coastal Management Authorities; one in each state for ensuring effective implementation of the notification.

Guidelines for water quality for nearshore areas have been evolved for five designated best uses as follows:

Class SW-I : Salt pans, Shell fishing, mariculture and ecologically sensitive areas.

Class SW-II : Bathing, contact water sports and commercial fishing.

Class SW-III : Industrial cooling (non-contact) and aesthetics.

Class SW-IV : Harbour.

Class SW-V : Navigational and controlled waste disposal.

Setting up of an Aquaculture Authority (AA) in 1997 is another important decision of the Government with powers to protect the ecologically fragile coastal areas and deal with the situation created by the shrimp culture industry in coastal states. The AA has finalized its rules and procedures for applications for new shrimp farms and has delegated tasks to coastal states to process such applications and make their recommendations to the Authority. The AA has also laid down guidelines for the adoption of improved technology by shrimp farmers, especially on design aspects, stocking density, pelleted feed etc. The guidelines also specify permissible activities on the part of shrimp farmers, and suggest measures the farmers should take to protect the ecosystem.

National Oil Spill Disaster Contingency Plan (NOS-DCP) has been in operation since 1996 and stipulates the organizational and operational details to effectively combat a national oil spill contingency. The

plan covers such aspects as reporting, communication, alerting, assessment, operations, administration, finances, public relations and other arrangements with contiguous states. The plan also assigns the responsibility to various tasks to be taken by the relevant Government departments and agencies and identifies trained personnel, equipment and resources. Indian Coast Guard is the central coordinating authority and has the overall responsibility to ensure that appropriate response is made to an accident in the seas around India. The ports however are responsible for the response to accidents within the port limits but can request any additional assistance from the Indian Coast Guard. Likewise, oil and petroleum exploration and production agencies are fully responsible for instituting preventive, precautionary and other measures for monitoring, controlling and combating an oil spill in their area of operations. The entire maritime zone around the Indian Coastline is divided into three Coast Guard regions viz. West, East and A&N with Headquarters at Mumbai, Madras and Port Blair respectively (NOS-DCP 1999).

Another important directive is the Environmental impact Assessment Notification, 1994. This notification makes environmental clearance mandatory for certain projects on environmental impact assessment report and environment management plan. The Environment (Protection) Rules of 1986 have also further amended and called Environment (Protection) (Amendment) Rules 1996. The amended rules include a large number of industries whose effluent should meet the prescribed standards defined for each group of industries, before release to aquatic environment.

At least 15 ecologically sensitive marine areas have been declared as marine protected zones. These include segments of the Gulf of Kachchh, the Gulf of Mannar and the Lakshadweep and A&N Islands.

To protect the interest of artisanal fishermen many maritime State Governments have banned the mechanized vessels from operating up to a specific distance (5-10 km) from the shoreline. However, there is no proper surveillance mechanism to prevent encroachment by mechanized vessels in areas reserved for artisanal crafts. Most fish groups undergo peak spawning during monsoon and to spare the spawning populations, several States along the West Coast ban operations of mechanized vessels for 30 to 145 d a year, though there are no such restrictions along the east coast (Devraj and Vivekanandan, 1999).

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