MANGROVES FOR THE FUTURE (MFF)

NATIONAL STRATEGY AND ACTION PLAN (NSAP): INDIA

JUNE 2008

Front cover page:

Photo at centre- Mangroves (*Rhizophora mucronata* anchored with silt roots)
Photos clockwise- Plankton; seagrass; coralreefs; shrimp; crab; Gastropod; whale shark; Olive ridley turtle; shore bird; Dugong (Sea cow); Dolphin

Back cover page:

Photo at centre- Women Planting mangroves for enhancement of coastal resource base;
Photos clockwise- Fishing by cast net operation in mangrove waters; Honey harvesting in difficult, ardous terrain of Sundarbans; Women installing seaweed raft for cultivation of *Kappaphycus alvarezii*; Boating in water mangrove creeks as a part of eco-tourism at Pichavaram, Tamil Nadu

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MANGROVES FOR THE FUTURE (MFF)
NATIONAL STRATEGY AND ACTION PLAN (NSAP) INDIA

EXECUTIVE SUMMARY

"Mangroves for the Future (MFF)" is a regional initiative, being coordinated by United Nations Development Programme (UNDP) and International Union for the Conservation of Nature (IUCN). MFF aims at promoting coastal ecosystem conservation in six tsunami-hit countries including India. Under this initiative the present document on *'National Strategy and Action Plan'* (NSAP) for India has been drafted in consonance with national policies and programmes of India.

India is blessed with a variety of coastal and marine ecosystems enriched with biodiversity, which provides essential resources for socio-economic development. The country is very strong on the policy front, as well as on the legal support available for conservation of the ecosystems. MFF initiative in India provides focus on promoting conservation and management of coastal and marine biodiversity, while mangrove ecosystems are at center-stage, on three important aspects: (1) coastal restoration; (2) coastal livelihoods; and (3) Integrated coastal zone management.

The initial Action Plan under the MFF initiative will be executed and monitored by the National Coordination Body (NCB) of India on the following three types of projects starting from 2008-09:

1. **Projects of large and medium size on conservation and management of coastal and marine biodiversity:** This project type is an action-oriented and field-level activity. Projects will operate within 3621 km^2 of mangroves in five States (West Bengal, Gujarat, Orissa, Andhra Pradesh and Tamil Nadu). This can be executed through community participation by creating eco-development committees, and through a Government departmental protection model. However, greater emphasis and a larger role shall be given to community participation. The action plan will consider (i) imparting new skills and upgrading of existing skills of people; (ii) enhancing the existing coastal resource base; (iii) providing basic amenities such as water, health, transportation, *etc.*; (iv) bringing all the mangrove areas under the control of

Forest department and also by financially supporting the private owners of the mangrove areas through Government schemes to protect and develop the mangroves; and (vi) improving the educational facilities as a long term strategy.

Under the large and medium size projects, mangrove restoration in approximately 200 km^2 areas will also be done mainly with the support of Government of India. The restoration strategy is adopted based on the tidal amplitude. Consequently, the entire coastal area in the five States is divided in to (i) high tidal amplitude area; and (ii) low tidal amplitude area. In the low tidal amplitude area, 'canal bank planting' technique with 'fish bone' design is preferable for restoration; and, in the high tidal amplitude area, restoration will be made by direct seed sowing and seedling planting in the mud flats. Wherever communities are willing, they can undertake restoration operations and the communities may be mobilized and funds may be transferred to them. In other areas, where communities are not involved or not dependant on the mangroves, the Government departments may have to step in to undertake restoration operations. The idea of contracting out the restoration works wherever possible to the eco-development committees or village forest committees or National Green Corps or NGOs or local private sector companies may be considered. Duration of this type of project is for 3-5 years.

2. **Small Grant Facility will support projects** for coastal community empowerment and capacity building on environment friendly activities as a part of the MFF coastal resource conservation and management strategy. This type of small grant project would provide leads to develop models for better conservation and management. Duration of this type of project may be for 6 months to 18 months .

3. **Targeted Research Projects** have to address knowledge gap areas, which are required for efficient management of coastal ecosystems and will provide essential inputs for the conservation and management strategy. This type of targeted research project would generate data and information for better conservation and management. Duration of this type of project may be for 1-2 years.

2. INTRODUCTION

"Mangroves for the Future (MFF)" is a regional initiative, being coordinated by UNDP and IUCN. It focuses on tsunami-hit countries such as India, Indonesia, Maldives, Seychelles, Sri Lanka and Thailand. It recognizes coastal ecosystems as rich assets, vital for human well-being that must be restored, protected and invested in. MFF adopts a new approach by promoting partnerships to stimulate investment, thereby moving from reactive responses to proactive activities. These activities include raising awareness and capacity for secured livelihoods, disaster preparedness and resilience-building, as well as climate change adaptation measures.

India has agreed to participate in the MFF initiative. To oversee and guide the entire India country programme under MFF, a National Coordination Body (NCB) of India was constituted under the Chairmanship of Dr. B.S. Parsheera. Under this initiative, the following two national consultants were appointed to prepare the National Strategy and Action Plan (NSAP) for India **(Annexure-I)**.

- Dr. Sukhdev Thakur, Principal Chief Conservator of Forests and Chief Wildlife Warden (Retd.), Govt. of Tamil Nadu; and,
- Dr. K. Kathiresan, Professor, Annamalai University, Tamil Nadu.

In order to facilitate preparation of the NSAP, a two day workshop on the "*Conservation and Management of Mangrove Ecosystems in India: Stakeholder Consultation for Assessment of Training and Capacity Building Needs and Design of a National Strategy and Action Plan*" was organized by the Ministry of Environment and Forests, together with Asian Institute of Technology, Bangkok and IUCN–MFF secretariat, Bangkok, on the 12th and 13th February 2008 at the Gujarat Ecological Education and Research Foundation in Gujarat. Based on the discussion and recommendations held in the workshop, the consultant team has prepared a draft NSAP. The National Consultant team also interacted with Mr. Dan Willhelmsson, an International Consultant to finalize the structure and proposed content of the NSAP. The draft NSAP was submitted to the NCB, IUCN country office and IUCN secretariat in March 2008. The MFF Secretariat appreciated the broad ecosystem approach of the draft NSAP and made some suggestions for its improvement. Accordingly the necessary revision was made to the draft NSAP in April 2008.

A delegation from India under the Chairmanship of Shri. B.S. Parsheera visited Sri Lanka to participate in the *"IUCN-MFF Initiate: Review Forum"* held on the 21st-24th April 2008, organized by MFF Secretariat and IUCN Sri Lanka. The Forum brought together 60 participants including MFF partners, country representatives and international and regional technical expertise to review progress of each MFF programme of work. A country working group for India discussed the key findings and recommendations from different Programme of Work (PoW) presented at the Forum and the relevant ones were incorporated in to the draft National Strategy and Action Plan (NSAP).

A second meeting of the core group of NCB was held at the IUCN country office in New Delhi on the 14th May 2008 to discuss the NSAP further and assistance was requested from the NCB members present and the MFF coordinator to improve the document. Based on the inputs given by them, the draft NSAP was further improved.

The present document on *'National Strategy and Action Plan'* for India (June 2008) has been prepared in consonance with National policies and programmes, to analyze, identify and tackle various facets of coastal and marine biodiversity, while mangrove ecosystems are at the centre-stage for conservation and management of coastal and marine biodiversity under the IUCN-MFF initiative.

2. IUCN AND INDIA: A STRONG ASSOCIATION

India has a long history of association with IUCN since the 1960s, beginning even before the Government of India became a state member in 1969. The IUCN's tenth General Assembly was held in New Delhi. Four hundred and twenty five Indian nationals serve in a voluntary capacity on IUCN Commissions, and 320 of whom are members of the Species Survival Commission. Twenty three organizations in India are members of IUCN; the highest number of members in Asia after Pakistan.

During the last four decades, IUCN has worked together with members and partners in India on a wide range of issues. A series of IUCN missions concluded that there was need for a country programme, led by an office in New Delhi so that the engagement in India would broaden, as well as deepen. An IUCN office in India was established in the end of 2006 and it has started its work in building partnerships with members and other organizations working within India in the region.

3. COASTAL AND MARINE ENVIRONMENT IN INDIA

3.1. Coastal Marine Ecosystems

Surrounded by the Indian Ocean, Arabian Sea and the Bay of Bengal, India has about 8,000 km long coastline that spans 13 maritime States and Union Territories (UTs) including Island UTs. India has rich assets of a variety of coastal and marine ecosystems (Table 1), including nationally and globally significant biodiversity. These coastal and marine ecosystems are extremely important from an economic perspective, as they provide a wide range of ecosystem goods and services to the entire country. Approximately 20% of India's populations are living in coastal areas and a large proportion of them are in urban centers such as Mumbai, Chennai and Kolkata. The people living in the coastal belt rely on coastal and marine resources for their immediate welfare and as a source of livelihood through fishing and other forms of economic activities. The December 2004 tsunami which struck the South East coast of India and the Andaman Islands reaffirmed the importance of maintaining healthy coastal and marine ecosystems for natural disaster risk-management and post-disaster recovery, as well as for general human well-being.

Table 1. Extent of coastal ecosystems in India

Coastal Ecosystem	Extent (km^2)
Tidal/ Mud flats	23,621
Sandy beaches/ bars/ spits	4,210
Mangroves	4,445
Coral reefs	2,375
Salt marshes	1,698
Lagoons	1,564
Estuaries	1,540
Other vegetation (including sea grass beds)	1,391
Aquaculture ponds	769
Salt pans	655
Creeks	192
Rocky coasts	177
Back waters	171
Total	**42,763**

3.2. Coastal and Marine Biodiversity

India has remarkable biodiversity in its coastal and marine ecosystems. The mangrove ecosystem alone has a total of 3985 biological species that include 919 flora and 3066 fauna. There are 199 coral species representing all the three major reef types (atoll, fringing and barrier reefs), 14 species of seagrasses and 844 species of seaweeds. A number of factors including the long coastline, tropical climate, and nutrients supplied by rivers along the coast, have combined to produce a variety of biologically rich and productive coastal and off-shore marine ecosystems (Table 1). Inter-tidal mudflats teeming with migratory birds in winter, dense mangrove forests inhabited by the endangered tiger, and delicate seagrass beds favoured by the enigmatic and elusive sea-cow (dugong), are just a few of the natural treasures to be found along the India's coastline.

India is 'home' for globally threatened species such as Royal Bengal tiger, sea turtles, fishing cat, estuarine crocodile, the Gangetic dolphin, and river terrapin. Long-term survival of the rare and endangered species depends on health of the coastal and marine ecosystems. There are also tremendous resident and migratory birds associated with the coastal and marine ecosystems in India. Nearly 2 million water birds of about 200 species over-winter in India before heading back to colder northern climes in April. Five of the world's seven species of sea turtles are found in India, namely the Olive Ridley (*Lepidochelys olivacea*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*) and the critically endangered Leatherback (*Dermochelys coriacea*) turtles. Orissa on the east coast of India has the world's largest mass nesting Olive Ridley Turtles during the months of October to April, supporting a nesting population of probably more than half a million of the species. The threatened whale shark (*Rhincodon typus*), the largest fish species in the world can be found off the coast of Saurashtra in Gujarat, while the last population of one of five threatened sub-species of Asiatic wild ass (*Equus hemionus khur*) occurs in the salt marshes of the Little Rann of Kutch in Gujarat. A detailed account of biodiversity of India's mangrove ecosystem, along with the species at threat, is given in **Annexure-II.**

Mangroves and tigers grow and perpetuate together

3.3. Economic values of coastal and marine ecosystems

Coastal and marine ecosystems are among the most biologically and economically productive ecosystems in the world and the same is true for India where these ecosystems provide both a source of livelihood and a range goods and services that are critical for the day-to-day well-being of millions of people, particularly coastal communities. For example, the fisheries sector provides employment to more than six million people and it accounts for 1.2% of India's total GDP and 5.4% of total agricultural GDP. Fish is an important protein source for many people. In addition to fisheries, the coastal and marine environment is also of importance to other major economic production sectors that include agriculture, tourism, ports and maritime shipping, other major transport and communication sectors and their related infrastructures.

3.4. Threats and constraints to coastal and marine ecosystems

Despite their tremendous ecological and economic importance, India's coastal and marine ecosystems are under increasing threat – in part, and as recognized by the Government of India, due to the country's on–going push for rapid economic growth over the past decade. There are also numerous direct and indirect pressures arising from different types of economic development across the country. Major anthropogenic direct drivers of ecosystem degradation and destruction include habitat conversion to other forms of land use (*e.g.* through coastal development for roads, ports, tourist resorts, aquaculture *etc*.); overexploitation of species and associated destructive harvesting practices (*e.g.* through use of inappropriate fishing gear and

methods); and the impacts of agricultural, domestic and industrial sewage and waste. Additionally, climate change is expected to have a growing impact on coastal and marine ecosystems, including a likely increase in extreme weather events, as well as sea level rise, warming of the sea surface temperatures, and ocean acidification. Coastal habitats are also subject to powerful natural weather phenomena, such as cyclones, hurricanes and storms. Indirect drivers of ecosystem change include demographic, socio-political, cultural, economic and technological factors.

The impacts of different economic sectors on coastal and marine biodiversity vary from region to region. In Gujarat for example, industrial development, urbanization port development, high maritime traffic and mechanized fishing are particularly significant, while in Orissa, large-scale mechanized fishing, commercial aquaculture, and off-shore oil exploration are important issues. It is often difficult to determine a clear causal link between the activities of a particular production sector and their environmental impacts, given that the direct and indirect drivers of ecosystem change operate at different temporal and spatial scales, and interact with each other in complex ways. It is clear, however, that the cumulative impacts of pressures on the coastal and marine ecosystems are intensifying as both India's economy and population, including its coastal population, continues to grow rapidly.

To date, biodiversity conservation efforts and investments in India (as in much of the rest of the world) have focused largely on terrestrial ecosystems. Nevertheless, India has established thirty three coastal and marine protected areas and three Marine Biosphere Reserves, with a total area of approximately 5,318.9 km^2. However, these protected areas cover only less than 1.3 per cent of the Indian continental shelf (4,15,000 km^2 including the Islands) and even less than 0.3 per cent of the Indian EEZ (approximately 2 million km^2).

While Marine Protected Areas (MPAs) are an important tool for conservation of coastal and marine biodiversity, these alone are unlikely to ensure the maintenance of biodiversity and ecosystem processes, given the complex ecological dynamics of coastal and marine ecosystems and the nature and scale of the direct and indirect drivers of ecosystem degradation. Additionally, MPAs by their very nature are inherently difficult to manage. Generally, the functioning of coastal and marine systems is far less well-understood than that of terrestrial systems and there is less technical capacity and expertise available for their effective management. It is also

difficult to manage such areas effectively, given the vast array of direct and indirect pressures on these areas; moreover, many of the pressures are difficult to exclude or control. Finally, the preceding factors greatly increase the cost of managing MPAs.

The Government of India has long recognized that the long-term solution to degradation of coastal and marine ecosystems requires a more holistic and integrated approach that promotes multi-sectoral coordination to integrate environmental management principles, including biodiversity conservation objectives, into economic production activities. Similarly, ensuring compliance with existing laws and regulations requires a coordinated response from a number of sectors.

A luxuriantly growing mangrove forest in Pichavaram, southeast coast of India

4. MANGROVES IN INDIA IN RELATION TO GLOBAL STATUS

4.1. Global Status of Mangroves

FAO has recently given a list of the recent, reliable national/area estimated for each country or territory as shown in the table 2. Global mangrove area currently stands at about 15.2 million hectares in 124 countries. The most extensive mangrove area is found in Asia, followed by Africa and North and Central America. Five countries (Indonesia, Australia, Brazil, Nigeria and Mexico) together account for 48 per cent of the total global area and 65 per cent of the total mangrove area is found in just ten countries. The remaining 35 per cent is spread over 114 countries and areas, of which 60 have less than 10,000 hectares of mangroves each. Asia is the region with the

lowest forest cover in terms of percentage of land area, but has the largest extent of mangroves (approximately six million hectares), while five of the ten countries with the largest extent of mangroves worldwide are found in this region.

Globally, mangrove ecosystems continue to disappear at an alarming rate. Twenty per cent, or 3.6 million hectares of mangroves, have been lost since 1980. More recently, the rate of net loss appears to have slowed down, although it is still disturbingly high. About 185,000 ha were lost every year in the 1980s; this figure dropped to some 118,500 ha per year in the 1990s, and to 102,000 ha per year during the period 2000-2005, reflecting an increased awareness of the value of mangrove ecosystems, supplied by mangrove projects in a numbers of countries, including India.

Table 2. Most recent reliable mangrove area estimate by country area as per FAO report (2007)

Country/ Area	ha	Year
Angola	33 600	2000
Benin	1 700	1989
British Indian Ocean Territory	n.a.	n.a.
Cameroon	251 545	2000
Comoros	117	2002
Congo	8 000	2003
Cote d'Ivoire	9 940	2000
Dem Rep. of the Congo	19 600	2000
Djibouti	1 000	1985
Egypt	512	2002
Equatorial Guinea	25 700	1995
Eritrea	6 400	1997
Gabon	152 940	2000
Gambia	58 100	2000
Ghana	13 729	2000
Guinea	276 342	1997
Guinea-Bissau	248 400	1990
Kenya	52 980	1982
Liberia	9 244	2000
Madagascar	303 814	2004
Mauritania	104	1993
Mauritius	120	2004
Mayotte	668	1989
Mozambique	392 749	1997
Nigeria	997 700	1995
Sao Tome and Principe	n.a.	n.a.
Senegal	127 702	2000
Seychelles	2 900	1960
Sierra Leone	105 300	2000
Somalia	10 000	1975
Country/ Area	**ha**	**Year**
South Africa	3 054	1999
Sudan	500	1995
Togo	1 094	2000
United Rep. of Tanzania	127 200	2000
Total Africa	**3 242 754**	**1997**
Bahrain	100	1992
Bangladesh	476 215	1995
Brunei Darussalam	18 418	1996
Cambodia	72 835	1997
China	22 480	2001
India	444 500	2005
Indonesia	3 062 300	2003
Iran, Islamic Rep. of	19 234	1997
Japan	800	2005
Kuwait	5	2004
Malaysia	564 971	2005
Maldives	n.a.	n.a.
Myanmar	518 646	1999
Oman	1 088	1995
Pakistan	158 000	2001
Philippines	247 362	2003
Qatar	500	1992
Saudi Arabia	20 400	1985
Singapore	500	1990
Sri Lanka	9 530	1996

Thailand	244 085	2000
Timor-Leste	1 802	2000
United Arab Emirates	4 000	1999
Viet Nam	157 500	2000
Country/ Area	ha	Year
Yemen	927	1993
Total Asia	6 047 798	2002
American Samoa	52	2003
Australia	1 451 411	2005
Christmas Island	n.a.	n.a.
Fiji	42 464	1991
French Polynesia	n.a.	n.a.
Guam	70	1993
Kiribati	258	1995
Marshall Islands	n.a.	n.a.
Micronesia (Fed. States of)	8 564	1983
Nauru	2	1991
New Caledonia	17 140	2003
New Zealand	26 032	2001
Niue	3 000	1981
Northern Marina Islands	7	1976
Palau	4 708	1985
Papua New Guinea	410 000	2000
Samoa	370	1999
Solomon Islands	50 572	1993
Tokelau	n.a.	n.a.
Tonga	1 305	1997
Tuvalu	40	1993
Vanuatu	2 519	1993
Wallis and Futuna Islands	25	2005
Total Oceania	2 018 537	2003
Anguilla	90	1991
Antigua and Barbuda	1 175	1991
Aruba	420	1986
Bahamas	141 957	1991
Barbados	4	2004
Belize	78 511	1990
Bermuda	16	1992
British Virgin Islands	587	2001
Cayman Islands	7 830	1998
Costa Rica	41 840	2000
Country/ Area	ha	Year
Cuba	545 805	2003
Dominica	10	1991
Dominican Republic	21 215	1998
El Salvador	28 000	2004
Grenada	255	1992
Guadeloupe	2 950	1997
Guatemala	17 727	1999
Haiti	15 000	1988
Honduras	78 668	2000
Jamaica	9 731	1997
Martinique	1 840	1998
Mexico	882 032	2002
Montserrat	5	1991
Netherlands Antilles	1 138	1980
Nicaragua	69 050	1998
Panama	174 435	2000
Puerto Rico	8 870	2000
Saint Kitts and Nevis	79	1991
Saint Lucia	200	2002
Saint Vincent and the Grenadines	51	1991
Trinidad and Tobago	7 150	1991
Turks and Caicos Islands	23 600	1988
United States	197 648	2001
Unites States Virgin Islands	216	1999
Total North and Central America	2 358 105	2000
Brazil	1 012 376	1991
Colombia	371 250	1997
Ecuador	149 556	1999
French Guiana	55 000	1980
Guyana	80 432	1992
Peru	4 550	1995
Suriname	114 600	1998
Venezuela (Bolivarian Rep. of)	250 000	1986
Total South America	2 037 764	1992

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Even though mangroves are often used for the collection of forest wood products, and as a source of subsistence for local populations, the removal of wood and non-wood forest products is rarely the main cause of mangrove habitat loss. Human pressure on coastal ecosystems and the competition for land for aquaculture, agriculture, infrastructure and tourism are often high and are major causes of the decrease in mangrove areas.

4.2. Mangrove Forests in India

4.2.1. Mangrove cover in India: Mangroves in India account for about five per cent of the world's mangrove vegetation with green cover of 4445 km^2 along the coastal States and Union Territories (UT) of the country, which is 0.14 per cent of the country's total geographic area. The Forest Survey of India has been assessing the mangroves using remote sensing since 1987. It published the first assessment in 1987 and the area estimated was 4046 km^2 (scale of assessment – 1:1 million). Thereafter, mangroves were assessed regularly on a two-year cycle from 1989 to 1999, where the scale of assessment was 1:250,000. The assessment for 2001 and 2003 was done on 1:50,000 scale.

State/UT wise mangrove cover as assessed by FSI in different assessments is given in the table 3. West Bengal has the greatest area of mangrove cover in the country, followed by Gujarat and Andaman and Nicobar Islands. About 60 per cent mangrove cover is found on the east coast of India, 14 per cent on the west coast and the remaining on the Andaman and Nicobar Islands. On a macro scale, geomorphic settings of the mangrove ecosystems of the east coast of India are different from those of the west coast. The presence of larger brackish water-bodies and a complex network of tidal creeks and canals characterize the mangrove ecosystems of the east coast. This is mainly due to the larger deltas created by east-flowing rivers and the gentle slope of the coast. On the other hand, the coastal zone of the west coast is narrow and steep in slope, due to the presence of the Western Ghats. Secondly, there are no major west-flowing rivers. As a result, the mangrove ecosystems on the west coast of India are small in size, lower in diversity and less complicated in terms of their tidal creek networks. The tables 4 and 5 present State/UT wise and district-wise status of mangrove cover as estimated in the 2005 assessment.

4.2.2. Status of mangrove cover: In the FSI assessment, mangrove cover in India has been categorized into (i) very dense mangroves (canopy density of more than 70%); (ii) moderately dense mangroves (canopy density between 40-70%); and (iii) open mangroves (canopy density between 10-40%). The very dense mangroves comprise 1,147 km^2 (25.8% of total mangrove cover), moderately dense mangroves is 1,629 km^2 (36.6%), while open mangroves cover an areas of 1,669 km^2 (37.6%) (Table 4).

4.2.3. Trend of change in mangroves: Compared with the 2003 assessment, there has been a marginal decrease in mangrove cover in India mainly because of the

tsunami that hit the Andaman and Nicobar Islands on the 26th December 2004. Gujarat has shown an increase in mangrove cover mainly because of plantations and forest protection measures (Table 4).

Table 3. State/UT wise mangrove cover assessment since 1987 as per Forest Survey of India (2005)

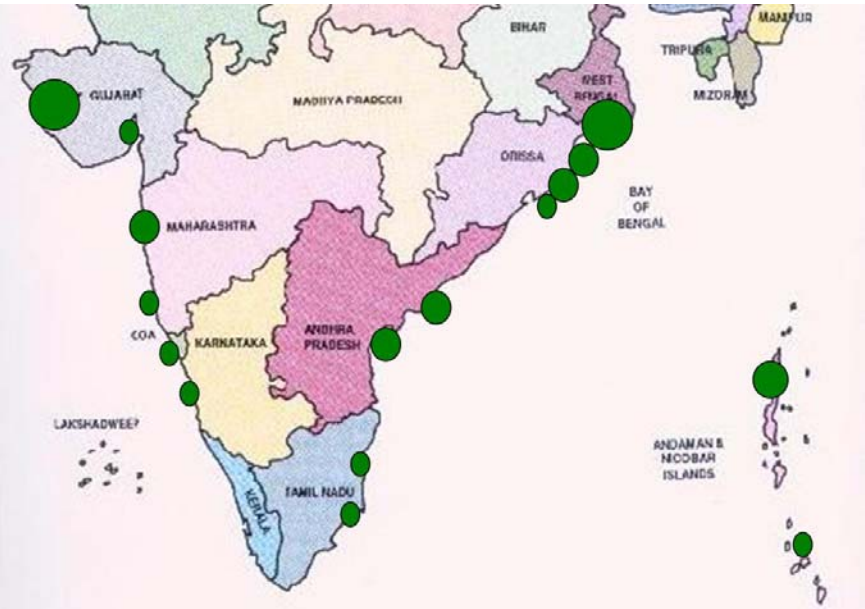
Sl. No.	State/UT	Assessment Year									
		1987	1989	1991	1993	1995	1997	1999	2001	2003	2005
1.	Andhra Pradesh	495	405	399	378	383	383	397	333	329	329
2.	Goa	0	3	3	3	3	5	5	5	16	16
3.	Gujarat	427	412	397	419	689	901	1031	911	916	936
4.	Karnataka	0	0	0	0	2	3	3	2	3	3
5.	Kerala	140	114	113	155	155	124	108	118	158	8
6.	Maharashtra	199	192	195	195	195	211	215	219	203	158
7.	Orissa	23	47	47	21	21	21	21	23	35	203
8.	Tamil Nadu	2,076	2,109	2,119	2,119	2,119	2,123	2,125	2,081	2120	35
9.	West Bengal*	686	973	971	966	966	966	966	789	658	2,118
10.	Andaman and Nicobar	0	0	0	0	0	0	0	1	1	637
11.	Daman and Diu	0	0	0	0	0	0	0	0	8	1
12.	Pondicherry	0	0	0	0	0	0	0	0	1	1
	Total	4,046	4,255	4,244	4,256	4,533	4,737	4,871	4,482	4,448	4,445

*As per the West Bengal forest department, mangrove area in the Sundarbans is approximately 4200 km^2 which is almost double the area estimated by FSI. This is mainly because West Bengal forest department includes the areas of water body also besides the mangrove vegetation. But for change detection, it is prudent not to include the water areas.

Table 4. State/UT wise mangrove cover as per Forest Survey of India (2005)

Sl. No	State/UT	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total	Change w.r.t 2003 Assessment
1	Andhra Pradesh	0	15	314	329	0
2	Goa	0	14	2	16	0
3	Gujarat	0	195	741	936	20
4	Karnataka	0	3	0	3	0
5	Kerala	0	3	5	8	0
6	Maharashtra	0	58	100	158	0
7	Orissa	0	156	47	203	0
8	Tamil Nadu	0	18	17	35	0
9	West Bengal	892	895	331	2,118	-2
10	Andaman & Nicobar	255	272	110	637	-21
11	Daman & Diu	0	0	1	1	0
12	Pondicherry	0	0	1	1	0

Total		1,147	1,629	1,669	4,445	-3



Significant mangrove areas on the Indian coastline

Table 5. District wise mangrove cover as per Forest Survey of India (2005)

Sl. No	State/UT and District	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total	Change w.r.t 2003 Assessment
1	Andhra Pradesh					
	East Godawari	0	7	181	188	0
	Guntur	0	3	44	47	0
	Krishna	0	5	88	93	0
	Prakasam	0	0	1	1	0
	Total	0	15	314	329	0
2	Goa					
	North Goa	0	10	1	11	0
	South Goa	0	4	1	5	0
	Total	0	14	2	16	0
3	Gujarat					
	Ahmedabad	0	2	4	6	4
	Bharuch	0	22	14	36	3
	Bhavnagar	0	6	8	14	0
	Jam Nagar	0	28	122	150	9
	Kuchchh	0	127	580	707	0
	Navsari	0	0	1	1	0
	Porbander	0	1	0	1	0
	Rajkot	0	1	1	2	0
	Surat	0	7	10	17	4
	Valsad	0	1	1	2	0
	Total	0	195	741	936	20

Sl. No	State/UT and District	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total	Change w.r.t 2003 Assessment
4	Karnataka					
	Udipi	0	2	0	2	0
	Kannad Uttar	0	1	0	1	0
	Total	0	3	0	3	0
5	Kerala					
	Kannur	0	3	4	7	0
	Ernakulam	0	0	1	1	0
	Total	0	3	5	8	0
6	Maharashtra					
	Mumbai City	0	0	2	2	0
	Mumbai Suburb	0	20	20	40	0
	Raigarh	0	9	38	47	0
	Ratnagiri	0	9	12	21	0
	Sindhudurg	0	1	0	1	0
	Thane	0	19	28	47	0
	Total	0	58	100	158	0
7	Orissa					
	Baleshwar	0	0	4	4	0
	Bhadrak	0	17	3	20	0
	Jagatsinghpur	0	2	2	4	0
	Kendrapara	0	137	38	175	0
	Total	0	156	47	203	0
8	Tamil Nadu					
	Chidambaranar	0	0	2	2	0
	Cuddalore	0	5	2	7	0
	Nagapattinam	0	8	9	17	0
	Ramanathapuram	0	1	0	1	0
	Thanjavur	0	4	4	8	0
	Total	0	18	17	35	0
9	West Bengal					
	Midinipur	6	1	2	9	0
	24 Pargana North	16	10	2	28	0
	24 Pargana South	870	884	327	2081	-2
	Total	892	895	331	2118	-2
10	Andaman & Nicobar					
	Andaman	255	262	108	625	-6
	Nicobar	0	10	2	12	-15
	Total	255	272	110	637	-21
11	Daman & Diu					
	Diu	0	0	1	1	0
	Total	0	0	1	1	0
12	Pondicherry					
	Yenam	0	0	1	1	0
	Total	0	0	1	1	0
	Grand Total	1,147	1,629	1,669	4,445	-3

4.2.4. Tsunami effects on mangroves and other forests: The Ministry of Environment and Forests, Government of India assigned the Forest Survey of India to undertake a rapid assessment of the damages caused by the 2004 Tsunami to forests in both Islands and mainland, using satellite imageries and ground truth information. Changes detected in forest cover and mangroves in the coastal states and A&N Islands due to Tsunami are given in the table 6.

No detectable damage to forest and mangrove cover were observed in coastal areas of Andhra Pradesh, Orissa, and Pondicherry. In Cuddalore district of Tamil Nadu, it was observed that a total of 76 ha of forest cover have changed to non-forest due to Tsunami. Of this, 20 ha belonged to dense forest and 56 ha to open forest category. There was no change in the mangrove cover in this area. In other coastal districts of Tamil Nadu, no loss of forest or mangrove cover was observed.

In Kerala, no major changes in forest and mangrove cover were observed except in Ernakulum district where 8 ha of mangrove cover have been lost in post-Tsunami period. Of this, 6 ha is dense and 2 ha is open.

Table 6. Loss of forest and mangrove cover due to Tsunami (area in ha)

Sl. No.	States/ UT's	Loss of Forest Cover			Loss of Mangrove Cover			Remarks
		Dense	Open	Total	Dense	Open	Total	
1.	Andhra Pradesh	-	-	-	-	-	-	No damage detected
2.	Orissa	-	-	-	-	-	-	No damage detected
3.	Tamil Nadu	10	30	40	10	25	35	In Cuddalore District of Tamil Nadu
4.	Pondicherry	-	-	-	-	-	-	
5.	Kerala	-	-	-	6	2	8	In Ernakulam District
6.	Andaman & Nicobar Island							In Little Andamans and Nicobar group of islands
	(i) Andaman District	175	83	258	Not mandated	Not mandated	Not mandated	
	(ii) Nicobar District	11,670	554	12,224	-do-	-do-	-do-	
	Total of A&N Islands	11,845	637	12,482	-do-	-do-	-do-	
	TOTAL	**11,855**	**667**	**12,522**	**16**	**27**	**43**	

Forest cover does not include mangroves
Dense Forest/Mangrove - Areas with more than 40% tree canopy density
Open Forest/Mangrove - Areas with tree canopy density between 10% and 40%

In Andaman group of islands (Andaman District), was noticed in Little Andaman Island where loss of 258 ha of forest cover has been assessed. This includes 175 ha of dense forest and 83 ha of open forest.

The results of the assessment are given in the table 7. Figures of the table 7 show that overall 12,670 ha of forest cover has been lost in different Islands of Nicobar which include 11,670 ha of dense forests and 554 ha of open forests. Maximum damage to forest cover has been observed in Great Nicobar Island (6,915 ha), followed by Katchall Island (2589 ha), Camorta (739 ha), Tarasa (551 ha) and Little Nicobar (594). An interesting finding is that changes in forest cover were more pronounced on western side of most of the islands than on eastern side which faced Tsunami waves directly.

Table 7. Loss of forest cover due to Tsunami in Nicobar Group of Islands (area in ha)

Sr. No.	Island Name	Loss in Dense Forest	Loss in Open Forests	Total Loss in Forest Cover
1.	Bompoka	43	-	43
2.	Car Nicobar	136	170	306
3.	Camorta	735	4	739
4.	Chowra	73	79	152
5.	Katchal	2,567	22	2,589
6.	Tarasa	499	52	551
7.	Trinket	285	2	287
8.	Little Nicobar	594	-	594
9.	Great Nicobar	6,690	225	6,915
10.	Trak, Treis & Pulo Milo	48	-	48
	Total	**11,670**	**554**	**12,224**

4.2.5. Threats to mangroves in India: In general, the current status indicates that except in Andaman and Nicobar Islands, in all the mangrove wetlands of India, low-saline tolerant species are gradually disappearing and species like *Avicennia marina* which can tolerate a high and broad range of salinity are becoming dominant. The main reason for such changes is the reduction in the periodicity and quantify of fresh water reaching the mangrove environment. In the Sundarbans (India and Bangladesh), *Heritiera fomes* species has been affected by a 'top-dying' disease since at least the late 1980s, which had been attributed to a combination of changes in hydrology, fungal disease and insect pests. It is a species of the landward edges of mangroves and along brackish tidal streams. Similarly, in Pichavaram mangroves, *Sonneratia apetala* and *Kandelia candel* were present till recently but now no individual of these species is

present. In Muthupet, the true mangrove species belonging to Rhizophoraceae were dominant about 150 years ago but now they are locally extinct. Dense and tall trees of *Avicennia officinalis, Excoecaria agallocha* and *Lumnitzera racemosa* constituted nearly 90 per cent of the population of the Godavari mangrove wetlands in the 1950s, but now they constitute only 37 per cent of the population and are replaced by bushes of *Suaeda maritima* and *S. nudiflora*.

Indiscriminate exploitation of fishery resources: Unregulated use of fishing nets of small mesh size in the estuary for the collection of tiger prawn (*Penaeus monodon*) seeds are also resulting in tremendous loss of diversity of faunal components in the estuaries of Sundarban Biosphere Reserve. It has been observed that for catching 8,106 tiger prawn seeds, collectors destroyed juveniles of 13,04,937 other prawns, 60,581 fish, 2,46,097 crabs, 8,391 molluscs and 66,792 unidentified meroplankton. The semi intensive and modified intensive shrimp culture in brackish water gheries adjacent to estuaries of Sundarban Biosphere Reserve and large inflow of organic and inorganic pollutants also cause considerable ecological pressure and environmental pollution in the aquatic ecosystem. The construction of Farraka Barrage in the upper reaches as well as building dykes and bunds arresting normal flow of water along with tidal waves further interferes with the natural equilibrium of the ecosystem and thereby poses threats to faunal diversity.

Prawn seed collection in Sundarban mangroves, West Bengal

The researchers have found out that the mangroves in India experience threats as shown in the table 8. The most significant threat is of human pressure on mangrove-resources for forestry, fishery products and salt farming. Hence, the Ministry

of Environment and Forests, Governemnt of India has given priority for sustainable management of the mangrove resources, with the local people's participation.

Table 8. Threats to mangroves of various maritime states of India

Major Threats	West Bengal	Orissa (Bhitarkanika)	Andhra Pradesh (Godavari)	Tamil Nadu (Pichavaram)	Andaman & Nicobar	Gujarat	Maharashtra	Goa	Karnataka	Kerala
Cattle / Goat / Deer / Camel grazing	+	+	+	+++	+	++	-	-	-	-
Tree felling for firewood & wood products	++	+	++	+++	+	+	+	+	-	-
Over exploitation of fishery resources	+++	+	+++	+++	+	-	-	+	-	++
Conversion of land for agriculture	++	+	+	-	-	-	+	-	+	++
Conversion of land for salt farming	~	~	~	~	~	+	~	~	~	~
Conversion of land for Aquaculture	+	-	+	-	-	-	-	-	-	-
For urban development/ human settlement	++	+	-	-	+	+	++	+	-	+
Lack of fresh water due to bridge construction or sand bar formation	+	-	+	++	-	++	-	-	-	-
Tourism	-	-	-	+	+	-	-	-	-	-
Shoreline / Geomorphic changes	+	-	+	++	-	++	+	-	-	++
Pollution & discharge of effluents	++	-	+	-	-	+++	++	+	-	++
Port / Harbour development	+	-	-	-	-	+++	-	-	-	-
Mining	-	-	+	-	-	++	+	-	-	-
Hyper salinity	+	-	-	++	-	++	-	-	-	-
Natural calamities (Cyclone & Sea level rise)	+	+	++	++	++++	++	-	-	-	-
Siltation and sedimentation	++	+	++	++	-	++	-	-	-	-
Total Number	**20**	**7**	**16**	**20**	**9**	**23**	**8**	**4**	**1**	**9**

+ = Intensity of threat; - = Insignificant threat; ~ = Studies not undertaken

4.2.6. Religious beliefs on Indian mangroves: Mangroves have long been regarded as 'sacred groves' in some places of India. There is an ancient temple at Chidambaram, nearer to mangrove forests at Pichavaram in Tamil Nadu. In this temple, a mangrove species namely *Excoecaria agallocha* has been worshipped as a 'temple tree' by the Hindu religious people, since the third century. There was a belief that a 'holy' dip in the temple's pond water that was surrounded by the mangrove species cured even incurable human diseases. The medicinal properties of the plant species have recently been proved scientifically. There is another type of temples by the name 'Bano bibi' temples present at the entry points of the Indian Sundarbans. Each temple has a forest god for the Muslims to worship, a forest goddess for the Hindus religious people, and a tiger god. Local people worship in the temple before entering the forest with a belief that the worship will protect them from the tiger attack.

Statues of 'Bana bibi' temple present at the entry points of the Indian Sundarbans for worshipping by local people.

In Gujarat, there are some religious sites of Muslims on the Islands of Mitha Chusna, Khara Chusna, Chhad and Pirotan. Muslims do not cut mangrove trees or molest animals on such Islands. The boat-loads of fishermen with their families arrive on certain festival days on those Islands. There were about four dozen old trees of *Avicennia* on Chhas and Zindra and most of them were protected religiously because fishermen worship them. Such individual trees are seen marked by green cloth or flag as symbol of site for muslim's worship place. Shravan Kavadiya is another place of religious importance in Gujarat. Even though the place is located more than 100 km away from the coastal area, it has a mangrove area of 0.7 hectares near the temple "Shravan Kavadiya". These inland mangroves were identified as temple forest and nobody cuts or causes any damage to very old tress of *Avicennia* in the groves.

Besides mangroves, marine mammals like dolphins and whales are also worshipped in India. The fishermen in Tamil Nadu believe that dalphins save them if they happen to fall in to the sea. The Kharwas community of Gujarat worships the whales as an incarnation of Lord Hanuman. However, the largest fish like whale sharks were hunted. Every year, at least 250 whale sharks were killed along the Saurashtra coast. Therefore, the Government of India put a ban on killing whale sharks in 2001. However, the forest department was struggling to implement it. A Hindu religious preacher by name 'Morari Bapu', stepped to save the whale sharks in 2003. He touched the sentimental feelings of people by comparing the whale shark with a daughter who comes from as far as the waters of Australia and Mexico to give birth at home in the warmth of the Arabian Sea along the Saurashtra. As a result, most fishermen have stopped fishing the whale sharks and even if they get entangled, the fishermen cut their nets that often cost up to Rs. 10000, to release the trapped fish. Corporate sectors like the International Fund for Animal Welfare and Wildlife Trust of India, Tata Chemicals and Gujarat Heavy Chemicals have also joined the campaign of the religious preacher to save the rare fish in the sea.

5. LEGAL FRAMEWORK IN INDIA FOR CONSERVATION OF COASTAL MANGROVES

Many countries have promulgated laws and regulations to protect the remaining mangrove areas and mitigate against further widespread loss. Effective enforcement of this legislation is, however, often hampered by a lack of financial and human resources. Several Asian countries have ratified the Ramsar Convention on Wetlands and have designated mangrove areas as Ramsar sites, or as National Parks, Reserves or Wildlife Sanctuaries. In India, mangrove forests that are declared as Reserve Forests, Reserve Lands or Sanctuaries are protected by the Forest Department of the concerned State/UT, but the mangroves located outside these Reserves and on community lands have not been assisted so far. Such areas exist in Kerala, Karnataka, Andhra Pradesh, Maharashtra and elsewhere.

India is very strong on the policy front, as well as on the legal support available for the conservation of biological resources in the country. Environmental protection is enshrined in the Constitution of India. Article 48-A and Article 51-A(g) of the Directive Principles of State Policy in the Constitution of India state that "*the State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife in the country, and it is a duty of every citizen to protect and improve the*

national environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures".

Under the system of democratic decentralization of responsibilities enshrined in Constitution amendment No. 73 of 1993, local bodies consisting of elected representatives, one third of whom are women, have been entrusted with the responsibility of safeguarding the local environmental capital stocks.

The National Forest Policy 1988 spells out very clearly that the principal aim of Forest Policy must be to ensure environmental stability and maintenance of ecological balance, including atmospheric equilibrium, which are vital for sustenance of all life-forms, human beings, animals and plants. The derivation of direct economic benefit must be subordinated to this principal aim.

The National Conservation Strategy and Policy Statement on Environment and Development (1992) highlights conservation and sustainable development of mangroves, including coastal areas, riverine and Island ecosystems. Similarly, the National Forest Policy and National Wildlife Action Plan emphasize the conservation of mangroves based on scientific principles, including social and cultural aspects.

India's National Environment Policy (NEP), approved by the Cabinet in 2006, seeks to achieve balance and harmony between conservation and development. The policy is intended to mainstream environmental concerns in all development activities. The dominant theme of this Policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods through conservation, than from degradation of the resources. The NEP prescribes that human beings are at the centre of concerns for sustainable development and they are entitled to a healthy and productive life in harmony with nature. The Policy recognizes that mangroves are an important coastal environmental resource. They provide habitats for marine species; protection from extreme weather events; and a resource base for sustainable tourism.

The National Environment Policy also recognizes that mangroves, as indeed the other coastal resources like coral reefs and coastal forests, face threats from the following quarters:

a) poorly planned human settlements;

b) improper location of industries and infrastructure;

c) pollution from industries and settlements;

d) over exploitation of living natural resources;

e) inadequate institutional capacities for, and participation of local communities in, formulation and implementation of coastal management plans;

f) lack of consensus on means of provision of sanitation and waste treatment; and

g) open access nature of many coastal resources.

In view of the above, the National Environment Policy underlines the need to mainstream the sustainable management of mangroves into the forestry sector regulatory regime and to adopt a comprehensive approach to Integrated Coastal Zone Management.

India has many policy and legal frame work especially for conservation of coastal and marine ecosystems as given in the table 6.

Table 6. India's Existing Policy and Legal Framework for Coastal and Marine Ecosystems

No	Year	Acts/policies/programmes	Features
1	1882	Indian Forest Act	Provides necessary statutory protection to the mangroves falling under Reserve Forests, Protected Forests and Village Forest Categories.
2	1897	Indian Fisheries Act	Regulates fishing and protects fisheries against destructive fishing using dynamite and explosives
3	1908	Indian Ports Act	Regulates port and vessel movement and safety
4	1950	Coast Guard Act	Levies penalties for pollution of port waters and responsible for combating marine pollution
5	1958	Merchant Shipping Act	Controls pollution from ships and offshore platform
6	1972	Wildlife Protection Act	Provides protection to marine flora and fauna.
7	1974	Water (Prevention and Control of Pollution) Act	Controls pollution from land sources with a jurisdiction upto 5kms from the sea.
8	1976	Maritime Zones Act	Describes various zones such as the EEZ, continental shelf, etc
9	1978	Marine Fishing Regulation Act	Provides guidelines to regulate fishing in territorial waters, regulates mesh size, zones for fishing sectors, fishing seasons, etc

10	1980	Forest Conservation Act	Protects forests, including mangrove forests
11	1982	Coastal Pollution Control Series (COPOCS Prog)	Aims to assess pollution status of coastal waters
12	1986	Environment Protection Act (EPA)	Sets standards for discharged effluents, guidelines for industries, etc
13	1991	Coastal Regulation Zone Notification (under EPA 1986)	Regulates activities in coastal region by classifying into 4 categories
14	1991	Coastal Ocean Monitoring and Prediction Systems (COMAPS)	Assesses the health of coastal waters, pollution monitoring, regulation and legislation
15	1995	National Environmental Tribunal Act	Provides for awarding compensation for damages to persons, property and environment from use of hazardous substances
16	1995	UNCLOS	Provides comprehensive legal framework for issues relating to oceans and seas
17	1996	Coastal Zone Management Plans	Coastal regulation by all coastal states as per order of the Supreme Court
18	1997	National Environment Appellate Authority Act	Addresses appeals related to areas where classes of industries may be established under the EPA for expeditious implementation of projects
19	1998	Ocean Observation and Information Services	Generates oceanographic data
20	1998	Integrated Coastal and Marine Area Management (ICMAM) Project	Provides for the integration of coastal and marine regions by preparing GIS studies and ICMAM model plan for 3 states.
21	1998	Turtle Excluder Device (TEDs)	All trawlers should be equipped with TEDs
22	1998	DOD Programme on assessing marine life beyond 70m depth	Initiated under the ninth five year plan for comprehensive understanding of the Indian EEZ.
23	2002	The Biodiversity Act	Conservation and protection of biodiversity in India
24	2004	Swaminathan Review Committee on CRZ Notification 1991	Suggested a more integrated and scientific approach to coastal zone management
25	2006	National Environment Policy	Adopts a comprehensive approach to environmental protection by addressing linkages in relevant policies, regulations and programmes
26	2007	Draft National Biodiversity Action Plan	Provides action plan for biodiversity protection; notes the limited information, expertise, funding, etc, on biodiversity of coastal and marine areas of the country.

In addition, there are special Acts such as the Karnataka Tree Act and Tamil Nadu Hill Preservation Act, which are specific to the States and have specific

application to particular tree species that need protection. The mangroves are also protected through a range of regulatory measures, such as Environment Impact Assessment (EIA) studies under the EIA Notification, 1994 for specialized industries; monitoring of compliance, with conditions imposed while according Environmental Clearance, by Regional Offices of the Ministry and State Pollution Control Boards; enforcement of emission and effluent standards by industries and other entities, and recourse to legal action against defaulters.

Coastal Regulation: For the purpose of protecting and conserving the coastal environment, the Ministry of Environment and Forests, Government of India issued the Coastal Regulation Zone (CRZ) Notification, 1991 under the Environment Protection Act, 1986. This notification provides a unique regulatory framework without any parallel, globally speaking, for the conservation of the coastal resources by regulating development activities within the CRZ.

The main features of the CRZ Notification (1991), as amended from time to time, are as follows:

- Government of India issued the coastal zone regulation on 19th February, 1991 under Section 3(1) and Section 3(2)(v) of the Environment (Protection) Act, 1986.
- The Coastal Regulation Zone (CRZ) Notification, 1991, declares coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters, which are influenced by tidal action (in the landward side) up to 500 meters from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the High Tide Line as the Coastal Regulation Zone.
- The Notification regulates all developmental activities in the CRZ area. In the Notification, as per para 6(1) under Annexure-I sub-heading Coastal Regulation Zone–I, mangroves are declared as CRZ–I(i) area. Further, as per para 6(2) sub-heading CRZ–I, no new constructions shall be permitted in CRZ-I area including mangrove areas, except those listed under the Notification.
- The Ministry has constituted National and State/UT Coastal Zone Management Authorities under the Environment (Protection) Act, 1986 for enforcing and monitoring the CRZ Notification (1991).

For regulating developmental activities, coastal stretches within 500 metres of the High Tide Line on the landward side are classified into four categories, as follows:

Category - I (CRZ-I) :

CRZ-I(i) :

Ecologically sensitive and important areas: The CRZ I (i) is afforded protection of the highest order to strictly protect all the sensitive coastal/marine living ecosystems.

- National Parks/Marine Parks
- Sanctuaries/reserve forests
- Wildlife habitats
- Mangroves
- Corals/coral reefs *etc.*

CRZ-I (ii) :

Area between the Low Tide Line and the High Tide Line.

- No development activities are permitted in CRZ-I, except for the most essential facilities like laying of pipelines, *etc.*

Category – II (CRZ-II):

CRZ-II includes built-up areas. CRZ II includes mainly developed areas such as metropolitan cities. Development in CRZ-II zone can take place beyond the limits of an authorized structure.

Category – III (CRZ-III):

CRZ-III categories refer to rural areas where developments like tourism can be extended beyond 200 meters on the landward side.

Category - IV (CRZ-IV):

CRZ-IV includes coastal stretches of the Andaman and Nicobar Islands, and Lakshadweep Islands.

The Ministry of Environment and Forests, Government of India is the nodal agency for implementing the CRZ rules. The Ministry, after implementation of the Coastal Regulation Zone Notification over a decade and consequent to the feedback and suggestions received from the stakeholders and NGOs, the Ministry constituted an Expert Committee under the Chairmanship of Dr. M.S. Swaminathan in July 2004 to review and make recommendations with regard to implementation of CRZ Notification, 1991. The Swaminathan Committee submitted its report in February 2005 to the Ministry of Environment and Forest, Government of India. A comparative statement of

CRZ notification and recommendations of the Swaminathan Committee is given in the table 7.

Table 7. A comparative analysis of CRZ notification and Recommendations of Swaminathan Committee

No.	Detail	Existing notification issued in Feb.1991	Swaminathan Committee recommendation	Remarks
1.	Coastal Regulation Zone (CRZ)	Coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action	Areas from territorial limits (12 nautical miles) including its seabed to the administrative boundaries demarcated on the landward side of the seacoast. It will also include tidal influenced water bodies	Seems difficult to implement. Implementing Agencies not identified.
2.	Set back line	(a) 500m from the High tide line (HTL) on the landward side. (b) Land area between the low tide line and high tide line. (c) In case of tidally influenced water bodies, 100 meters on either bank	Setback line in CMZ-II and CMZ-III will be based on vulnerability of coast to natural and manmade hazards. The vulnerability line will be demarcated based on elevation, geology, geomorphology, sea level trends, horizontal shoreline displacement, tidal ranges and wave heights.	The vulnerability line demarcation may give rise to horizontal shore line displacement affecting large extent of areas particularly in low lying flat areas involving even densely populated urban areas. Therefore, this recommendation is likely to face stiff resistance. Hence, not implementable

3.	Categorization of Zones	CRZ consists of 4 Regulatory Zones. (i) CRZ-I.(Sensitive and inter tidal areas) which includes, National Parks and sanctuaries, RFs, wildlife habitats, mangroves, coral reefs, breeding and spawning grounds of fish and marine life, natural heritage and areas rich in genetic diversity, area between the Low and High tide line. (ii) CRZ-II.(Urban or developed) Areas that have been developed up to or close to the shore line i.e. within the Municipal limits, any other legally designated urban area which is already substantially built up and having infrastructure facilities. (iii) CRZ-III.(Rural or undeveloped) Areas that relatively undisturbed and those which do not belong to categories I and II. These include coastal zone in rural areas (developed and undeveloped) and also areas within municipal limits /in other legally designated urban areas which are not sufficiently built up. (iv) CRZ-IV (Islands) Andaman and Nicobar and Lakshadweep.	Proposes 4 Coastal Management Zones. (i)CMZ-I-Ecologically sensitive areas like mangroves, coral reefs, sand dunes, inland water bodies, mudflats, Marine Parks and sanctuaries, coastal forests and wildlife, coastal fresh water lakes, salt marshes, Turtle nesting grounds *etc.* (ii) CMZ-II Areas of particular concern like coastal Municipalities/Corp-orations/ Panchayats with population density more than 400/sq.m., Ports and harbors *etc.* (iii) CMZ-III All other coastal areas not covered under other zones. (iv)CMZ-IV(Islands) Andamanand Nicobar and Lakshadweep.	No comments

4.	Developmental activities	Prohibited and permissible activities detailed in the notification.	Prohibited and permissible activities will be based on an Integrated Coastal Zone Management Plan to be prepared and implemented with shareholder involvement.	It is a huge task, extremely complicated requiring mosaic of planning units and extremely difficult to implement.
5.	Institutional arrangement	(i) State Coastal Zone Management Authorities (SCZMA). (ii)National Coastal Zone Management Authority (NCZMA)	National Board for sustainable Coastal Zone Management. NCZMA SCZMA NISCM AICS and ICZM	Both current and proposed Institutional arrangements appear grossly inadequate to handle the said task. It would have been better if the Govt. created the Coastal Zone Regulatory Authority rather than Management Authority and Management part left to the State Govts. to implement.

The Swaminathan Committee has evolved the following 12 basic guiding principles to govern future decisions on coastal zone management:

(1) Ecological and cultural security, livelihood security and national security should be the cornerstones of an integrated coastal zone management policy.

(2) The coastal zone will include an area of the sea to form territorial limits (12 nautical miles), including its sea-bed, to the administrative boundaries or the biological boundaries demarcated on the landward side of the sea coast. The coastal zone

management will also include the inland tidal water bodies influenced by tidal action and the land area along such water bodies. This area should be taken up for an integrated, cohesive, multi-disciplinary and multi-sectoral coastal area management and regulatory system.

(3) Regulation, education and social mobilization should be the three major components of a participatory and sustainable coastal zone management strategy. Panchayat Raj institutions in coastal areas should be fully involved in the educational and social mobilization programmes.

(4) The protection and sustainable development of the marine and coastal environment and its resources should be in conformity with international law, as laid down in 1982 UNCLOS, as well as with the suggestions contained in Chapter 17 of Agenda 21. The Draft National Environment Policy of India also contains useful guidelines. Every effort should be made towards ensuring an Integrated Marine and Coastal Area Management (IMCAM) as prescribed in the 1995 Jakarta Mandate under the 1992 Convention on Biological Diversity.

(5) Coastal regulation needs to be based on sound, scientific and ecological principles and should safeguard both natural and cultural heritage. Heritage sites need particular care and should be conserved in their pristine purity. These include buildings, artifacts, precincts of spiritual, historical, aesthetic and architectural and/or areas of environmental significance such as richness of biodiversity and scenic beauty. Bird sanctuaries, parks and breeding grounds of migratory birds should be protected.

(6) The precautionary approach should be used where there are potential threats of serious or irreversible damage to ecologically fragile critical coastal systems and to living aquatic resources. Scientific uncertainty should not be used as an institution for the unsustainable exploitation of coastal resources - both living and non-living as well as to prevent environmental degradation, injustice, and harm.

(7) Significant or irreversible risks and harm to human health and life, critical coastal systems and resources, including cultural and architectural heritage, would be considered unacceptable. Ecological economics should underpin economic activities, so that present day interests and future prospects are not antagonistic. Significant biological, cultural and natural assets should be considered incomparable, invaluable and irreplaceable and should receive overriding priority in the allocation of resources for coastal area protection and conservation.

(8) Coastal policy and regulations should be guided by the principles of gender and social equity as well as intra-generational and inter-generational equity, (*i.e*., the interests of future generations). They should be based on Mahatma Gandhi's

dictum, "*Nature provides for everyone's needs, but not for everyone's greed.*" All stakeholders should be involved in decision-making. Precious biological wealth, coming under Marine Biosphere Reserves, should be managed in a Trusteeship mode, with all the stakeholders protecting the unique natural wealth of biosphere reserves as Trustees and not as owners. A case study should be made on how the Gulf of Mannar Biosphere Trust is functioning, so that the Trusteeship pattern of sustainable management can be replicated by the principal stakeholders.

(9) Coastal protection and bio-resources conservation policies should be guided by techno economic efficiency, the precautionary approach, 'polluter-pays' principle(s) and 'public trust' doctrine. There should be strict liability on the part of those engaged in hazardous or inherently dangerous coastal activities, including the liability to compensate the victims of all human made hazards such as marine pollution and fish contamination. They should also bear the cost of restoring the coastal environmental degradation. The onus of proof in such cases should be on the developers/industrialists for demonstrating that their "development" activities are environmentally benign.

(10) The principles contained in the Biodiversity Act (2002), should be applied to coastal bio-resources management. This will involve concurrent attention to conservation, sustainable use and equitable sharing of benefits. To address the issue of pressures on marine and coastal ecosystems, as defined in the Johannesburg Plan of Implementation (Part IV) adopted at the 2002 World Summit on Sustainable Development, every effort should be made to promote sustainable fisheries, prevent loss of biological diversity, prevent all forms of marine pollution and ensure that coastal area development and urbanization are eco-friendly.

(11) The regeneration of mangrove wetlands, coral reefs and seagrass beds as well as the promotion of coastal forestry and agro-forestry will confer both short and long term ecological and livelihood benefits. Carbon sequestration through coastal bio-shields will make an important contribution to promoting a balance between carbon emission and absorption, in addition to offering protection during coastal storms and calamities like Tsunami. An important lesson taught by the tsunami disaster is that the rehabilitation of degraded mangrove forests and the raising of coastal plantations of *casuarina* and appropriate species of halophytes will represent a "win-win" situation both for nature and coastal human habitations. No further time should be lost in initiating a national coastal bio-shield movement along the coasts of the mainland of India as well as Islands. This can be a priority task under the National Rural Employment Guarantee and Food for Work Programmes.

(12) The severe loss of life and livelihoods as well as property caused by Tsunami in Andaman & Nicobar Islands and in the coastal regions of Tamil Nadu, Kerala, Andhra Pradesh and Pondicherry teaches us that short term commercial interests should not be allowed to undermine the ecological security of our coastal areas. Human memory tends to be short and neglecting the lessons of Tsunami will be equivalent to writing off the future of coastal communities.

The Committee has also recommended a National Coastal Zone Management Action Plan with an objective "*to protect the coastal zone with people's participation, the livelihood security of the coastal fisher and other communities, and the ecosystem, which sustains the productivity of the coastal areas, while promoting sustainable development that contributes to nation's economy and prosperity*." The salient features of the Committee's recommendations are as follows:

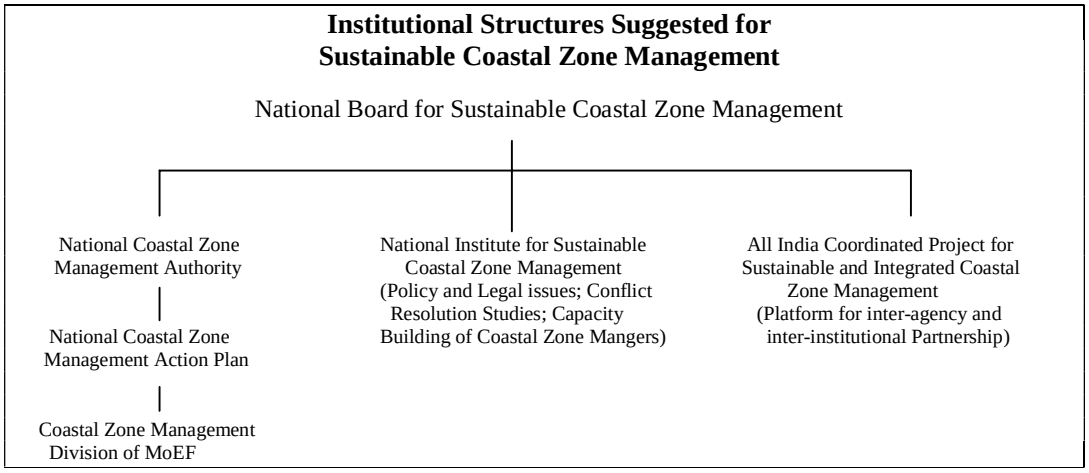
The Committee has recommended the reclassification of the coastal zone into four Zones and they are:

1. **Coastal Management Zone-I** - consists of areas designated as Ecologically Sensitive Areas such as Mangroves, Coral reefs, Sand Dunes, Inland tide/water bodies such as estuaries, lakes, lagoons, creeks & straits, Mudflats, Marine parks and sanctuaries, Coastal forests & wildlife, Coastal fresh water lakes, Salt Marshes, Turtle nesting grounds, Horse shoe crabs habitats, Seagrass beds, Sea weed beds, Nesting grounds of migratory birds.
2. **Coastal Management Zone-II** - consists of areas identified as Areas of Particular Concern such as economically important areas, high population areas and culturally/strategically important areas. The administrative boundaries of these areas would be boundaries of CMZ-II.
3. **Coastal Management Zone-III** - consists of all other open areas including the coastal seas but excluding those areas classified as CMZ-I, CMZ-II and CMZ -IV.
4. **Coastal Management Zone-IV** - consists of Islands of The Andaman and Nicobar and Lakshadweep.

For the purpose of managing the above areas, the Committee has suggested Integrated Coastal Zone Management Approach. After taking into account the recent Tsunami, the Committee has laid emphasis on demarcation of vulnerability line all along the coastal areas and has suggested developmental activities to be regulated on the seaward side of the vulnerability line. Since the coastal management is a multi-disciplinary subject, the Committee has suggested a National Sustainable Coastal

Zone Management Institute along with organizational structure to address issues relating to policy, law, conflict resolution and to creating public awareness. The Committee has laid special emphasis on developing bio shields all along the coastal areas by intensive plantation of mangroves, casuarinas *etc.*

For the implementation of the recommendations, the report also suggests creation of an organisation:



The Ministry of Environment & Forests has broadly accepted the recommendations made in the Report and has initiated an action for implementing the recommendations (For details: http://envfor.nic.in).

Punitive actions in case of illegal mangrove destruction: Illegal destruction of mangroves is a violation of the Coastal Regulation Zone Notification 1991 and it attracts the provisions of the Environment (Protection) Act 1986. As per the said Act, the Ministry of Environment and Forests or any other Authority that has been delegated with such powers can issue a direction to violators under Section 5 of the Act which includes closure of the unit, stoppage of electricity, or water to such units.

Non-compliance of the directions issued under Section 5 of the Act attracts Section 15 of the said Act which provides imprisonment for a term of 5 years with a fine which may exceed to one lakh rupees, or both, and in case the failure to contravention continues, with additional fine which may extend to five thousand rupees for every day. If the failure or the contravention continues beyond one year, the offender shall be punishable for a term which may extend to seven years.

As per Section 19 of the said Act, no court shall take cognizance of the offence under the Act except on a compliant made by the Central Government or any other Authority authorized by the Central Government or any person who has not been given notice of not less than 60 days.

The above powers have been delegated to the Coastal Zone Management Authorities constituted at the 13 coastal States/UTs. These authorities are responsible for enforcement and monitor implementation of coastal zone regulation notification 1991 in their respective States/UTs.

Fisheries Policies of India: India is committed for ensuring sustainability of fish population and securing livelihood of about six million people dependent on it. State Governments deal with coastal fishing in the territorial waters, which extend up to a distance of twelve nautical miles from the shore. Whereas, the Central Government handles deep sea beyond a distance of twelve nautical miles from the shore to the deep sea or exclusive economic zone that extends up to a distance of 200 nautical miles. At the central level, the fishery activities are handled by two bodies of the Ministry of Agriculture - Department of Animal Husbandry and Dairying, and the Indian Council for Agricultural Research.

The Governments have tried to conserve fish population by resorting to command and control methods- dictating periods and time of fishing, imposing bans, specifying size of nets and kind of gear. The following examples give an idea about the command and control methods that have been practiced:

- Setting apart inshore waters up to a depth of 20 m for the exclusive use of the traditional fishermen;
- The Government has banned the use of certain methods of fishing. For instance, in 1993, the Supreme Court banned the process of bottom trawling in the monsoon seasons;
- A ban of fishing in the seawater in east coast for 45 days from April 15th to May 30th and in west coast for 65 days from 10th June to 15th August;
- No fishing gear of less than 10 mm mesh from knot to knot in respect of nets other than trawl net shall be used in Tamil Nadu;
- Banning of midnight trawling in certain parts of Tamil Nadu and Andhra Pradesh;
- The non-mechanised fishing vessel, but not mechanized fishing vessel shall be used for fishing within three nautical miles from the shore and shall go for

hook and line fishing and boat seine in Tamil Nadu. Fishing within 100 metres below a river mouth is prohibited.

Coastal Aquaculture Authority, Government of India has provided guidelines in 2006 for the coastal aquaculture practices. It has specifically instructed that mangroves, agricultural lands, saltpan lands, ecologically sensitive areas like sanctuaries, marine parks should not be used for shrimp farming. A minimum distance of 50 – 100 metres shall be maintained between the nearest agricultural land (depending upon the soil condition), canal or any other water discharge/ drainage source and the shrimp farm. All shrimp farms should maintain 100 m distance from the nearest drinking water sources. The shrimp farms should not be located across natural drainage canals/flood drain. While using common property resources like creeks, canals, sea, *etc,* care should be taken that the farming activity does not interfere with any other traditional activity such as fishing *etc.* Shrimp farms should be located at least 100 m away from any human settlement in a village of less than 500 populations, and beyond 300 m from any village of over 500 populations. For major towns and heritage areas it should be around 2 km. Water spread area of a farm shall not exceed 60 per cent of the total area of the land. The rest 40 per cent could be used appropriately for other purposes. Plantation could be done wherever possible.

International Co-operation: India has promoted regional and international co-operation for effective implementation of suitable strategies for conservation of biodiversity. The Country has participated in major international events on environment and biodiversity conservation since 1972. India has also contributed to developing the agreed texts, ratified, and complied with the commitments in various international conventions relating to biodiversity. These agreements are : Convention on Biological Diversity (CBD), Convention on International Trade in Wild Species of Endangered Flora and Fauna (CITES), Ramsar Convention on Wetlands, World Heritage Convention, and the Bonn Convention on Conservation of Migratory Species (CMS). Some other international agreements with a bearing on biodiversity, to which India is a party include: UNFCCC, UNCCD, Commission on sustainable Development, World Trade Organisation, FAO facilitated International Treaty on Plant Genetic Resources and UN Law of the seas. A Global Tiger Forum of Tiger Range Countries has been created for addressing international issues related to tiger conservation. India has also agreed to the '*2010 Biodiversity Target'* of the CBD to achieve by 2010 a significant reduction of the current biodiversity loss.

India has also actively supported numerous regional and bilateral programmes on biodiversity especially with neighboring countries through SAARC, ASEAN and ESCAP. MoEF, the nodal Ministry for the CBD and other biodiversity related conventions, is also the nodal agency in the country for the United Nations Environment Programme (UNEP), SACEP, ICIMOD, and IUCN-MFF (Mangroves for the Future). It has institutionalized the process for developing the country's position on major issues for negotiations under different International Conventions.

India along with sixteen other mega-diverse countries, which are rich in biodiversity and traditional knowledge, has formed a group known as the Like-mineded Megadiverse Countries (LMMCs). These countries are Bolivia, Brazil, China, Colombia, Costa Rica, democratic Republic of Congo, Ecuador, Indonesia, Kenya, Madagascar, Malaysia, Mexico, Peru, Philippines, South Africa and Venezuela. The LMMCs hold nearly 70% of all biodiversity. India chaired the LMMCs for a two-year period from March 2004 to March 2006, and coordinated the activities of this group focusing particularly on access and benefit sharing issues under the CBD.

Access to genetic resources and sharing of the benefits arising out of these resources constitute the core elements of the Convention. While access and benefit sharing is subject to national legislation, as provided for in the Article 15 of the CBD, national action alone is not sufficient to ensure benefits to the country that prides the resources, particularly in instances where the genetic resources is utilized in another country for developing processes and products on which protection is obtained. In this background, an international regime (IR) on Access and Benefit sharing (ABS) is presently being negotiated by a working group on Access and Benefit Sharing under the aegis of CBD, pursuant to a landmark decision of Seventh Conference of Parties (COP) to the CBD. The eighth COP held in March 2006 has set a deadline of 2010 for completing the negotiations of IR on ABS.

Notable progress in this area notwithstanding, concerted efforts are now required to further improve bilateral, regional and multilateral cooperation, as also cooperation with UN agencies and other international organizations on issues related to biodiversity. There is also a need to enhance our own capacities to comply with our commitments, and ensure sustained flows of resources for biodiversity management.

6. ROLE OF GOVERNMENT IN CONSERVATION AND MANAGEMENT OF MANGROVES AND CORAL REEFS IN INDIA

In India, the Ministry of Environment and Forests under Government of India has an overall responsibility for conservation and management of coastal and marine ecosystems. The Government of India provides 100% financial assistance for implementation of Management Action Plan (MAP) related to mangroves, coral reefs and other related ecosystems. To assist the Ministry and regulate the activities, a committee namely the "*National Committee on Mangroves and Coral Reefs*" is functioning. The overall mandate of the Committee is to assist Government regarding policies and action programmes for conservation of mangroves, coral reefs and related ecosystems. The National Committee is chaired by the secretary of Ministry of Environment and Forests or his nominee. The Committee has representatives of Forest Departments, Coast Guards, Department of Ocean Development, Central Marine Fisheries Research Institute, Space Application Centre, and experts/scientists from academic and research institutions. A similar committee at different maritime States/Union Territories (UTs), namely '*State Level Steering Committee on Mangroves and Coral Reefs*' is also functioning.

The State/UT Governments prepare Management Action Plans (MAPs) for specific mangrove and coral reef areas. After obtaining approval of the State Level Steering Committee, the States/UTs submit their MAPs to the national committee for financial assistance.

The MAPs have the following components:

(i) Survey, assessment and demarcation;
(ii) Capacity building: staff training and skills;
(iii) Shelter belt development;
(iv) Protection and monitoring;
(v) Restoration and regeneration measures;
(vi) Alternate and supplementary livelihoods;
(vii) Community participation;
(viii) Mangrove afforestation/plantation on degraded areas and open mudflats;
(ix) Biodiversity conservation;
(x) Sustainable resource development;
(xi) Desilting;

(xii) Weed control;

(xiii) Pollution control;

(xiv) Environmental education and awareness;

(xv) Impact assessment;

(xvi) Concurrent and terminal evaluation.

Currently approved management action plans (MAPs) are being implemented in 38 mangrove areas and 4 coral reef areas all along the Indian coastline **(Annexure III)**. New mangrove/coral reef areas can be identified by State/UT Governments for their inclusion in the MAPs.

7. ROLE OF MFF IN CONSERVATION AND MANAGEMET OF COASTAL ECOSYSTEMS IN INDIA

In order to conserve and manage coastal and marine ecosystems, the Government of India is already pursuing activities, which are relevant to the Programmes of Work (PoW) as proposed by the MFF initiative. Thus the activities of Government of India will be complementary to the efforts of the MFF initiative. All these efforts were made without any financial help by IUCN, but with resources generated through various schemes and programmes of the country. Data generated in the past activities will form baseline information which would be of immense help to undertake the MFF initiative in India.

The country has many sites which are vulnerable to natural calamities to be brought under management action plans. The country also has some knowledge gaps which are essential for more efficient coastal management and better livelihood. In this context, the financial support is essential under MFF initiative to support and promote the efforts of Government of India for conservation and management of coastal and marine ecosystems. Priorities for MFF support are given in Section 9.

8. KEY ISSUES IDENTIFIED

8.1. Coastal livelihood issues (PoW 8)

Unlike other forest, direct benefits from mangroves are very limited. Fishing in the mangroves is the only source of income for the mangrove dependent communities. However, activities that integrate mangrove conservation with fishery development such as traditional canals fishing methods, crab fattening in mangrove waters, oyster and clam cultures may be promoted within the mangrove wetlands. This will increase the economic stake of the local community in mangrove restoration, conservation and management.

Human inhabitations are significant along the estuaries, deltas, backwaters and townships of India. The Sundarbans has large human settlements within the mangrove forest. Other mangrove forests in India have negligible villages inside the mangrove forests. In the absence of any alternative employment, the poor people depend on traditional skills to earn their livelihood and depend largely on forest resources; they tend to resort to illegal practices like over-fishing, poaching and felling. The people are collecting the tiger shrimp seeds in large numbers thereby causing damage to juvenile fish stocks. It is estimated that in the Sundarbans each year, about 5000 fishermen and 500 honey collectors and woodcutters enter the forests in search of livelihood ignoring even the threat of attacks by tigers and crocodiles!

Honey harvesting team in difficult arduous terrain of Sundarbans

An important use of mangrove forest for the coastal population in Gujarat State is in the form of fodder. Majority of households living in the coastal villages own animals which use mangroves as fodder. Camel herding is one of the activities practised by the pastoral communities known as 'Maldharis' in Gujarat. The maldharis are in the habit of shifting along with their livestock to far away areas in search of fodder for their cattle. In fact, maldharis and mangroves have become an inseparable part of coastal ecosystem. The dependence is observed mainly in some villages of Gulf of Khambhat and Western mangroves. Only 21% have medium to high dependence and five per cent of coastal maldharis depend solely on camel herding. The dependence is governed by several factors such as livestock type, availability of alternative fodder and official access to mangroves. There has not been substantial impact of pastoral activities on the mangrove degradation except Alia bet, in the mouth of Narmada estuary. The degradation and non-access of mangroves has critically

impacted their livelihoods. A maldhari sensitive mangrove regeneration framework must aim at improving the resource availability. The maldharis must be made real stakeholders and appropriate benefit sharing arrangements need to be worked out.

Environmentally sustainable livelihoods are extremely important to be provided to the people, in order to reduce pressure on the coastal environment and to make coastal communities less dependent on coastal resources, and to motivate local people for to support protective management measures. The efforts of MFF should target especially the communities involved in the most unsustainable practices regarding coastal resources use.

Some examples of coastal livelihoods are: (i) Mariculture practices in the open coastal water for farming of seaweeds, shell fish and finfish; (ii) Integrated fish farming with cultivation of mangroves, other halophytes, fishes, prawns, mollusks, crabs *etc*.; (iii) Organic cultivation of vegetables along the non-saline or less saline landward areas of coast, and near human dwellings; (iv). Honey production using apiculture practices, which will also help in better pollination opportunities for some mangrove species that are insect-pollinated; and (v) Ecotourism.

Ecotourism especially in coastal and marine areas has great potential for generation of better livelihood for the local community. However, it requires stronger Governmental involvement for the reasons: (i) reliance on public common property resources; (ii) direct competition between tourists and local people for use of the resources; (iii) high degree of risk in the adverse marine and coastal environment; and (iv) complex and dynamic nature of the coastal and ocean environment. The ecotourism needs to be incorporated with proper model along with awareness building through interpretation centres. The eco-tourism model has to aim at saving the coastal and marine ecosystems and helping the local community. The model has to be developed in site-specific manner, following the four guidelines *viz.,* (i) minimize adverse impact; (ii) build environmental and cultural awareness and respect; (iii) provide enriching experiences for visitors and stakeholders; (iv) channel direct economic benefit to conservators; and (iv) empower and involve local communities.

Boating through mangrove water creek for ecotourism

A new concept of “Dawn Festival” is conducted at Pichavaram mangrove forests, Tamil Nadu once in a year at the early morning hours by the district administration in association with Tamil Nadu Tourism Development Corporation and local Panchayat. The aim of this event is to showcase Pichavaram as an ecotourism destination especially to the stakeholders of the industry like inbound tour operators, tourism consultants, hoteliers, State and National media and tourism media.

A tourism consultant (‘Help Tourism’) in partnership with WWF and the Sundarbans Tiger Project developed a new ecotourism module in 2003 at Bali Island, near Gosaba National Park, where the tourists can stay, interact with the local people and enjoy nature, with a package cost of Rs. 4500-15000. The locals run a nature shop, selling gifts and handicraft items. The money that comes in from the shop goes back to the locals

8.2. People’s participation issue (PoWs 2, 3, 6, 8, and 10)

People’s participation is extremely important in conservation and management of coastal resources. Realizing this, almost all States of India have initiated Joint Forest Management (JFM) activities in conservation and management of their coastal ecosystems.

No decision-making is complete without participation of local people whose livelihood depends upon wetland resources. People have been using mangrove areas

in a traditional manner since times immemorial. Both traditional and latest scientific technologies need to be blended to achieve long-term conservation goals. Participatory Rural Appraisal (PRA) involving local communities should be the main approach to ensure community participation. This approach should also take into consideration issues of gender sensitization and involve women in the management issues.

The main constituents of this component should include:

- Situation Analysis to understand the biophysical conditions and resource utilization pattern;
- Additional alternate income generation programmes such as handloom, handicrafts, integrated farm management techniques and other measures to reduce pressures on mangroves;
- Highlighting of gender-related cross-cultural, governance-related practices and other special concerns for assessment and change by community;
- Selection of villages based on socio-economic conditions and willingness of local communities to participate;
- Participatory Rural Appraisal for understanding the concerns of the community relating to mangrove conservation and socio-economic development;
- Formation of village level institutions;
- Identification of Mangrove Management Units for restoring and conserving the area;
- Village level microplans for implementing the activities;
- Implementation, monitoring and evaluation.

The M.S. Swaminathan Research Foundation (MSSRF) and State Forest Department have successfully demonstrated a pilot project on Joint Forest Management (JFM) in restoration and conservation of mangrove wetlands through a people's participatory approach in Tamil Nadu, Andhra Pradesh and Orissa. However, JFM is at various stages of development in different States. The mangrove atlas of India for the three States prepared by MSSRF contains information about mangrove resources which will be helpful for the user agencies to develop management action plans.

In the Sundarbans, the forest department has formed 54 forest protection committees and 11 eco-development committees (EDC), covering 47,325 families in an area of 87,287 hectares. JFM has picked up in almost 70% of the committees. It has achieved remarkable improvement of relationship between people and the forest department, in saving most of the strayed tigers, protecting the plantations and voluntary patrolling to protect the forest. Many eco-development activities have been taken up; their success depends on the level of participation of the community, particularly of women members in planning and implementing besides proper monitoring and evaluation.

In the Sundarbans, about 95% of the population depends primarily on agriculture and about 50% of them are landless labourers. The priority need of the communities is for freshwater, which is required for irrigation and drinking purpose. As the Sundarbans are within a high rainfall zone, the EDC/JFM activities relating to rainwater harvesting have great scope and demand and such activities are likely to get full support of the people. Hence, under the JFM programme, the people are provided with deep tube wells for drinking water, irrigation tanks and canal for agriculture and ponds for fish culture. Larger support for those activities will improve livelihoods and income generation for landless families and marginal farmers. However, the availability of land is a major constraint.

Ecotourism generates employment for local people in the Sundarbans. Entry fees are collected from tourists entering the buffer area of the Sundarbans Tiger Reserve, with 25% of the revenue earned in the Reserve area is ploughed back to the eco-development committees.

Other eco-development activities in the Sundarbans include (i) improvement of village roads, bridges and culverts; (ii), construction of jetties; (iii) supply of seedlings for forestry, fruit species for orchards, and fuel wood and fodder species; (iv) provision of poultry and piggery units; (v) bee hives for apiculture; (vi) solar street light and solar lanterns in remote villages; (vii) artificial insemination and immunization of cattle; (viii) conducting medical camps; (ix) provision of smokeless ‘chullahs’, nylon net and fencing nets; and, (x) offering training to people on crab fattening, sewing, apiculture, nursery techniques, *etc.,* to improve their skills and to help them attain economic independence.

8.3. Coastal restoration issues (PoW 2 and 9)

About 38% of Indian mangroves are of an open type with sparse vegetation. This deserves immediate attention for rehabilitation and restoration practices. In this regard, understanding of the planting site is necessary, especially, in respect of tidal amplitude, ground level height, salinity, soil texture and topography.

A priority task in the coastal zone of India is the creation of bio-shield consisting of mangroves and coastal shelter belts with appropriate width and density, along the entire length of the coast. It was observed during the 2004 Tsunami that a coastal shelter belt less than 200 meters wide is not very effective against Tsunami forces. It is also necessary to take up large-scale plantation programmes in all the catchment areas or watershed regions to minimize soil erosion.

Now elected panchayats are mandated to be responsible for disaster preparedness, mitigation and management. Since mangroves play an important role in reducing the impact of natural disasters such as cyclone and Tsunami, the elected panchayats should be actively involved in planning and implementation of mangrove management plans. Apart from this, elected panchayats may be given full responsibility to raise mangrove plantation in suitable areas that are located outside reserved forest lands. In almost all the States, coastal wetlands that are suitable to raise mangroves are present in large patches of about 10 to 100 hectares and many of these lands are classified as coastal 'proamboke' and owned by the Revenue Department of the State government. These lands may be demarcated and handed over to the elected panchayat to raise mangroves and other coastal vegetation as coastal bioshield.

Participatory restoration practice: a successful option

8.4. Coastal management issues

Sustainable management of coastal and inshore marine resources is imperative for the benefit of society, especially natural resource-dependent coastal communities. In this regard, three important issues such as private ownership, local field surveys and marine and coastal protected areas are highlighted here-under:

8.4.3. Private ownership issue (PoW 3 and 12)

Mangrove lands are privately owned in some areas especially in the States of Kerala, Karnataka, Andhra Pradesh and Maharashtra. To cite an example, the mangroves of Kerala cover a total area of 17 km^2, but only about 2 km^2 are controlled by government and the rest are with private ownership. A high rate of human population growth has resulted in acute land scarcity that led to widespread reclamation of wetlands, which has resulted in significant loss of mangroves.

8.4.4. Local field surveys (PoW 1, 5, 7 and 14)

For the purpose of effective management, survey intensity of mangrove forests needs to be improved and strengthened. Whereas the Forest Survey of India (FSI) may continue with the current scale, intensity and interval of its survey activities, the mangrove States should take up State-level annual surveys on a much larger scale, so that it is possible to pick up even the smaller and fragmented patches of mangroves, using the forest department's existing facilities and wherever such facilities are found inadequate to implement the task, they may avail the MFF funds to upgrade their GIS facilities under Small Grant Facility.

8.4.4. Marine and Coastal Protected Areas (MCPAs) (PoW 13.1)

The MCPAs are recommended as a good potential tool for marine resource conservation, provided clear objectives are set for each of such area supported by a strong locally-designed management plan. However, it should be focused more on national priorities than on regional ones. Management effectiveness of the MCPA implementation should be based on biodiversity rather than on economics. There is a need for a separate department and Authority for dealing the MCPAs. Basic information on MCPAs are required as follows:

1. What is the global extent of MCPAs?
2. What is actual extent of MCPAs in India?
3. What are the potential areas of MCPAs in India for further action?

A detailed description of Marine and Coastal Protected Areas is given in **Annexure-IV.**

8.5. Other related Issues

8.5.1. Capacity and training needs for integrated coastal management (PoW 7.1):

Capacity needs are required much on ecotourism, restoration of coastal ecosystems, and coastal protection. There is a need for training frontline forest staff on SCUBA diving, snorkeling, monitoring of corals and efficient mangrove nursery raising. In Andhra Pradesh, the Forest Department formed Eco-Development Committees (EDC) and 'Vana Samarakshana Samithis' (VSS) in the mangrove areas under an on-going World Bank aided forestry project. The local communities (EDC/VSS) have been provided with training and capacity building in skill development for alternate livelihood and in restoration of mangroves. As a result of these activities, there is an increase in the area under dense mangrove forest and water bodies, as well a decrease in scrub forests, grasslands and saline blank areas.

8.5.2. Ecosystem valuation issues (PoW 4.1)

Better understanding and information on economic valuation of coastal and marine ecosystems is essential. This valuation would be of immense help in planning and appraising coastal conservation and developmental activities. For the valuation, simple, consistent, user-friendly tools and methods are necessary.

8.5.3. Civil society awareness (PoW 6.1)

There are flagship species related to ecotourism and livelihood. People do not know the value of them. For example, highly endangered Whale shark visits Gujarat coast; Olive Ridley turtles migrate for breeding to Orissa coast where 50% of world turtle population is found. However, the eggs of the turtles are poached by dogs, wildlife and humans; Irawadi dolphins and other cetaceans are of great concern the world over. Therefore, environmental education and awareness is necessary.

8.5.4. Issue of participatory monitoring (PoW 6.1 and 14.3)

There is a need to develop and demonstrate the monitoring of coastal ecosystems using appropriate indicators (including socioeconomic and biological indictors). In this process, local people have to be involved along with scientists especially social scientists. This participatory approach will greatly increase manpower to collect large amounts of data in a short time at a low cost. The effort will help in educating the local

community and enhancing their feeling of ownership for the ecosystems. A guideline for the participatory monitoring is given in **Annexure-V.**

8.5.5. Sustainable financing mechanisms (PoW 10.3)

This aspect is vital to ensure community participation in coastal management activities. Incentives in cash and kind are necessary inputs for sustainable financing. Women should be involved as coastal managers in sustainable financing. Sustainability should not be lost when credit is withdrawn.

An example in this aspect is described here. Gujarat Ecology Commission has been successful in restoration of mangroves in Gujarat with the help of India-Canada Environment Facility and Gujarat State Government. With the involvement of local communities in regeneration of mangroves, about 4,000 hectare area has been brought under mangrove cover at ten different villages within the span of five years. Community participation has been institutionalized through formation of 10 Community Based Organization (CBO) at the village level. A corpus fund has been created in each village by depositing a part of daily wages in the bank account. Out of daily wage amount of Rs. 80, Rs. 56 is paid in cash, whereas Rs. 20 is deposited in the corpus fund. Remaining Rs. 4 is treated to be the contribution from the community towards the project. 60% of this fund along with the interest is reserved for maintenance of mangroves and other assets created under the project. Balance 40% amount is used as revolving fund to give loans at an interest rate (not exceeding bank rates) for income generation activities of CBO members.

8.5.6. Communication issues

Information based on scientific principles and successful stories are useful only when they reach the end users. This requires attractive and efficient channels of visuals, toolkits, websites and outreach activities.

8.5.7. Knowledge gaps (PoW 1.1)

There are knowledge gaps in the management of coastal resources. To fill the gaps, research activities are required. The research findings can be incorporated for effective management action. The gap areas include (i) biodiversity (taxonomic impediments in terms of coastal marine biodiversity which deserve attention) (ii) bioprospecting, (iii) genetic and tree breeding, (iv) pests and diseases, (v) interrelationship between coastal ecosystems, (vi) coastal processes, and (vii) pollution abatement.

8.5.8. Issue of climate change

Climate change and its impacts on coastal regions of India are little known. Researchers at the Centre for Atmospheric Study, Indian Institute of Technology, Delhi, have predicted a mean sea level rise of 15-38 cm in India along with a 15% projected increase in tropical cyclones by the end of this century. An estimated total area of 5763 sq. km along the coastal States of India could be inundated and almost 7.1 million (4.6% of the coastal population) could be directly affected. The most vulnerable areas along the Indian coastline are the Kutch region of Gujarat, Mumbai and South Kerala. The deltas of the Ganges (West Bengal), Cauvery (Tamil Nadu), Krishna and Godavari (Andhra Pradesh), Mahanadi (Orissa) and also the Islands of Lakshadweep Archipelago are likely to be damaged heavily. On the East Coast, West Bengal is the most vulnerable to sea level rise, followed closely by Orissa. Past observations of the mean sea level along the Orissa coast indicated a long-term rising trend of about 1.0 mm, on an annual mean basis. However, the recent data suggests a rising trend of 2.5 mm a year in sea level rise along the Indian coastline, particularly in and around Orissa.

Mangroves act as a sink of atmospheric carbon. They are able to sequester about 1.5 metric tons of carbon per hectare per year, and the upper layers of mangrove sediments have high carbon content, with conservative estimates indicating the levels of 10 per cent. Conversion of mangroves to fishponds – which invariably involves excavation of about two metres of sediment – will eventually result in a release of about 1400 tons of carbon from the sediments alone.

9. PRIORITIES

9.1. Priorities in the Programmes of Work

There are four priority areas related to the MFF Programmes of Work and they are:

- **Environmentally sustainable livelihoods, to off-load pressure from coastal ecosystems (PoWs 8.1, 8.3, 8.4, and 8.5):** There is a great need for training to empower people to take up different enterprises. It is necessary to develop alternate livelihood options for the people who are dependent on coastal mangrove resources. The alternate options may be mangrove resources based, wherein additional or alternate employment opportunity is created in more than one stage, through the process of value addition owing to the training and skills acquired. Livelihood projects should explicitly target the people involved in illicit felling, poaching and destructive fishing methods, and women groups. The identification of

activities and training needs should be done through the consultative process between the community, NGOs and the Governmental departments. PRA exercises should form part of the Micro-Plans prepared for the coastal villages.

- **Plantations of mangroves for creating green belts (PoW 2 and 9.3);**
- **Civil society awareness, its participation in coastal decision-making and its sustainable financing (PoW 6.1, 6.2, 6.4, 6.6, 10.3 and 11.1);**
- **Improving the knowledge gaps (PoW 1.1).**

9.2. Priorities in Types of Projects

MFF Project priorities for India are broadly three fold, as follows, and all these three priorities are placed equally and merit simultaneous attention.

- **Large and Medium Size Projects** are to address major gap areas and issues in conservation and management of coastal and marine biodiversity. This project type is an action-oriented and it involves field-level activities.
- **Small Grant Projects** are to generate leads for developing efficient models for conservation and management of coastal and marine biodiversity.
- **Targeted Research Projects** are proposed as back-up for 1 and 2 above, to generate data and information to fill the knowledge gap areas.

10. LARGE AND MEDIUM SIZE PROJECTS

10.1. Aims of Large and Medium Size Projects

General Aims:

- To conserve and restore coastal mangrove ecosystems as a key asset to support human well-being and coastal security against natural calamities.
- To promote people's participation in coastal conservation, restoration and management of mangrove resources.
- To support coastal livelihood initiatives that are sustainable and helpful to maintain natural coastal resources.

Specific Aim:

The total potential area, which is ready for restoration in the country is estimated at about 200 sq km. It is proposed to be covered in a period of 3-5 years, beginning 2008-2009.

10.2. Scope of Large and Medium Size Projects

General Scope:

- **Provision of basic amenities and infrastructure for better living:** The local people will be provided with basic requirements such as safe drinking water, sanitation, transport, electricity, education and health.
- **Facilitating the understanding of people about key resources use problems, constraints, and conflicts:** The efforts will facilitate the understanding of the local people about the status of resources, issues of degradation and the importance of conservation.
- **Empowering people with skills:** The local people will be equipped with skills so as to help them take up alternative and supplementary livelihoods, based on coastal resources.
- **Enhancement of resource base:** The local people will be involved in developing the mangroves and associated fishery resources through restoration activities in unproductive and unused lands.
- **Higher learning facilities:** The children will be provided with higher levels of education so as to enable them to have better job opportunities and to reduce the pressure of the future generation on natural resources.
- **Strengthening collaboration:** The project will initiate and strengthen the collaboration among multiple partners, including Government agencies, NGOs, research institutions, UN agencies and multilateral bodies.

Specific Scope of Large and Medium Size Projects:

The potential areas include even difficult areas which may require fairly high investment per unit area, particularly in respect of Tamil Nadu, where the investment required may go up to Rs. 40,000 per hectare, plus maintenance cost of Rs. 15,000 to 20,000 per annum for 2 years. Therefore, the achievement of annual targets will depend on the availability of financial resource.

10.3. Priorities in Large and Medium Size Projects

The Large and Medium Size Projects have to be implemented for better conservation and management of mangrove ecosystems in the coastal States which are vulnerable to natural calamities. In order to get significant effect of implementing the projects, a 3-5 year time period is necessary with proper monitoring of the projects at regular

interval of six months. The large and medium size projects include conservation, restoration, people's participatory approach, development and strengthening of collaborative efforts between multiple partners including local people, government, NGOs, research institutes and other multilateral bodies.

It is suggested that the priority should be given to restoration of less difficult areas so that more area can be covered for less expenditure. The more difficult areas can be tackled after restoring other areas.

10.4. Site Selection for Large and Medium Size Projects

For execution of these types of projects, five States in India were identified as the priority. For MFF, the selection has been made based on the following three major criteria:

- Large extent of mangroves;
- Biodiversity richness of mangroves; and,
- Tsunami effected mangroves.

West Bengal and Gujarat fall under the first category; Orissa and West Bengal come under the second category; and, Andhra Pradesh and Tamil Nadu fall under the third category.

The selection of the five States has also been based on seven other criteria, as given in Table 8.

Table 8. Criteria-based Selection of Five States for Implementing Large and Medium Size Projects

No.	Criteria	States	Reason
1	Human pressure	West Bengal	Human settlement is significant within mangrove forest.
2	Pollution	Gujarat, West Bengal	In Gujarat, several mining, cement and saltpan industries, increased terminal oil pipeline passages and refineries pose pollution problems. In Sundarbans, a large amount of wastewater is discharged daily through the Hoogli estuary, besides release of oil and grease from fishing vessels.

3	Degradation	Gujarat, West Bengal and Andhra Pradesh	These states have open sparse mangrove areas of 741, 331, 314 km^2 respectively.
4	Cyclone	Orissa, Andhra Pradesh, Tamil Nadu	These states are frequently affected by cyclones.
5	Climate change and sea level rise	West Bengal	According to World Bank Report, about 80% of the Sundarbans area will go under the sea by 2050.
6	Seascape setting	Gujarat and Tamil Nadu	All three marine and coastal ecosystems such as mangroves, sea grass and coral reefs are existing together.
7	Unique features	West Bengal and Tamil Nadu	Sundarbans has 60% of Indian mangroves with high biomass productivity and it is the only mangrove-tiger land in the world; and, Tamil Nadu has a mangrove species which is endemic to India.

11. SMALL GRANT PROJECTS

The major aim of the MFF Small Grant Facility (SGF) is to support local community action in the restoration and management of coastal ecosystems as a basis for sustainable development. SGF projects will also provide tangible 'models' to inspire policy-making. They will contribute concrete measures to ensure participation, gender equality and secure livelihoods for marginalized groups.

12. TARGETED RESEARCH PROJECTS

There are still knowledge gaps in the management of coastal resources in India. Research activities are required to fill the gaps. The MFF should support targeted research to improve the scientific bases for management, but it is essential that the research findings can be incorporated for effective management action. The gap areas include (i) biodiversity, (ii) bio-prospecting; (iii) genetic and tree breeding; (iv) pests and diseases; (v) interrelationship between coastal ecosystems; (vi) coastal processes; and (vii) pollution abatement. These research needs are summarized below.

12.1. Biodiversity assessment (site specific) (PoW 1.1 and 1.5)

There are some coastal sites having rich biodiversity. For example, Bhitarkanika in Orissa is one of the two genetic paradises in the world of mangroves. The Government

of India has recognized the area as a "*Mangrove Genetic Resource Centre*". In this regard, a comprehensive biodiversity assessment and development of a data base is required.

12.2. Bioprospecting for high value products (PoW 1.5 and 15.1)

Bioprospecting in coastal ecosystems for their pharmaceutical and industrial values should be undertaken. This effort may lead to development of patents, which in the future can be an enormous source of revenue and other opportunities. The mangroves have already been found to be a source of high value products such as enzymes, medicines, pigments, microbial bio-fertilizers, bio-feed and single cell proteins of industrial utility. A recent study in India by M.S. Swaminathan Research Foundation has isolated salt-tolerant gene from a mangrove species and introduced it into a paddy crop, and the salt tolerant paddy variety is under experimental trail.

12.3. Genetics and tree breeding for enhancement of mangrove growth and biomass production (PoW 1.1, 1.5 and PoW on coastal climate change issues)

Mangroves exhibit poor growth in extreme environmental conditions. However, some genotypes of mangroves exhibit remarkable growth and biomass production even under stress conditions. These genotypes have to be selected and propagated to develop mangroves capable of growing well even in adverse conditions.

With the increasing seawater intrusion due to coastal climate change, it is necessary to find out high salt tolerant genotypes of mangroves. Tree breeding may also be attempted to get superior genotypes of mangroves. Therefore, MFF can support genetic and breeding studies in mangroves of India and this will have a bearing on resilience and recovery of mangrove species under coastal climate change issues.

12.4. Pest and disease studies and remedial measures (PoW 2)

Mangrove leaves are often found damaged especially in *Avicennia* species. Propagules are also heavily damaged, which reduce their survival, sprouting and establishment. The poor health condition makes the mangroves with reduced genetic vigor and poor resilience to environmental changes. This also leads to loss of reproductive potential and regenerative capability of mangroves. It is necessary to study pest and disease problems in relation to mangrove health issues, and to find suitable remedial measures to control insect and disease damages for rehabilitation of mangroves.

12.5. Interrelationship between coastal ecosystems for augmentation of fish resources (PoW 1.5 and 2.4)

Coastal ecosystems are functionally linked, but the linkages are not properly understood. It has been proved experimentally in the Caribbean Sea that when coral habitat is connected with mangroves, the biomass of several commercially important fish species is more than doubled. Conversely, after removal of mangroves, the largest herbivorous fish in the Atlantic, *Scarus guacamaia* has suffered extinction. It is therefore necessary to study the connectivity among mangroves, coral reefs and sea grasses for augmentation of fish resources.

12.6. Studies of coastal processes (Hydrodynamics, siltation, erosion *etc*.) for better conservation and management of coastal ecosystems (PoW 2, 3 and 3.3)

Mangrove forests are highly dependent upon water sources. Reduction in freshwater flow is a serious threat to mangroves of West Bengal (Sundarbans), Andhra Pradesh and Tamil Nadu. Freshwater from upstream regions or rainfall is required for reduction of salinity that facilitates the germination and sprouting of seedlings. Seawater is also required for salt requirement of mangroves and for wetting mangrove habitat at regular intervals. The reduced freshwater flow due to dam and embankment construction has lead to increases in salinity. Moreover, the river mouths all along the east coast of India are heavily silted thereby the entry of seawater into the mangrove forests is prevented, resulting in poor flushing of mangrove habitat and in hyper-salination of soil. The high saline condition has resulted in reduction of seed germination, change of species composition, change in fish migration, and damage to wildlife. Therefore, research studies are required to determine the critical requirement of water for sustenance of mangroves and their fishery and wildlife resources in coastal environment. The data can be utilized to convince people and policy-makers to allow flow of certain quantity of water into mangroves during certain period in a year. This will ensure a long-term survival of the mangroves and coastal water bodies. This is a specific aspect of integrated land and water resource management (PoW 3.3), which is relevant to both sound coastal ecosystem rehabilitation and sustainable management (PoW 2 and 3).

12.7. Studies of pollution abatements by mangroves for motivation of industries in restoration of mangroves (PoW 1.5 and 15)

Mangroves are believed to be the bio-filters of pollutants. However, their efficacy has still not been understood for carbon sequestration and other pollution abatement

processes. This will have a bearing on motivating the coastal polluting industries to take up mangrove plantations on a large scale. Hence, studies on the use of mangroves for pollution control are necessary. It is important to stimulate the private industrial sectors to engage in coastal restoration and livelihood needs.

13. NATIONAL STRATEGY AND ACTION PLAN

The total extent of mangrove forests already available in five identified States is about **3621 km^2** and the extent of area immediately available for restoration is approximately **200 km^2.** Therefore, National Strategy and Action Plan (NSAP) has been prepared under the following two categories:

1. Conservation Strategy and Action Plan for the existing mangroves; and,
2. Restoration Strategy and Action Plan for potential and or degraded mangrove area.

Through this NSAP, MFF India will advocate for both these strategies within the targets mentioned above of 3621 km^2 and 200 km^2 respectively (over five years).

13.1. Strategy and Action Plan for Conservation

Conservation Strategy consists of three components:

1. Conservation through community participation by creating eco-development committees and facilitated by NGOs and Forest Department;
2. Conservation through Government departmental protection model. However, greater emphasis and larger role shall be given to category 1; and,
3. Long term strategy: Education (SGF and large projects to be earmarked for improvement of educational facilities)

Action Plan for conservation:

The National Forest Policy, as well as the other Acts, prohibits destructive utilization of mangroves. The non-destructive use of mangroves provides nothing much to be shared by local communities, except fishing. Therefore, eco-development committees may be allowed free fishing/prawn collection in existing mangrove waters. This should be encouraged particularly in the canal bank plantations. In addition, entry point activities, employment generation activities and imparting skills and up-grading of available skills for value addition can be taken up under eco-development programmes. These activities assume greater importance in the light of the fact that marine resource production potential is fully realized.

This Action Plan considers the following options:

Imparting new skills and upgrading of existing skills: In view of serious mismatches between supply and demand, it is imperative to equip the excess population with new skills to enable them to take up new vocations. This could be taken up in accordance with the micro-plan prepared based on Participatory Rural Appraisal (PRA) exercises.

Simultaneously, steps may be taken to upgrade the existing skills to enable value addition for enhancing the incomes from the existing levels. Also the levels of value addition have potential for additional employment generation. All these activities should be carried out through self-help groups (SHGs) and eco-development committees (EDC) or village forest committees (VFC) as per the micro-plans prepared collectively by the villagers, NGOs and Forest Department. Difficulties in formation of village level committees, if any, have to be addressed.

The EDC/VFC should function as a source of micro-credit for the SHGs. This interdependence is suggested to prevent polarization of village communities. The employment generation activities and alternate income generation activities may be identified in the micro-plan. In this regard, ecotourism has greater potential. The activities undertaken by West Bengal in Sundarbans under the eco-development programme can be examined by other States for their possible adoption, in addition to their own innovations. All Small Grant Projects will be undertaken for capacity building under this component.

Increasing and enhancing the existing resource base: This will be achieved by expanding the mangrove area through the process of restoration. It is estimated that nearly 200 km^2 of area shall be brought under mangroves under the mangrove restoration programme. This area, hitherto totally unproductive, will generate additional marine resources to support a part of the excess population pressure.

Entry point activity: This component will aim at creating community assets such as village roads, drinking water, electrification, fish drying yards, improvements to schools and provision of health services *etc.* This will be achieved by interdepartmental coordination and pooling the resources of various departments in the EDC villages.

For this purpose, a District Co-ordination Committee under the chairmanship of the District Collector shall be created and the Divisional Forest Officer (DFO) shall be the Member-Secretary. The district heads of the various departments such as fisheries, tourism, fishermen welfare, electricity, rural development, health, education departments, local panchayats *etc.*, will be the members. This will be a model similar to the one that is being implemented by Gulf of Mannar Biosphere Trust under a GEF-UNDP assisted project in Tamil Nadu. Thus, an integrated planning and implementation with involvement of various departments should be strengthened in conservation processes.

Management of different categories of ownership for mangroves

- Mangroves under the charge of forest departments are managed as per management plans or working plans approved by the Government.
- Mangroves under the control of other Government departments need to be taken over by the forest department for protection and proper management by constituting them as either protected forests or Reserved Forests.
- Privately owned mangroves are usually in small patches and scattered. Wherever they are contiguous to Government owned mangrove patches, the same may be acquired by the Government on an outright purchase basis, or they may be constituted as 'Community Reserve' or 'Conservation Reserve' under the Wildlife (Protection) Act, 1972, if the said area is considered ecologically sensitive or biologically important. In other cases, the private owners have to be motivated and financially supported to protect and develop the mangroves. The Government of India, Ministry of Environment and Forests has a scheme for such cases under the "*Grant-in-aid for Greening India Project*". Under this scheme, even private owners can take up afforestation activities. The scheme provides a subsidy of Rs. 18/- per seedling planted. Another scheme of the Government yet to be finalized is '*Gram Van Yojana*'.
- There are some isolated linear strips having no clear cut ownership status. Such areas should be identified and brought under protection by the respective State Governments.

Long-term strategy for conservation: The long-term strategy for conservation aims at imparting higher levels of skills through education (including higher education) so that the next generation does not have to depend entirely on the existing marine resources. Therefore, the education system has to be strengthened as an entry point,

while the District Co-ordination Committee may also have to take up necessary efforts in this regard.

Involvement of students in awareness and action of coastal conservation and restoration: a desirable option

National Green Corps (NGC)/Eco-clubs can be profitably made use of for conservation of coastal and marine ecosystems. The NGC/Eco-clubs is an ambitious programme aimed at spreading environmental awareness among children and involving them in environment related activities. The best way to attempt to bring about a change in the society is through children as they are the single most important influence in any family and are the future custodians of nature. With this in mind, the State Governments and the Ministry of Environment and Forests, Government of India have launched the NGC/Eco-club programme. In Tamil Nadu alone, there are around 3 lakh student members under the programme. The activities of each school/college are undertaken under the guidance of a teacher co-ordinator and those of each educational district are carried out by an environmental awareness co-ordinator. The Ministry of Environment and Forests, Government of India has given guidelines on the NGC functioning. These guidelines are framed for a minimum of 120 hours of activity per year, as follows: (i) orientation (30 hours); (ii) campus activities (40 hours); (iii) community activities (50 hours); and, (iv) Eco-camp activity (3 days).

13.2. Strategy and Action Plan for Restoration

Strategy for Restoration

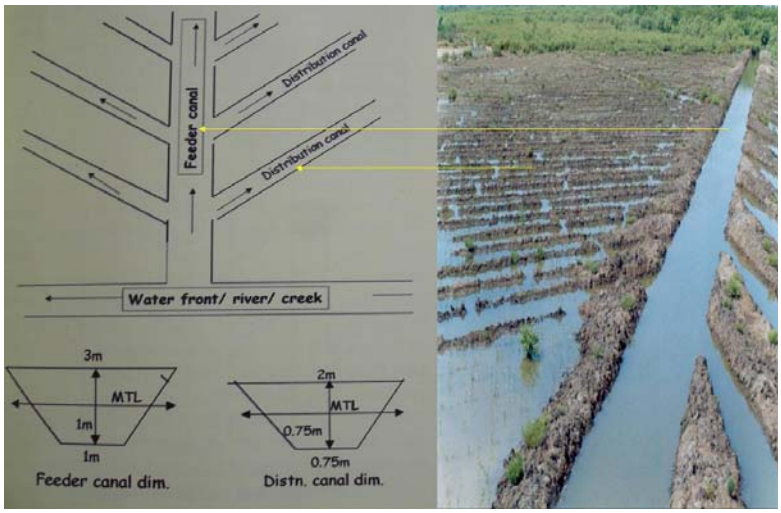
The restoration strategy is adopted based on the tidal amplitude. Consequently, the entire coastal area is divided in to two categories *viz.,*

1. High tidal amplitude area, and
2. Low tidal amplitude area.

High tidal amplitude areas: Gujarat and West Bengal fall under this category. In the high tidal amplitude areas, it is suggested that the existing planting technique of direct seed sowing and planting seedlings in the mud flats should be continued. Tamil Nadu has dispensed with the nurseries practice and has adopted direct propagule planting with very good results. This technique can also be adopted by other States as it would save the cost of operating nurseries.

Low tidal amplitude areas such as Tamil Nadu and Andhra Pradesh have developed a planting technique called "Canal Bank Planting' for restoration of mangroves and the 'Fish bone' design has been the most successful of all the canal bank planting designs tried so far, and it happens to be the latest improved design for the canal bank planting. This technique involves formation of the feeder canal; 3 m-top, 1 m- bottom and 1 m-deep; and the distribution canals of 2 x 0.75 x 0.75 m dimension in the mud flats and planting propagules directly in the inter-tidal zone of the canals. Along the banks of the canals, planting is made. The biodiversity enrichment is left to the nature to take care and nature does it very efficiently. However, the biodiversity enrichment in less diverse areas can be considered.

In a nutshell, wherever tidal amplitude is low, the preference for restoration should be the canal bank planting technique with fish bone design; and, wherever tidal amplitude is high, the technology adopted should be seedling planting and direct seed sowing in the mud flats.



"Canal bank planting" and fish bone design: a preferred restoration technique for low tidal amplitude areas

Any of the following three categories of mangrove plantation with different density and spacing can be followed:

Category 1: Plantation by direct dibbling of 10,000 seeds per hectare at a space of 1.0 m x 1.0 m;

Category 2: Plantation of direct dibbling of 3000 seeds + 2000 nursery-derived polybags per hectare at a space of 2.0 m x 1.0 m; and,

Category 3: Plantation of 2500 nursery-derived polybags per hectare at a space of 2.0 m x 2.0 m.

Action Plan for Restoration

Restoration will be carried out through:

a) Community participation, and
b) Government departmental effort

Wherever communities are willing and can undertake restoration operations, the communities may be mobilized and funds may be transferred to them. In other areas, where communities are not involved, or not dependant on the mangroves, the Government departments may have to step in to undertake the restoration operation. In this case, the possibility of contracting out the restoration works wherever possible to the EDCs/VFCs/NGOs/NGCs/local private sector companies should be considered. The schematic diagram for the overall strategy and action plan is given in the Fig. 1.

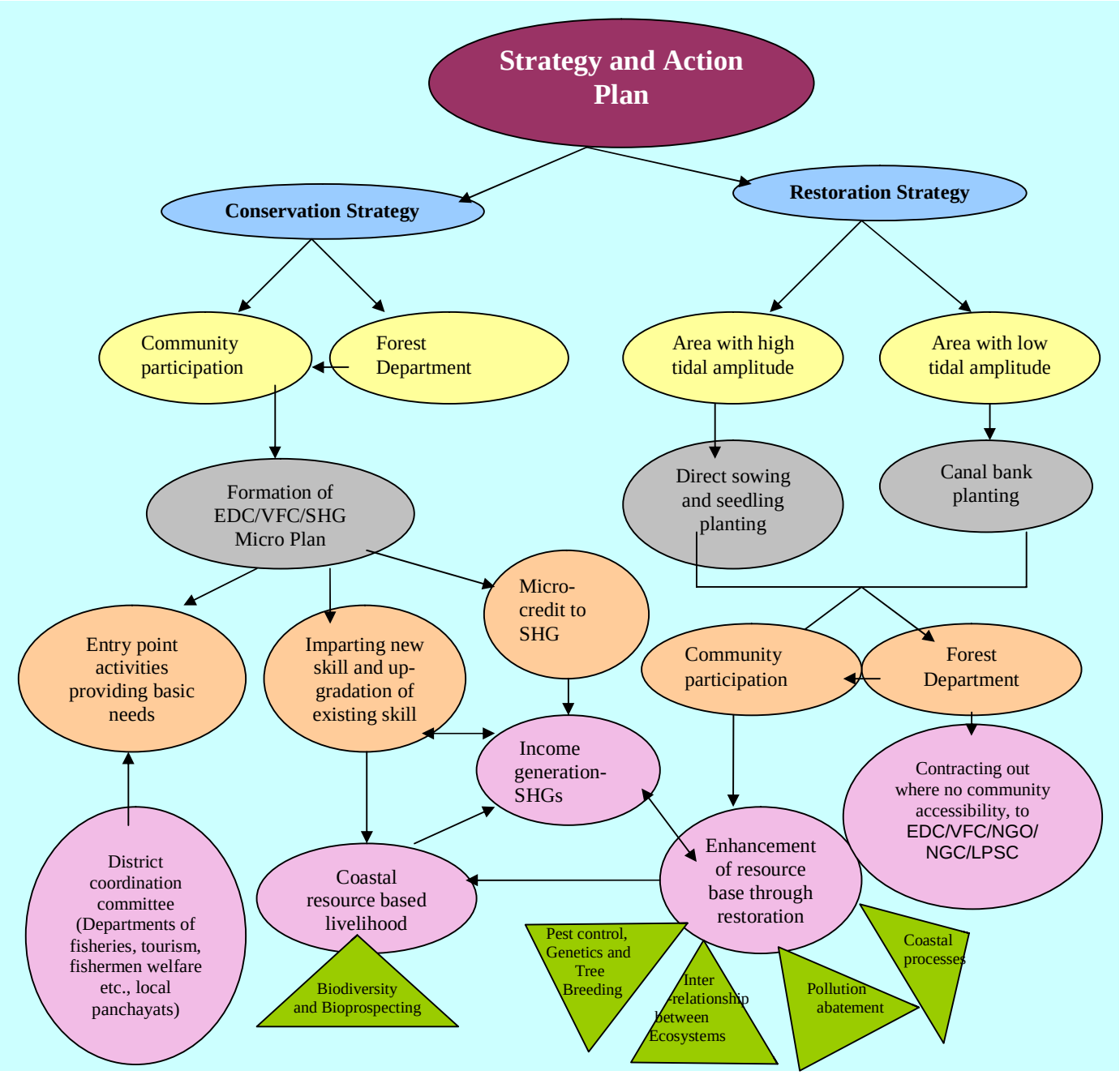


Fig. 1. Schematic diagram for National Strategy and Action Plan

(VFC = Village Forest Committee, SHG = Self Help Group, CBO = Community Based Organization, EDC = Eco-Development Committee, NGC = National Green Corps, LPSC = Local Private Sector Companies). The triangles indicate research priorities

14. STRUCTURE AND FINANCIAL ARRANGEMENTS

The National Strategy and Action Plan formulated for India deserves support of the MFF. The NSAP will be implemented through the Ministry of Environment and Forests (MoEF), Government of India through the National Coordinating Body (NCB) of MFF India. Organizational Structure and implementation of action plan are shown respectively in the Fig. 2 and Table 9.

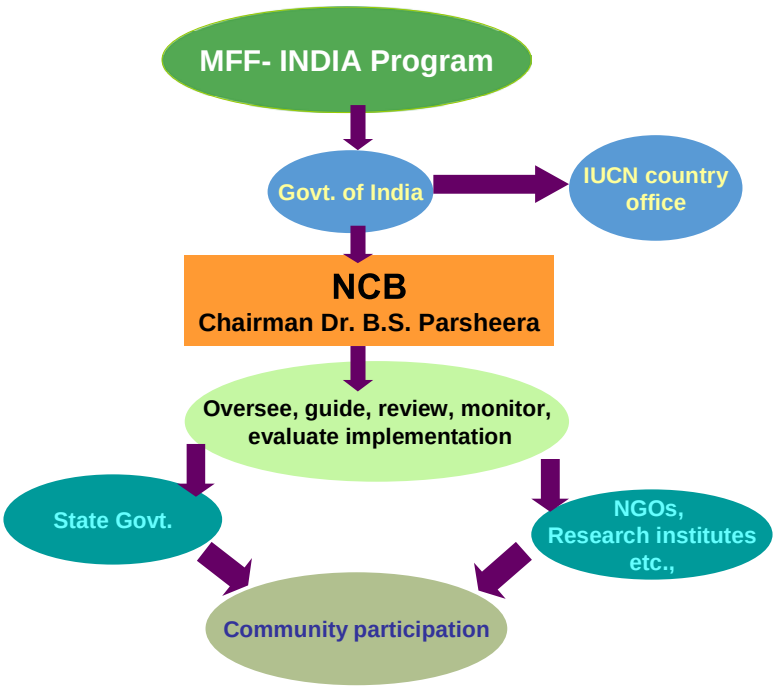


Fig. 2. Organizational structure for implementing the National Strategy and Action Plan

The mangrove areas proposed in the NSAP for conservation and restoration are lying under the Government control. Moreover, large and medium size projects will be implemented by the Governmental agencies with the participation of VFCs/EDCs and NGOs. Therefore, the MFF may support implementation of such projects through Ministry of Environment and Forest, Government of India. The IUCN country office may work in close cooperation with the Ministry. It is therefore, suggested that the MFF funding support for large and medium size projects may be indicated to the MoEF year-wise and the MoEF may be requested to invite proposals from each State Government, which can be processed by the MoEF and the IUCN country office jointly. The use of good office of MoEF for this purpose will facilitate better compliance by the State Governments. The plan size for 2008-2009 will depend up on the size of funding for the year and the same should be communicated to the Ministry immediately so that

the project proposals can be invited from the concerned State Governments, received and processed by July-August so that implementation of project starts before the onset of north-east monsoon, as far as eastern coast of the country is concerned.

To start with, the National Coordination Body (NCB) in India will identify the institutions for Small Grant Projects and Targeted Research Projects for implementation, based on the available funds. The NCB will also sanction and monitor the progress of the projects.

Large and Medium Size Projects require to be supported for a period of 3-5 years, for implementing the conservation of about 3621 km^2 of existing mangroves, and restoration of 200 km^2 mangrove areas in the five states namely West Bengal, Gujarat, Orissa, Andhra Pradesh and Tamil Nadu. The MFF initiative will serve as demonstration projects towards achieving these targets.

Small Grant Projects require to be supported for a duration of 6 months to 18 months, depending upon the nature of work, replicability of the results, scaling up potential for the benefit of coastal people.

Targeted Research Projects require funding for 1-2 years to fill knowledge gaps in management of coastal resources and to provide essential inputs for future conservation strategy and livelihood support.

Table 9. Types of projects, agencies and programme of work to be initiated under MFF initiative for 2008-09

Name of project	Type of agencies Identified by NCB	Month of work initiation (Tentative)	Duration of project
Large and Medium Size Projects (Number depending on funding)	State Govt. Forest Departments of West Bengal, Gujarat, Orissa, Andhra Pradesh and Tamil Nadu	July-August, 2008 (States of east coast)	3-5 years
Small Grant project (Number depending on funding)	NGOs, Research Institutions, *etc.*	October, 2008	6-18 months
Targeted Research projects in knowledge gap areas (Number depending on funding)	Research and academic institutions *etc.*	December, 2008	1-2 years

15. CONCLUSION

This National Strategy and Action Plan has brought out more than 100 potential project ideas, under the fifteen IUCN-MFF Programme of Work, as given in the table 10. The project ideas delineate the key aspects related to conservation of the coastal and marine ecosystems, strengthening of empowerment, and enhancement of governance in integrated coastal zone management. These project ideas will form basic concepts for formulating projects of different types: Large and Medium Projects, Small Grant Projects and Targeted Research Projects.

Table 10. Potential project ideas *vis-à-vis* IUCN - MFF Programme of Work (PoW) Under National Strategy and Action Plan for India

PoW No.	PoW	Potential Project idea
1	Improving the **Knowledge base** for coastal planning, policy and management	… Biodiversity assessments in less explored and unexplored coastal and marine areas (*e.g.* deep sea biodiversity) … Generate baseline data of all associated flora and fauna of coastal ecosystems, including keystone species … Bio-prospecting of coastal and marine resources for high value products and genes … Ecological evaluation of coastal ecosystems … Biology of mangrove/coral reef/seagrass species especially those at threat … Understanding of structure, growth and functions of coastal ecosystems … Interrelationships between coastal ecosystems … Pests and diseases of corals, mangroves and seagrasses and their remedial measures … Coastal processes such as hydrodynamics, siltation and erosion on coastal and marine ecosystems … Studies on coastal circulation and sediment transport to identify sites for coral recruitment/growth of new colonies and seagrasses … Carbon sinks and sequestration potential of mangroves … Effects of coastal pollution on coastal and marine ecosystems … Bioremediation potential of mangroves in pollutant abatement … Focused research on the impact of global warming, climate change and sea level rise on coastal ecosystems … Documenting and promoting the use of traditional knowledge on management of coastal and marine resources

2	Designing ecologically and socio-economically sound **coastal ecosystem rehabilitation**	… Assessment of the past and current restoration works … Identification of potential areas for rehabilitation and natural regeneration of mangroves/seagrasses/coral reefs. … Models for innovative community based coastal restoration … Efficient techniques for mangrove restoration and regeneration … Biodiversity enrichment in mangrove plantation and its impact on ecology and fishery resources … Coral transplantation and rehabilitation … Seagrass transplantation … Identification of appropriate biological and socio-economic indicators for monitoring of coastal ecosystems … Impacts of canal digging in saline blank areas on ecology (salinity, hydrology, siltation *etc.*) and fisheries … Design and development of efficient 'canal bank planting' techniques for mangrove restoration … Training courses on coastal restoration and rehabilitation … Assessment of fishing activities using different crafts and gears and their impacts on fish stocks in coastal waters … Development and implementation of captive breeding and sea ranching for enhancing the fish stocks of commercial uses … Demerits of sea ranging on coastal and marine ecosystems … Ecological impacts of alien/invasive species in coastal and marine environment … Design and development of mechanisms for enhanced action on coastal restoration and associated livelihoods with involvement of stakeholders
3	Providing decision support for 'reef-to-ridge 'approaches to **land and resource management.**	… Assessment of land based activities and their effects on coastal ecosystems and livelihood … Effect of reduced freshwater flow on coastal ecosystems and fishery resources … Awareness programmes for river-based planners and inland resource managers and policy makers … Design and development of mechanisms for inter-sectoral coordination in environmental aspects of coastal management

4	Integrating coastal ecosystem **economic values** into development planning and appraisal	… Economic valuation of ocean and coastal ecosystem services … Development of ecosystem valuation tools and methods … Data base development on coastal and marine ecosystem values in response to specific development and conservation issues … Impacts of mangrove degradation on local communities and socio-economics … Training and awareness programmes for development and conservation planners on economic values of coastal ecosystems and the use of valuation tools
5	Learning from **evaluation of the environmental effects of coastal management** initiatives	… Evaluation of the effects of coastal management initiatives … Develop simple methodologies for monitoring reefs, mangroves and seagrasses … Training for *in situ* monitoring of coastal ecosystems with involvement of stakeholders … Assessment of eco-development activities on conservation of coastal and marine ecosystems … Impact of education and awareness programmes on conservation of coastal ecosystems … Analysis of existing laws/policies (*e.g.* Fishing holidays) and their impacts on coastal resources and management
6	Promoting **civil society awareness and participation in decision-making**	… Awareness programmes for stakeholders on importance of conserving the coastal and marine ecosystems … Preparation of information materials in local language in an attractive manner … Resource users conflict in coastal and marine environment (eg. Fishers and farmers, traditional and non-traditional) … Designing of websites, visuals and toolkits for effective communication … Development of primary and secondary school curricula on coastal and marine ecosystems … Multi stakeholders fora especially women fora for coastal zone management. … Analysis of constraints in the formation of village committees and their remedial measures … Establishment of awards and incentives for the individuals and community contributing towards coastal protection and conservation of coastal and marine biodiversity

		… Involvement of National Green Corps/Eco-clubs especially from coastal regions to spread environmental awareness among school children and to involve them in environment related activities … Establishment and/or modernization of Interpretation centres at least one in each State/Union Territory at the entry point … Up-gradation and modernization of infrastructure facilities for nature education and eco-tourism … Public awareness about coastal and marine resource conservation through locally popular folklore like 'Yakshagana' in Karnataka State. … Public awareness of wetland values and benefits especially the mangroves should be created by undertaking programmes on the "International Mangrove Action Day" on July 26th each year as adopted by Mangrove Action Project, and the "World Wetland Day" on 2nd February as adopted by Ramsar Convention of Wetlands.
7	**Building the capacity of professional coastal managements** for integrated coastal management	… Assessment of status and threats for conservation of coastal and marine ecosystems … Development of new methodologies, criteria and indicators for sustainable management of coastal and marine ecosystems … Capacity for regular coastal resource survey … Capacity building on existing techniques of GIS and remote sensing. … Training and capacity building on coastal and marine taxonomy … Exploring possibility of adoption of new techniques such as creation of virtual herbaria, autonomous underwater vehicles, remotely operated vehicles, and molecular techniques for reef research, survey and management … Support to higher education and research in Integrated coastal management through grants, partnership and leadership development programmes … Development of training modules for coastal practitioners and coastal managers … Develop on-line training programme on coastal management … Training the frontline staff on SCUBA diving, snorkeling, coral monitoring and mangrove health monitoring *etc.* … Work with mass media to build the capacity of journalists and writers to report on ecosystem concerns in radio, TV and newspapers, with a special focus on local language presentation.

		… Developing national center for coastal and marine biodiversity and resources … Developing national centre for coastal and ocean management
8	Supporting environmentally **sustainable livelihoods** among coastal communities	… Analysis of sustainable coastal livelihood incomes, equality and gender issues … Coastal ecotourism strategies for conservation of habitats and generation of livelihoods. … Mariculture practices in the open coastal waters for farming of seaweeds, shellfish and finfish … Integrated fish farming with mangrove silviculture and other halophytes, prawns, mollusks, crabs *etc.* … Apiculture practices and their ecological and economic valuations … Organic cultivation of vegetables along the non-saline or less saline landward areas of coast … Development of guidelines for environmentally sustainable fishing activities … Critical assessment of alternate coastal livelihoods … Training on livelihood options among local communities … Development of efforts to add value to local use and marketing of non fish mangrove products … Impact of livelihood rehabilitation on fishery resources
9	Improving **community resilience to natural disasters**	… Assessment of status of coastal shelterbelt and green belts for coastal protection … Design and development of models for coastal bio-shield with regard to density, width, species composition *etc.* … Proactive management strategies for mitigation of natural disasters in coastal environment … Community-based development of beach/coastal forests and sand dunes
10	Identifying **Sustainable financing mechanisms** for coastal ecosystem conservation	… Analysis of existing sustainable funding mechanisms. … Design and development of innovative models for sustainable financing at protected area management, coastal ecosystem rehabilitation, and community livelihood activities. … A pilot study on payment for ecosystem services schemes for selected coastal ecosystems and management programmes, based on private-public-community partnerships … Impact of women in sustainable financing practices

11	Supporting **national integrated coastal management** programmes	… Assessment of national institutional mechanisms and programmes for Integrated Coastal Management. … Support to the operations of State-level coastal zone management authorities.
12	Strengthening the integration and enforcement of environmental and social safeguards in **coastal land use planning**	… Analysis of legal and regulatory measures governing coastal zone land use and development … Development of plans for coastal zones at national and local levels, including needs for ecosystem protection within land use zoning. … Working out the mechanisms to deal with land-use conflicts around critical ecosystems, particularly protected areas.
13	Building national systems of **Coastal and marine protected areas** that contribute to a regional network	… Analysis of existing protected area coverage and recommend areas in need of additional protection. … Assessment of management effectiveness of existing protected areas leading to the development of strategies for management improvements. … Training the managers on effective management of coastal and marine protected areas … Development of new, or strengthening of existing, protected areas in critical or under-represented coastal ecosystems. … Integrating marine data into the World data base on protected areas … Establishment of national and regional networks of marine protected areas
14	Promoting adaptive **coastal management programmes** that include ongoing ecological and socio-economic assessment and monitoring	… Training for community-based scientific monitoring of coastal ecosystem health using biological and socio-economic indicators … Identification and inclusion of simple parameters like ratios of *Porites/Acropora* and growth patterns (vertical and horizontal growth as indices of reef health and recovery … Establishment of *in situ* and *ex situ* gene banks (Genome resource centres) for mangroves corals and seagasses
15	Encouraging environmentally **sustainable business practices** in coastal areas	… Awareness programmes on Corporate Social Responsibility, under which the industries/companies are committed to community-focused initiative, including environmental protection … Development of industrial sector specific guidelines on environmental risk, threats and opportunities, and existing regulatory mechanisms. … Development of models for coastal conservation by partnerships between Governments, NGOs and local communities and the private sectors

		.. Implementation of captive breeding of ornamental fishes for restocking of the reef and generation of alternate livelihoods

Our strategy is based on basic tenets of the National Environment Policy and it is in consonance with cardinal principles promulgated by the M. S. Swaminathan Committee Report on regulation of coastal zones. The strategy prepared in this document is consistent with national objectives, national policies and national programmes. Action will be taken through all the three types of projects, namely (i) large and small size projects, (ii) small grant projects and (iii) targeted research projects, simultaneously with one project complementing the other. In doing so, the objectives of both India and the MFF initiative on conservation and management of coastal and marine biodiversity would be achieved successfully.

No. 3-2/2006-CS(M)
Government of India

Annexure-I

Paryavaran Bhawan
CGO Complex
Lodi Road
New Delhi-110003

Date: 22.10.2007

OFFICE MEMORANDUM

Subject: National Coordination Body (NCB) of India for IUCN's Project 'Mangroves for Future (MFF)' - regarding

A. The project entitled "Mangroves for Future (MFF): a strategy for promoting investment in Coastal Ecosystem Conservation" is being coordinated by World Conservation Union (IUCN) covering, initially, six Tsunami affected countries(including India) in South & South East Asia & Western Indian Ocean. The project involves collaboration between multiple partners, including government agencies, NGOs, Research Institutes, UN agencies and other multilateral bodies.

B. To oversee and guide the entire India country programme under MFF as well as review, monitor and evaluate its implementation, it has been decided to constitute a National Coordination Body with the following composition & terms of reference:

1. Mr. B.S. Parsheera — Chairman
   Additional Secretary, MoEF
   New Delhi.

2. Mr. Sudhir Mital — Member
   Joint Secretary, MoEF
   New Delhi.

3. Joint Secretary(Fisheries) — Member
   Department of Animal Husbandry,
   Dairying & Fisheries
   Ministry of Agriculture, Government of India
   Room No 221, Krishi Bhavan
   New Delhi 110 001

4. IGF (NAEB) — Member
   MoEF, New Delhi.

5.	Representative of IUCN India Country Office 20, Anand Lok New Delhi-110049	Member
6.	Representative of UNDP India Country Office 55, Lodi Estate New Delhi.	Member
7.	Representative of CARE CARE India Post Box No. 4652 New Delhi-110016	Member
8.	Representative of M.S. Swaminathan Research Foundation, Chennai.	Member
9.	Director, Centre for Living Marine Resources & Ecology, Ministry of Earth Sciences Kochi.	Member
10.	Representative of Hazira Port Trust	Member
11.	Representative of Tata Chemicals.	Member
12.	Representative of IA-Division Handling World Bank ICZM Project MoEF, New Delhi	Member
13.	Director MoEF, New Delhi.	Member-Secretary

C. The Terms of Reference (TOR) of the NCB – India will be as follows:

i) The NCB shall determine the geographic area of MFF work and focus on formulating the national plans, projects and activities under the MFF. It will also oversee and approve the preparation of progress reports, documents & final technical report from India under MFF.

ii) It will select and approve national & international consultants for preparing country-specific projects, programmes & activities under MFF.

iii) It will review, monitor & evaluate the implementation of national programmes and activities under MFF.

iv) It will liaise with UN & other donor groups at national level, where they are present and facilitate raising funds for India specific programmes & activities.

v) The representatives of WWF India, Wetland International, FAO and UNEP as well as other national NGOs, CSOs, Experts from Universities, CSIR Labs etc. will be invited as special invitees as may be appropriate.

D. For participation in the IUCN – MFF initiative, the Ministry of Environment & Forests has taken concurrence of Ministry of External Affairs and Ministry of Finance (Department of Economic Affairs), Government of India.

E. This Office Memorandum issues with the approval of competent authority and the powers delegated to the Ministry.

(Sudhir Mital)
Joint Secretary to the Govt. of India

To

All Members.

Copy to:-

1. PS to MOS(E)
2. PPS to Secretary (E&F)
3. PPS to Special Secretary(E&F)
4. PPS to DG&SS
5. File folder.

(Sudhir Mital)
Joint Secretary to the Govt. of India

ANNEXURE- II

Biodiversity of mangrove ecosystem in India

Living along the interface between land and sea, the mangrove ecosystem supports genetically diverse groups of aquatic and terrestrial organisms. Mangrove habitats include diversified habitats such as core forests, litter-forest floors, mudflats, water bodies (rivers, bays, intertidal creeks, channels and backwaters), and adjacent coral reefs and sea grass ecosystems (wherever these occur). The mangroves can exist and flourish under wide ranges of salinities, tidal amplitudes, winds, and temperatures, even in muddy and anaerobic soil conditions. Their highly variable conditions of life style make them profusely rich in biodiversity.

Total number of biological species

Indian mangrove ecosystems are known to have a total of 3985 biological species that include 919 floral species and 3066 faunal species (Table 1). Of the biological species, the faunal species occupy about 77%, and the floral species is 23%. Thus, the faunal species component is about 3 times greater than the floral component of the mangrove ecosystem.

Table 1. Total numbers of floral and faunal species reported to exist in mangrove ecosystems of India (Revised from Kathiresan, 2000; Kathiresan and Qasim, 2005).

No.	Groups	No. of Species
Floral groups:		
1	Mangroves	39
2	Mangrove associates	86
3	Seagrass vegetation	11
4	Marine algae (Phytoplankton + seaweeds)	557
5	Bacteria	69
6	Fungi	102
7	Actinomycetes	23
8	Lichens	32

Faunal groups:		
9	Prawns and lobsters	55
10	Crabs	134
11	Insects	705
12	Mollusks	302
13	Other invertebrates	740
14	Fish parasites	7
15	Fin fish	543
16	Amphibians	11
17	Reptiles	82
18	Birds	419
19	Mammals	68
	Total number of species	**3985**

Biological species at threat

Mangroves at threat: In India, species of mangrove ecosystems are generally in vulnerable condition. Only two mangroves namely *Avicennia marina* and *Excoecaria agallocha* are at the IUCN category of lesser risk, and the remaining 37 mangroves are at varying degree of threat (Table 2). Eleven mangroves are “Critically Endangered” and they need intensive care and immediate attention for their protection and propagation for recovery. Only one mangrove species is known to be endemic to India, that is, *Rhizophora annamalayana* Kathir., a natural hybrid derived between two species of *Rhizophora* (*R. apiculata* and *R. mucronata*) occurring in Pichavaram of Tamil Nadu (Kathiresan, 1995, 1999), which is confirmed as a new species by using DNA markers (Parani *et al.,* 1997). There are only 171 individual trees of the species, mostly located between its parental species in Pichavaram. This species requires utmost care for immediate conservation. Species of *Xylocarpus* are becoming rare in Sundarbans due to the past over-exploitation (Naskar and Mandal, 1999). *Brownlowia tersa* was reportedly some 80 years before, growing abundant nearer to large creeks of Middle Andamans and Dhanikhari creek is now rarely observed there (Hajra *et al.,* 1999).

Table 2. Mangroves at threat and lower risk in India
(Revised from Kathiresan, 2000; Kathiresan and Qasim, 2005)

No	Species	East coast					West coast					
		West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	A & N Islands	Gujarat	Maharashtra	Goa	Karnataka	Kerala	IUCN status of species
1	*Acanthus ebracteatus*Vahl	-	-	-	-	r	-	-	-	-	r	EN
2	*Acrostichum speciosum* Willd.	-	r	-	-	r	-	-	-	-	-	EN
3	*Cynometra ramiflora* Linn.	c	r	-	-	r	-	-	-	-	-	EN
4	*Excoecaria indica* (Willd) Muell.Dx.dall achyana (Bail.) Benth.	r	-	-	-	-	-	-	-	-	r	EN
5	*Lumnitzera littorea* (Jack.) Voigt.	-	-	-	-	f	-	-	-	-	-	EN
6	*Nypa fruticans* Wurmb.	r	-	-	-	f	-	-	-	-	-	EN
7	*Rhizophora annamalayana* Kathir.	-	-	-	r	-	-	-	-	-	-	EN
8	*Rhizophora lamarckii* Montr.	-	-	-	-	r	-	-	-	-	-	EN
9	*Rhizophora stylosa* Griff.	-	r	-	-	f	-	-	-	-	-	EN
10	*Scyphiphora hydrophyllacea* Gaertn.	r	-	r	-	c	-	-	-	-	-	EN
11	*Sonneratia griffithii* Kurz.	r	r	-	-	r	-	-	-	-	-	EN
12	*Aegialitis rotundifolia* Roxb.	c	c	r	-	r	-	-	-	-	-	VU
13	*Bruguiera parviflora* (Roxb.) W. A. ex Griff.	c	r	-	-	c	-	-	-	r	-	VU
14	*Bruguiera sexangula* (Lour.) Poir.	f	f	-	-	r	-	-	-	-	r	VU
15	*Ceriops decandra* (Griff.) Ding Hou	c	c	c	c	r	-	-	-	-	-	VU
16	*Ceriops tagal* (Perr.) C.B. Rob.	r	r	-	r	c	r	c	r	c	c	VU
17	*Cynometra iripa* Kostel.	c	c	-	-	r	-	r	-	-	-	VU
18	*Dolichandrone spathacea* (L.f) Schum.	r	r	-	-	c	-	r	-	-	c	VU
19	*Heritiera fomes* Buch. –Ham.	r	a	-	-	-	-	-	-	-	-	VU
20	*Heritiera littoralis* Dryn.	-	c	-	-	f	-	-	-	-	-	VU
21	*Pemphis acidula* Forst.	-	-	-	f	c	-	-	-	-	-	VU
22	*Sonneratia alba* J. Smith	-	r	r	-	r	-	a	f	c	r	VU
23	*Sonneratia apetala* Buch.-Ham	f	f	c	r	r	r	r	-	-	-	VU
24	*Sonneratia caseolaris* (L.) Engl.	f	r	-	-	f	-	c	c	r	r	VU
25	*Xylocarpus granatum* Koen.	c	c	r	r	f	-	r	-	-	-	VU
26	*Xylocarpus mekongensis* (Prain) Pierre	f	r	-	r	r	-	r	-	-	-	VU
27	*Acanthus ilicifolius* L.	c	c	f	c	c	c	c	c	c	c	LR
28	*Aegiceras corniculatum* (L.) Blanco	a	a	f	c	c	r	c	c	r	r	LR

29	*Avicennia alba* Bl.	c	a	c	-	f	f	c	c	c	-	LR
30	*Avicennia officinalis* L.	c	c	c	c	c	f	c	c	c	c	LR
31	*Acrostichum aureum* L.	c	c	-	r	f	-	c	c	c	a	LR
32	*Bruguiera cylindrica* (L.) Bl.	c	a	f	c	r	-	c	r	c	c	LR
33	*Bruguiera gymnorrhiza* (L.) Savigny	c	c	c	-	c	r	c	c	c	c	LR
34	*Lumnitzera racemosa* Willd.	f	c	c	r	r	-	c	r	c	r	LR
35	*Kandelia candel* (L.) Druce	f	a	-	-	r	-	c	c	c	c	LR
36	*Rhizophora apiculata* Bl.	c	r	c	f	a	-	c	c	r	r	LR
37	*Rhizophora mucronata* Poir.	c	c	c	f	a	r	c	c	c	c	LR
38	*Avicennia marina* (Forsk.) Vierh.	c	f	c	a	c	a	c	c	c	c	LR
39	*Excoecaria agallocha* L.	a	a	a	a	f	-	a	f	c	c	LR

EN = Endangered, VU = Vulnerable, LR = Lower risk, - = Not recorded

Abundant (a) - if the species is present in 81-100% of sampling points

Frequent (f) - if the species is present in 61-80% of sampling points

Common (c) - if the species is present in 31-60% of sampling points

Rare (r) - if the species is present in 1-30% of sampling points

Faunal species at threat: In Indian mangroves, faunal species are also at threat. In Sundarbans, 4 reptile, 3 bird and 5 mammal species are extinct, and 10 reptile, 3 bird and 2 mammal species are at threat (Table 3-5; Chaudhuri and Choudhury, l994). In Gujarat, 3 birds and 2 turtle species are threatened (Table 6; Wesley Sunderraj and Serebiah, l998). Of 41 invertebrates assessed, 4 species are endangered, 4 species are vulnerable and only one species is critically endangered (Table 7). Of 52 species of marine fish assessed, 9 are vulnerable and 2 are endangered (Rao *et al*., l998; Table 8);

Table 3. Threatened and extinct reptile species in Sundarbans

No.	Name of Species	Family
1.	*Crocodilus porosus*	Crocodilidae
2.	*Varanus bengalensis*	Varanidae
3.	*V. salvator*	”
4.	*V. flavescens*	”
5.	*Chelonia mydas**	Chelonidae
6.	*Eretmochelys imbricata**	”
7.	*Lepidochelys olivacea*	”
8.	*Caretta caretta**	”
9.	*Dermochelys coriacea**	”
10.	*Lissemys punctata*	Trionychidae
11.	*Trionyx gangeticus*	”
12.	*T. hurun*	”
13.	*Batagur baska*	Emydidae
14.	*Python molurus*	Boidae

*Extinct species (Source : Chaudhuri and Choudhury, l994).

Table 4. Threatened and extinct bird species in Sundarbans

No.	Name of Species	Family
1.	*Pelecanus philippensis*	Pelecanidae
2.	*Theskiornis melanocephalus*	Threskiornithidae
3.	*Leptoptilos javanicus**	Ardeidae
4.	*Ardea goliath*	”
5	*Sarkiodornis melanotus**	Anatidae
6.	*Cairina scutulata**	

* Extinct species (Source : Chaudhuri and Choudhury, l994).

Table 5. Threatened and extinct mammal species of Sundarbans

No.	Name of Species	Family
1.	*Panthera tigris*	Felidae
2.	*Muntiacus muntjac**	
3.	*Bubalis bubalis**	
4.	*Rhinoceros sondaicus**	
5.	*Cervus deruchea**	Cervidae
6.	*Axis porcinus**	
7.	*Platanista gangetica*	Platinistidae

*Extinct species (Source: Chaudhuri and Choudhury, l994).

Table 6. Threatened species in mangroves of Gujarat

No.	Name of Species	Family
1.	**Birds:** *Platelia leucorodia*	
2.	*Pelecanus philippensiscrispus*	Pelecanidae
3.	*Pelecanus philippensis*	
	Turtle:	
4.	*Chelonia mydas*	
5.	*Lepidochelys olivacea*	

(Wesley Sunderraj and Serebiah, l998).

Table 7. Threatened species of invertebrates in mangrove ecosystems of India

No.	Name of Species	Family
1.	*Cardisoma carnifex****	Gecarcinidae
2.	*Gelonia erosa***	Geloindae
3.	*Uca tetragonon***	Ocypodidae
4.	*Macrophthalamus convexus***	-do-
5.	*Pilodius nigrocrinitus***	Xanthidae
6.	*Sesarma taeniolata**	Grpsidae
7.	*Penaeus canaliculatus**	Palaemonidae
8.	*Penaeus japonicas**	-do-
9.	*Meretrix casta**	Veneridae

*** Critically endangered, ** endangered, * Vulnerable (Rao *et al.,* l998).

Table 8. Threatened species of marine fish in mangrove ecosystems of India

No.	Name of Species	Family
1.	*Boleophthalmus dussumieri***	Gobiidae
2.	*Scartelaos viridis***	-do-
3.	*Arius subrostratus*	Ariidae
4.	*Psammaperca waigaensis*	Centropomidae
5.	*Elopes machnata*	Elopidae
6.	*Boleophthalmus boddarti*	Gobiidae
7.	*Periophathalmus koelreuteri*	-do-
8.	*Leiognathus splendens*	Leiognathidae
9.	*Secutor ruconius*	-do-
10.	*Muraenichthys schultzei*	Muraenidae
11.	*Desyatis uarnak*	Trygonidae

** Endangered, * Vulnerable (Rao *et al.,* l998).

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ANNEXURE - III

Mangrove & Coral Reef Sites in India under implementation of management action plan

State/Union Territories	Mangrove Sites
West Bengal	1. Sunderbans
Orissa	2. Bhaitarkanika 3. Mahanadi 4. Subernarekha 5. Devi 6. Dhamra 7. Mangrove Genetic Resources Centre 8. Chilka
Andhra Pradesh	9. Coringa 10. East Godavari 11. Krishna
Tamil Nadu	12. Pichavaram 13. Muthupet 14. Ramnad 15. Pulicat 16. Kazhuveli
Andaman & Nicobar	17. North Andamans 18. Nicobar
Kerala	19. Vembanad 20. Kannur (Northern Kerala)
Karnataka	21. Coondapur 22. Dakshin Kannada/Honnavar 23. Karwar 24. Manglore Forest Division
Goa	25. Goa
Maharashtra	26. Achra-Ratnagiri 27. Devgarh-Vijay Durg 28. Veldur 29. Kundalika-Revdanda 30. Mumbra-Diva 31. Vikroli 32. Shreevardhan 33. Vaitarna 34. Vasai-Manori 35. Malvan
Gujarat	36. Gulf of Kutchh 37. Gulf of Khambhat 38. Dumas-Ubhrat
State/Union Territories	**Coral Sites**
Gujarat	Gulf of Kachchh
Lakshadweep	Lakshadweep
Tamil Nadu	Gulf of Mannar
Andaman Nicobar Islands	Andaman Nicobar Islands


INDIA
Mangrove Forests
N
NEPAL
BANGALADESH
BURMA
Gulf of Kachchh
Gulf of Khambat
Dumas-Ubhrat
Mumbai
Ratnagiri
Maharashtra
Malvan
Goa
Karwar
Coodapur
Kannur
Vembanad
LAKSHADWEEP (LACCADIVE) ISLANDS
ARABIAN SEA
Subernarekha
Sundarbans
Dhamra
Bhitarkanika
Mahanadi Delta
Devi
Chilka
Coringa
East Godavari
Krishna
Pulicat
Kazhuveli
Pichavaram
Muthupet
Ramnad
SRI LANKA
BAY OF BENGAL
ANDAMAN ISLANDS
10° Channel
NICOBAR ISLANDS
INDIAN OCEAN
0
300 km

ANNEXURE-IV

Marine and Coastal Protected Areas in India

Establishment of marine protected areas is among the best conservation strategies. Its aim is to protect and conserve the natural marine ecosystems in their pristine condition. The IUCN has defined a Marine Protected Area (MPA) as "*any area of intertidal or sub tidal terrain, together with its overlaying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment*".

Marine productivity in India is concentrated in small areas of coral reefs, lagoons, mangroves, estuaries and seagrass beds around the coast, which provides rich feeding and breeding ground for fish and other marine life. By protecting these habitats under MPAs, the vital life support processes of the sea are protected as well as sustainable productivity and fish production are ensured.

The MPAs in India are primarily classified into following three categories:

Category-I: This covers National Parks and Sanctuaries and having entire areas in intertidal/sub-tidal or mangroves, coral reefs, creeks, seagrass beds, algal beds, estuaries, lagoons.

Category-II: This includes Islands, which have major parts in marine ecosystem and some part in terrestrial ecosystem.

Category-IIIA: This includes sandy beaches beyond intertidal line but occasionally interacting with the seawater.

Category-IIIB: This includes ever green or semi ever green forests of Islands.

The Marine Protected Areas (MPAs) in India comprise of a number of national parks and wildlife sanctuaries designated under the Wildlife (Protection) Act, 1972, encompassing a few of the country's richest coastal habitats. India has a total of 33 marine sanctuaries and national parks, which cover an area of about 6,271.21 sq. km (Table 1). Marine National Park and Marine Sanctuary in the Gulf of Kutch form one unit (one MPA). Similarly Bhitarkanika National Park and Bhitarkanika Sanctuary are an integral part of one MPA. Thus, there a total of 31 MPAs in India. The protected areas cover 15.6% of the total coastal wetlands of the Country, only less than 1.33% of the Indian continental shelf (4,15,000 km^2 including the islands) and even less then

0.3% of the Indian EEZ (approximately 2 million km^2). Further, MPAs cover less than 4.01 % of the total area of all Protected Areas of India.

Table 1. National Coastal and Marine Protected Areas

Name	Declared	Area	*Ecosystem and Important Species*
Category-I Marine Protected Areas (National Parks and Sanctuaries)			
Mahatma Gandhi Marine NP, Wandoor (South Andaman) Andaman	1983	281.50	*15 islands, terrestrial moist forests, mangroves, coral reefs, marine life, dolphin, crocodile, sea turtle and birds.*
Rani Jhansi Marine NP (Richies Archipelogo), Andaman	1996	256.14	*Evergreen Forests, Mangroves and Coral Reefs.*
Lahabarrack Sanctuary (South Andaman)	1987	100.00	*Dense Mangroves, Littoral forests, creeks, marine water and tropical evergreen forest.*
Gulf of Kutch Marine NP (Jamnagar), Gujarat	1982	162.89	*Mangroves, Mudflats, Coral reefs, Marine life – dugong, dolphin, sea turtles, sea snakes and birds.*
Marine Sanctuary, Gulf of Kutch (Jamnagar) Gujarat	1980	295.03	*Mangroves, Mudflats, Coral reefs, Marine life – dugong, dolphin, sea turtles, sea snakes and birds.*
Malvan Marine Sanctuary (Sindhudurg), Maharashtra	1987	29.12	*Mangroves, corals, sandy beach, marine life and birds, Seagrasses, Marine Algae, Sponges, Sea Anemones.*
Bhitarkanika NP, Cuttak, Orissa	1998	145.00	*Estuaries and deltas, Mangroves, Crocodiles, diverse marine life.*
Bhitarkanika Sanctuary, Kendrapara, Orissa	1975	672.00	*Estuaries, Mangroves, Terrestrial Forests, diverse marine environment.*
Gahirmatha Marine Sanctuary, Kendrapara, Orissa	1997	1435.00	*Diverse Marine environment – Dolphins, Porpoise, 4 species of marine turtles, congregation zone of Olive Ridleys.*
Chilka (Nalabund)Wildlife Sanctuary, (Khundra, Puri, Ganjam) Orissa	1987	15.50	*Island, lagoons and brackishwater, dolphins and home to the critically endangered Irrawady dolphin.*
Coringa Wildlife Sanctuary, East Godavary, Andhra Pradesh	1978	235.70	*Mangroves, estuaries and backwater creeks and mudflats, Birds, Sea turtles, Otters and Estuarine Crocodiles.*
Krishna Wildlife Sanctuary, (Krishna/Guntur) Andhra Pradesh	1999	194.81	*Mangroves, backwaters, creeks and mud-flats.*
Pulicat Lake Bird Sanctuary, Nellore, Andhra Pradesh	1999	500	*Mangroves, estuaries and algal beds, wide range of birds.*

Pulicat Lake Bird Sanctuary, Thiruvellore,Tamil Nadu	1980	153.67	*Mangrove and Estuarine environment, wide range of birds.*
Point Calimere Sanctuary, Nagapattinam, Tamil Nadu	1967	17.26	*Tidal swamp mangroves, creek and evergreen forests.*
Gulf of Mannar NP, (Ramnad, Tuticorin),Tamil Nadu	1980	6.23	*Chain of 21 islands across 4 groups. Coral Reefs, Mangroves, Seagrass, rich marine life inclusive of dolphins, turtles, dugong, sea horses, sharks, whales and water birds.*
Sundarbans NP, Tiger Reserve, (North and South 24-Parganas), West Bengal	1973/84	1330.00	*Mangroves, estuaries, swampy islands, tiger, chital, fishing cat, dolphins, estuarine crocodile, sea turtle and birds.*
Halliday Sanctuary, South 24-Pargana, West Bengal	1976	5.95	*Mangroves, estuaries, swampy islands and mudflats.*
Lothian Island Sanctuary, South 24-Pargana, West Bengal	1998	38.00	*Mangroves, estuaries, creeks, swampy islands and mudflats.*
Sajnakhali Sanctuary (South 24-Pargana), West Bengal	1998	362.40	*Mangroves, estuaries, creeks, swampy islands and mudflats*
Category II: Marine Protected Areas (Island MPAs)			
North Buttan NP, Middle Andaman	1987	0.44	*Evergreen and littoral forests, mangroves, beaches and coral reefs, marine turtles.*
Middle Buttan NP, Middle Andaman	1987	0.44	*Evergreen and littoral forests, mangroves, beaches*
South Buttan NP, Middle Andaman	1987	0.03	*Evergreen and littoral forests, mangroves, beaches.*
North Reef Island Sanctuary, North Andaman	1987	3.48	*Evergreen and littoral forests, mangroves, beaches.*
South Reed Island Sanctuary, Middle Andaman	1987	1.17	*Beaches and Coral Reefs.*
Cuthbert Bay Sanctuary, Middle Andaman	1987	5.82	*Coral Reefs and Beaches, Marine Turtles*
Cingue Sanctuary, South Andaman	1987	9.51	*Evergreen Forests, Coral Reefs and Beaches.*
Galathea Bay Sanctuary, Great Nicobar	1997	11.44	*Evergreen Forests and Mangroves.*
Parkinson Island Sanctuary, Middle Andaman	1987	0.34	*Evergreen and littoral forests, Mangroves.*

Mangrove Island Sanctuary, Middle Andaman	1987	0.39	*Mangroves and Marine life.*
Blister Island Sanctuary, North Andaman	1987	0.26	*Mangroves and beaches.*
Sandy Island Sanctuary, South Andaman	1987	1.58	*Sandy Islands*
Pitti Wildlife Sanctuary, Lakshadweep	2000	0.01	*Sandy Island; migratory avifauna.*
Total		***6271.21***	

In India, some mangrove forests get total protection under the Marine Protected Areas (MPAs) (Table 1). The MPAs are notified under Wildlife (Protection) Act, 1972 either as National Parks or as Wildlife Sanctuary. About 7,300 sq. km area of inter-tidal zone has been legally notified in India (Singh, 2002). Other areas of mangroves escape from any of these legal protections. Constraints in the protected areas include lack of adequate manpower and infrastructures, poor enforcement of laws and human encroachment.

There are much areas of mangroves required to be brought under MPAs (Singh, 2002). In West Bengal, about 50% of total Sundarbans mangroves gets protection and an area of 4,263 sq. km are notified as 'Reserved Forests' (R.F.). In Orissa, Bhitarkanika covers 133 sq. km and Gahirmatha has 15 sq. km of mangroves. Some part of mangroves in this state is not part of MPAs and notified forests. In Andhra Pradesh, about 60% of total mangroves are in MPAs and also notified forests. In Tamil Nadu, the Point Calimere Wildlife Sanctuary has only small areas of mangroves and the remaining mangroves are protected under the R.F. Pichavaram, which has good mangrove area, is not part of MPAs but is protected under R.F. In Gujarat, 14% of total mangroves are coming under MPAs. Mangroves in Kachchh are not notified as 'Reserved Forests'. The forests that are not notified are found to be present in Porbandar, Junagadh, Bhavnagar, Bharoach, Surat, Valsad, Mundra and Kandla Port. In Andaman and Nicobar Islands, major part of mangroves is not coming under MPAs. However, substantial areas receive protection as MPAs and notified forests in Mahatma Gandhi, Rani Jhansi Marine National Parks and other Sanctuaries.

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ANNEXURE-V

Guidelines for monitoring of mangrove habitat with involvement of stakeholders

Monitoring of mangrove areas is essential to detect changes in the habitats over time. These may be (i) positive trends due to effective management interventions, *e.g.,* protection and restoration; and/or (ii) negative trends due to human activities or natural disasters (Wagner, 2005). However, the monitoring should be done frequently enough on a long-term basis. This will help in making timely predictions of changes for better management of mangrove habitats. Hence, a national monitoring program with a participatory approach in mangrove areas across the country is highly necessary. The advantages of the participatory monitoring programme is two fold: (i) The effort greatly increases the manpower involved that will help in collection of large amounts of data in a short time at a low cost ; and (ii) The effort will educate the local community, enhance a feeling of "ownership" of those ecosystems, and also create motivation among the local people to protect and conserve the mangrove ecosystems.

In this regard, three approaches are suggested for collection and interpretation of data and they are: (i) Forest Level Monitoring; (ii) Documentation of local knowledge; and, (iii) Analysis of data using GIS. This will be executed by participation of two groups of people: (i) Local communities; and, (ii) Scientists including social scientists. Local communities can be involved in regular forest level monitoring, after providing them proper training. Scientists can participate in all the three approaches exclusively in analysis of data using GIS.

Forest Level monitoring: Internationally recognized scientific techniques recommended by the Australian Institute of Marine Science (AIMS) (English *et al.,* 1994) can be used for monitoring forest structure. In this technique, the 'Transect Line Permanent Plots' are marked. Plots (each 10 m x 10 m) are taken randomly along transects perpendicular to vegetation types. Within each plot, mangrove plants are counted by species and classified by three maturity classes (seedling, sapling and tree based on height <1m, 1-3 m and >3 m respectively). The heights of seedlings and the girth at breast height (GBH) of saplings and trees are recorded. Stumps are also measured and counted by species as an indication of cutting pressure. Shedding of leaves can be measured as an indicator of stress in mangroves. Benthic macro fauna are monitored in some sites by counting them according to major taxonomic groups in 0.25 m x 0.25 m quadrate. The number of crab holes will also be recorded. Moreover,

GPS readings are recorded for every plot or transect monitored so that data can be fed into a GIS database. Some mangroves do indicate certain environmental changes and habitat conditions (Table 1; Kathiresan & Bhatt, 2008). They can be used as indicator species to monitor the changes in the mangrove habitat.

Table 1. Indicator species of mangrove habitat

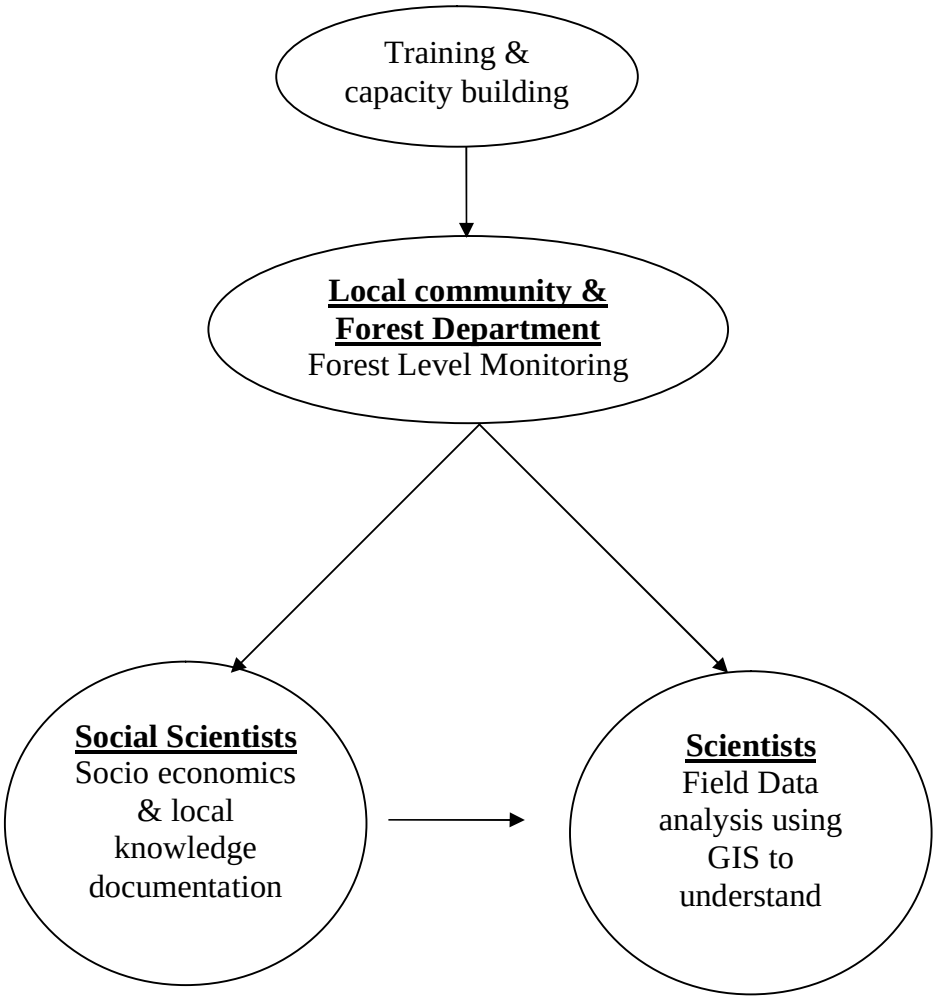
No.	Indicator species	Environmental conditions
1	Salt marsh species (*Suaeda* sp., *Salicornia* sp. etc.)	High salinity
2	*Avicennia marina*	Aridity, high salinity, high organic load
3	*Acanthus* sp.	Low salinity
4	*Nypa fruiticans, Heritiera fomes, Sonneratia caseolaris*	Freshwater inflow
5	Species with tall trees	High nutrients & high rainfall
6	*Acrostichum* sp.	Acid sulphate soil, degradation of mangrove habitat

Documentation of Local Community Knowledge: As the field data collection is undertaken, local community knowledge can be documented about the past threats and trends in the ecosystems being studied, recent trends and on-going threats as well as socioeconomic status of the people. Sociologists will play a role in this activity. The knowledge will be gained through discussions with local community members, as well as other people encountered in or around the ecosystems during fieldwork. Information gained will thus be site specific and, when compiled, will lead to a clear picture of the drivers of change in the area.

Analysis of Data using GIS: Data are fed into GIS databases and processed to obtain distribution and location of resources, status of resources in terms of changes and species composition. The data recorded in mangrove forests will be analyzed to obtain information on species diversity, the density and basal area of each species as well as ecosystem maturity and regeneration capacity. The level of degradation due to cutting pressure will also be ascertained. Changes in ecosystem condition over time will be analysed in order to detect any possible significant changes of time and try to understand drivers of change. In addition, predictions about future ecosystem condition will be made.

A schematic diagramme is given in Fig.2. for monitoring of mangrove forest involving stakeholders.

Fig. 2. Schematic diagramme for monitoring of mangrove habitat



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