
Mangroves for the Future
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Towards
Conservation and
Management of
Mangrove Ecosystems
in India

Towards Conservation *and* Management *of* Mangrove Ecosystems *in* India

Produced by the Mangroves for the Future (MFF) India
20, Anand Lok, August Kranti Marg, New Delhi-110 049
with financial support of Norad and Sida.

ISBN 978-2-8317-1263-5

Citation: **Towards Conservation and Management of Mangrove Ecosystems in India**/ed. by Bhatt J. R., Macintosh D. J., Nayar T. S., Pandey C. N. and B. P. Nilaratna, IUCN India.
xii, 280pp+156 colour photographs. Includes scientific articles, bibliography and indices
1. Mangroves 2. Conservation 3. Management
4. Policy 5. Recommendations
577.6980954

Available from: IUCN India Office

Cover: S. Suresh

Front: *Parasesarma plicatum* on *Aegiceras corniculatum*, photo by K. Shanij
Back: *Acanthus ilicifolius*, photo by S. Suresh

Design and Layout: T. S. Nayar

Printed at St Joseph's Press, Thiruvananthapuram 695 003, Kerala, India

Restoration of Degraded Mangroves in Andhra Pradesh

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Introduction

Mangrove forests are degrading due to a combination of anthropogenic factors and geo morphologic changes in the mangrove ecosystem. Restoration of degraded mangroves is being carried out in tropical and subtropical estuaries throughout the world (Field, 1996; Qureshi, 1996; Snedaker and Biber, 1996; Soemodihardjo *et al.*, 1996; Untawale, 1996). Restoration of mangroves started in Indonesia in the early 1960s and an area of about 38,920 ha. was restored upto 1992 (Soemodihardjo *et al.*, 1996). Macnae (1968) planted *Rhizophora apiculata* in the newly accreted soils in Sri Lanka for stabilization of the area and for trapping the sediments. Goforth and Thomas (1979) reported the planting of mangroves in Florida for reducing coastal erosion. Restoration of mangroves arrests further degradation of mangroves adjoining the degraded patches and increases the fishery resources.

In Andhra Pradesh the extent of mangrove wetlands in Godavari and Krishna are 33,263.32 ha. and 24,999.47 ha. respectively. Although the extent of mangrove wetlands in Godavari are 33,263 ha., the dense vegetation is only about 17,000 ha. The remaining areas are under water bodies, mud flats, degraded mangroves, sandy beach and *Casuarina* plantations. Similarly, in Krishna only about 10,000 ha. are with dense mangroves and the remaining areas are under mudflats and degraded areas. The M. S. Swaminathan Research Foundation (MSSRF) and the Forest Department, Government of Andhra Pradesh are restoring degraded mangroves to enhance the mangrove vegetation. In Andhra Pradesh MSSRF with the participation of eight village level institutions (Eco Development Committee/Vana Samrakshan Samiti) has restored 520 ha. of mangroves (Table 1) and the Forest Department, about 2000 ha.

Excoecaria agallocha, flowers

Table 1. Details of restored area and the area under protection by the villagers

Demonstration village	Area restored (ha.)	Area under protection (ha.)
Matlapalem	5	502
Dindu	25	900
Kobbarichettupeta	35	3925
Gadimoga	25	900
Bhairavalanka	75	615
Dheenadayalapuram	236	2000
Zinkapalem	114	600
Nali	5	-
Total	520	9442

Study area

The restoration of degraded mangroves was carried out in the Krishna and Godavari estuaries. Godavari and Krishna wetlands in Andhra Pradesh are located in the deltaic regions between 16° 30' - 17° N and 82° 23' E in the East Godavari district and between 15° 42' - 15° 55' N and 80° 42' - 81° 01'E in Krishna and Guntur districts respectively.

Causes for degradation

The coastal community living near the mangroves utilises the mangrove resources as fuel wood, fodder, fencing and house construction material. The extensive use of the mangrove resource is one of the causes for mangrove degradation along the fringes. The topographically elevated areas adjoining the creeks (levees) formed due to the sediment deposition during floods prevent regular tidal flushing leading to increase in soil salinity. Creeks supplying tidal water into the mangroves are also silted preventing tidal water flow in some of the areas. Mangroves are also degraded due to:

- Changes in biophysical condition due to coupe felling in the past (clear felling as a part of the Government management practice).
- Reduction in freshwater flow.
- Conversion of mangrove forests for other purposes.

Research needs before initiating mangrove restoration

Identification of degraded areas

Degraded areas were identified through a biophysical survey and using remote sensing images obtained from NRSA, Hyderabad.

Biophysical study

Soil samples collected from the degraded area were analyzed for nutrients and soil salinity. Pore water salinity (subsurface water) was analysed during different seasons. Tidal amplitude and topography of degraded areas were studied and canal dimensions were determined. Topography of the area was measured using a level instrument. The Survey of India maps and anecdotal evidences (Participatory Rural Appraisals) were collected to verify the earlier existence of mangroves. Based on the distribution of mangrove species (zonation), the species were selected for planting in the degraded area.

Soil profile

Mangroves require clayey soil for good establishment. Mangroves grow well in alluvium deposits (accreted areas) because of their high nutrient content. However, mangroves are stunted in sandy clay areas. In Andhra Pradesh, the soil is clayey except for a few places near the sea in the Godavari and Krishna estuaries.

Species selection

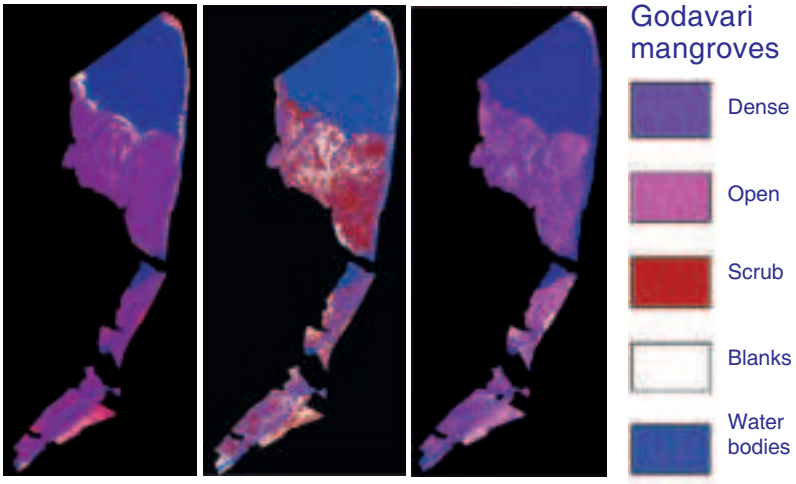
The recently formed mudflats are *Porteresia coarctata* and small seedlings of *Avicennia alba* and *Sonneratia apetala*. In the seaward areas *Sonneratia apetala, Avicennia alba* and species of *Rhizophora* are the suitable species for planting. *Avicennia marina* is the most common species suitable for mangrove restoration in the degraded areas. This species has the ability to tolerate salinity up to 90 ppt. The halophytes *viz*.: *Suaeda* and *Salicornia* are also seen along with stunted *Excoecaria agallocha* and *Avicennia marina*.

The pore water salinity was found between 80 and 120 ppt. Based on the soil salinity, the highly saline tolerant mangrove species like *Avicennia marina, Excoecaria agallocha* and *Avicennia officinalis* were selected for planting in the degraded areas. Other species such as *Bruguiera gymnorrhiza, Xylocarpus moluccensis, Rhizophora apiculata* and *R. mucronata* were also planted for genetic diversity.

Restoration techniques

Afforestation in mudflats

Mangroves normally establish themselves naturally in the newly formed mudflats in the estuary as these areas receive tidal water twice a day. Planting of saplings is only necessary for developing mangroves with one meter spacing. This method has been extensively followed in the Sunderbans and Bangladesh. If the mangroves are not developing in the accreted mudflats, then the reasons have to be studied in detail. In Godavari and Krishna, the newly formed mudflats have a dense growth of mangroves. Hence, afforestation was not carried out in Andhra Pradesh. The expenditure for raising these plantations is very low when compared to the restoration of degraded mangroves using the canal method.



Problems commonly encountered in afforestation programme are:

- Entanglement by debris and filamentous green algae such as *Enteromorpha* and *Cheatomorpha*.
- Leaf-eating insects and moth larvae.
- Encrustation by sessile organisms like barnacles.
- Erosion.

Restoration of degraded mangroves using the canal method

The canal method or trench method is largely followed to restore mangrove areas that are degraded due to clear felling in the past under the coupe system of management. The Mangrove Reserve Forests have been clear felled in large areas for revenue generation by various government agencies since the time of the British Government. This system of clear felling was followed in 15 to 25 year rotations. Because of the large scale felling, soil water in the coupe-felled areas evaporated (mangrove soil contains 80% of water), which in turn caused subsidence of sediments. As a result, smooth topography of the mangrove wetland has become trough shaped and tidal water entering into these trough shaped areas stagnates. The evaporation of the stagnant water leads to hyper saline condition and prevents natural regeneration of mangroves in the coupe_felled areas. The canal method is also suitable for topographically elevated areas formed due to sediment deposition during floods.

Micro topographic survey

In some of the degraded areas, the land adjoining the creeks is elevated (levees) due to the deposition of sediments during floods. Due to such elevation, the area inside hardly receives any tidal flushing. Only the fringe areas support mangroves while the interior areas are blank, without any vegetation. The topographic survey revealed that the land was elevated

about 35-40 cm near the creek side. The topographic study helps in deciding the canal depth and accordingly the canals were dug. The canal depth was 35 cm deep in the elevated area.

Tidal amplitude

The tidal amplitude ranges from 0.4 to 1.4 m in Godavari. In Krishna it ranges from 0.35 m to 1.3 m. Accordingly the dimensions of the canals were designed.

Mangrove nursery

Avicennia marina is selected based on its wide range of saline tolerance (up to 90 ppt). The survival rate of nursery-raised saplings was high because of the well developed root system. The planting of saplings was done immediately after the southwest monsoon since survival is better in low saline conditions. Untawale (1996) and Snedaker and Biber (1996) also reported that the survival rate of nursery raised saplings was higher than that of direct sowing. However, direct planting of mangrove propagules will reduce the cost of establishment substantially.

Land preparation (canals)

To facilitate tidal water flow into the degraded areas, shallow canals were dug for tidal flushing. The plants were planted along the canals. In the low lying degraded areas the saplings were also planted in between the canals.

Dimension of the canals

The depth of the main canal varies from 0.45 to 0.7 m and the side canals from 0.6 to 0.45 m. The top width of the main canal was between 3.5m and 2 m and the bottom width, between 1 m and 0.4 m. The dimensions of side canals were: 2m top width, 0.4 m bottom width and 0.45m depth. The distance between the two side canals was 12.5 m. The planting of mangrove saplings was done 2 m apart along the canals. However, subsequently the distance between the side canals was reduced to 8 m and the dimensions of the side canals were reduced as 1.5 m top width, 0.3 m bottom width and 0.45 m depth.

Selection of species

In the degraded areas, the halophytes like *Suaeda maritima, S. nudiflora* and *Salicornia brachiata,* and mangroves like *Excoecaria agallocha* and *Avicennia marina* are present in stunted form. In the low lying areas, even the halophytes could not establish due to water stagnation for a prolonged period and soil salinity due to the evaporation of water. The pore water salinity in the degraded area was between 80 and 120 ppt. Based on the soil salinity, *Avicennia marina, Excoecaria agallocha* and *Avicennia officinalis* were selected for planting in the degraded areas as they were highly saline tolerant mangroves.

Planting of species

Eight month old mangrove saplings of *Avicennia marina, Excoecaria agallocha* and *Avicennia officinalis* raised in the nursery were used for planting. Other

species like *Bruguiera gymnorrhiza, Xylocarpus moluccensis, Rhizophora apiculata* and *R. mucronata* were also planted for genetic diversity. Mangrove saplings were planted along the slopes (20-25 cm from the top) of the canals at 2m intervals. The planting is done during October and November after the southwest monsoon. The monsoon and tidal flushing before planting reduce the soil salinity and lead to successful establishment of the mangrove saplings. Experimental trials of the direct dibbling of mangrove seeds/ propagules were also carried out. The survival percentage of direct dibbling of seeds is lower than the nursery raised saplings. Other species *viz.*: *Aegiceras corniculatum*, *Dalbergia spinosa, Caesalpinia crista, Lumnitzera racemosa, Derris trifoliata, Acanthus ilicifolius* and *Myriostachya wightiana* were established naturally.

Growth

In the mangrove plantations, survival is more than 80% but the initial growth rate is slow (2m in 3 years). This may be because of the fact that the restoration areas are elevated and the average inundation in the canals in a month is about 15 days. Problems commonly encountered using this method are silting of canals and grazing.

Conclusion

Freshwater flow is very important for mangroves and studies have to be carried out for optimum freshwater requirement for better mangrove growth. Mangrove restoration using the canal method has to be monitored and if necessary desilting has to be done for at least three years beforehand. Site specific mangrove restoration techniques have to be used based on the tidal amplitude and topography. The user community has to be involved in mangrove conservation and management programmes so as to utilize the resources judiciously.

To determine the causes for mangrove degradation the biophysical conditions and a topography survey have to be carried out before undertaking mangrove restoration. The biotic interferences like grazing and felling have to be addressed and continuous monitoring of the plantation is required for successful restoration of the degraded mangroves.

Acknowledgements

The authors thank Prof. M. S. Swaminathan, Chairman and Shri. A. M. Gokhale, Executive Director, M. S. Swaminathan Research Foundation for their constant guidance and encouragement. They also thank the staff of the Andhra Pradesh Forest Department and the coastal community for their cooperation. The India-Canada Environment Facility (ICEF), New Delhi is thanked for the financial support.

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Avicennia officinalis in high tide, Sundarbans (Overleaf)