

CONSERVATION OF COASTAL PLANT COMMUNITIES IN INDIA

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India with its 7,200 km long coast line including many islands, estuaries and deltas is washed by the Bay of Bengal in the east, the Arabian sea in the west and the Indian Ocean touching the south. The indeterminate, ribbon shaped crystal land mass of on shore littoral region lies between the mainland and innermost edge of the sea shore varies widely in structure and function. The coast line on western part of India, specially the Konkan and Malabar Coast is narrow and mainly dominated by cliffs, barriers, spits, lagoons, backwaters, pocket beaches and low relief of alluvial deposits in estuary. Extent of the coast line along the Konkan and Malabar regions varies from 2 - 20 km where highlands are found just immediately behind the shoreline. The coast line on the eastern part of India, specially, Coromandel-Circar regions is wide extends from 20 - 50 km and dominated by sandy beaches, dunes, off-shore bars and low relief of depositional plains along the deltas and estuaries. Here shore zone and coast zone are very prominent. Though climatically Indian coastal regions receive profound influence of average rainfall and length of dry season but due to different topographic situation macro-climatic variations are also prominent in different coastal states in India such as, N. W. part of Kathiawar is arid with annual average rainfall of less than 500 mm and dryness prevail for 9-11 months. S. E. Kathiawar and Gujarat is semi arid with 500 - 600 mm rainfall and dryness of 8 months. In Konkan coastal zone climate varies from dry to subhumid and humid, in the Malabar region climate ranges from dry to subhumid type tropical rainfall. The Bengal and Utkal coastal plains are situated within the humid range.

Depending upon the impact of various ecological factors such as, wave action, wind forces, sunlight, variation of tide, salinity and edaphic conditions, plant communities concentrate on the supra-tidal and mid-tidal zones along the on shore littoral regions. In general, on shore coastal ecosystem can be divided into two distinct formations based on the rate of receding tidal flux and super saturated or unsaturated conditions of the substratum. Low undulating relief along the on shore where substratum remains super saturated with water, the rate of receding tide becomes very slow and that keeps the condition wet. On the other hand, the steep and slopped sandy or rocky relief where the substratum remains unsaturated. The rate of receding tide becomes very quick keeping the condition dry. Zonation of coastal plant communities on these two formations is quite distinct and the vegetation of coastal ecosystem is broadly divided into two major types such as, Dry Coastal Plant Communities and Wet Coastal Plant Communities. With the impact of various maritime environmental factors, dry coastal plant communities from the mean high tide level to the end of sandy or rocky relief can be subdivided into 4 strands such as, semi stabilised strand, stabilised strand, dune strand and coastal woodland. The rocky shore lines are free from sands but contain lime stones of shell reef of considerable width and the pot holes and crannies of these harbour some interesting calcium loving plants.

Semi stabilised strand : It is the pioneer vegetation zone and on sandy areas some restricted species like *Cyperus arenarius* and

Sesuvium portulacastrum and on rocky coast *Artiplex stocksii* and *Polycarpea spicata* extend with their long runner system and tolerate wind and wave action in this hostile environment.

Stabilised strand : This zone is more or less stabilised and free from frequent impact of the sea waves and give rise to a dense population of *Hydrophylax maritima*, *Ipomea pes-caprae*, *Canavalia maritima*, *Euphorbia rosea*, *Geniosporum tenuiflorum* on sandy strand and *Helichrysum cutchicum*, *Enicostema hyssopifolium*, *Kickxia ramosissima* over the rocky substratum. They function as sand binders and baby dune producer on sandy areas and accumulator of debris on the potholes of rocky regions. Occurrence of *Hyphaene dichotoma* and *Acacia planifrons* along this stabilised zone is of interest.

Dune strand : Stabilised sand strand follows immediately the dune strand of various size and shape, zonation of plants over the front side and the lee side of the dunes depends on the impact of wind and sunlight. Some beautiful sand binders with long horizontal runners and fleshy nodal roots are common on the lower slope of the sand dunes for protecting uplift of wind blown sands. Middle and upper zone of sand dunes are covered with bushy herbs and shrubs which are capable to check the wind blown sands. The lee side of the sand dunes have different picture of vegetation and more or less similar to the inland formation. Plants commonly found in this zone are : *Spinifix littoreus*, *Hydrophylax maritima*, *Borreria articularis*, *Launaea sarmentosa*, *Rothia trifoliata*, *Portulaca tuberosa*, *Calotropis procera*, *Aristolochia brachiata*, *Oldenlandia stricta*, *Sida cordifolia*, *Zornia diphylla*, *Bulbostylis barbata* and others.

Coastal wood land : This is the last part of the coastal zone where the flora merge gradually with the inland formation. Some common palm and sand loving tree species are dominated in this zone such as : *Borassus flabellifer*, *Hyphaene dichotoma*, *Calophyllum inophyllum*, *Pandanus*

sp., *Zizyphus oenoplia*, *Maytenus emarginata*, *Dodonaea viscosa*, *Lepisanthes tetraphylla* and others.

With the impact of various estuarine, deltaic and riverine environmental factors, wet coastal mangrove plant communities from the mouth of estuaries towards the end of saline tide water flow along the inner riverine system can be divided into 4 distinct types such as, Estuarine Mangroves, True Mangroves, Semi Mangroves and Transitional Mangroves.

Estuarine Mangroves : Estuarine banks along the river mouths, influenced by maximum salinity, tidal waves and silty substrate are mainly dominated by *Avicennia marina* (Forsk.) Vierh. *Aegialitis rotundifolia* Roxb. *Bruguiera cylindrica* Bl., *B. parviflora*, *Sonneratia griffithii* Kurz., *Ceriops tagal* (Per.) Roxb., *Avicennia alba* Bl. and *Lumnitzera racemosa* Willd. These species are able to tolerate maximum salinity condition of the areas with the help of salt excreting glands or by increasing water storage tissue in their leaves.

True Mangroves : Middle part of the estuarine regions where the land masses are notably influenced by innumerable meandering creeks, and channels resulting formation of several fringes and islets are dominated mostly by *Rhizophora apiculata* Bl., *R. mucronata* Lamk., *Ceriops decandra* (Griff.) Ding Hou, *Kandelia candel* (L.), Druce, *Xylocarpus granatum* Koenig., *Bruguiera gymnorhiza* (L.) Savigny, *Aegiceras corniculatum* (L.) Blanco and others which are adapted by means of stilt roots and vivipary for adjusting greater tidal forces of the creeks and channels.

Semi Mangroves : Most inland tidal flats of the inner estuarine regions which are subjected to greater fresh water influence and lower tidal action due to elevation are characterized by remarkable brackish water mangrove formation predominating *Heritiera fomes* Buch.-Ham. and *Nipa fruticans* Wurm. communities. It has been observed that depending on the availability of fresh water flow, *Heritiera fomes* in association

with *Cerbera manghus* Linn., *Cynometra iripa* Kostel., *Intsia bijuga* (Colb.) Kuntz, *Aglaia cuculata* (Roxb.) Pelleg. *Bruguiera sexangula* (Lour.) Poir. and *Avicennia officinalis* Linn. forms dominant community in the muddy substrate and are adapted by means of woody pneumatophores for exchange of gasses in the root system.

Transitional or Hinterland Mangroves : Most interior part of the mangrove swamps where fresh water flow is predominant except some high spring tide. Species of *Derris*, *Dalbergia*, *Excoecaria*, *Barringtonia*, *Ponganna*, *Thespesia* and *Acrostichum* communities are dominated without any morphological adaptation.

Coastal on shore plant communities are well-known for the greater diversity of flora and fauna as well as a greater degree of specialization in structure and function of their constituent ecosystems. Variation of ecological processes and composition of biological components in a graded sequence within a short topographic changes are very distinct. Floristic diversity along these sensitive ecosystem is not very high due to large physical forces of the sea and lack of stable substrate but the ecosystems constitute most importance by virtue of their large biological productivity, specialized capacity, ecological complexity and finally the importance of the resources for direct uses and indirect values. A large array of diversity in food, fuel, fodder, vegetable, pulses, fibre crops, medicinal plants, condiments and spices are found either growing along the beach forests, sand dunes, coastal rocky terraces, cliffs and exposed mountain slopes or along the inter-tidal regions of estuaries, deltas and oceanic islands. Floristic diversity in both the dry and wet coastal ecosystem represents more than 1020 species and 356 genera belonging to 115 families. About 80% of coastal flora comprises very special type of adaptation and restricted to special ecological niche. Most unique and vulnerable plants belonging to mangroves which play major role for protection of coastal erosion, wind and floods and provide food and shelter for millions of fishes, crabs and other wild

animal are the species of *Rhizophora apiculata*, *R. mucronata*, *Bruguiera gymnorrhiza*, *Avicennia marina*, *Ceriops decandra*, *Lumnitzera racemosa*, *Xylocarpus granatum* and others. The species which are commercially important known as *Heritiera fomes* and *H. littoralis* are confined only along the coast. Several species like *Spinifex littoreus*, *Hydrophylax maritima*, *Cyperus arenarius*, *Ipomoea pes-capre* and many others serve for sand binder, dune binder and stabilizer of the shore line.

Richness and diversity of coastal flora depend on the topographic and ecological diversities of the coast. The East coastal system with maximum numbers of large deltas estuaries, beaches, dunes and sands bars harbours largest numbers of mangrove species of the world and maximum numbers of sand-binding species in India. The West coast with narrow sea-inlets, backwaters, lagoons, pocket beaches is poor in mangroves and sand binders but rich in numbers of valuable commercial and economic tree species due to coastal cliffs, ghats and hills.

Coastal desert ecosystem along the Gujarat coast including Rann of Kutch possesses very less numbers of mangroves and sand binders due to arid and hyper saline soil condition but dominated with salt marsh species. Dry arid regions of this ecosystem are dominated by spiny coastal shrubs and dry wet regions are dominated by the formation of salt marshes with the common halophytic species of *Suaeda*, *Salicornia*, *Artiplex*, *Sesuvium* and some salt tolerant grasses.

Dry and wet coastal plant communities provide basic sustenance for millions of people both from the direct products and from the amenities provided by the resources, besides the function of stabilizing the shore and reducing coastal erosion, it serves an ideal base for pisciculture, crabs, crocodile farming, nesting ground of many migratory birds, turtles and many endangered animals including the Royal Bengal Tiger. Depending upon these resources may big cities, towns and villages have been built up along

the coast and more than 221 millions of people have been settled up along the Indian coast.

Though there are various institutes in India conducting survey and identification of coastal and marine plant resources but recently DOD with the consultation of various scientists in India has estimated near about 44 locations in India to be declared as Ecologically Sensitive Coastal and Marine Zones. These areas need to be detailed survey, collection and monitoring for coastal and marine resources. List of the areas are as follows:

1. Sunderban, 2. Lothian Island, 3. Bhitarkanika, 4. Gaharimata, 5. Mahanadi Delta, 6. Hookitola & Batighat, 7. Jambu Island, 8. Kansardian & Bharkhanashi, 9. Chilka Lake, 10. Godavari Delta, 11. Sarcomanto Island, 12. Coringa, 13. Krishna Delta, 14. Muthupalam, 15. Ellichitadibba, 16. Nizampatnam, 17. Pulicat Lake, 18. Kolleru Lake, 19. Cauveri Delta in Pichavaram, 20. Palk Strait, 21. Palk Bay, 22. Gulf of Mannar, 23. Vedaranyam, 24. Tuticorin, 25. Asthamundi Lake, 26. Vambanad Lake, 27. Cochi, 28. Ernakulum, 29. Calicut, 30. Karwar, 31. Cundapur, 32. Honovar, 33. Ratnagiri, 34. Mangalore, 35. Malpae, 36. Gokaran, 37. Bombay, 38. Goa, 39. Malvan, 40. Diu Islands, 41. Gulf of Cambay, 42. Saurashtra, 43. Gulf of Kutch, 44. Rann of Kutch.

Preparation of Database for coastal and marine plants with the help of sophisticated Computer Network is urgently necessary for monitoring the sustainable uses, protection and conservation of the valuable resources but before that, some gaps in the survey and identification of coastal and marine plants should be properly encountered. The following major gaps to be studied urgently :

1. Mangroves and Salt Marshes in the backwaters and lagoons.

2. Detail survey of coastal & marine fungi specially the Actinomycetes.

3. Survey and estimation of seasonal population growth of phytoplankton and periphyton in coastal and marine ecosystem.

4. Micro and Macro Algae and sea grass population along the coral reefs.

5. Detail sea grass study along the West coast and lagoons.

6. Bacterial population on the seasonal pattern and specially in polluted water surface of marine, coastal lagoon waters.

7. Status survey of rare, threatened and endangered marine and coastal plant diversity.

CONSERVATION AND MANAGEMENT OF PLANT DIVERSITY

For environmental protection of the coastal areas, the Government of India has issued directions under the Environment (Protection) Act, 1986. Coastal Regulation Zone (CRZ) is defined to be the area between the low tide line and the high tide line and 500 meters of land above the high tide line.

Restrictions have been imposed on the setting up and expansion of industries, operations or process, etc. in the CRZ. Certain activities are prohibited in the CRZ. These include new industries other than those requiring water front or for shore facilities like, ports and harbours, ship repairs and ship building. Discharge of untreated wastes and effluents from industries and human settlements are strictly prohibited. Land reclamation, building, disturbance to the natural flow of sea water, mining of sands, rocks and substrata materials, harvesting or drawal of ground water and dressing or altering sand dunes, hills, natural features, etc. are totally prohibited.

For regulating development activities, the coastal stretches within 500 meters are classified into four categories. The first category consists of areas, which are ecologically sensitive and important, such as, national parks, reserve forests, wildlife habitats, mangroves, coral reefs, breeding and spawning grounds of fish and other marine life, and areas likely to be inundated due to rise in the sea level consequent upon global warming. Obviously, these areas require total protection from activities, which are likely to disturb the ecological balance. Another important category is

the area from the high tide line to 200 meters landward. This is the "no development zone" where no construction is permitted. The permitted activities are agriculture, horticulture, gardens, pastures, parks, play fields, forestry and salt manufacture from sea water. Other categories consist of areas on which activities are permitted in varying but controlled degrees. Areas requiring special protection include the coasts of Andaman & Nicobar Island and Lakswadweep.

The State Governments are required to prepare the coastal zone management plans for the coastal areas in their respective states. There are, however, a number of non-government organisations (NGO) who are very actively working for protection of the coasts. Coastal Vegetation plays an important role. Mangroves constitute the main forest ecosystem in the coastal areas. Mangrove management plans are being formulated and implemented as parts of the coastal development plants. Management of mangroves has already been discussed in chapter of mangroves in the country.

A unique experiment is being tried during the last few years to see the efficacy of mangrove for controlling erosion in the coastal areas. It was felt that instead of engineering measures at the huge cost, biological measures could give better results at much less expenditure. This vegetation is also helping in mitigating the air and water pollution emanating from the industries and habitation in the developing town.

In coastal zone management, the activities to be studied can broadly be under development of agriculture, fishing, rural and urban development, industries, tourism and communication and transport network. In all these groups, there are various activities which affect the coastal environment. Some of the important ones are residences, solid and liquid waste disposal, irrigation and water supply, use of pesticides and fertilizer, crop pattern, roads, railways, pipelines, communication network, industries, oil refining, mining, fishing, sea ports, airports, land and marine oriented recreation etc.

Certain development work and industry which are being undertaken in the coastal areas require special attention. A number of thermal plants have been set up in the coastal areas. More are coming up and being planned to be sited close to the sea. The thermal plants cause serious threats to the coastal environment such as, discharge of hot water can harm the aquatic flora and fauna. Ash may be dumped in the sea water causing damage to water quality and sea bed contours or may cause undesirable landfills. Fly ash and emission may cause air pollution and harm the flora and fauna. All these require strict control, particularly as these plants are rather away from watchful eyes of the administration and environmentally vigilant people. One very important aspect is the disposal of nuclear waste in the sea water. Such wastes dumped in the sea may cause disaster and watch has to be kept against such occurrence. Quarrying operation in the coastal areas is on the increase. Rocks are being blasted, excavated and extracted affecting the natural ranges, the water flow and flora and fauna. Corals are being removed to be used as building and construction material for roads and housing.

In coastal areas the main occupation of the people are agriculture and fishing. High salinity, submergence of land by tidal water and disturbed climatic condition like strong wind and cyclones affect the agriculture adversely all along the coastal belt. Unplanned agriculture also leads to soil erosion where soils are being washed away to sea. This causes loss of fertile top soil and causes further erosion by quick water run off. Most of the coastal areas have only one crop a year. Cash crop is grown in some coastal belt. Cashew nuts, areca nuts, coconuts, bananas etc. are cultivated in these areas. For economic benefit of the people in the coastal belts, agriculture should be planned in a manner to suit the geographical and physical conditions of the coastal areas.

CONSERVATION OF BIODIVERSITY

The conservation of biodiversity is increasingly receiving 'stepdaughter' treatment by

many government authorities. The major reason is that loss of biodiversity is a silent crisis, where the changes taking place are not understood by most. Persons who make decisions that affect coastal ecosystems are usually not aware of the consequences. Therefore, the paradigm underlying biodiversity conservation has to be more 'people-oriented' to gain support. Expatriates commonly lack in depth knowledge and experience of the local society, situations and context, which inevitably a recipe for failure. Implementation will only be successful if management plans are 'owned' and understood by all the relevant local groups of protagonists, including district administrators and private enterprises.

Man and the environment have to find their due places in the holistic approach. Man's needs have to be met keeping in mind the requirements for sustainable development. It is necessary to conduct extensive studies into the physical conditions of the coastal areas and the socio-economic condition of the people inhabiting these areas. Environmental Impact Assessment (EIA) for the different types of activities and for major units of industry, beach resorts, ports and harbours etc. should be conducted and appropriate environmental management plans (EMPs) should be drawn up. The Union Government, the Governments of the Coastal States, the Panchayats of the coastal areas and the voluntary organizations and above all the people of these areas are required to join hands in environmental protection, conservation and planned use of resources in the coastal land and sea.

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