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Rehabilitation of Mangrove Ecosystems in India: A Review

Tirunelvely A. Harikrishnan

Introduction

Mangroves are salt-tolerant forest ecosystems of tropical and subtropical intertidal regions and are abundant along the coasts of the Indian subcontinent (Figure 1). Like terrestrial tropical forests, mangroves have been a significant part of the Indian economy for thousands of years and are a reservoir of valuable natural resources. Owing to their high detritus content and rich biotic environment, the coastal mangroves can be highly productive lands that can be used for various uses including fishing, navigation, recreation, transportation and research (Odum and Heald, 1972).

Figure 1. Typical Mangrove forest during high tide (Source: West Bengal Forests, Forest Directorate, Government of West Bengal, 1964)

The Indian subcontinent offers a large diversity of aquatic habitats differing in size, hydrological regimes, sediment characteristics, nutrient status and human impacts in several climatic zones ranging from humid tropical to hot arid and montane temperate. Aquatic plants of the mangroves have been an important part of the cultural ethos of coastal wetlands in India. People use them for shrimp and prawn production, grazing, firewood (*Avicennia spp*.), wood for building boats (*Heritiera fomes*), waterproof stains for fishermen's nets (*Excoecaria agallocha*), fruits and flowers (Figures 2 and 3), honey and other uses. Ecological values and functions of the Indian wetlands have not been fully understood and appreciated though negative impacts to water resources utilization from silting of lakes and streams and the depletion of oxygen by dead plants have received more attention (Gopal, 1990). The degradation and depletion of forest cover in

India is highlighted by Ambasht (1993), who describes the main forest types including the coastal mangroves and advocates urgent and decisive steps for preventing further degradation. The overarching problem of serious socio-economic disturbance forces the local people to exploit more and more of the already dwindling resources of the mangroves. Rehabilitation needs to emphasize large-scale restorations that would effectively meet societal needs and retain environmental quality.

This paper discusses the status of mangroves in India and describes rehabilitation measures for seven mangrove areas in coastal India. The study proposes efficient land use practices for maximizing the resource potential of each of the selected areas and describes the agencies and organizations involved in the rehabilitation efforts.

Status and rehabilitative land use of Indian mangroves

Indian coastal wetlands are in a state of constant flux owing to several natural and manmade changes over the past few centuries including climatological disturbances, geological processes, deforestation, reclamation and pollution. The total wetland area in India converted to other uses has been estimated to be about 40 million hectares (Untawale, 1992). The major problems associated with indiscriminate use of the coastal wetlands are increasing soil acidification, loss of nutrients, soil erosion, and decreasing fishery potential, which in turn have led to many ecological and economic problems along the coast (Untawale, 1992).

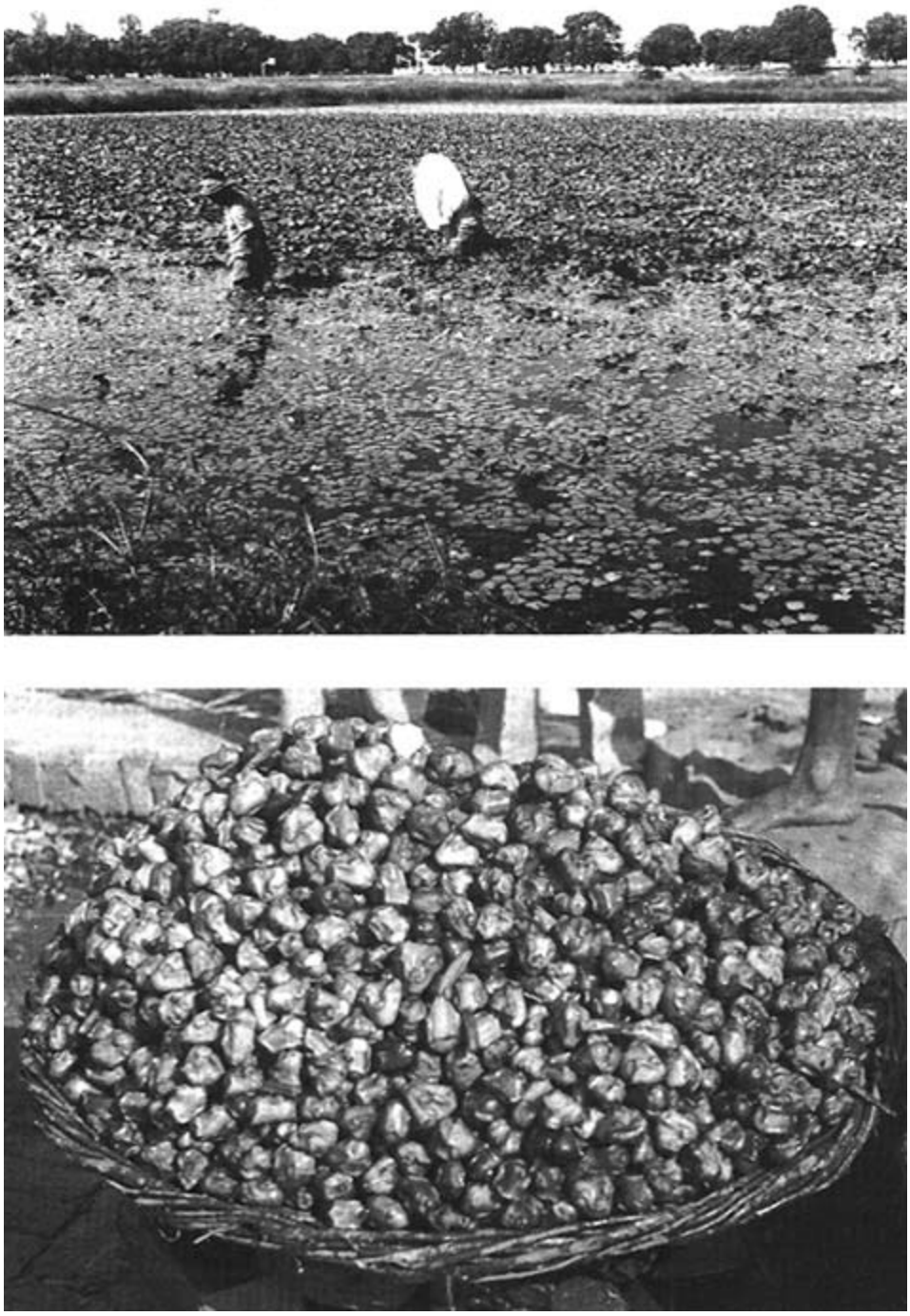

Figure 2. *Trapa bispinosa* is cultivated and manually harvested for its fruits (Source: Ecology and Management of Aquatic Vegetation in the Indian Subcontinent, Ed. Brij Gopal, Kluwer Academic Publishers, Dordrecht, The Netherlands).

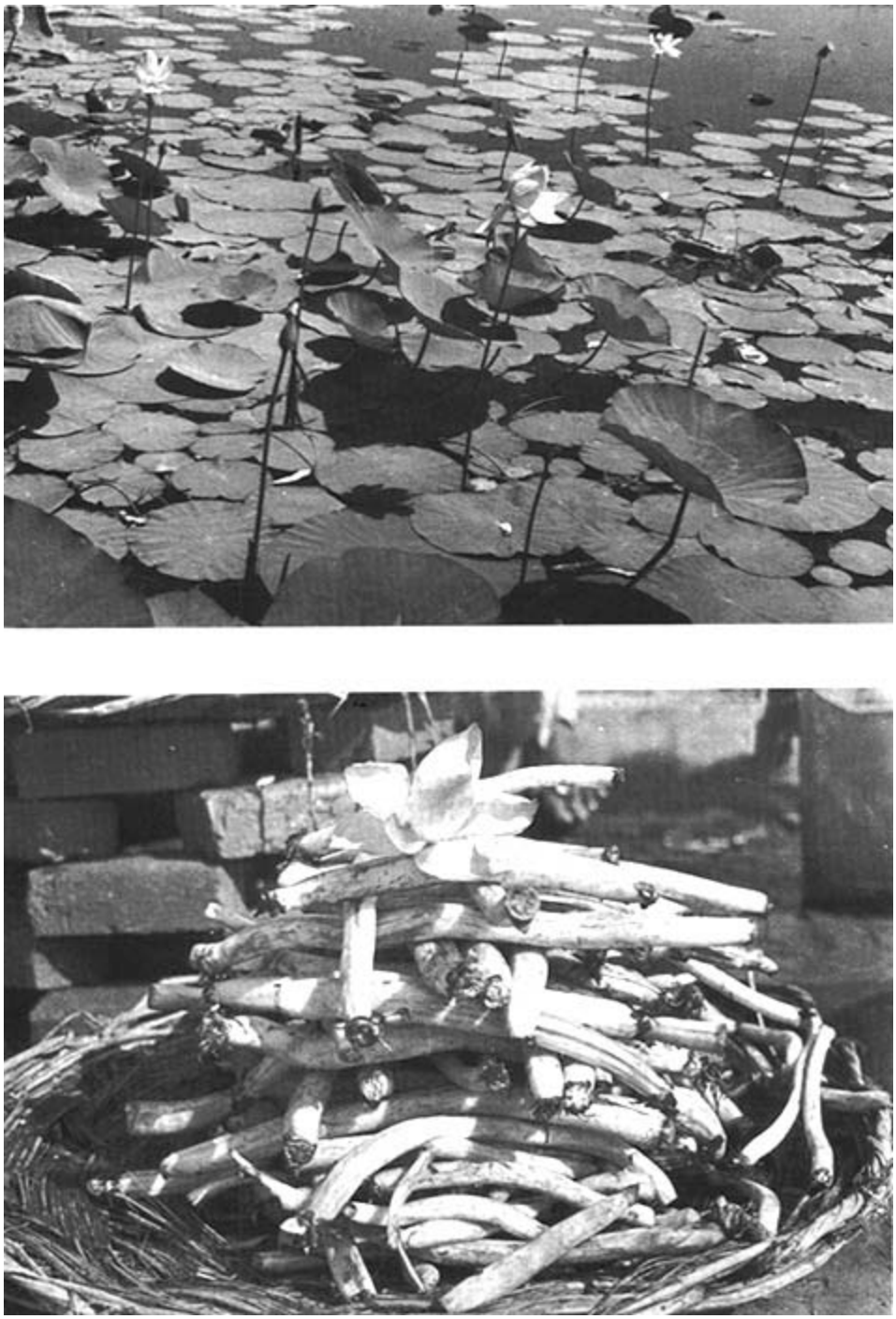

Figure 3. The lotus plant (*Nelumbo nucifera*) is cultivated for its flowers, fruits, rhizomes and petioles (Source: Ecology and Management of Aquatic Vegetation in the Indian Subcontinent, Ed. Brij Gopal, Kluwer Academic Publishers, Dordrecht, The Netherlands).

Management practices for the coastal mangroves have been studied in order to provide guidelines for sustainable, multiple-use management of mangrove ecosystems (Hamilton and Snedaker, 1984). The mangrove area is roughly estimated to be about 356,500 hectares (Blasco, 1977). Recent remote sensing studies of the coastal mangroves of Andhra Pradesh however, support an earlier estimate of 680,000 hectares (Sidhu, 1963). It is therefore imperative to inventory and evaluate the mangrove resources by using the recent tools of remote sensing and Geographic Information Systems (GIS) for accurate mapping of different characteristics including degraded areas, water bodies and open areas, which will be instrumental in devising practical solutions for rehabilitation. From the available data, it can be reasonably determined that the current condition of the mangroves is highly degraded owing to a combination of pressures of resource use and lack of awareness and planning.

Untawale (1992) suggests rehabilitation based on efficient land use practices. He suggests brackishwater fish farming as a potential use for open degraded areas and a range of uses including fishing, navigation, transport, recreation and research for the estuarine waters fringing the mangroves. The marshy areas with high to very high soil salinity and low rainfall can be restored for salt production and *Artemia* (brine shrimp) culture. The open swampy areas with regular tidal flushing and silty clay soil are most suitable for mangrove afforestation, which would be a traditional and effective practice for their restoration.

Rehabilitation Case Studies for mangroves on the West Coast

A range of different climatic, geological, environmental and biotic conditions exist along the Indian coast but it is reasonable to address the rehabilitation of degraded mangroves (Figure 4) while keeping in mind the national priorities and local needs. Successful rehabilitation can be gauged by an improvement in the socio-economic and ecological conditions.

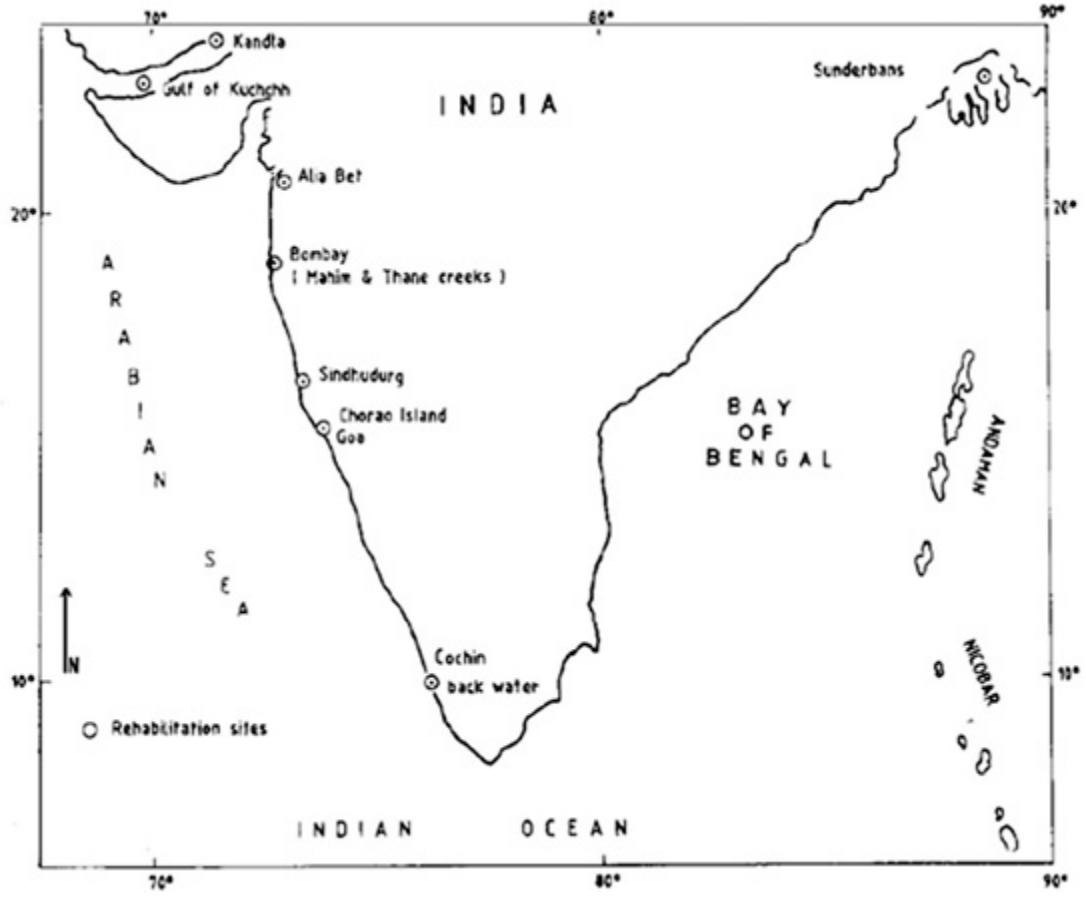

Figure 4. Map of India showing the coastal rehabilitation sites (Source: Ecosystem Rehabilitation Volume 2. Ed. Mohan K. Wali, SPB Academic Publishing bv, The Hague, Netherlands).

Gulf of Kuchchh, Gujarat

Situated along the northwest coast, the Gulf of Kuchchh is a semi-arid region characterized by very high temperatures and low rainfall resulting in high soil salinity. The locals depend solely on the mangroves for fuel, fodder and even food. Large areas of the mangroves have been converted for salt production. Blasco (1977) described the salt marshes of this region and attributed the openness of the area to the unique soil properties and not to the people and animals residing in the area. In recent years, the wildlife potential of the region has been realized as these mangrove areas abound in resident and migratory bird populations. Prevention of indiscriminate cutting of the existing mangrove forests and mangrove afforestation will increase coastal stability and productivity. The south coast of the Gulf, where mangrove vegetation exists, has been declared a protected area by the state government. Rehabilitation measures include mangrove planting program and declaration of Pirotan Island in the Gulf as a ‘marine park’. Large-scale reforestation using *Avicennia marina* with its dense mat of pneumatophores in the upstream catchment area is suggested as a rehabilitative solution.

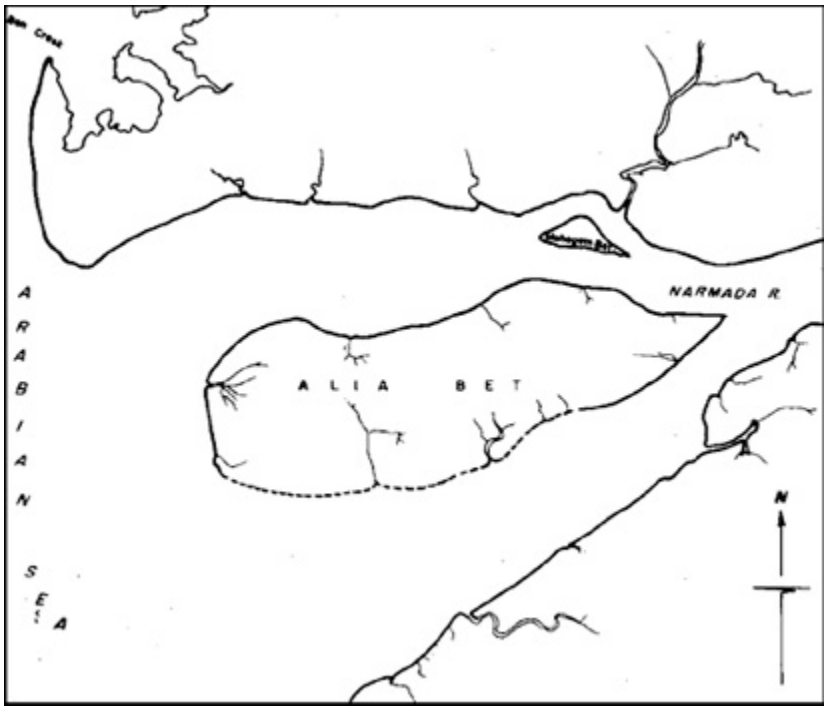

Figure 5. Map showing the island of Alia Bet at the mouth of the Narmada River (Source: Ecosystem Rehabilitation Volume 2. Ed. Mohan K. Wali, SPB Academic Publishing bv, The Hague, Netherlands).

Alia Bet, Gujarat

Situated at the mouth of the Narmada River, the estuarine island of Alia Bet (Figure 5) abounds in the mangrove grass *Porterasia coarctata*, which is used by the large camel population maintained on the island for breeding purposes. Severe deforestation and heavy freshwater influx in the upstream catchment area have contributed to high sediment flow in the river and the island has been subject to considerable erosion from strong currents and tidal bore impact due to the lack of mangrove vegetation. The rehabilitation program prepared by Gujarat Narmada Valley Fertilizers Company Limited (1986) recommended large-scale reforestation with *Porterasia coarctata* and *Avicennia marina.* It also recommended embankment of creeks with sluice gates for brackishwater fish farming as a means to generate more seafood and jobs for the local people. These measures are aimed at stabilizing the island's coastline and checking erosion.

Bombay Coast, Maharashtra

What is presently the city of Bombay was originally a cluster of seven islands fringed with rich mangroves that were reclaimed for development into a burgeoning city that continues to make incessant demands on the land for space and resources. In spite of all the pressure, there are still some remnants of mangrove patches along Mahim Creek and Thane Creek.

Mahim Creek, considered a heavily polluted area, is under several developmental pressures including railroad lines, water pipes, bridges, industry and slums. Though the heavily contaminated (toxic industrial waste) mangrove waters cannot support animal life, small patches of mangroves are still growing with *Avicennia marina* as the dominant species. Restoration efforts include deepening of the channels to reduce the pollution level. The Bombay Municipal Corporation and the World Wide Fund for Nature (Bombay) have jointly agreed to rehabilitate this area as a mangrove park for habitation by diverse bird fauna. The setting up of a mangrove nursery makes mangrove afforestation in the Mahim Nature Park possible. With towers for studying bird behavior, this park will be used for education and recreation.

Heavy pressures for housing, industries, salt pans and increasing demand for fuel characterize Thane Creek, which bears dwarf mangroves like *Avicennia* spp. and *Acanthus* spp., and some grasses and sedges. Godrej Trust, a social organization, is making efforts for the rehabilitation of these mangroves depleted due to developmental pressures. Use of the open degraded areas for fish farms and salt production would generate jobs and income and afforestation in the Creek would address the demands of firewood for harvesting.

Sindhudurg Coast, Maharashtra

Sindhudurg Coast, situated south of Bombay, has also been exploited severely for fuel and fodder and efforts have been made recently to stabilize the coast with mangrove vegetation. The Kolhapur Circle of Social Forestry Department has successfully carried out rehabilitation by resorting to large-scale afforestation of 100 acres of land using mangrove nurseries. Technical knowledge for the program was gained from the National Institute of Oceanography at Goa.

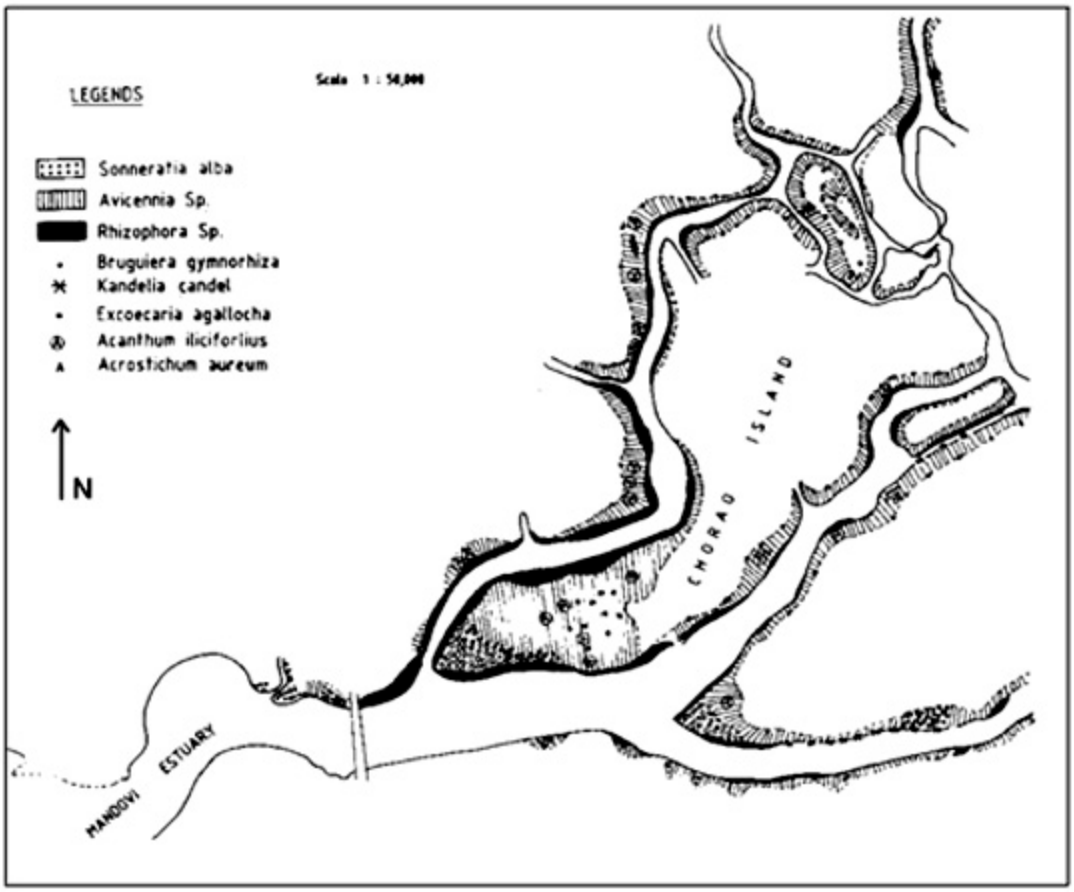

Figure 6. Map of Chorao island in the Mandovi estuary (Source: Ecosystem Rehabilitation Volume 2. Ed. Mohan K. Wali, SPB Academic Publishing bv 1992).

Chorao Island, Goa

Similar to the restoration efforts along Sindhudurg coast, the integrated restoration of Chorao, an estuarine island of Goa (Figure 6), has been undertaken by the Forest Department by massive afforestation covering 200 hectares. The rehabilitation for this area however, takes the form of integrated development for preservation, crocodile farming, brackishwater fish farming, a bird sanctuary and a World Wildlife Fund sponsored Environmental Education Center for disseminating knowledge about such projects with an intent to open the island for tourism. Limited information is available from the published report (Untawale, 1992) about the details of the areas and extent of mangrove degradation.

Cochin Backwater, Kerala

The Cochin Backwater (Figure 7) was originally fringed by mangroves and was famous for prawn fishery; the mangroves were cut down to convert the backwater to agriculture. Construction of the large Thaneermukam Dam considerably altered the dynamics of the area, one of the largest ecosystems of the state of Kerala. Influx of freshwater and the resulting decrease in salinity have led to the luxuriant growth of the water fern, *Salvinia*, which now covers most of

the backwater surface. Balakrishnan and Devi (1984) have identified this region as one of the major ecological and economic problems of Kerala.

There is a need for detailed studies to be undertaken before rehabilitation or restoration of any kind is attempted. Restoration would need to address local needs and local practices affecting the ecosystem. For instance, polyculture of paddy and prawn (*Pokkali*) is still practiced here by the locals. Research and documentation on the culture of alternative crops in the region will help in advocating and promoting optimum use of the backwater by the locals.

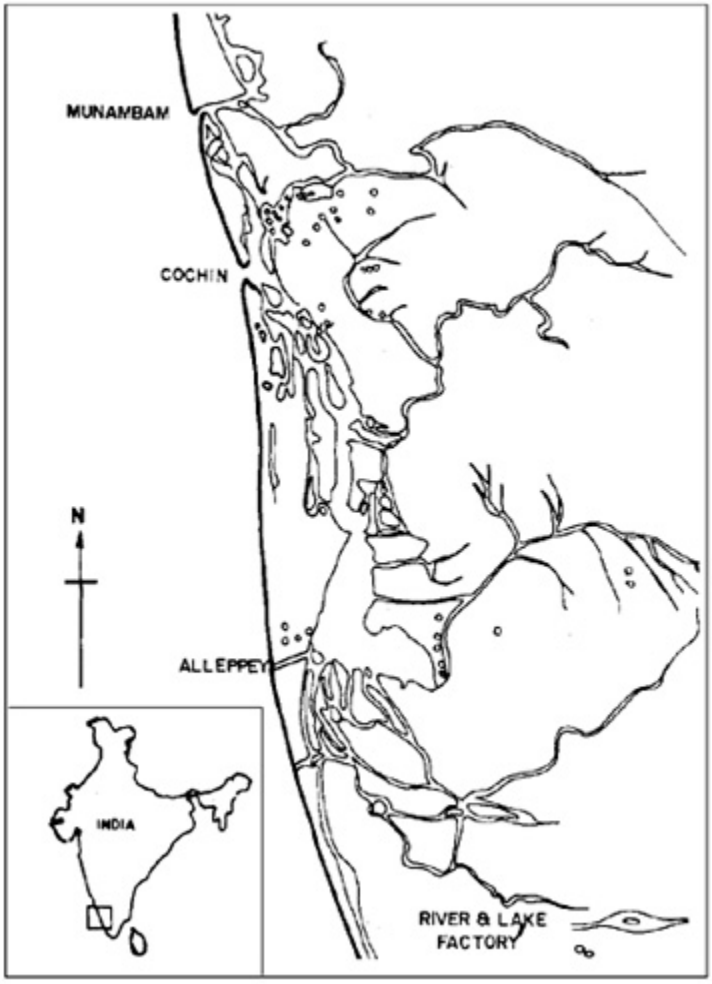

Figure 7. Map showing the Cochin Backwater system of Kerala (Source: Ecosystem Rehabilitation Volume 2. Ed. Mohan K. Wali, SPB Academic Publishing bv 1992).

Gangetic Sunderbans, West Bengal

Covering around 400,100 hectares in the Gangetic delta, the Sunderbans is one of the largest mangrove forests in India (Figure 8). The Sunderbans mangroves have been considerably

reduced due to several physical and biotic factors including geotectonic movement, change in river flow (Banerjee, 1964), natural disasters like floods and cyclones, and deforestation at a large scale.

Currently, there is a tiger reserve and a bird sanctuary in the region. Realizing the need to attend to restoration of the damage already done and to prevent future degradation, the Central Government has proposed to create a 'Biosphere Reserve' with the virgin mangrove forests of the Gangetic Delta. This reserve is to be divided into different zones including a 'core area' comprising about 170,000 hectares of pristine mangrove forests that would include the tiger reserve. The core zone will be bordered by a 'buffer zone' and subsequently by the 'manipulation zone' which would allow practices based on sustainable land use in this zone.

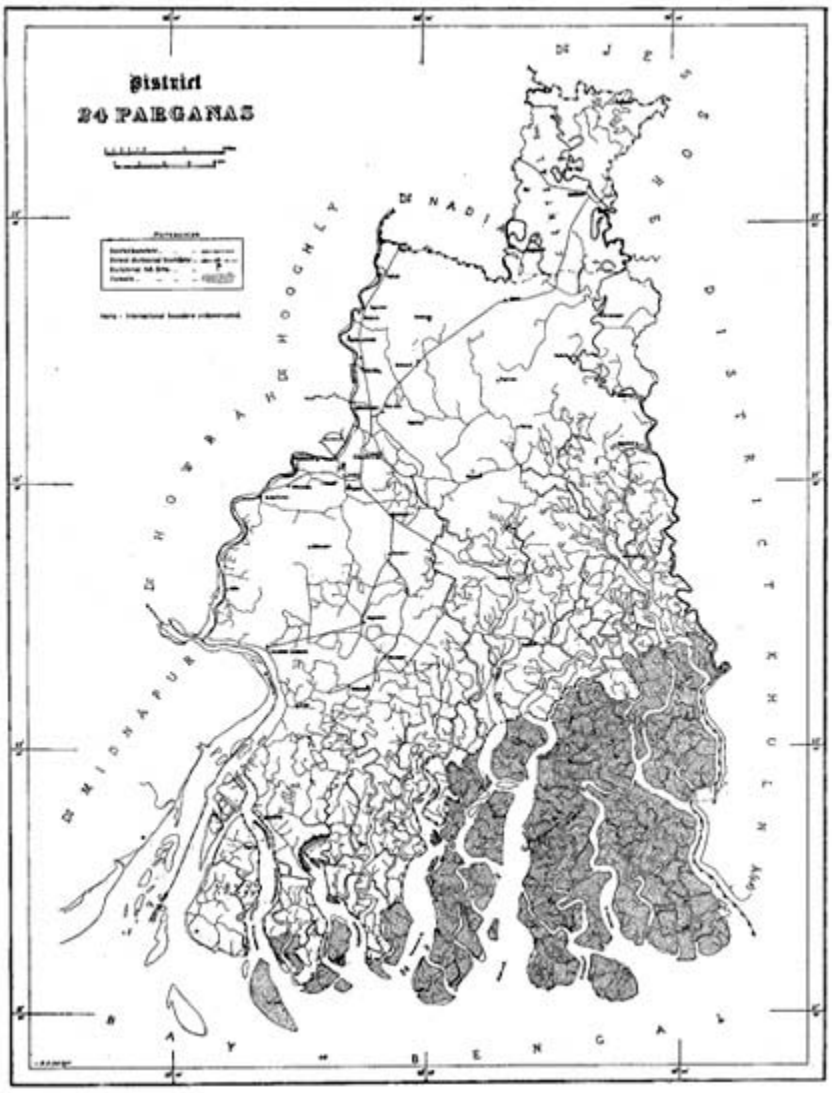

Figure 8. Forests of the Sunderbans in the 24 Parganas District, shown by shaded areas (Source: West Bengal Forests, Forest Directorate, Government of West Bengal, 1964).

Conclusion

The case studies indicate that the Indian coastline presents different types of geographical, geological, and climatological conditions. All areas have site specific human practices and pressures on the ecosystems that need to be addressed while formulating restorative strategies. The suitable measure of effectiveness of the restoration too, would vary with the geographic location of the project and the best way of gauging performance would be to measure the change in the social and economic conditions of the inhabitants and the ecological changes to the system. Though measures have been taken in India to address the crucial issue of mangrove degradation, more needs to be done. The Forest (Conservation) Act, amended by the Government of India in 1988, addresses the depleting mangrove forests of India. The Government has set up a National Mangrove Committee with state level steering committees to plan and implement research and development programs for the rehabilitation and conservation of mangroves.

References

Ambasht, R.S. (1993). Conservation of some disturbed Indian tropical forest ecosystems. In Restoration *of Tropical Forest Ecosystems*, ed. Helmut Lieth and Martina Lohmann, pp. 203-208. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Bakker, J.P., Esselink, P., Van der Wal, R. and Dijkema, K.S. (1997). Options for restoration and management of coastal salt marshes in Europe. In*Restoration Ecology and Sustainable Development*, eds. Urbanska, K.M., Webb, N.R., and Edwards, P.J., pp. 286-322.

Balakrishnan, K.P. and C.B. Lalithambika Devi (1984). Development and eco-disaster: A lesson from Cochin Backwater System. *Water Science Technology*16:707-716.

Banerjee, A.K. (1964). Forests of Sunderbans. In *West Bengal Forests*. Centenary Commemoration Volume, pp. 166-175. West Bengal, Calcutta, India.

Blasco, F. (1977). Outline of ecology, botany and forestry of the mangroves of the Indian subcontinent. In *Ecosystems of the world*, ed. V.J. Chapman, pp. 241-260. Elsevier Scientific Publishing Company, Amsterdam, the Netherlands.

Gopal, B. (1990). Conclusions and needs for future research. In *Ecology and Management of Aquatic Vegetation in the Indian Subcontinent*, ed. Gopal, B., pp. 243-246.

Gopal, B. (1990). Indian subcontinent and the aquatic habitats. In *Ecology and Management of Aquatic Vegetation in the Indian Subcontinen*t, ed. Gopal, B., pp. 7-28.

Gujarat Narmada Valley Fertilizers Company Limited. (1996). *Development of Wasteland of Alia Bet – A project proposal*. Narmada Nagar, Gujarat, India.

Hamilton, L. S. and C. Snedaker, eds. (1984). *Handbook for Mangrove Area Management* United Nations Environment Program, East-West Center, Environmental and Policy Institute, Honolulu, Hawaii, USA.

Odum, W.E. and E.J. Heald (1972). Trophic analyses of an estuarine mangrove community. *Bulletin of Marine Science* 22: 671-738.

Schouten, M.G.C. (1996). Disturbance, conservation and restoration of ecological systems – dreams and realities. In *Disturbance and Recovery in Ecological Systems*, eds. Giller, P.S. and Myers, A.A., pp. 101-118. Royal Irish Academy, Dublin.

Untawale, A.G. (1992). Rehabilitation of Coastal Wetlands of India. In *Ecosystem Rehabilitation, Volume 2: Ecosystem Analysis and Synthesis*, ed. Wali, M.K. pp. 333-348. Academic Publishing bv, The Hague, Netherlands.