

**BEFORE THE HONOURABLE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI**

In

O.A.No.160 of 2020 (SZ)

IN THE MATTER OF:

EAS Sarma&Ans

...Applicant(s)

Vs

Union of Indiaand Ors.

...Respondent(s)

**Joint Committee Report on
EXTENT OF DAMAGE/COST REQUIRED FOR RESTORATION**

Joint Committee Report
In
Application No.160 of 2020

Index

Sl.No	Particular	Page No.
1	Joint Committee Report on extent of damage/cost required for restoration.	1-5
2	Annexure-I	6-11
3	Annexure-II	12-12
4	Annexure-III	13-23
5.	Annexure-IV	24-57

BEFORE THE HONOURABLE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

In

Application No.160 of 2020

**Joint Committee Report on OA No.160 of 2020(SZ) filed before the
Hon'ble National Green Tribunal, Southern Zone, Chennai.**

Introduction

The Hon'ble NGT(SZ) vide its Order dated 18.02.2021 in OA No.160 of 2020(SZ) has directed the Joint Committee to file further report by explaining the extent of damage and cost required for restoration and time limit within which the same has to be done.

The Hon'ble NGT(SZ) pointed out that the project site is within 1.8 Km from the Eco Sensitive Zone (ESZ) of Coringa Wildlife Sanctuary and since the Eco Sensitive Zone (ESZ) has not been notified so far, the default zone of 10 Kms as directed by the Hon'ble Apex Court has to be followed. (Copy of the Order dated 18.02.2021 in OA No.160 of 2020(SZ) is at **Annexure-I**).

During the field inspection on 10.12.2020, the joint committee realized that there were some damages caused to Mangroves and the same was reported to the Hon'ble NGT (SZ). The damage to mangroves was happened to an extent of around 5 acres. The surveyed map of actual affected area prepared by the port authorities is at **Annexure-II**.

Regarding the project activity fall under the default zone of 10 Km distance from Eco Sensitive Zone of Coringa Wildlife Sanctuary, the present activity is coming under 7(e) of the schedule to EIA Notification, 2006 and it is stated that "maintenance dredging is exempted provided it formed part of the original proposed for which Environment Management Plan (EMP) was prepared and environment clearance obtained".(Copy of the schedule to EIA Notification, 2006 is enclosed as **Annexure-III**).

Restoration of Mangroves and expenditure involved

Restoration of degraded mangroves was being carried out in the tropical and subtropical estuaries throughout the world. Restoration of mangroves started in Indonesia in the early 1960's and an area of about 38,923 ha of mangroves were restored. In Andhra Pradesh, the Forest Department initiated restoration of mangroves in Godavari by canal digging during 1991.(As per the Manual "Mangrove Forest Restoration in Andhra Pradesh, India" by M.S. Swaminathan Research Foundation)

For the same, the staff of the Forest Department was taken on an exposure visit to the Pichavaram mangroves where restoration was done by M.S. Swaminathan Research Foundation. After observing the restoration at Pichavaram, the Forest Department started digging canals at 30° from the main canal from 1999 onwards. The canals were dug perpendicular to the river and the side canals were at right angles to the main canal. This reduces the rate of siltation of canals and also facilitates easy flow of tidal water. Accordingly an area of 2,000 ha has been restored by the Forest Department in Godavari and Krishna Mangroves.

The manual on Mangrove Forest Restoration in Andhra Pradesh by M.S. Swaminathan Research Foundation also have practical suggestions to restore mangrove and associated cost. This publication reflects the process and results of restoration activities carried out over seven years by the project Coastal Wetlands: Mangrove Conservation and Management, implemented in Godavari and Krishna wetlands by MSSRF with its field centre at Kakinada. M.S. Swaminathan Research Foundation (MSSRF) started its activities of mangrove restoration and management in Andhra Pradesh from 1997 and restored 520 ha of degraded mangroves and facilitated community participated mangrove management in 9,442 ha. Copy of the manual is at **Annexure-IV.**

As per the manual the restoration cost for canal construction and planting of seedlings per unit depends on extent of area, nature of the soil and distance between the village and the restoration site (if it is community participation)

In Godavari basin, the cost for canal digging for one ha was Rs. 18,000/-. Therefore, the cost of restoration of degraded mangroves in an area of 10 ha which includes survey, nursery raising, advance work in canal construction and planting would require Rs. 2,00,000/- and for desilting in the first three years, it will cost Rs. 1,00,000/-. Hence, Rs. 3, 50,000/- will be the total cost for restoration of 10 ha of degraded mangroves through community participation.

Thus Rs. 70000/ was the expenditure for restoring the mangroves at 5 acres through community participation in Godavari area. However, this mangrove plantation was done in 1999 (before 20 years) and also through community participation. **After taking account of inflation rate and non**

community participation the amount required may be around 25 times more than the amount spend on 1999 for the purpose of restoration of mangroves in the same district of Andhra Pradesh. That is Rs.70000x 25=Rs.1750000/-

Timeline for the restoration work

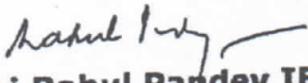
1. Construction of Canal and associated channeling work should be completed before monsoon (June, 2021).
2. Planting of additional mangrove saplings should be done during October and November (2021) after the Southwest monsoon for ensuring better survival rate.
3. Further mortality if any, should be replenished up to December/January 2021.
4. Desilting of canals should be done before the onset of summer i.e., February/March 2021.
5. The estimated time required for restoration of mangroves is one (1) year from March 2021.
6. The maintenance workslike casualty replacement and desilting of canals should be carried out yearly up to March 2024.

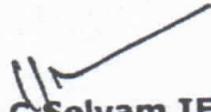
Recommendation of the committee:

1. The Restoration methods In the manual "Mangrove Forest Restoration in Andhra Pradesh, India" published by M.S. Swaminathan Research Foundation can be followed since It was a successful project in Andhra Pradesh.
2. Rs.20 lakhs may be required for the purpose of restoration of mangroves in the affected area.


(Dr.C.Palpandi)
Scientist 'C'
MoEF&CC


(Dr.K.G.Prijilal)
Research Officer
MoEF&CC


(Shri.Rahul Pandey IFS)
CCF (Wildlife)


(Shri.C.Selvam IFS)
DFORajahmundry, WLM Division


(Shri.A.Ramarao Naidu)
Environmental Engineer, APPCB
for APCZMA



Item No.4:

CCF (Wildlife)
PESHI
U 1 MAR 2021

**BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI**

Original Application No. 160 of 2020 (SZ)

(Through Video Conference)

IN THE MATTER OF:

E.A.S. Sarma and another.

... Applicant(s)

Versus

Union of Indian and others.

... Respondent(s)

Date of hearing: 18.02.2021

CORAM:

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER

HON'BLE MR. SAIBAL DASGUPTA, EXPERT MEMBER

For Applicant(s):

Sri. Ritwick Dutta

For Respondent(s):

Smt. ME. Saraswathy for R1

Smt. Maduri Donti Reddy for R2 to R4

Sri. Dattaray Vyas for R6

Sri. R. Palani Andavar for R7

Sri. Prasanna Venkat represented

Sri. Prabakat Reddy for R5 & R8

ORDER

1. When the matter came up for hearing today through Video Conference, Sri.

Ritwick Dutta represented the counsel for the applicant. M/s. ME. Saraswathy

Wildlife
Def (w/c)
Please examine
ad H up
al
2/3/21
CCF/wr
Urgent Time Bound
Super/Wr-1
2/3/21

1505 504 T represented first respondent, Smt. Maduri Donti Reddy represented respondents 2 to 4, Sri. Dattatray Vyaas represented 6th respondent, Sri. R. Palani Andavar represented 7th respondent and Mr. Prasanna Venkat represented M/s. Prabakar Reddy counsel for respondents 5 and 8. So service is complete.

2. We have received the Joint Committee report submitted by the committee dated Nil and received on 12.01.2021 which reads as follows:-

Joint Committee Report on OA No.160 of 2020(SZ) filed before the Hon'ble National Green Tribunal, Southern Zone, Chennai.

INTRODUCTION

Vide Order dated 27.8.2020 in O.A No. 160 of 2020, the Hon'ble NGT (SZ) has constituted a Joint Committee comprising of 1) a Senior Officer from Regional Office, Ministry of Environment, Forest & Climate Change (MoEF & CC), Chennai, 2) a Senior Officer from Andhra Pradesh Coastal Zone Management Authority (APCZMA), 3) a Senior Officer not below the rank of Chief Conservator of Forest to be designated by the Principal Chief Conservator of Forest & HOFF, Andhra Pradesh and 4) the Divisional Forest Officer, Coringa Wildlife Sanctuary to inspect the area in question and submit a factual as well as action taken report, if there is any violation found including assessment of environmental compensation and remedial measures to be taken to restore the damage caused to the environment.

However, several times the site visit was postponed due to various constrains like request vide letter No. ALN/70/2019-SA(E2) dated 15.7.2020 from District administration due to Covid-19 pandemic in the District, thereafter due to the heavy rainfall in the State of Andhra Pradesh and Telangana and finally due to the Nivar Cyclone at East Coast.

The committee is also directed to consider the question of nature of damage caused to the mangroves and mudflats due to the activities of the sixth respondent and also on the account of the construction of the bund preventing the flow of sea water in that area and the consequential damage caused to the mangroves and the mudflats and its effect on the environment and eco sensitive zone namely, the Coringa Wildlife Sanctuary and if any damage caused to the environment apart from assessing the environmental compensation required for the restoration of damage caused to

the environment.

The committee is also directed to consider the question as to whether any activity of the sixth respondent has been extended in the prohibited CRZ - I and CRZ- IA areas as alleged in the application.

Meanwhile, Hon'ble NGT vide its common order dated 20.11.2020 in I.A.Nos.119&120/2020 of OA No. 160 of 2020(SZ) deleted the 5th respondent and impleaded M/s.GMR Energy Ltd as 8th respondent.

BACKGROUND

*GMR Energy Limited, the 8th Respondent has relocated a Barge Mounted Power Plant from Mangalore to Kakinada during June, 2010 by transporting the barge in a mother vessel upto Kakinada high sea. From the high sea, the barge was towed to the existing mooring basin after deepening the commercial channel and dredging the area of mooring basin. From March 2013, the plant remained to shut down due to the non availability of natural gas and do not foresee any chance for getting natural gas in near future, the management decided to sell the barge for managing the financial crisis. As a preparatory work for towing the barge out of mooring basin to high sea to handover to prospective buyer, dredging of the same navigation channel used for bringing the barge to Kakinada mooring basin is done. For dredging, necessary approvals/ clearance were obtained. The approval for dredging given by Andhra Pradesh Maritime Board is at **Annexure-I**.*

OBSERVATIONS DURING THE SITE VISIT

The committee members conducted field inspection on 10.12.2020 in the presence of petitioners as well as respondents. On behalf of Shri E.A S Sharma (petitioner) Shri K.M Rao with a team of Environmentalist has described about the damages caused to the mangroves along the roadside patch. The Respondent No.7 informal that the area in question is under their control and covered by the approved master plan and the activities are being under taken as per the approved master plan.

*The Respondent No.8 conveyed that dredging was undertaken after obtaining necessary permissions. As directed by Andhra Pradesh Maritime Board, to avoid mixing of dredging spoil with sea water they constructed a bund in the designated area **for depositing dredging spoils**. Later they realized that the mangrove patch along the road side got affected and removed certain **portion** of bund to allow inflow of sea water into mangrove patch. It is also informed that due to this they have stopped all their activities in that area until further directions.*

They also informed that they have taken necessary steps for the regeneration/restoration of the affected mangroves by appointing an Expert Consultant for this purpose. However the petitioner demanded for the complete removal of the bund and the Respondent No. 8 has agreed up on. They also expressed their willingness to restore the damaged area to **its original position** under the supervision of Andhra Pradesh **Maritime Board** since the area is under their control. They also informed that apart from the mangrove patch along the road the area adjacent to GMR Power plant did not have mangroves as alleged by the petitioners, in fact it was a reclaimed area and only growth of Prosopis plants was found earlier. The photos taken during the site visit is at Annexure-II.

The area **in question is not a notified forest area** and not under the control of forest department. The affected **portion of mangrove area** is approximately 1.80 km away **from Coringa Wildlife sanctuary boundary** as well as away **from proposed Eco Sensitive Zone of Coringa WLS (the Coringa WLS Eco Sensitive Zone is not yet notified hence default zone of 10 km from Coringa WLS is currently applicable)**. It is noted that the important migratory bird species like Great knot and Indian skimmers are seen along with other species in the Kumbhabhishekam mudflats area which is under the control of AP Maritime Board. The committee also noticed that the area is fully covered with high buildings, immense warehouses, Industries, Ports, Fishing harbor and other facilities related to port related activities.

Recommendations of the committee

The main allegation of the petitioner in OA No.160 of 2020(SZ) is that there is a violation of Environmental Laws by the respondent No.8 while dredging. Further, due to deposition of dredging spoil and construction of bund in that location, the mangroves got damaged and requested to remove the bund and restore the mangroves to its original status as well as maintenance of Kumbhabhishekam mudflats area which is important for migratory birds. In view of this and based on the

observations/discussions during the site visit, the followings are recommended.

As demanded by the representatives of the petitioner and as agreed by the Respondent No.8 during the site visit, the affected portion of Mangroves has to be restored to its original position by 8th respondent by engaging suitable consultant/subject expert under the supervision of AP Maritime Board. The balance portion of the bund also has to be removed to allow in flow of sea water into this area by taking due care that the deposited dredging spoil not mixed with sea water.

The Kumbhabishekam mudflats area is to be maintained suitably by AP Maritime Board without affecting the existing port activities since important migratory bird species like Great Knot and Indian Skimmers along with other, migratory bird species are visiting this area every year. The area is falling in the default ESZ and therefore, they have to follow the rules and regulations imposed on ESZ.

Vigilance should be taken to protect the existing Mangroves and mudflats by the project proponent, AP Maritime Board and Forest Department while dredging the canal in future for port related activities.

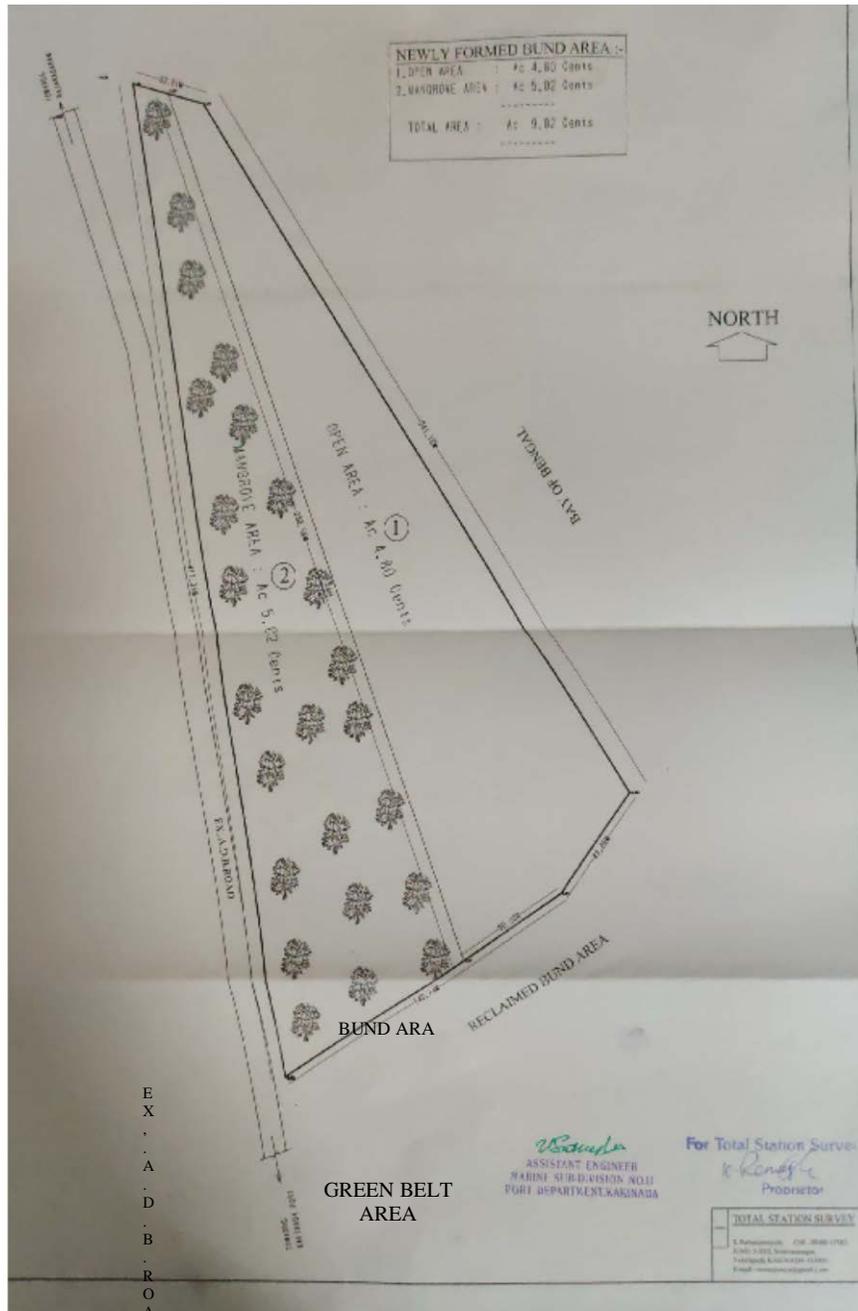
3. It was mentioned in the report, that there was some damage caused to Mangroves and it requires restoration which will have to be undertaken by the Andhra Pradesh Maritime Board. However, they have not mentioned the extent of damage and cost required for restoration and time limit within which the same has to be done.
4. It is also seen from the report that the project site is within 1.8 Km from the Eco Sensitive Zone (ESZ) of Coringa Wildlife Sanctuary and since the Eco Sensitive Zone (ESZ) has not been notified so far, the default zone of 10 Kms as directed by the Hon'ble Apex Court has to be followed.
5. So under such circumstances, the committee is directed to file a further report explaining the above aspects before the next hearing date.

6. The counsel for the applicant and also the other respondents wanted to file their objection to the committee report. The newly additional added partly also wanted to file their counter statement to the allegations made in the application. The parties are at liberty to file their objections and pleadings before the next hearing date.
7. The committee is directed to file a further report as directed to this Tribunal on or before 19.03.2021 by e-filing in the form of searchable PDF/OCR Support PDF and not in the form of Image PDF along with necessary hard copies to be produced as per rules.
8. The Registry is directed to communicate this order to the members of the committee as well as the official respondents immediately through e-mail so as to enable them to comply with the direction.
9. For consideration of further report and the report already submitted and objections if any and for completion of pleadings, post on 19.03.2021.

.....J.M.
(Justice K. Ramakrishnan)

.....E.M.
(Shri. Saibal Dasgupta)

O.A. No.160/2020,
18.02.2021, Sr.



E
X
·
A
·
D
·
B
·
R
O
A
D

Area under restoration is 2 ha

1(c)	River Valley projects	(i) ≥ 50 MW hydroelectric power generation; (ii) $\geq 10,000$ ha. of culturable command area	(i) < 50 MW ≥ 25 MW hydroelectric power generation; (ii) $< 10,000$ ha. of culturable command area	General Condition shall apply. Note: Irrigation Project not involving submergence or inter-state domain shall be appraised by the SEIAA as Category 'B' Projects.
1(d)	Thermal Power Plants	<p>≥ 500 MW (coal/lignite/naphtha & gas based);</p> <p>≥ 50 MW (Pet coke, diesel and all other fuels including refinery residual oil waste except biomass);</p> <p>≥ 20 MW (based on biomass or non hazardous municipal solid waste as fuel).</p>	<p>< 500 MW (coal/lignite/naphtha & gas based);</p> <p>< 50 MW ≥ 5 MW (Pet coke, diesel and all other Fuels including refinery residual oil waste except biomass);</p> <p>< 20 MW > 15 MW (based on biomass or non hazardous municipal solid waste as fuel).</p>	<p>General Condition shall apply. Note:</p> <p>(i) Power plants up to 15 MW based on biomass and using auxiliary fuel such as coal/ lignite / Petroleum products up to 15% are exempt.</p> <p>(ii) Power plants up to 15 MW, based on non-hazardous municipal waste and using auxiliary fuel such as coal / lignite / petroleum products up to 15% are exempt.</p> <p>(iii) Power plants using waste heat boiler without any auxiliary fuel are exempt.</p>

(1)	(2)	(3)	(4)	(5)
1(e)	Nuclear power projects and processing of nuclear fuel	All projects		
2	Primary Processing			
2(a)	Coal washeries	≥ 1 million ton/annum throughput of coal	<1 million ton/annum throughput of coal	General Condition shall apply (If located within mining area the proposal shall be appraised together with the mining proposal)
2(b)	Mineral beneficiation	≥ 0.1 million ton/annum mineral throughput	< 0.1 million ton/annum mineral throughput	General Condition shall apply (Mining proposal with Mineral beneficiation shall be appraised together for grant of clearance)

3				
(1)	(2)	(3)	(4)	(5)
3(a)	Metallurgical industries (ferrous & non ferrous)	<p>a) Primary metallurgical industry All projects</p> <p>b) Sponge iron manufacturing ≥ 200TPD</p> <p>c) Secondary metallurgical processing industry All toxic and heavy metal producing units $\geq 20,000$ tonnes /annum</p>	<p>Sponge iron manufacturing <200TPD</p> <p>Secondary metallurgical processing industry</p> <p>i.) All toxic and heavy metal producing units $<20,000$ tonnes /annum</p> <p>ii.) All other non -toxic secondary metallurgical processing industries >5000 tonnes/annum</p>	<p>General Condition shall apply.</p> <p>Note:</p> <p>(i) The recycling industrial units registered under the HSM Rules, are exempted.</p> <p>(ii) In case of secondary metallurgical processing industrial units, those projects involving operation of furnace, only such as induction and electric arc furnace, submerged arc furnace, and cupola with capacity more than 30,000 tonnes per annum (TPA) would require environmental clearance.</p> <p>(iii) Plants / units other than power plants (given against entry no. 1(d) of the schedule), based on municipal solid waste (non-hazardous) are exempted.</p>
3(b)	Cement plants	≥ 1.0 million <1.0 million tonnes/annum production capacity	<1.0 million tonnes/annum production capacity. All Stand alone grinding units	General Condition shall apply

4				
Materials Processing				
(1)	(2)	(3)	(4)	(5)
4(a)	Petroleum refining industry	All projects		
4(b)	Coke oven plants	≥2,50,000 tonnes/annum	<2,50,000 & ≥25,000 tonnes/annum	General Conditions shall apply
4(c)	Asbestos milling and asbestos based products	All projects		
4(d)	Chlor-alkali industry	≥300 TPD production capacity or a unit located outside the notified industrial area/estate	<p>(i) All Projects irrespective of the size, if it is located in a Notified Industrial Area/Estate.</p> <p>(ii) <300 tonnes per day (TPD) and located outside a Notified Industrial Area/Estate.</p>	<p>General as well as Specific Conditions shall apply</p> <p>No new Mercury Cell based plants will be permitted and existing units converting to membrane cell technology are exempted from this notification.</p>
4(e)	Soda ash Industry	All projects	-	-
4(f)	Leather/skin/hide processing industry	New projects outside the industrial area or expansion of existing units outside the industrial area	All new or expansion of projects located within a notified industrial area/estate	General as well as specific conditions shall apply.
5				
Manufacturing/Fabrication				
5(a)	Chemical fertilizers	All projects except Single Super Phosphate.	Single Super Phosphate	-
5(b)	Pesticides industry and pesticide specific intermediates (excluding formulations)	All units producing technical grade pesticides		

(1)	(2)	(3)	(4)	(5)
5(c)	Petro-chemical complexes (industries based on processing of petroleum fractions & natural gas and/or reforming to aromatics)	All projects		
5(d)	Manmade fibres manufacturing	Rayon	Others	General Condition shall apply
5(e)	Petrochemical based processing (processes other than cracking & reformation and not covered under the complexes)	Located out side the notified industrial area/ estate	Located in a notified industrial area/ estate	General as well as specific conditions shall apply.
5(f)	Synthetic organic chemicals industry (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals and chemical intermediates)	Located out side the notified industrial area/ estate	Located in a notified industrial area/ estate	General as well as specific conditions shall apply.
5(g)	Distilleries	(i) All Molasses based distilleries (ii) All Cane juice/ non-molasses based distilleries ≥ 30 KLD	All Cane juice/non-molasses based distilleries <30KLD	General Condition shall apply
5(h)	Integrated paint industry	-	All projects	General Condition shall apply

(1)	(2)	(3)	(4)	(5)
5(i)	Pulp & paper industry excluding manufacturing of paper from waste paper and manufacture of paper from ready pulp with out bleaching	Pulp manufacturing and Pulp& Paper manufacturing industry -	Paper manufacturing industry without pulp manufacturing	General Condition shall apply
5(j)	Sugar Industry	- -	≥ 5000 tcd cane crushing capacity	General Condition shall apply
6		Service Sectors		
6(a)	Oil & gas transportation pipe line (crude and refinery/ petrochemical products), passing through national parks /s anctuaries/coral reefs /ecologically sensitive areas including LNG Terminal	All projects -		

(1)	(2)	(3)	(4)	(5)
6(b)	Isolated storage & handling of hazardous chemicals (As per threshold planning quantity indicated in column 3 of schedule 2 & 3 of MSIHC Rules 1989 amended 2000)		All projects	General Condition shall apply
7		Physical Infrastructure including Environmental Services		
7(a)	Air ports	All projects including airstrips, which are for commercial use.		Note: Air strips, which do not involve bunkering/refueling facility and or Air Traffic Control, are exempted.
7(b)	All ship breaking yards including ship breaking units	All projects		
7(c)	Industrial estates/parks/ complexes/ areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes.	If at least one industry in the proposed industrial estate falls under the Category A, entire industrial area shall be treated as Category A, irrespective of the area. Industrial estates with area greater than 500 ha. and housing at least one Category B industry.	Industrial estates housing at least one Category B industry and area <500 ha. Industrial estates of area > 500 ha. and not housing any industry belonging to Category A or B.	General as well as specific conditions shall apply. Note: 1. Industrial Estate of area below 500 ha and not housing any industry of Category 'A' or 'B' does not require clearance. 2. If the area is less than 500 ha but contains building and construction projects > 20,000 Sq mtr. and or development area more than 50 ha it will be treated as activity listed at serial no. 8(a) or 8(b) in the Schedule, as the case may be.

7(d)	Common hazardous waste treatment, storage and disposal facilities (TSDFs)	All integrated facilities having incineration & landfill or incineration alone	All facilities having land fill only	General Condition shall apply
7(e)	Ports, harbours, break waters, dredging.	≥ 5 million TPA of cargo handling capacity (excluding fishing harbours)	< 5 million TPA of cargo handling capacity and/or ports/ harbours ≥ 10,000 TPA of fish handling capacity	General Condition shall apply. Note: (i) Capital dredging inside and outside the ports or harbors and channels are included; (ii) Maintenance dredging is exempt provided it formed part of the original proposed for which Environment Management Plan (EMP) was prepared and environmental clearance obtained.
7(f)	Highways	i) New National High ways; and ii) Expansion of National High ways greater than 30 KM, involving additional right of way greater than 20m involving land acquisition and passing through more than one State.	(i) All State Highway Projects; and (ii) State Highway expansion projects in hilly terrain (above 1,000 m AMSL) and or ecologically sensitive areas.	General Condition shall apply Note: Highways include expressways.

7(g)	Aerial ropeways	(i) All Projects located at altitude of 1,000 mtr. and above (ii) All Projects located in notified ecologically sensitive areas.	All projects except those covered in column (3).	General Condition shall apply
7(h)	Common Effluent Treatment Plants (CETPs)		All projects	General Condition shall apply
7(i)	Common Municipal Solid Waste Management Facility (CMSWMF)		All projects	General Condition shall apply
8		Building /Construction projects/Area Development projects and Townships		
8(a)	Building and Construction projects		≥20000 sq.mtrs and < 1,50,000 sq.mtrs. of built-up area#	#(built up area for covered construction; in the case of facilities open to the sky, it will be the activity area)
8(b)	Townships and Area Development projects.		Covering an area ≥ 50 ha and or built up area ≥1,50,000 sq.mtrs++	++All projects under Item 8(b) shall be appraised as Category B1

Note:-

“General Condition (GC):

Any project or activity specified in Category 'B' will be treated as Category 'A', if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the Wild Life (Protection) Act, 1972; (ii) Critically Polluted areas as notified by the Central Pollution Control Board from time to time; (iii) Eco-sensitive areas, as notified under section 3 of the Environment (Protection) Act, 1986, such as Mahabaleshwar, Pangani, Matheran, Panchmarhi, Dhanu, Doon valley, and (iv) inter-State boundaries and international boundaries:

Provided that the required regarding distance of 10 km of the inter-State boundaries can be reduced or completely done away with by an agreement between the respective States or U.Ts sharing the common boundary in case the activity does not fall within 10 kilometers of the areas mentioned at item (i),(ii) and (iii) above.”

Specific Condition (SC):

If any Industrial Estate/Complex / Export processing Zones /Special Economic Zones/Biotech Parks / Leather Complex with homogeneous type of industries such as Items 4(d), 4(f), 5(e), 5(f), or those Industrial estates with pre -defined set of activities (not necessarily homogeneous, obtains prior environmental clearance, individual industries including proposed industrial housing within such estates /complexes will not be required to take prior environmental clearance, so long as the Terms and Conditions for the industrial estate/complex are complied with (Such estates/complexes must have a clearly identified management with the legal responsibility of ensuring adherence to the Terms and Conditions of prior environmental clearance, who may be held responsible for violation of the same throughout the life of the complex/estate).

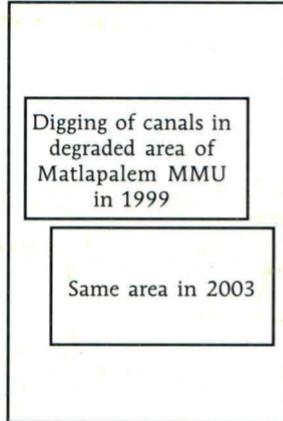
MANGROVE FOREST RESTORATION IN ANDHRA PRADESH INDIA



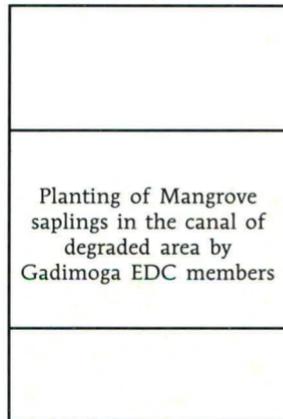
R. Ramasubramanian and T. Ravishankar

M. S. Swaminathan Research Foundation

Front cover



Back cover



Mangrove Forest Restoration in Andhra Pradesh, India

**R. Ramasubramanian
and
T. Ravishankar**



**M. S. Swaminathan Research Foundation
Chennai, India**

MSSRF/MA/04/13

M. S. Swaminathan Research Foundation

3rd Cross Street, Institutional Area

Taramani, Chennai – 600 113

INDIA.

Tele: 91 44 22541229; 22541698

Fax: 91 44 22541319

www.mssrf.org

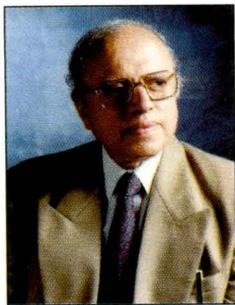
Email: msswami@mssrf.res.in

executivedirector@mssrf.res.in

raviethnobotanist@rediffmail.com

August 2004

This publication was prepared with the generous support of
India Canada Environment Facility (ICEF), New Delhi



Foreword

I am glad that a manual on Mangrove Forest Restoration in Andhra Pradesh has been prepared by R. Ramasubramanian and T. Ravishankar. The manual contains practical suggestions which can help to foster community conservation and restoration efforts in mangrove wetlands. The multiple benefits conferred by mangrove forests are now being recognized widely. What is now important is for local communities to undertake propagation of planting material and restoration of degraded mangrove areas. I hope the manual will stimulate a programme on the lines of the social forestry movement. Unless restoration of degraded mangrove forests becomes a community movement, we will lose precious mangrove areas, leading to enhanced vulnerability to coastal storms and cyclones and loss of opportunities for sustainable livelihoods. I therefore hope that the manual will be widely read and used.

M.S. Swaminathan
M.S. Swaminathan

Acknowledgment

We are grateful to Prof. M.S. Swaminathan, Chairman, M.S. Swaminathan Research Foundation for his encouragement and guidance. We thank Dr. M. Velayuthum, Executive Director, MSSRF, for his guidance and Dr. V. Selvam, Programme Director, MSSRF for his critical comments and suggestions.

We are thankful to Shri. S. K. Das, IFS, Principal Chief Conservator of Forests, Shri. K. Subba Rao, IFS and Shri. S. D. Mukherjee IFS, former Principal Chief Conservators of Forests, Shri. T. Ramakrishna, IFS, Shri. Hitesh Malhotra, IFS, Additional Principal Chief Conservator of Forests, Shri. A.V. Joseph, IFS, Chief Conservator of Forests, Shri. Ramesh Kalghatgi, IFS, Shri. J.V.K.T. Prabakar Rao, IFS, Shri. Manoranjan Bhanja, IFS, Conservators of Forests, Andhra Pradesh for their support in implementing the project. We thank Shri. N. Varapasada Rao, Shri. Thatha Rao, Shri. K. Ravi Kumar, Shri. K. Prakasha Rao, Deputy Conservators of Forests, Shri. N. Bhujanga Rao, Shri. C.V.V. Satyanarayana, Shri. M. V. Satyanarayana Murthy, Shri. Mallikarjuna Rao, Forest Range officers and the staff of Coringa and Krishna Wildlife Sanctuaries, Andhra Pradesh for their help during the mangrove restoration work from 1996 to 2003.

We acknowledge the contributions of Dr. D. Sridhar and Shri. D. Ramakrishna in the restoration and hydrological studies respectively.

We thank Dr. Ujwal Chaudary and Dr. Jaya Chatterji of India Canada Environment Facility (ICEF), New Delhi, for their support in making this work possible.

We extend our thanks to the members of the EDC and VSS committees of Godavari and Krishna mangroves for their participation and involvement in the restoration. We thank Shri. R. Satyanarayana, AFBO and Mr. D. Srinu, for their help and assistance in the fieldwork and the boat drivers Shri. Satyam and M. Srinu.

Contents

1. Mangrove forests - an overview	-	1
2. Mangrove forests in Andhra Pradesh	-	3
2.1 Riverine systems in Andhra Pradesh	-	5
3. Causes of degradation	-	7
3.1. Past management practices	-	7
3.2. Hydrological and geomorphological causes	-	8
3.3. Anthropogenic causes	-	9
4. Restoration methods	-	10
4.1. Restoration of degraded mangroves in the past	-	10
4.2. Methodology for restoration of degraded mangroves at present	-	11
4.2.1. Geomorphology and hydrology in mangrove restoration	-	13
4.2.2. Hydrological studies in Godavari	-	15
4.2.3. Hydrological studies in Krishna	-	16
4.2.4. Dimensions of canals	-	17
4.2.5. Selection of species and planting	-	18
4.2.6. Desilting of canals and casualty replacement	-	19
4.3. Mangrove area restored	-	19
5. Impact of mangrove restoration	-	20
5.1. Cost of the restoration activity and long-term benefits	-	22
5.2. How the restoration work has improved the socio-economic condition of Bhairavalankavillage in Godavari mangroves	-	24
References	-	25

List of Acronyms

APFD	-	Andhra Pradesh Forest Department
EDC	-	Eco-Development Committee
GIS	-	Geographic Information System
GPS	-	Global Positioning System
ha	-	Hectare
MMU	-	Mangrove Management Unit
MSSRF	-	M.S. Swaminathan Research Foundation
NGO	-	Non-Government Organization
ppt	-	Parts per thousand
PRA	-	Participatory Rural Appraisal
RF	-	Reserved Forest
Sq km	-	Square kilometres
VLI	-	Village level institution
VSS	-	Vana Samrakshana Samithi

Mangrove Forest Restoration in Andhra Pradesh, India

1. Mangrove forests - an overview

Mangroves are the plant communities occurring in inter-tidal zones along the coasts of tropical and sub-tropical countries. They are one of the most productive ecosystems. Mangroves represent a rich and diverse living resource and are valuable to both the economy and protection of coastal environments. Mangrove plants belong to several families but possess marked similarity in their physiological characteristics and structural adaptations to similar habitat preferences. Mangroves have been variously described as “coastal woodland” and “inter-tidal forest”. The term mangrove is loosely used to describe a wide variety of often-unrelated tropical and subtropical trees and shrubs, which share common characteristics. The total mangrove area of the world has been assessed to be approximately 18.15 million hectares. India's mangrove wetlands range from 6,81,000 ha (Sidhu, 1963) to 5,00,000 ha (FSI, 1998).



Mangrove forests perform multiple ecological functions such as production of woody trees; provision of habitat, food, and spawning grounds for fin-fish and shellfish; provision of habitat for birds and other valuable fauna; protection of coastlines and accretion of sediment to form new land. Mangrove areas have high biological productivity, associated with heavy leaf production, leaf fall and rapid decomposition to form detritus. The mangrove ecosystem is dynamic, changing in both location and composition, and has great resilience with the ability to restore itself after heavy damage, as long as seed sources and water flow are maintained. There are also many economic benefits from mangrove resources; like as a source of firewood, self-replenishing areas of fishery resources, for collecting honey and for tourism.

Despite the benefits that they offer, mangrove forests are increasingly under threat and are getting degraded, due to pressures from growing populations, which lead to changes in land use and over-utilization of the resources. The depletion of mangroves is a cause of serious environmental and economic concern to many developing countries.

Until recently, tropical forests have been used as a renewable resource. With the burgeoning human population, urban areas expanded and more land area for agriculture was needed. As a result, forest areas started declining at an alarming rate. Efforts were taken up by the Forest Departments and other agencies to restore, develop and conserve forest resources for sustainable use and management. Nevertheless, these conservation programs were concentrated in the upland forests and not undertaken in mangroves. The Andhra Pradesh Forest Department started restoration activities from 1994 onwards.

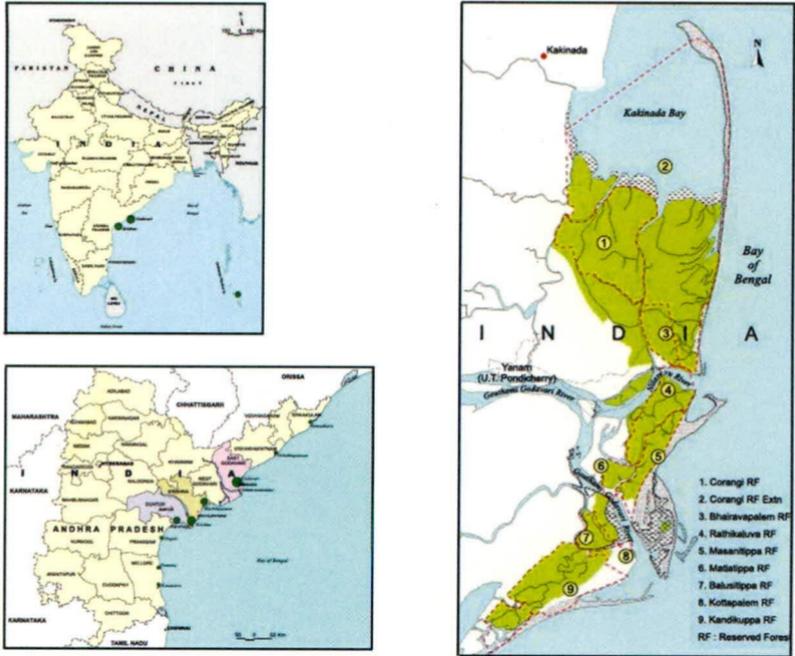
M.S. Swaminathan Research Foundation (MSSRF) started its activities of mangrove restoration and management in Andhra Pradesh from 1997 and restored 520 ha of degraded mangroves and facilitated community participated mangrove management in 9,442 ha.

This publication reflects the process and results of restoration activities carried out over seven years by the project Coastal Wetlands: Mangrove Conservation and Management, implemented in Godavari and Krishna wetlands by MSSRF with its field centre at Kakinada. Hence it will be necessary to make modifications as per the site conditions, mangrove ecosystem, tidal amplitude and topography of the area chosen for restoration. This publication is meant for foresters, field technicians, researchers and others interested in restoration of degraded mangroves.

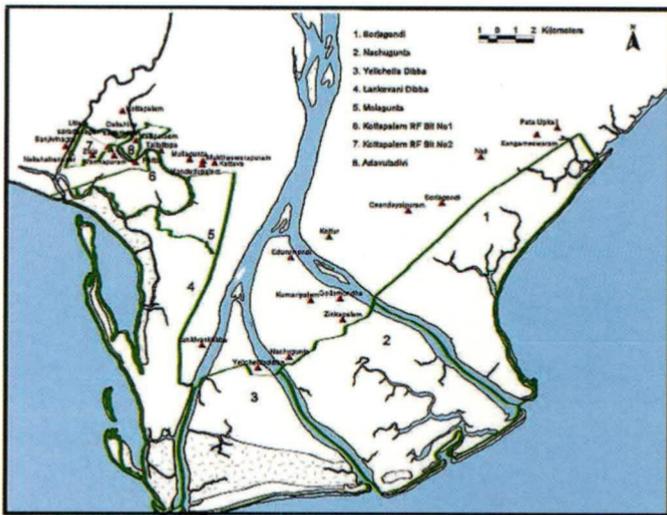
2. Mangrove forests in Andhra Pradesh

The mangrove forests in Andhra Pradesh are located in the estuaries of the Godavari and the Krishna rivers. The Godavari mangroves are located in Godavari estuary of East Godavari district and the Krishna mangroves in Krishna estuary of Krishna and Guntur districts. Apart from these estuaries, mangroves are also found in small patches along the coast of Visakhapatnam, West Godavari, Guntur and Prakasam districts. The total area under Godavari and Krishna mangrove wetlands are 58,263 ha of which 33,263.32 ha are under Godavari and 24,999.47 ha are in Krishna. However, the dense mangroves in Godavari and Krishna are only 17,000 ha and 7,347 ha respectively. The rest are distributed between mudflats, water bodies, sand bodies and casuarina plantations. The Coringa Wildlife Sanctuary has three Reserve Forests, namely Corangi RF, Corangi Extn. RF and Bhairavapalem RF. Most of the mangroves in the Sanctuary are not directly connected with the Bay of Bengal. The mangroves of Coringa Wildlife Sanctuary receives tidal flushing through Matlapalem canal, Corangi river and Gaderu river. The Gaderu and Corangi rivers are the distributaries of the River Godavari. The other six Reserve Forests namely Rathikalava RF, Masanitippa RF, Matlatippa RF, Balusutippa RF, Kothapalem RF and Kandikuppa RF are situated on the southern side of Nilarevu River and fall under non-sanctuary area -Map 1.

The total area of the mangrove wetland declared as Krishna Wildlife Sanctuary is 19,481 ha, which includes Sorlagondi RF,



Map 1. Location of Godavari Mangroves



Map 2. Location of Krishna Mangroves

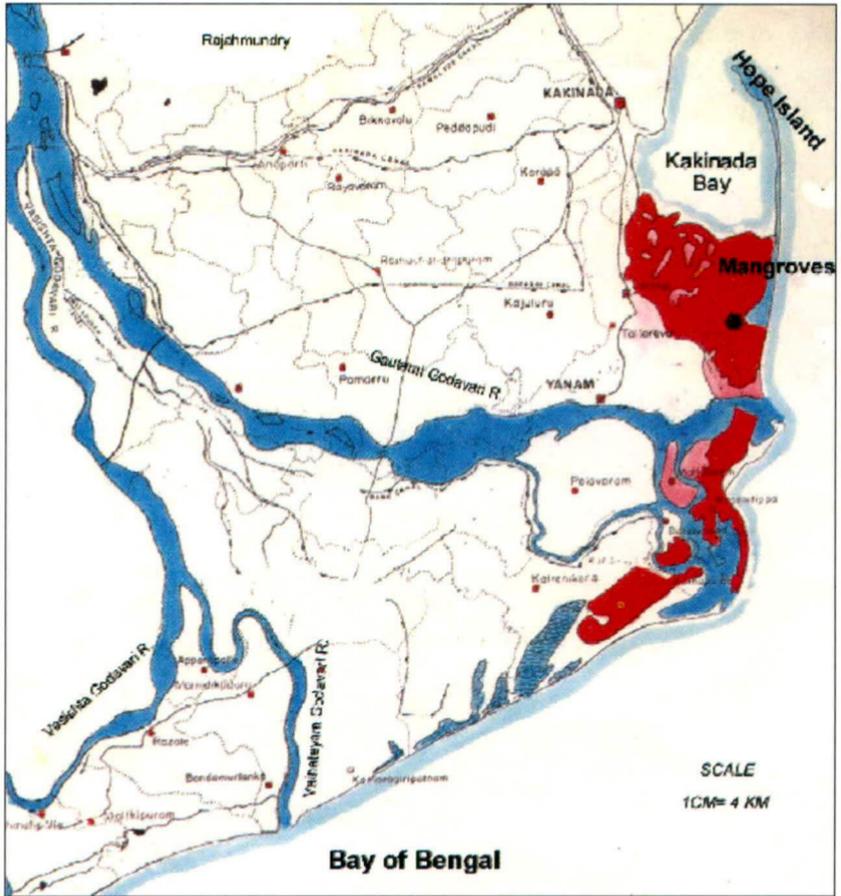
Nachugunta RF, Yelichetladibba RF, Lankivanidibba RF, Molagunta RF, Kottapalem RF Bit-1, Kottapalem RF Bit-2 and Adavuladivi RF (Map 2).

2.1. Riverine systems in Andhra Pradesh

Andhra Pradesh has a geographical area of 2,76,000 sq km, of which 63,770 sq km are under forests. Mangrove forests account for only 582 sq km, representing only about 0.9% of the State's total forest area. An advantage Andhra Pradesh enjoys is that most of the east-flowing rivers pass through the heart of the State and bring in copious sediments from the Western and Eastern Ghats and the Deccan Plateau. 40 major, medium and minor rivers flow through the State. Of these, the most important rivers are the Godavari, the Krishna, the Pennar and the Vamsadhara. Mangroves are found in the estuaries of these rivers but extensive mangrove wetlands are present only in the Godavari and Krishna deltaic regions.

The Godavari river originates in Maharashtra near Nasik and flows towards east into the sea. The Godavari river branches into the Vasishta and the Gautami near Dowleswaram (Map 3) which is considered the head of the delta. The Gautami Godavari river joins the Bay of Bengal at two places one near Bhairavapalem and the other near Kothapalem. The Gautami-Godavari river is connected to the Kakinada Bay by two distributaries, namely the Corangi river which rises at Yanam and Gaderu river which has its origin at Bhairavapalem. There are numerous tidal channels and creeks which feed the mangrove areas and eventually flow into the Kakinada Bay. An important feature determining the health of the Godavari mangroves is the Kakinada Bay, which is very shallow.

The Godavari deltaic region falls under the category of tropical humid climate. The monsoon season commences from June and extends up to December. This area receives fresh water during monsoon season, during which period the salinity is low. From January onwards, the weather is mainly dry and progresses gradually to the hot summer months of April and May.



Map 3. Distributaries of River Godavari

The Krishna river has its origin in the Western Ghats at an altitude of 1,337 metres, north of Mahabaleshwar, about 64 kilometres from the Arabian Sea. It flows across three states, namely Maharashtra, Karnataka and eventually into Andhra Pradesh, before emptying into the sea. The Hamsaladevi distributary is the first to branch out, 60 km downstream from Vijayawada, near Avanigadda and flows northward into the sea near Machilipatnam. Mangroves have been reported to be less abundant here. The Gollamattapaya and Nadimeru distributaries branch out 25 km downstream from Avanigadda and

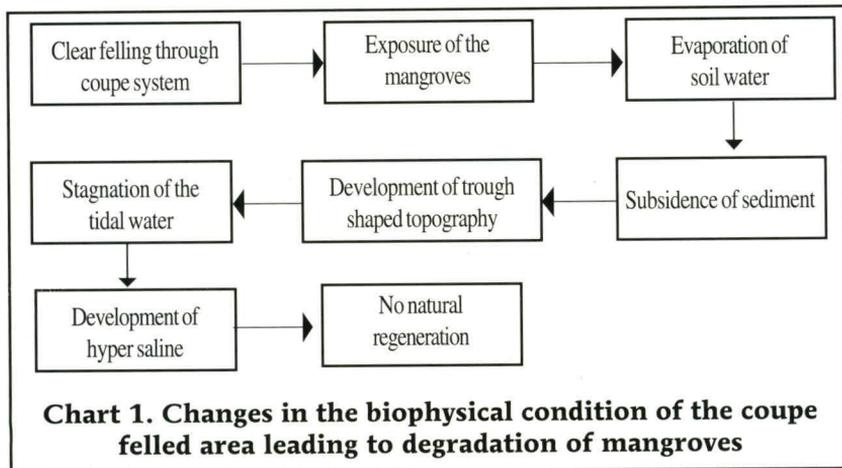
flow northward to join the sea. The main Krishna canal flows southward to join the sea near False Divi point. Mangroves are mainly prevalent around tidal creeks, channels, lagoons, tidal flats and mudflats of the three distributaries namely Gollamattapaya, Nadimeru and main Krishna canal. The area has a warm, humid and tropical climate with an annual rainfall of around 110 cm.

3. Causes of degradation

The mangroves of Andhra Pradesh are being degraded due to a variety of causes, some of which are similar to those in other mangrove areas in India. As in other places, vast areas of land adjoining the mangroves have been converted to aquaculture ponds. Apart from these general causes, some site-specific reasons also contribute to mangrove loss. The causes of mangrove degradation are described below:

3.1. Past management practices

The mangrove forests were coup felled by the Government agencies for revenue generation till 1972. Some of the clear felled areas could not be regenerated due to topographic changes. Moreover all mangrove species are not of the coppicing type. Chart 1 shows how a chain reaction triggered by coupe felling - caused degradation.



3.2. Hydrological and geomorphological causes

Reduction in fresh water flow

The Krishna river is one of the highly utilized rivers in peninsular India, for a variety of purposes. As a result, there has been a reduction in fresh water flow over a period of time, which has had a telling impact on the growth and regeneration of mangroves.

Decrease in sediment load into the mangroves

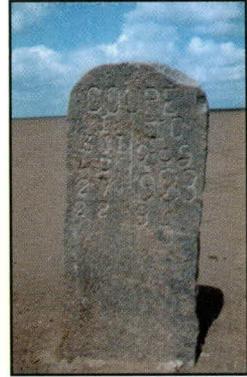
The decrease of sediment load has also had an impact on the ecosystem by way of reduction in sediment supply, due to which the nutrients which are needed for the health of the mangroves have also been reduced.

Cyclones and storm surges

The Krishna mangroves have borne the brunt of two severe cyclonic storms in 1977 and 1990. Though the destruction of mangroves due to these cyclonic storms have not been properly documented, the surges associated with these storms have caused extensive sand casting resulting in the area becoming unsuitable for growth and survival of many mangrove species. It has also resulted in the siltation of many drainage channels that were feeding both fresh and tidal water, as a result of which the mangroves have become degraded.

Geomorphological changes

The sand spit in the Kakinada Bay has undergone changes in its morphology with a rapid rate of growth. The spit which had just shown up in the year 1851 has now extended to about 18 km in length. In addition to this, the Kakinada Bay has been undergoing rapid siltation, as evidenced by the hydrographic study. With increased developmental activities and the setting up of fertiliser units, some effluents are being discharged into the Kakinada Bay. The bay waters are now characterized by high amounts of ammonium and nitrate which may contribute to degradation. As the present depth of the Bay is very low, there is hardly any lateral mixing of waters, as



a result of this, there is lot of stagnation of bay waters which may also contribute to degradation. The movement of pollutants in the bay is still not properly studied.

Geomorphologically, the Gautami River has undergone some changes, after the construction of the Cotton Barrage at Dowleswaram in 1852. In 1893, Kothapalem mouth had deepened and widened considerably and hence the major flow of fresh water was taking place through the Kothapalem mouth. By 1985, the Kothapalem mouth had gradually silted up and after 1986, the major outflow of fresh water started taking place through the Bhairavapalem mouth and only very little flow now takes place through the Kothapalem mouth. Due to the change in flow pattern, mangroves occurring in the Kothapalem RF, Masanithippa RF and Balusithippa RF have been affected.

Formation of topographically elevated areas

The land has become relatively elevated at a few places along the river banks and creeks due to silt deposition during floods in the monsoon period. Once the land becomes elevated, the area is unable to have any tidal flushing, as a consequence of which only the fringe areas support mangroves, while the interior areas are devoid of mangrove vegetation.

3.3. Anthropogenic causes

Increase in population, coupled with activities related to economic

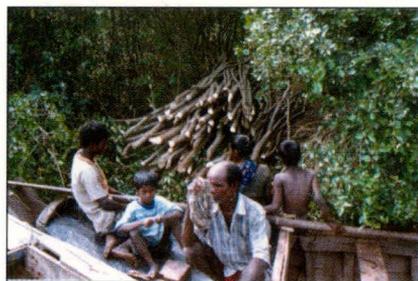
growth, lead to the use of mangrove lands for various purposes such as construction of roads, ports, harbours and industries.



Alternative uses of mangrove lands, especially conversion of mangrove forests to aquaculture ponds has been increasing. Since 1980, large tracts of mangroves in India are being converted to aquaculture

ponds which bring in higher monetary returns within a short period. At the same time, conversion of mangrove forests for salt pans and paddy fields have increased.

Effluents discharged from factories, direct dumping of municipal wastes into the rivers and pesticide run-off from agricultural fields eventually result in the accumulation of heavy metals in the mangrove wetlands, affecting the health of



the mangrove ecosystem. Oil pollution is increasing in mangrove areas from shipyards, ship breakers, offshore oil wells, spillage from oil tankers due to accidents and from cleaning of cargo vessels.

Coastal villagers utilize mangroves for their genuine basic needs such as firewood, fodder, fencing, house construction, thatching and fishing poles.

4. Restoration methods

4.1. Restoration of degraded mangroves in the past

Restoration of degraded mangroves was being carried out in the tropical and subtropical estuaries throughout the world (Field, 1996; Qureshi, 1996; Snedaker and Biber, 1996; Soemodihardjo *et al.*, 1996;

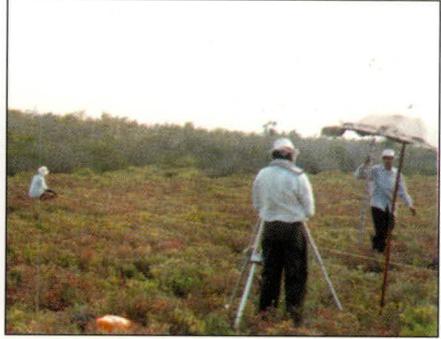
Untawale, 1996). Restoration of mangroves started in Indonesia in the early 1960's (Soemodihardjo *et al.*, 1996) and an area of about 38,923 ha of mangroves were restored till 1992. Macnae, (1968) planted *Rhizophora apiculata* in the newly accreted soils in Sri Lanka for better stabilization of the area and to facilitate the trapping of sediments. Goforth and Thomas (1979) have reported the planting of mangroves in Florida for reducing the erosive action of the sea.

In Andhra Pradesh, the Forest Department initiated restoration of mangroves in Godavari by canal digging during 1991. The canals were dug perpendicular to the river and the side canals were at right angles to the main canal. The staff of the Forest Department were taken on an exposure visit to the Pichavaram mangroves where restoration was done by MSSRF. After observing the restoration at Pichavaram, the FD started digging canals at 30° from the main canal from 1999 onwards. This reduces the rate of siltation of canals and also facilitates easy flow of tidal water. Till now an area of 2,000 ha have been restored by the Forest Department in Godavari and Krishna Mangroves.

4.2. Methodology for restoration of degraded mangroves at present

A survey of the entire Godavari and Krishna mangroves was carried out to identify the degraded areas. Floristic studies and vegetation survey were undertaken in nine Reserve Forests in Godavari mangroves and eight Reserve Forests in Krishna mangroves using remote sensing FCC images. The floristic study helped in determining the nature of degraded areas and the species composition to include species for genetic composition while planting seedlings in the degraded areas. In this process, degraded patches of mangroves have been identified to an extent of 4,195 ha in Godavari and 12,629 in Krishna. These degraded patches have been plotted with GPS and a GIS database has been developed.

Participatory Rural Appraisal (PRA) was also conducted for identifying the degraded areas through various methods, namely



transact walk, resource mapping and historical analysis. Microplans were prepared in the respective villages for the restoration of these degraded mangroves. Hydrological and geomorphological reasons for degradation were discussed with the community to enhance the scientific awareness of the community on mangrove restoration. The Mangrove Management Units (MMU), which include both degraded area for restoration and the pristine mangroves for management were identified for each Village Level Institution (VLI). The restoration activity was carried out with the VLI, namely Eco-Development Committee (EDC) and Vana Samrakshana Samiti (VSS). The VLIs were trained in nursery raising and digging canals. The topography survey was carried out using theodolite instrument. Contour levels were collected at an interval of 25 m (25x25 m) and the contour map was prepared for 5 cm level, using a computer aided package.

The main canals were dug at an angle of 45° to the natural creek. The side canals were dug at an angle of 30° to the main canal. Pegs and chalk powder were used for marking the canals.



Canals were designed like fishbone in order to facilitate easy inflow and outflow of tidal water. The design for the canal for mangrove restoration is given in Fig.1. The canal dimensions were

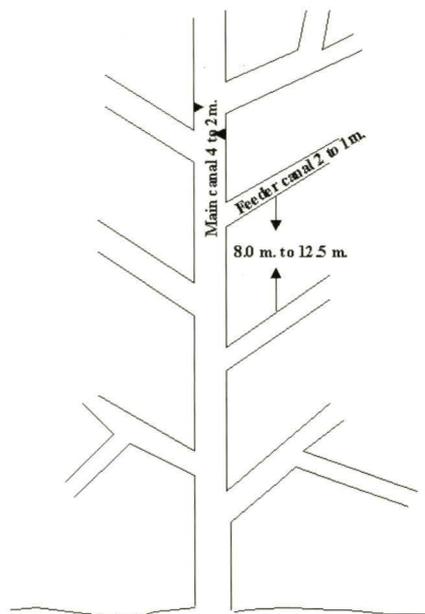


Fig. 1. Aerial view of fishbone type of canal

determined as per the contour levels and the tidal amplitude of the degraded area chosen for restoration - Fig.2. The canals were dug in a trapezoidal shape in order to plant the saplings at the mid level of the canal. This is to ensure that the plants receive tidal water, but at the same time they are not submerged.

4.2.1. Geomorphology and hydrology in mangrove restoration

Based on the contour survey and hydrology study, the canal depths and dimensions are fixed, corresponding to the topography and tidal amplitude of the selected restoration site. The topography study revealed that the areas lying close to the bunds of creeks / rivers are elevated (levee) compared to the areas inside. The levees

Salinity variation in the Saveru creek, Rathikalava RF, varies from 6 ppt during the south-west monsoon to 31 ppt during fair weather season. In the Coringa Wildlife Sanctuary area, at Matlapalem canal, salinity showed a variation from 4.6 ppt during the south-west monsoon to 30 ppt during fair weather season.

Based on the hydrological studies, the depth of canals for restoration was decided to be 0.65 m with reference to mean sea level so as to have adequate tidal flushing (Fig. 5).

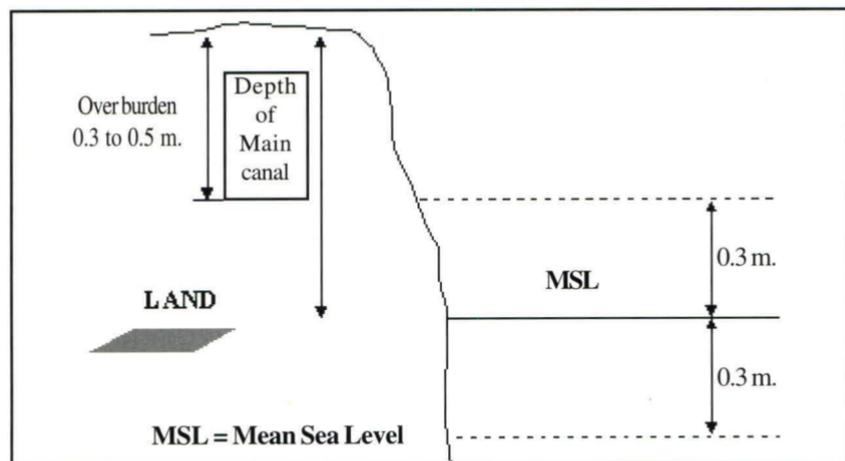


Fig. 5. Topography of a canal bund in non-sanctuary area of Godavari mangroves

4.2.3. Hydrological studies in Krishna

In the Krishna estuary, water level and current data were recorded in the estuary and in the creek at Sorlagundi RF and Nakshatra Nagar during the monsoon and pre-monsoon seasons respectively. One day tidal and current measurements were carried out during the fair weather season at six locations along the three channels of the Krishna river. Measurement of cross sections was carried out using echo sounder. Position fixing was done using GARMIN GPS. Measurement of *in situ* salinity and temperature was carried out along the axis of the three channels of Gollamattapaya, Nadimeru and main Krishna river during monsoon and fair weather seasons at selected stations.

The tidal range along the three main channels of the Krishna varies from 0.7 to 1 metre. Current velocity shows a variation from 0.13 to 0.72m/s which was the maximum velocity that was recorded at Avulaganta. In the creeks adjoining the mangroves, the tidal range was 0.15 to 0.6m at Deenadayalpuram during monsoon. In the creek at Nakshtranagar in Kottapalem RF, the tidal range had a maximum value of 0.25m during pre-monsoon.

During the monsoon season, salinity varied from 8.5 ppt to a maximum of 35ppt near the mouth. During fair weather, the salinity varied from 17 ppt to 36 ppt. Temperature showed a variation from 27 to 30°C along the three channels of the river during the monsoon season, while during fair weather season it varied from 28 to 31°C.

Based on the hydrological studies in Sorlagondi RF, the depth of canals for mangrove restoration was decided to be 0.6m for the main canal. In other RFs adjoining the three channels of Krishna river, namely, Nachugunta RF, Yelichetladibba RF and Lankavanidibba RF, the depth of the main canals was decided to be at least 0.7m .

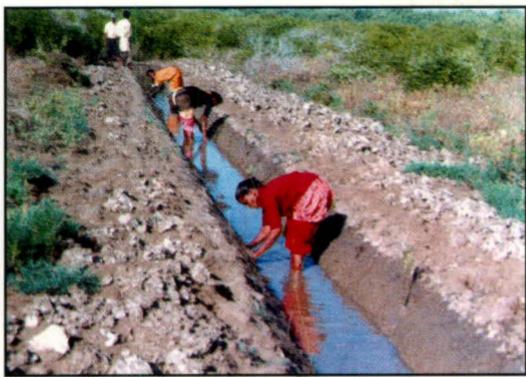
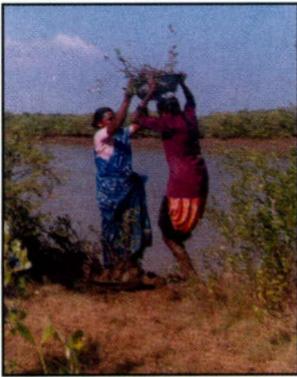
4.2.4. Dimensions of canals

The dimensions of the canals were determined based on the contour levels and tidal amplitude. The canals were constructed with a depth of 0.7 m to 1.0 m near the bunds of the creeks or the rivers and 0.45 m inside. The depth of the main canal varied from 0.45 to 1.0 m and the side canals from 0.6 to 0.45 m as per the contour. The top width of the main canal was between 3.5 m and 2 m and the respective bottom width was between 1 m and 0.4 m. The dimensions of the side canals were 2 m top width, 0.4 m bottom width and 0.45 m depth. The distance between the two side canals was 12.5 m during the first year of plantation. The planting of mangrove saplings was done 2 m apart along the canals at about 20 cm down the slope.

In the subsequent years, distance between side canals was reduced to 8 m in order to ensure dense canopy. As the canals were dug closely the dimension of the side canals was reduced accordingly to 1.25 m top width, 0.2 m bottom width and 0.4 m deep.

4.2.5. Selection of species and planting

Based on the salinity levels of soil, mangrove species namely *Avicennia marina*, *Avicennia officinalis* and *Excoecaria agallocha* were selected for planting in the degraded areas. Reason being that these species could tolerate wide range of salinity. Normally the soil salinity of the degraded area is about 140 ppt during summer. To reduce the high soil salinity, tidal flushing was facilitated by constructing canals as described in the previous pages. Due to this, the soil salts are slowly leached out and the soil salinity is reduced gradually. The reduction in salinity improved the survival percentage and also reduced the saline stress to the young seedlings. The planting was done during October and November, after the southwest monsoon. During that period the rainwater reduces the salinity further. The salinity of the creek water is also low (about 10-15 ppt).



Mangroves namely *Aegiceras corniculatum*, *Bruguiera gymnorrhiza*, *Rhizophora apiculata*, *Rhizophora mucronata* and *Xylocarpus moluccensis* were also



planted to ensure genetic diversity. Eight-month-old mangrove saplings raised in the nursery were used for planting. The mangrove saplings were planted along the slopes (20-25 cm from the top) of the canals with a gap of 2 m.

4.2.6. De-silting of canals and casualty replacement

The bunds formed by the deposition of the excavated soil during canal digging will silt the canals during the monsoon seasons. The silted canals have to be de-silted before the onset of summer, because during summer the tidal amplitude is generally low. Tidal flushing is very important during summer because the soil salinity will shoot up due to high temperature and cause damage to the roots of the seedlings. Such seedlings will be replanted in the following monsoon season. The survival percentage is measured in the initial period for better monitoring. Initially the growth rate was slow and after 2 to 3 years the seedling growth rate was faster. The natural regeneration of the seedlings also occurs simultaneously. After four years, the planted saplings start bearing fruits, which will regenerate, and the density of the area will increase.

4.3. Mangrove area restored

A total area of 520 ha of degraded mangroves was restored in the Godavari and Krishna mangroves. Restoration was carried out in

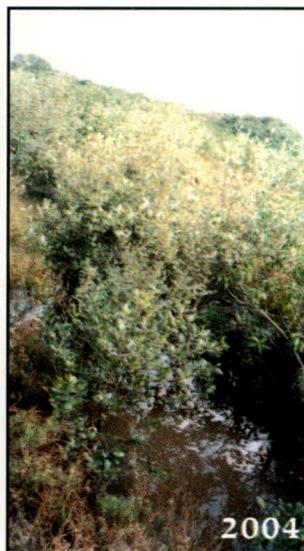
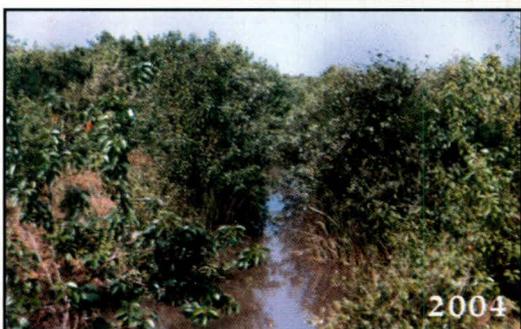


the Mangrove Management Units (MMU) of Matlapalem, Dindu, Bhairavalanka, Gadimoga and Kobbarichettupeta in Godavari and Dheenadayalapuram, Zinkapalem and

Nali in Krishna Mangroves. An area of 9,442 ha is under the management of eight village level institutions. The area restored by each VLI and the management area allotted to respective demonstration village for mangrove protection and management is given in Table 1.

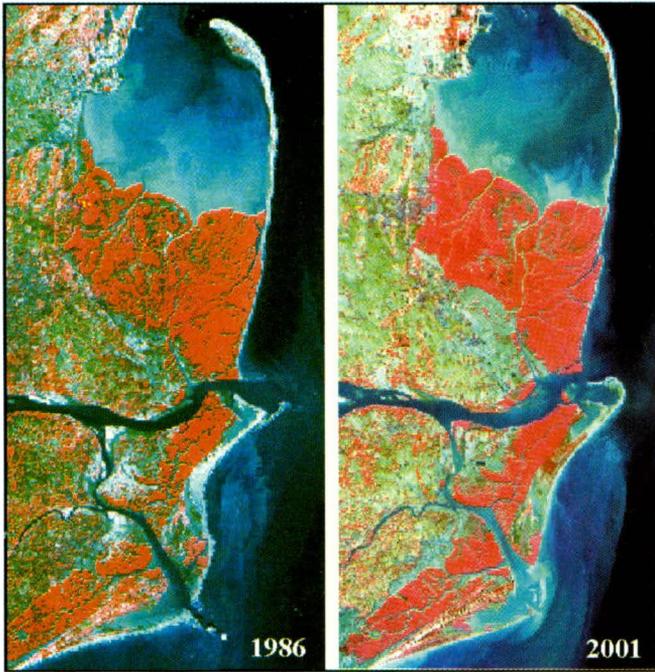
Table 1. Details of area restored and the area under MMU

S.No	Demonstration village	Area Restored (ha.)	Area under MMU (ha.)
1.	Matlapalem	5	502
2.	Dindu	25	900
3.	Kobbarichettupeta	35	3,925
4.	Gadimoga	25	900
5.	Bhairavalanka	75	615
6.	Dheenadayalapuram	236	2,000
7.	Zinkapalem	114	600
8.	Nali	5	----
	Total	520	9,442

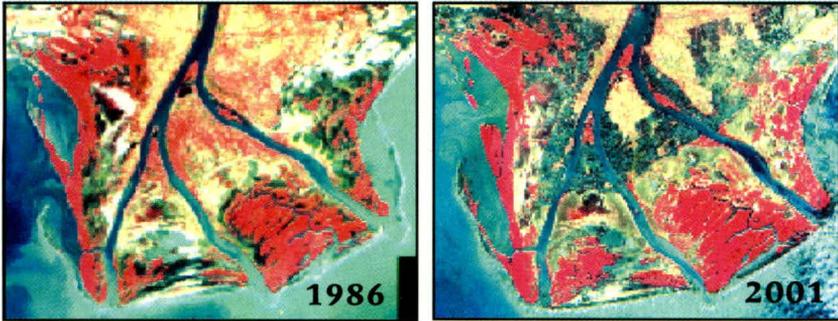


5. Impact of mangrove restoration

Degraded mangroves are being restored to increase the mangrove cover all over the world. In Andhra Pradesh, MSSRF, jointly with eight village level institutions (namely Sri Vigneswara EDC, Matlapalem, Sri Nookamma EDC, Dindu, Sri Devi EDC, Kobbarichettupeta, Sri Kanakadurga EDC, Gadimoga and Dr. B.R. Ambedkar VSS, Bhairavalanka, Dheenadayaljee EDC,



Godavari Mangroves



Krishna Mangroves

Dheenadayalapuram, Zinkapalem EDC, Zinkapalem and Sri Sita Rama Lakshmana EDC, Nali) and Andhra Pradesh Forest Department, has restored 520 ha Restoration of mangroves has arrested further degradation of mangroves adjoining the degraded patches and also increased the fishery resources. The bio-diversity of the area has improved. The crab population in the restored areas has

increased due to the increased water regime. Since the work involves intensive labor, the members of the village level institutions were benefitted by getting employment opportunities. NGOs, namely Sravanthi and Action in Godavari area and Sangamithra Service Society and Coastal Community Development Program in Krishna, were trained in restoration techniques and in participatory approaches in community mobilization and mangrove management. These NGO's have restored 215 ha of degraded mangroves.

5.1. Cost of the restoration activity and long-term benefits

Restoration cost for canal construction and planting of seedlings per unit depends on

- extent of area
- nature of the soil and
- distance between the village and the restoration site

The number of main canals needed for a larger degraded area is less when compared to smaller areas. For example, if the extent of the area is 30 ha it needs only 2 or 3 main canals. The number of main canals needed will be the same even if the area is smaller, that is between 5 and 6 ha.

In the Krishna mangroves, the restoration site near Zinkapalem is very close to the village and the soil is sandy clay. Hence the cost for canal digging was only Rs. 12,000/- per ha. However, in Godavari, the restoration sites are far away from the village and the soil of the degraded area is clayey (hard). Therefore, the cost for canal digging for one ha was Rs. 18,000/- including transport of labour through boats to the restoration sites.

The participatory methods of community mobilization and organization, planning and implementation have to be undertaken before the restoration work is started. The Group formation, PRA, Socio-economic benchmark survey and Microplan apart from awareness generation and entry point activities, have to be undertaken. These exercises involve a cost of Rs. 50,000/-.

A further budget requirement for the socio-economic development of the communities would cost an amount of Rs. 1,00,000 to 2,00,000/-, which has to be leveraged from developmental schemes of the government and the constitution development fund of the peoples representatives and also from the Panchayat Raj schemes. Therefore, the cost of restoration of degraded mangroves in an area of 10 ha which includes survey, nursery raising, advance work in canal construction and planting would require Rs. 2,00,000/- and for desilting in the first three years, it will cost Rs. 1,00,000/-. Hence, Rs. 3,50,000/- will be the total cost for restoration of 10 ha of degraded mangroves through community participation.

Even though as an initial investment the cost appears high, the ecological and socio-economic benefits to the local community will be rewarding in the long run. This is evident from the fact that due to the established water regime, the population of edible crabs has increased in the restored areas, which is a livelihood benefit to the local communities. There is a good growth of fodder grass which has helped the local community in feeding their livestock.

As the biodiversity has come back and the denuded patches have been covered with mangrove restoration, populations of larger animals like otters have increased substantially. In addition to this, the bird population has also increased.

As the water regime has been established, the further degradation of mangroves has stopped. This has resulted in the natural regeneration of mangroves. In addition to this, the canopy cover has become denser which is evident from the remote sensing images.

Hence, as far as restoration of mangroves is concerned even though the initial investment appears high, the delivery cost has to be calculated from the angle of long-term economic benefits that accrue to the local communities and the ecological goods and services that are enhanced due to restoration.

5.2. How the restoration work has improved the socio-economic condition of Bhairavalanka village in Godavari mangroves

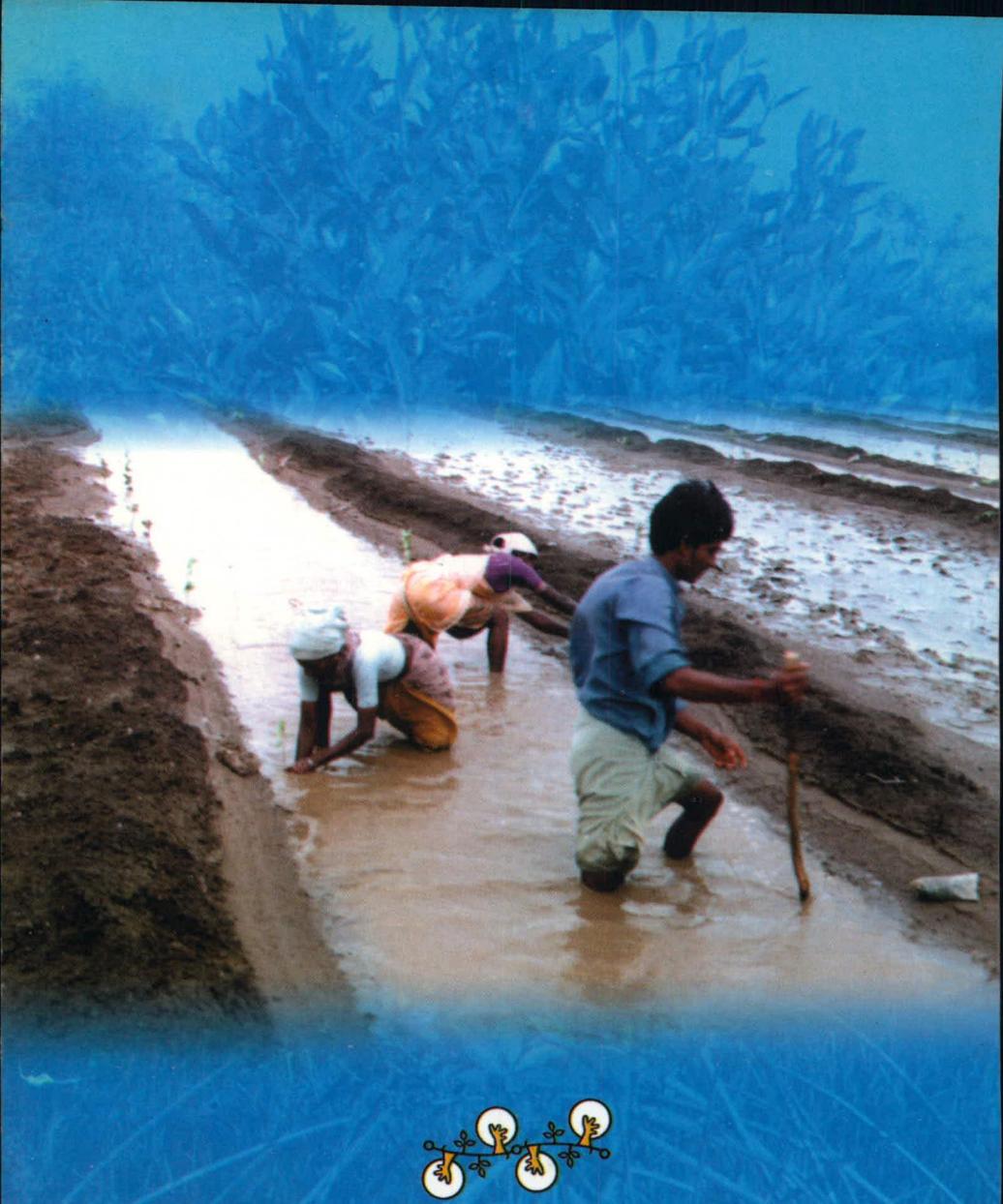
The villagers of Bhairavalanka started canal digging during 1999, but due to lack of practice of digging canals, they could not undertake the task. The work was done with the help of Chollangipeta villagers who have been doing canal construction for a long time for the Forest Department. The wages were given to them at a small function, in the form of demand draft after the completion of the work. One of the village elders, who is also a traditional leader, gave the Demand Draft to them and said that if his people had done the work, this money would have come to their village. It was a huge sum, which they were very much in need of, because of the failure in agriculture and aquaculture sectors. This made them think and come forward for the field training in the following year. They were trained by the experienced labour from Chollangipeta. They procured similar types of spades and crowbars and started digging the canals. The timing of work also changed. Earlier they used to work between 9.00 a.m. and 3.30 p.m. But after seeing the nearby villagers go to work at 4.30 a.m. they also changed their timings, which helped them to avoid work under the scorching sun. After this, they have completed nearly 65 ha of mangrove restoration and the money got from the wages was used for house construction, which was started with the help of ARTIC - NGO with the support of OXFAM and State Housing Corporation. Most of the houses were unfinished due to financial problems, which they have to contribute as beneficiary contribution. After this they also got similar type of work from the Forest Department and from Sravanthi an NGO. In the Food for Work Program they could execute tasks like pond renovation, laying roads in the village and earned a large quantity of rice. The district administration has appreciated this work and the change the project has brought.

They also undertook restoration work for the forest department and other NGOs which has fetched them more money. The Forest Department also provided 15 ha of *Casuarina* plantation for the VSS. The revenue from this plantation is being shared by the community through the Village Development Fund.

References

- Field, C.D. (Ed.), 1996. *Restoration of Mangrove Ecosystems*, International Society for Mangrove Ecosystems, Okinawa, Japan.
- Forest survey of India 1999. *Status of Forest Report*, Ministry of Environment and Forests, Government of India, New Delhi
- Goforth, H.W and J.R. Thomas 1979. *Planting of Red mangrove Rhizophora mangle L. for stabilization of marsh shoreline in Florida Keys*. In: D.P.Cole (ed.) *Proceedings of the 6th Annual Conference on Restoration and Creation of Wetlands*. Hillsborough Community College, Tampa, Florida, pp 207 - 242.
- Mittal, R. 1993. *Management Plan for Coringa Wildlife Sanctuary*, Forest Department, Government of Andhra Pradesh, Hyderabad.
- Qureshi, M. T. 1996. *Restoration of Mangroves in Pakistan*. In: *Restoration of Mangrove Ecosystems* C.D. Field, (ed.) International society for mangrove ecosystem, Okinawa, Japan, pp 126 - 142.
- Ramasubramanian, R., Ravishankar, T. and Sridhar, D. 2003. *Mangroves of Andhra Pradesh - Identification and Conservation manual*, M.S. Swaminathan Research Foundation, Chennai pp 67 (MSSRF/MA/03/06).
- Ramakrishna, D., Ravishankar, T. Sridhar, D. and Ramasubramanian, R. 2003. *Guidelines for restoration of degraded mangrove areas in Godavari and Krishna mangrove wetlands* In: Discussion papers for "National workshop on Restoration and conservation of mangroves through Participatory Mangrove Management" 12 - 14, February 2002 organized by M.S. Swaminathan Research Foundation, Rajahmundry.
- Rangarao, V., Reddy, B.S.R., Raman, A.V. and Ramana Murthy, M.V. 2003. *Oceanographic features of the Bay - Mangrove waterways of Coringa, East coast of India*, Proceedings of AP Akademy Science., 135-142.

- Ravishankar, T., Gnanappazham, L., Ramasubramanian, R., Sridhar, D., Navamuniyammal, M. and Selvam, V. 2004. *Atlas of Mangrove Wetlands of India Part 2- Andhra Pradesh*, M.S. Swaminathan Research Foundation, Chennai pp 136 (MSSRF/MG/03/15).
- Ravishankar, T., Ramasubramanian, R. and Sreenivasa Rao, N, 2004. *Intersectoral linkages for conservation and Management of forest resources - a case study on Mangroves of India* In: The proceedings of the Asia Regional workshop on Mainstreaming Biodiversity and Climate change 6-11 April 2003, Dehradun, India.
- Selvam, V. 2003. *Environmental classification of Mangrove Wetlands of India* Current Science, 84 (6): 757-765.
- Sidhu.S.S. 1963. *Studies on the mangroves of India: East Godavari Region*, Indian Forester, 89: 337-351.
- Snedaker, S.C. and P.D. Biber 1996. *Restoration of Mangroves in the United States of America: A case study in Florida*. In: Restoration of Mangrove Ecosystems C.D. Field, (Ed.) International Society for Mangrove Ecosystem, Okinawa, Japan, pp 170 - 188.
- Soemodihardjo, S., P. Waroatmodgo, F. Mulia and M.K. Harahap 1996 *Restoration of Mangroves in Indonesia: A case study of Tembilaham, Sumatra*. In: Restoration of Mangrove Eco systems C.D. Field, (Ed.) International society for mangrove ecosystem, Okinawa, Japan, pp 97-110.
- Untawale, A.G. 1996. *Restoration of Mangroves along the Central West Coasts of India*. In: Restoration of Mangrove Ecosystems C.D. Field, (Ed.) International society for mangrove ecosystem, Okinawa, Japan, pp 111 -125.



M.S. Swaminathan Research Foundation

Third Cross Road, Taramani Institutional Area
Taramani, Chennai - 600 113, India

Phone: +91-44-2254 1229, 2254 2698, 2254 2699 Fax: +91-44-22541319

E-mail: msswami@mssrf.res.in; executivedirector@mssrf.res.in

Website: www.mssrf.org