

**Development and Restoration of Mangrove
Ecosystems in the Context of Emerging
Climate Change Risks: Interventionist Policies
and Outcomes in India**

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Presentation outline

- Changing perspectives on Mangroves and their restoration in the post-Tsunami context:
“mangroves as protecting the coastal ecosystem wealth/ biodiversity and supporting coastal livelihoods”
- International/ National/ regional policies/ programmes for restoration of mangroves: West Bengal, Orissa, Andhra, Tamilnadu, Gujarat
- Outcomes of mangrove restoration programmes: multifunctionality of mangroves and effects on the coastal communities: preliminary evidences from Gujarat
- Community Based Mangrove Restoration as adaptation/mitigation strategies against the potential climate change induced threats in coastal regions
- CBMR: Conservation Challenges, Policy and Institutional imperatives

Restoration of mangroves: changing perspectives

- Increasing realisation that mangroves are not mere swamps any longer, but are integral or critical components sustaining the livelihoods of coastal communities and protecting ecosystems and marine biodiversity.
- The increased awareness and activism towards the conservation/ restoration of mangroves, have originated particularly after the devastating 2004 Asian Tsunami.
- Apparently, there is also a wider appreciation about the values and multifunctionality of mangroves in terms of their socio-economic benefits and ecosystem functions, including protection of coastal zones in the wake of climate change induced hazards, like cyclones, Tsunami, sea level rise, salinity ingression, etc.
- More evidences now suggest that mangroves also offer immense potential as sources of carbon sequestration in the context of emerging climate change risks in the coastal regions (REDD+ scenario).

Mangroves: Global and regional scales

- An inventory of the existing mangroves at the global scale indicate a total cover of about 18 million ha, inhabiting in 118 countries and territories in the tropical and subtropical regions (Spalding 1997).
- Mangroves of South and Southeast Asia are the most extensive and diverse systems comprising 42% of global mangroves.
- Indian mangroves make up 3.1% of the total global, 3rd largest in Asia (7%), after Indonesia (63%) and Bangladesh (8%) [MSSRF, 2004]
- The Indian mangroves are distributed along the east (59.6%) and western (27%) coasts and the Andaman & Nicobar islands (13.3%), covering an area of about 4461 sq. km along the 7,500 km long Indian coastline.
- The floral diversity of mangroves of India is comprised of 38 core mangrove species (Kathiresan 2003).
- Despite the potential multifunctional attributes of mangrove plantations the world over, their area had declined over time due to increasing threats from natural disasters and pressures from anthropogenic activities: over harvesting, aquaculture and development interventions along the coasts.

Major threats to mangroves

Threat to mangroves	Regions		
	South and Southeast Asia	Africa	Central and South Africa
1. Natural disasters	Low-High Increasing	Medium-Increasing	Low-Increasing
2. Population pressure	High-Increasing	High-Increasing	Low-medium Increasing
3. Over-exploitation by traditional users	High-Increasing	High-Increasing	Low Stable-Decreasing
4. Forestry	High-Stable	Medium-Increasing	Low Stable
5. Agriculture	High-Decreasing	High-Increasing	Low Stable-Decreasing
6. Aquaculture	High-Increasing	Low-Increasing	Medium-High Increasing
7. Salt production	High-Decreasing	High-Stable	Low-Medium Decreasing
8. Mining	Low-Medium Decreasing	Medium-Increasing	Low-Decreasing
9. Urban and Industrial development	High-Increasing	Medium-Increasing	Low-Decreasing
10. Tourism	Low-Medium Increasing	Low-Increasing	Low-Medium Increasing
11. Hydrological diversions (eg. Dams)	Medium-High Increasing	Medium-High Increasing	Low-High Increasing
12. Coastal pollution	Medium-High Increasing	Medium-High Increasing	Medium-High Increasing
13. Management shortcomings	Medium-High Decreasing	High Stable	Low-High Stable

World Bank, ISME, cenTER Aarhus (2003). *Draft Code of Conduct for the Sustainable Management of Mangrove Ecosystems*.

Mangroves and multifunctionality

- The **socio-economic importance of mangroves** has become an important area of research with scholars trying to capture the productive and protective values of mangroves (Reitenbeek, 1994; Walters, 1997; Adger *et al.*, 2001; Vannucci 2004; Barbier, 2006; Walters *et al.*, 2008).
- Mangroves play a **pivotal role in reducing the impact of tropical cyclones and tidal surges** (Kathiresan 2003a,b), which frequently occur in the coasts of South Asia (Kathiresan and Rajendran 2005). It was reported that during the Tsunami mangroves acted as a bio-shield at some places (Dahdouh- Guebas *et al.* 2005).
- During the cyclone that struck the southwest part of Bangladesh on 15th November 2007, **the protective role of mangroves in the Sundarbans has been highly appreciated, besides their role in reducing the sea-wave energy.**
- The mangroves also **provide necessary nutrients and habitats for a range of species of animals: the rich fisheries resources in the coasts** of many countries can be attributed to the presence of mangroves (Amarasinghe *et al.* 2002, Islam and Haque 2004, Islam and Wahab 2005).

Multifunctional mangroves

- Millions of people in South Asia earn their livelihoods by extracting mangrove resources and working in industries which use mangrove as raw material.
- It has been estimated that in Bangladesh and India, around 9 million people are dependent on the Sundarbans for their livelihoods (PDO-ICZMP 2004, GOI 2005).
- In the Impact Zone of the Bangladesh Sundarbans, around 18 per cent of the households are directly dependent on the forest (Iftekhar and Islam 2004; Awal 2010). Around 200,000 fishermen operate daily in the Sundarbans water.
- In India, the estimated values for different functions of Bhitarkanika mangrove (Orissa), such as nutrient retention was US\$ 865 /ha/year, offshore fishery US\$ 37.97/hr, inshore fishery US\$ 1.9/hr, fry collection US\$ 0.2/ hr; and storm abatement US\$ 116.28/household (Badola and Hussain, 2003; Iftekhar, 2008).

Valuation of Mangroves (TEV- Barbier, 1993; 1994)

Use Value

Non- Use Value

Existence & bequest
(legacy) values

Direct use value

Indirect use value

Option values

value of (wetland
assets) to future
generations.

- Consumption use value [fishery products]
- Non-consumptive use value [recreational values] – tourist attraction, etc.

support for fisheries,
storm protection, etc

Value of Increased
information in future

- Socio- Economic and Ecological functions of mangroves
- Coastal Protection and Climate Change mitigation benefits
- Community based mangrove restoration (CBMR)

Total Economic Value of Mangroves studies

Country	Direct and indirect use Values/ ha/year (US\$)	Source
Egypt	149,200	Spurgeon (2002)
Indonesia	3,188	Meilani (1996)
Thailand	3,420	Sathirathai (1997)
Malaysia	61,357	Leong (1999)
Mexico	2,772	Cabrera et al. (1998)
Global	3,207	Costanza et al (1997)
Philippines	315	Walton et al. 2006a
Thailand	520-667	Sathirathai (1997)
Viet Nam	315-1,085; 721 (average)	http://www.unepscs.org/Documents/RTF-E1/RTF-E.1-6%20Extracts.pdf
Malacca Straits	3.25 billion	PEMSEA, 2004
Southern Thailand	27,264- 35,921	Sathirathai and Barbier (2001)
Sri Lanka	12229	Iftekhhar (2008)
India	865 (nutrient retention); 37.97 (off-shore fishery); 1.9 (in-shore fishery); 116.28/ household (storm abatement)	Badola and Hussain (2003)
India	498.54 million	Hirway and Goswami (2007)
Kenya (Gazi Bay)	2902.87	Kairo and Caroline (2006)

Source: Author's compilation based on review of empirical studies.

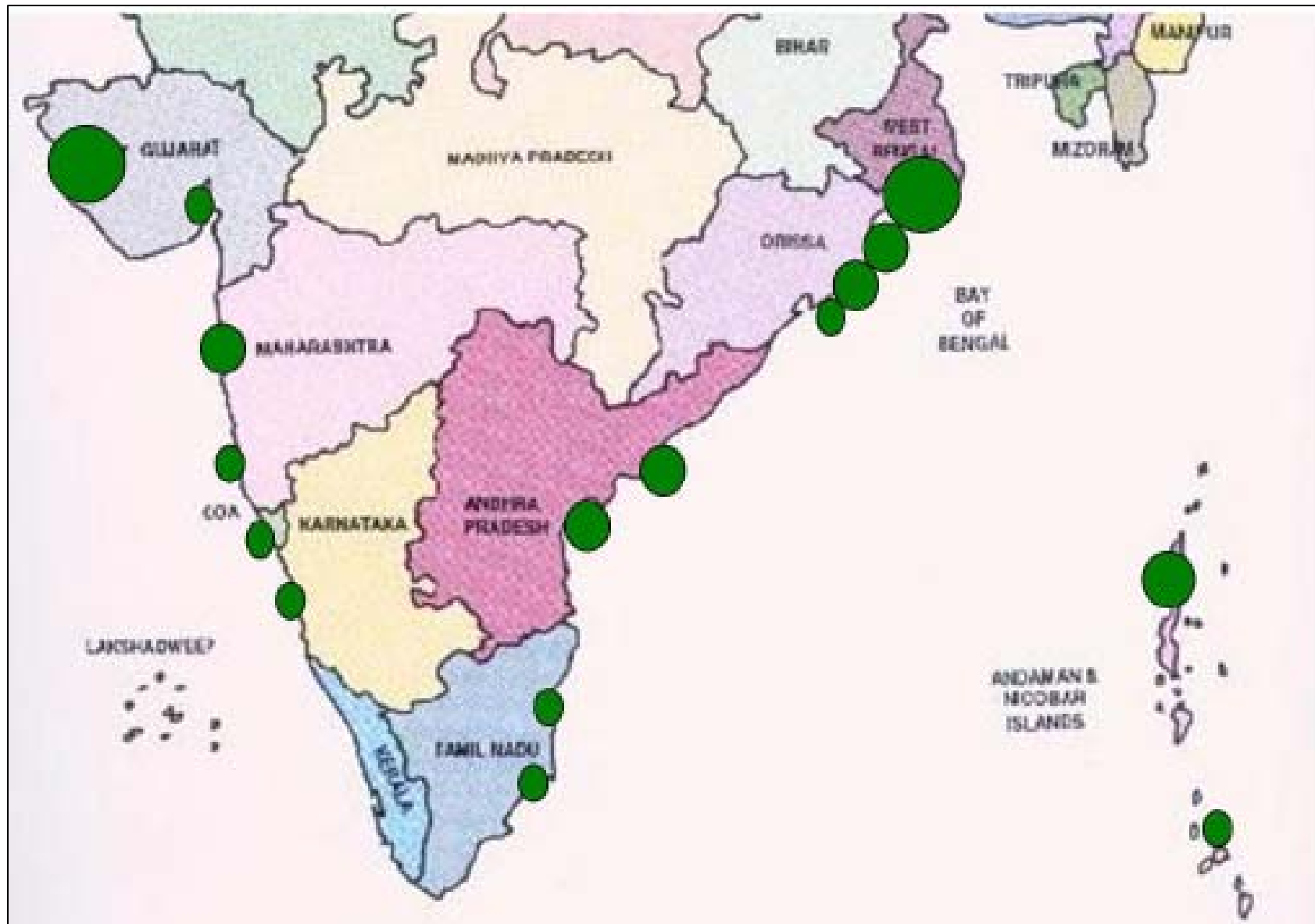
Restoration of mangroves: Global/ regional policies & interventions

- Since early 1990s in particular, emergence of policies and interventions with increasing efforts by national governments, NGOs and local communities around the world to conserve, rehabilitate and manage mangroves on a sustainable basis
- Early signals of climate change threats felt around this time. It is observed that along with various anthropogenic factors, climate change (sea level rise, etc) poses additional threats to mangrove ecosystems as mangroves occupy marginal land areas that would shrink significantly under the influence of projected sea level rise (UNEP-UNESCO, 1992).
- Need for policies and interventions became imperative in many countries as they virtually had no policies for management of mangroves or failed in enforcing the conservation policies and protection measures.
- A major initiative for development/ restoration of mangroves has received worldwide attention since 2005 following the Tsunami that struck the Indian Ocean on 26 December 2004.
- Efforts by National governments and NGOs to replant and rehabilitate mangrove ecosystems as “natural barriers” to future tsunamis and other tropical storms: Indonesia, Thailand, Sri Lanka, India, Bangladesh

Restoration/ Regeneration of Mangroves in India: state initiatives

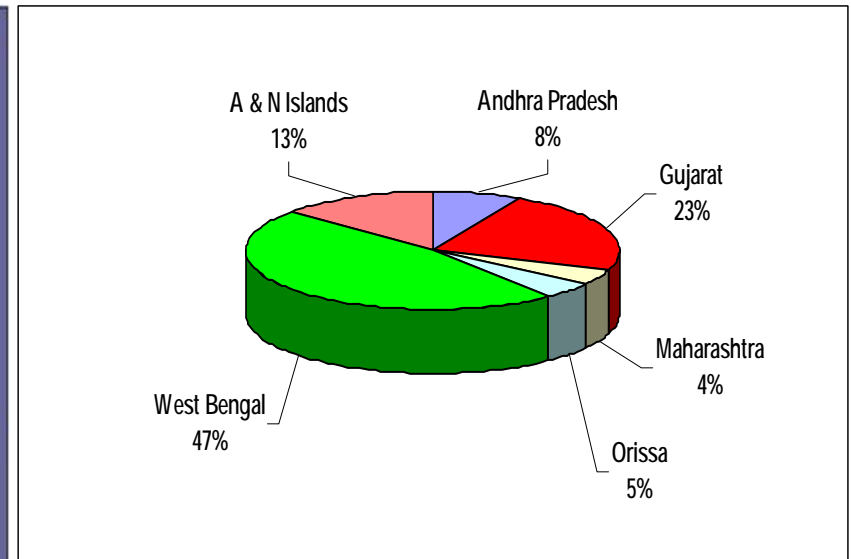
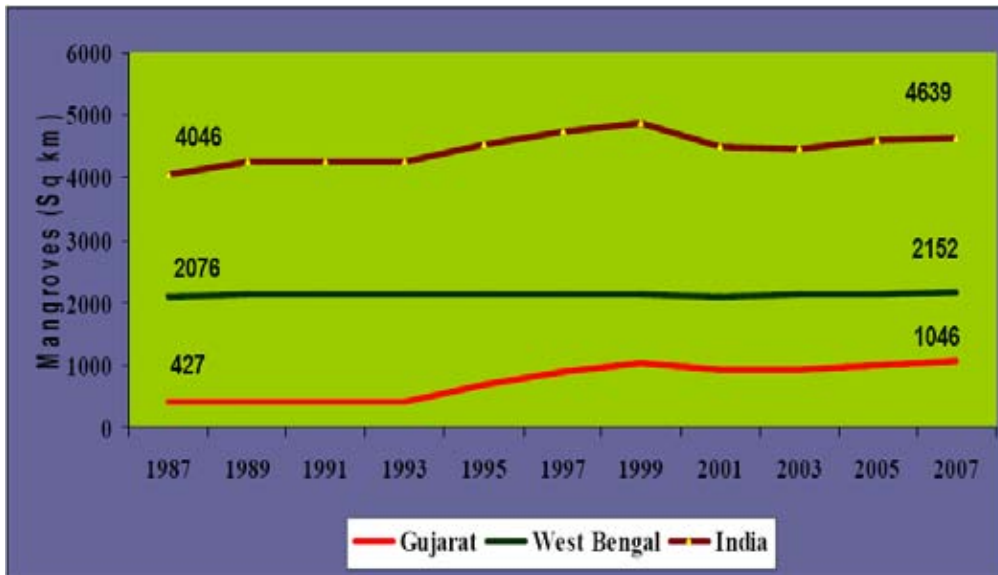
- The early initiatives by the MSSRF even before the tsunami. The MSSRF launched a major programme in 1996 for restoration of mangrove wetlands of the east coast of India, with financial support under the India Canada Environment Facility (ICEF) and in collaboration with the Ministry of Environment and Forests and State Forest Departments of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal
- In Gujarat, mangrove restoration project (REMAG) was implemented by the State Forest Department along with Gujarat Ecology Commission (GEC) during 2002-2007 with financial support from the ICEF.
- Expansion in mangrove area as achieved by Gujarat has been mainly attributed to the 'community based restoration' model.

Significant mangrove spread areas on the Indian coastline



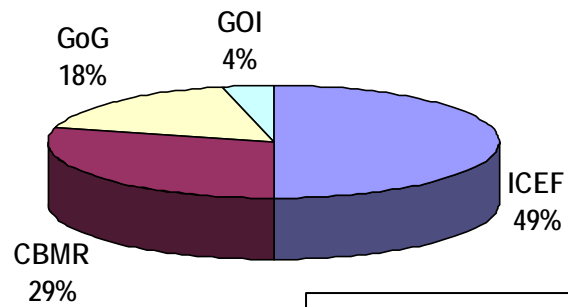
Growth in mangrove area in India

States	1991	1995	2001	2005	2007	% share
1. Andhra Pradesh	399	383	333	354	353	7.6
2. Gujarat	397	689	911	991	1046	22.5
3. Maharashtra	113	155	118	186	186	4.0
4. Orissa	195	195	219	217	221	4.8
5. West Bengal	2119	2119	2081	2136	2152	46.4
6. A & N Islands	971	966	789	635	615	13.3
Total	4244	4533	4482	4581	4639	100.0



Source: FSI, 2009.

Mangrove restoration in Gujarat, 2003-2010



CBMR in Gujarat: A broad spectrum

- A broader spectrum of CBMR in Gujarat, unlike other states
- As it promotes restoration/ development of mangroves under a multiple-stakeholder initiative
- With involvement of coastal communities in plantation/ restoration activities taken up by various state and non-state (private) agencies.
- Mangrove plantations by the state agencies (74% of 8326 ha.) and various private sector companies/ industries (26%), which form the dominant category after the ICEF and the Government of Gujarat.
- Among various private sector companies, the largest mangrove area developed by Adani (28%), followed by Pipapav Shipyard (23.4%), Shell Hazira (14%) and NIKO (12%).
- Compliance by industries towards allocating a stipulated land area for green belt development as a measure of keeping safe the ambient environment

Mangrove restoration: multi-stakeholder perspective

Type of Implementing Agency	Area-Ha	% share
A. STATE SECTOR AGENCIES		
1. Gujarat Heavy Chemicals Limited (GHCL)	50	0.81
2. Gujarat Maritime Board (GMB)	120	1.95
3. Gujarat Mineral Development Corporation (GMDC)	170	2.76
5. India Canada Environment Facility (ICEF)	4101	66.51
6. Ministry of Environment and Forests (MoEF)	300	4.87
7. Government of Gujarat (GoG)	1415	22.95
Sub Total	6166 (74.1)	100.00
B. PRIVATE SECTOR AGENCIES		
1. ADANI	600	27.78
1. Pipavav Shipyard	505	23.38
3. Shell Hazira	300	13.89
4. NIKO Resources India Ltd.	250	11.57
5. Essar	200	9.26
6. Ambuja Cement	150	6.94
7. Others*	155	7.17
Sub Total	2160 (25.9)	100.00
Grand Total	8326 (100.0)	

Mangroves restoration: Socio-Economic and Environmental Benefits in Gujarat

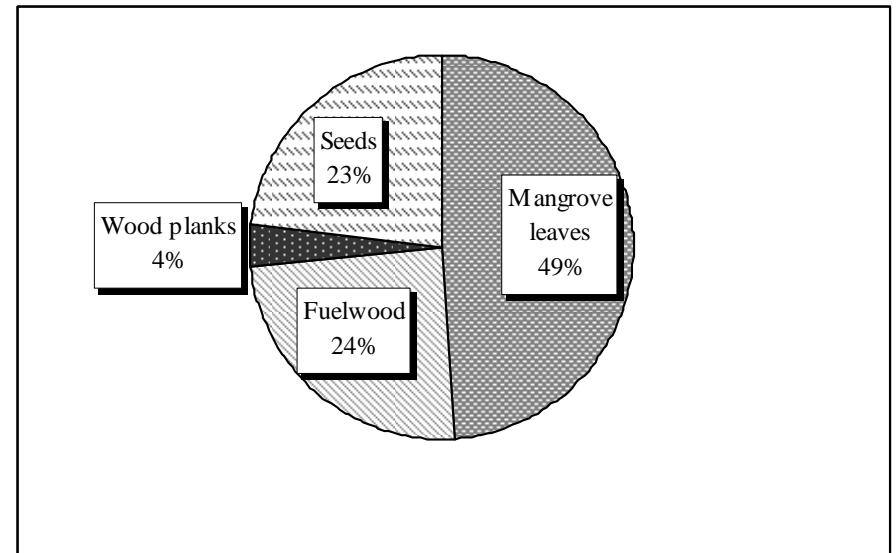
- Empirical study covered a survey of 227 households, undertaken during 2010 in seven coastal villages, viz., Lakki, Ashira Vandh, Nada, Kantiyajal, Dandi, Karanj and Tada Talav, spread over six talukas in four districts, viz., Kutch, Bharuch, Surat and Anand.
- The villages selected are diverse in terms of growth of plantations and their beneficial outcomes.
- Villages are seen to be distinct in terms of concentration of communities with uniform activity status (like fisheries, agriculture, livestock, etc) and the household dependence on mangroves.

Mangroves and the multiple community benefits

	Descriptives and beneficial outcomes	All study villages (n=227)
Socio-economic	1. Household dependence on mangroves (%)	34.1 (27-55)
	2. Presence of fishermen communities (%)	29.5 (20-67)
	3. Land close to mangrove sites (%)	52.5 (25-80)
	4. Women household members getting employment (%)	53.9 (45-63)
	5. Annual average employment generated per household during 2002-07 (No.)	134 (85-243)
	6. Annual average earnings from mangroves work (Rs.)	8735 (4728-14820)
	7. Percent gain in fishery income after mangroves planting	31.5 (14-73)
Livestock/fuel	8. Households own livestock (%)	38.3 (13-94)
	9. Households extracting mangroves for various uses (%)	45.8 (22-94)
	10. Women extracting mangroves (%)	62.5 (27-90)
	11. Mangroves extraction for fodder (%)	64.3 (56-100)
	12. Mangroves extraction for fuel (%)	35.7 (10-90)
Environmental	13. Mangroves reduce salinity ingress in crop lands (%)	55.4 (44-77)
	14. Mangroves reduced crop damage due to winds (%)	50.1 (19-82)
	15. Households reporting seriousness of cyclones (%)	78.9 (51-97)
	16. Hhs. reporting reduced effects of coastal cyclones after mangrove planting	73.6 (25-95)

Note: Figures in parentheses indicate the low and high values respectively

- Among various uses for which mangroves are extracted, fodder and fuel uses are the prominent ones, including other benefits
- This provided two major benefits to the communities, viz., a) helping them avoid purchase of fodder from the market; b) increase in milk production as mangrove leaves were available in plenty to be fed upon to the livestock.
- Several environmental benefits were realised by households: protecting farm lands from frequent coastal cyclones, which caused damage to farms and loss of crops.
- Salinity ingress in crop lands has also been a perennial problem significantly mitigated by mangroves.
- The coastal cyclones always cause serious damages to the houses and other immovable properties of the households, which have now been protected by the mangrove belt.



Mangroves development - labourers at work site



Mangroves and biodiversity benefits

- We undertook a detailed biological assessment to examine the vegetative growth and biodiversity dimensions of mangrove plantations in the study villages.
- Bring about the diversity of the study villages in terms of presence of invertebrates, mobile fauna and other species. The mangrove areas are found quite rich in terms of other species, such as mudskippers, crabs, bivalve, gastropods, fish, and habitat for other species.
- As mangroves areas have achieved good growth over the past few years, they also found to be providing habitat for birds and marine reptiles, like snakes.

	Tadatalav	Lakki	Ashirawandh	Karanj	Dandi	Nada	Kantiyajal
1. Crustacean							
a). Crabs	++	++++	+++	+++	++	++	++++
b). Prawns	++	+++	++	++	+	+	++
2. Molluscan							
a). Gastropods	++	++++	+++	+++	+++	+++	++++
b). Bivalves	++	+++	++	++	+	+	+++
3. Snake	+	-	-	-	-	-	+
4. Birds	-	++	+	-	-	-	++
5. Mudskipper	+++	++++	++++	++++	+++	++++	+++
6. Other Fish	++	+++	++	++	++	++	+++

Note: - Absent, + Satisfactory, ++ Good, +++ Excellent, ++++ Quite rich.

Biodiversity in Mangrove Ecosystems



Mudskipper catch



Habitat supported by mangrove ecosystem



**CBMR as institutional strategy towards addressing
Climate change issues: challenges, policy and
institutional imperatives**

- CBMR in Gujarat and other states, viz., Tamilnadu, Andhra and Orissa have been found to be quite significant: socio-economic and environmental outcomes
- Urgency for implementation of REDD+: 1700 km coastal areas in Gujarat with a vast majority facing problems of salinity ingress, depletion of fisheries and coral ecosystems/ marine biodiversity due to industrial pollution, vulnerability of communities..
- Several challenges to be addressed if it has to be scaled up as an institutional strategy for mitigating the climate change effects in the coastal regions of these states.
- CBMR as being implemented is yet to receive wider acceptance among the communities. Participation especially in Gujarat villages is very limited to the extent of taking benefits from employment & other short-term/ immediate benefits created by the restoration activities.
- Local communities and CBOs mostly lack initiatives to consistently engage into conservation of mangrove ecosystems due to several operational constraints which are generic to management of CPRs in several contexts

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- Communities and CBOs need strengthening in terms of increased awareness, skill development, capacity building, etc so as to enable them to conserve/ restore the mangrove ecosystems against any climate change risks/ other shocks.
- Though majority of communities (91%) do feel that growing mangroves is important for protecting the coastal systems and livelihoods from adverse effects of cyclones, soil erosion, salinity ingress, etc, they still lack motivation, incentives and resources to conserve the ecosystem on a sustainable basis.
- These challenges need addressing through policies and interventions for achieving sustainable conservation and restoration goals.

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- There are no institutional mechanisms in the mangrove restored villages (except the CBOs, which are less active) to protect plantations from a future perspective as a buffer or shield against all contingencies, including climatic change induced risks to coastal ecosystems and livelihoods
- Major challenge is determining the stakes and corporate social & environmental responsibilities of industries that are also part of mangrove development and restoration activities in Gujarat.

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- In most cases, private sector initiatives in mangrove development could be merely motivated by private gains that might bring in terms of carbon credits (?), increased access to global markets as a result of compliance with green belt development activities, etc.
- A major issue that needs addressing is whether the green belt development activities with a thrust on mangrove plantations by industry stakeholders are leading to better conservation/ restoration outcomes along with increased involvement of local communities in these initiatives?.

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REDD+ and beyond: Mangroves for the Future (MFF)

- MFF is a regional initiative, launched by Bill Clinton in December 2006 and is being coordinated by UNDP and IUCN.
- It aims at promoting coastal ecosystem conservation in six tsunami-hit countries including India. Under this initiative, India has already brought out a draft '*National Strategy and Action Plan*' (NSAP), which has been drafted in consonance with national policies and programmes of India.
- This approach means moving from a reactive response to disasters, to progressive activities that address long-term sustainable management needs. These include building awareness and capacity for improved food and livelihood security, disaster preparedness, and climate change adaptation. This new approach also means supporting economic development by promoting sustainable investment opportunities and ensuring coastal ecosystem goods and services are properly valued and protected.
- States have to evolve a co-ordinated approach and strategic action plans towards implementation of REDD+ and MFF initiatives

Assessment of vulnerability of coastal regions to Climate Change and other anthropogenic interventions

- A major knowledge gap about the vulnerability of climate change and its impacts on coastal regions of India.
- Imperative of detailed investigations about the occurrence and intensity of various climate change induced events in the coastal regions and their possible impacts on the coastal communities, mangroves as well as other ecosystems and biodiversity.
- Since coastal regions are highly diverse in terms of ecosystems, habitat, biodiversity and community livelihoods, these diversities need to be properly understood and captured through coastal surveillance systems and intensive field research using inter-disciplinary methodologies and analytical procedures in spatial and temporal dimensions.
- The information and data generated through this research should form the basis for appropriate policies and interventions in respect of adaptation towards and mitigation of climate change induced hazards in the coastal regions.



Mangrove forest in Gulf of Kutch, Gujarat