Mangrove Restoration

Through

Public-Private Partnership

GUJARAT

GEC

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Through

Public-Private Partnership

GUJARAT

Gujarat Ecology Commission

Government of Gujarat

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Narendra Modi
Chief Minister
Gujarat State

सत्यमेव जयते

Message

Mangroves are resilient, hardy trees that are found across over 1,000 sq km of Gujarat's coast. The state's share in the country's mangrove cover is as much as 23%. While other coastal states have shown marginal increase or even a decline in their mangrove cover over the last two decades, Gujarat's cover has more than doubled in the same period. This phenomenal increase in mangrove cover is attributable to the state's and the people's conservation and restoration efforts. As Gujarat has the longest coastline in the country, the state has been keenly aware of its responsibility towards nurturing and protecting its natural coastal resources.

Gujarat has seen several initiatives in the state for the conservation of mangroves. Recently, after the tsunami in 2004, there has been a growing realisation among communities of the coastal belts about the need to restore their degraded mangroves. Through the innovative public-private partnership project launched by Gujarat Ecology Commission in 2007, the people and the private sector have come forward, and have partnered with the state in the plantation and managing of the new mangroves areas. More than 20 of Gujarat's leading industries have come together and contributed nearly Rs. 500 lakh towards raising new mangrove plantations over an estimated 5,000 hectares. With technical guidance and facilitation by GEC, the communities have carried out the plantation activities and the industries have not only funded the plantation but kept their own monitoring mechanism to make sure that the new, tender plants survive to adulthood. This has been unprecedented, as nowhere in the country has the similar collaborative model of local communities, private sector and the Government been developed for successful mangrove conservation.

This public-private partnership project for the cause of mangroves has set a new benchmark in the country for a successful alliance between the government, the communities and the industry in environment-related initiatives.

I compliment Gujarat Ecology Commission for leading this pioneering project.

Date: July 6, 2012

(Narendra Modi)

Mangubhai Patel
Minister, Tribal Welfare, Forest &
Environment,
Government of Gujarat

सत्यमेव जयते

Message

Mangroves are found in tropical and subtropical regions. They have an incredible ability to survive saline and swampy, waterlogged regions, where most other plants would perish. The importance of mangroves to man has been most acutely felt since the tsunami of 2004. There was a sudden awareness of the role mangroves played in protecting the shoreline and preventing it from getting washed and swept away by strong waves and winds. Wherever mangroves had been healthy, the regions were substantially less ravaged by the tsunami.

Gujarat has the second largest mangrove cover in the country, and its mangrove cover has been steadily increasing in recent decades. Its mangrove regions are concentrated in the districts of Kutch, Jamnagar, Rajkot and Bharuch, with Surat and Bhavnagar too having sizeable cover.

Mangroves in most parts of the world have been subject to degradation. They are able to thrive better in places where there is local participation in their maintenance. In 2007, Gujarat Ecology Commission launched a unique mangrove restoration project where it sought to include the communities as well as the private sector in the restoration efforts. With three key stakeholders including the government, the local communities and the industry, it managed to carry out plantation work in an estimated 5,000 hectares of land.

This report is a documentation of this public-private partnership project and elaborates how the task of restoration in a difficult, swampy terrain was done with the joint participation of the communities and industry. It highlights the benefits such a partnership brought to large companies as well as local struggling communities, especially pastoralists and fisher folk.

I congratulate GEC for bringing out this valuable book.

Mangubhai P.

Date: July 6, 2012

(Mangubhai Patel)

Dr. S. K. Nanda, IAS
Principal Secretary
Forest and Environment
Government of Gujarat

सत्यमेव जयते

Message

Mangroves have attracted much attention in the last decade, after the tsunami of 2004. Locals, environmentalists, policy makers and industry began to realise the critical need for balancing socio-economic priorities with a sustainable environment. Mangrove regions have been diminishing in area around the world because of increased human pressure and activities. Due to reduced mangrove cover, coastal regions have become more vulnerable to natural calamities, the lands are becoming more infertile, and there is loss of biodiversity in these once rich mangrove-based ecosystems.

Mangroves support a great diversity of life either directly or indirectly. Birds, fishes, amphibians, reptiles and small and large mammals all turn to mangroves for food, shelter or both. Shrinking mangrove cover not only jeopardises human well-being, but also puts the well-being of the planet at risk. In coastal areas, mangrove rich regions have been found to mitigate the effects of global warming due to their role as carbon sinks. Carbon sequestration by mangrove habitats makes them valuable carbon-storage assets.

The project on Mangrove Restoration through Public-Private Partnership by Gujarat Ecology Commission is laudable for several reasons. It not only sought to expand the state's mangrove cover, but it also tried to reintroduce diversity of mangrove species. Significantly, GEC tried to achieve these objectives by involving local communities and private sector companies. It made them partners in environment conservation. While community-based environment projects exist in the country, never before have so many leading companies come together for an environment-related cause. The project covered 5,000 hectares of land with mangrove plantations, and the private sector collectively contributed as much as Rs. 500 lakh to carry out plantation activities.

I congratulate GEC for its unique project and the effort to document it in this book.

Date: July 6, 2012

(Dr. S. K. Nanda, IAS)

Kiritsinh Rana
Minister of State, Forest & Environment
Government of Gujarat

सत्यमेव जयते

Message

Mangroves are one of the most productive ecosystems, supporting a variety of aquatic and terrestrial life. The regions around the mangroves are rich breeding grounds for fish, and so where there are mangroves, fish is also abundant. Coastal communities in Gujarat depend on this valuable mangrove resource for their fuel and fodder, their fish catch and also for the role they play in protecting their farmlands. Villages like Kantiyajal in South Gujarat have lost a great deal of their farmlands to wave and wind action. As mangroves disappeared, the people's farms became vulnerable to salt laden winds and sea water, and became infertile. In Kutch, the loss of mangroves meant that Maldharis found it difficult to feed their camel herds.

Gujarat Ecology Commission started involving such communities that had a big stake in mangroves in its restoration project. In 2007, it launched an ambitious project that not only brought communities like fisher folk and pastoralists on board, but it also brought the private sector operating in coastal regions on the same platform. The common objective of all stakeholders was the restoration of mangroves. With technical expertise of GEC, plantation work by communities and monitoring by private sector companies, the project managed to cover a vast area of 5,000 hectares.

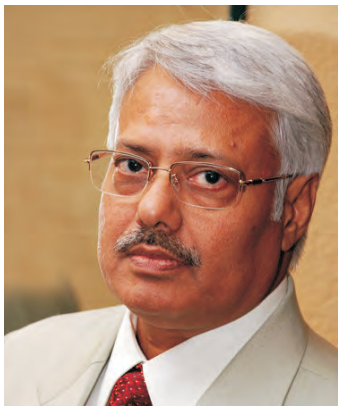
The book 'Mangrove Restoration through Public-Private Partnership' describes how the project evolved and was a resounding success for the communities, the industry and the society at large.

Date: July 6, 2012

(Kiritsinh Rana)

A. K. Verma, IFS
Member Secretary
Gujarat Ecology Commission

सत्यमेव जयते



Message

The Mangrove Restoration Project through public-private partnership was launched in 2007. During the course of its implementation, Gujarat Ecology Commission developed special mechanism to coordinate with two unequal partners. The project had sought out local communities and private sector partners who had stake in the immediate coastal areas around them to partner with the Government. As many as 21 leading companies of Gujarat, especially those from the petroleum, port and cement-based industries, came forward to work on mangrove restoration. Local communities, with active participation of women, offered whole-hearted support through their time and labour to carry out the plantation activities. The industry partners contributed an estimated Rs. 500 lakh for the restoration work.

Mangrove plants are different from other terrestrial plants. They grow in water-logged muddy regions which are difficult to reach and work in. Timing of activities is very important, as seeds have a very short life after collection, and the tidal movements of the sea give very limited time to carry out plantation work before the region is submerged in water. Moving and working in the swampy mud is also difficult. Against these odds, the communities and industry partners lent their support and worked on mangrove restoration. Site selection for new mangrove areas were done jointly by all stakeholders. GEC trained the communities about mangrove plantation techniques. It showed industry partners how to track the growth of the young plants. So far, communities, industry and GEC together have raised 5,000 hectares of mangrove plantations and the participatory model has also matured in its processes and mechanism.

With the enthusiasm of all stakeholders, introducing diversity in mangrove species was also attempted. Land degradation, soil erosion, increased turbidity, pollution and other factors have had far-reaching adverse impacts on mangrove ecosystems. Many mangrove regions of Gujarat once had a number of mangrove species. However, today, Avicennia marina is dominant in most regions due to its ability to survive even in highly saline and hostile conditions. The project carried out plantation activities not only of Avicennia marina, but also tried to raise Rhizophora mucronata and Ceriops tagal species on a limited scale. I express my gratitude to the GEC team, the private sector partners and the local communities who made this project successful.

Date: July 6, 2012

(**A. K. Verma, IFS**)

Acknowledgement

By virtue of having a longest coastline compared to other states and union territories of India, State of Gujarat carries a moral obligation of taking care of not only the coastal communities but the coastal natural resources also with equal quantum. Gujarat Ecology Commission has been a part of addressing various challenges faced by one of the extremely sensitive coastal and marine ecosystems of Gujarat including local communities.

Publication of "Mangrove Restoration through Public Private Partnership" is a step ahead in this regard. I express immense sense of gratitude to Dr. S.K. Nanda, IAS, Principal Secretary, Forest & Environment Department for his unending inspiration.

My sincere thanks are due to Shri A.K. Verma, IFS, Member Secretary, Gujarat Ecology Commission for frequently reviewing and making valuable suggestions in making this an important document.

I place on record the support extended by all the industries who have approached GEC for taking up mangrove regeneration activity on their behalf with a dual goal of ensuring better survival through technically sound methodology and active participation of local Community Based Organisations.

Lastly, I would like to mention the contributions made by Shri Nischal Joshi (Sr. Manager), Shri Lomesh Brahmbhatt (Manager – Field) and all other field functionaries whose untiring efforts have brought accolades to GEC in establishing a unique model of mangrove regeneration through PPP.

C.H. Pandya
Director

Contents

INTRODUCTION






What are Mangroves

Along the edges of continents, around islands, wherever land meets sea, seashores are to be found. At nearly 440,000 km, the coastline across the Earth runs over a staggering distance, and can encircle the equator almost 13 times over. These miles and miles of shoreline have fascinating diversity and are not the same everywhere.

On the coasts along the tropics on either side of the equator, are the regions where mangroves flourish. These areas are warm, humid and swampy intertidal zones where tropical rivers flow into the sea. The coasts here are a far cry from the alluring sandy beaches and pristine waters that draw holiday-goers, swimmers, and generally anyone looking to enjoy the sea. Rather, the regions where mangroves thrive are those that are mosquito-ridden, smelly and water-logged. They are regions where few other plants would survive because the combination of heat, choking mud and high salt levels would kill them in mere hours.

Mangroves, with their ability to survive incredibly hostile environments, are veritable marvels of nature. They literally live on the edge, partly on land and partly in the sea, along shaded creeks, islands and estuaries. They can grow in salty, slippery mud that is alternately exposed to air during low tides and covered by salt water during the high tides. These hardy trees range from bush-sized plants to those towering as high as 60 meters.

Mangrove plant with waxy leaves

Mangrove forest





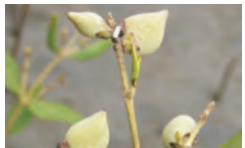

The word 'mangrove' finds its origin from the Portuguese and English words 'Mangue' and 'Grove' respectively, and indicates mangrove plants as well as a group of trees. Mangroves not only imply a type of specialised tree, but also an ecosystem that predominantly consists of mangrove trees. The large groups of mangroves and other plants that live in the tropical and subtropical intertidal zones may additionally be called mangrove forests or simply, mangal.

The number of mangrove species and associated plants vary across different parts of the world. They are most prolific around Southeast Asia, and most live within the Tropic of Cancer and Tropic of Capricorn. Yet, there are a few species to be found even in the cooler, temperate climates. But whether in the hot, humid marshes or far away from the tropical sun, mangroves across the globe have one similarity. They have a remarkable ability to adapt and survive in their suffocating, salt-laden environment.

Mangrove with pneumatophores





Unique Adaptations

At the intersection of land and sea, the mud is soft and swampy. Taking each step is an effort as the ground is slippery and the feet sink in deep and get completely muddy. For plants, it is difficult to stay anchored to one spot as the mud is too soft and the tides can easily wash them away. The mud also has too much salt and too little air for the plants to breathe. Mangroves manage to survive these conditions through several remarkable adaptations. They are one of the most productive and biologically complex ecosystems on the planet. Their roots, leaves and seeds are all designed for the hard life in the swamps.


Mangroves in intertidal zone

Low oxygen level in the soil brings in its wake several problems. Each time the tide comes in, the soil is washed with salt water. As there is insufficient oxygen in this water, bacteria thrive and free up harmful substances like phosphates, sulphides and methane. To find a way to breathe, certain mangrove trees have roots that are akin to snorkels. These adaptations, known as pneumatophores, instead of growing down in the ground, protrude out of the mud and let the mangrove breathe. To prevent the tree from slithering away into the sea with the shifting mud, some trees grow stilts and buttresses from the trunk.


Stilt roots





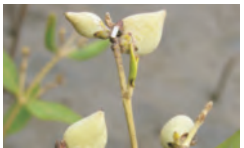

A big challenge mangroves are faced with is dealing with the highly saline marine water. That is why all of them have a special filtration system to keep out the excess salt. For instance, the roots of the red mangroves have a waxy substance within them to prevent the salts from entering the plant. White mangrove trees on the other hand have glands on their leaves that collect the large amounts of salt. When the tree sheds the leaves, the salts get eliminated too. Interestingly, mangroves not only have the special ability to keep the salts out, but they also have mechanisms to allow freshwater in. The pores in their leaves can close up to retain the water. Mangroves also have to guard against drying out, so most species tend to have thick, waxy leaves that can hold in the moisture.

Like the vast number of other plants, mangrove species rely on pollination by bees and insects to reproduce. However, the environment around mangrove trees is precarious, with strong tides incessantly coming in and going out. There are very few opportunities for the seed to establish itself in the sediment before getting swept away by water currents. In some trees, the seed thus continues to remain on the parent tree where it germinates and grows roots before separating. Once they are on the ground, they often bloom unusually fast to avoid getting washed away by the sea. In some species, the seeds are released inside a capsule that continues to float until it is deposited in a place where it can grow and become a new tree.

Preparing nursery beds in Dandi





Web of Life

Amidst their thick tangle of roots, on their branches and around the area where they live, mangroves support a stunning diversity of life, both terrestrial and aquatic. A vast assortment of fishes, birds, amphibians, reptiles and mammals depend on mangroves in one way or the other, and some of these species are unique to mangroves. There is increasing evidence that bears out that mangroves are critical not only to the well-being of humans but also to the health of the planet.

Egret catching fish

Waders and other birds flock to the canopy of mangrove trees for roosting, nesting and feeding. Crocodiles and snakes lurk in the mangrove swamps. Monkeys and deer turn to the trees to look for their meals. Smaller creatures such as ants, spiders, moths and scorpions search out hollowed twigs where they can feed and nest. The dead leaves and branches that settle in the water become the bed on which microorganisms grow. These in turn become food for other young marine animals.

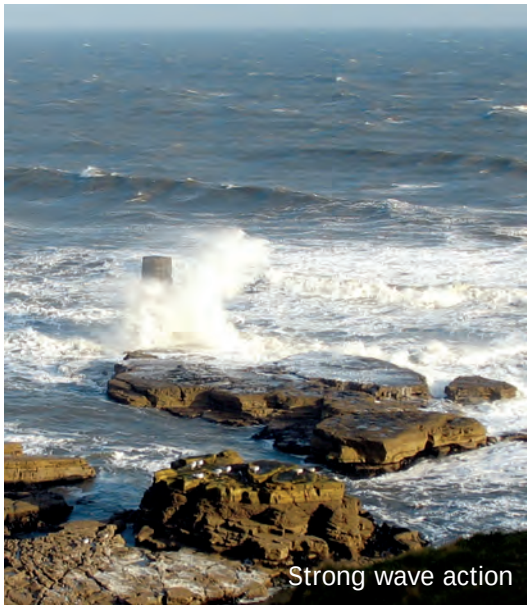
Painted Stork and egret in mangrove habitat






Coastal Protection and Land Builders

Coastal zones are dynamic regions with high levels of instability. They can be besieged by natural disasters like sea intrusions, cyclones and tsunamis year after year. Wave and wind action also play along the coastline, steadily eroding away the land. Mangroves, in such a scenario, serve as bioshields. They act as a shelter belt and are the first line of defence against sea currents, cyclonic storms and heavy winds. They help reduce the velocity of winds and waves when they strike.


Strong wave action

Wherever mangroves have been cleared, damage to coasts from hurricanes and typhoons has been more catastrophic. There have been far greater losses in terms of death of people, livestock and other living organisms as well as damage to property when mangrove cover has been sparse or absent. According to a study titled 'Mangrove Ecosystems of Indian Ocean Region' by Kathiseran & Rajendran published in the Indian Journal of Marine Sciences (2005) , it has been estimated that 30 trees in an area of every 100 sq m in a belt 100m wide has the potential to reduce the pressure from a tsunami by more than 90% if the wave height is within 4m.


Mangroves as bio-shields

Additionally, mangrove roots do not yield easily to tidal waves, and help to hold the soil in place, preventing it from getting washed away to sea. Their dense root systems trap the sediments and stabilise the coastline from erosion. Mangroves also have an important role to play in protecting soil quality and preventing land from becoming infertile. By reducing the energy and flow of landward sea currents, they help prevent salinity ingress.






Mangroves are also very important to life in the sea. They act as nurseries and safe havens for young fish, oysters, shrimps, molluscs and other organisms. Juvenile fish take refuge in them during their first few weeks when they are most vulnerable to larger predators. Without the mangroves, they would be forced to go towards the deeper and more dangerous waters where the chances of survival are bleak. Under water, mangrove roots support a rich variety of aquatic life. In addition to the coral reef and other fishes that hover around, the roots are coated with a multitude of colourful creatures such as barnacles, oysters, crabs, sponges and anemones.


Honey comb

Some of the fishes that dwell around mangroves are of commercial significance as they are an essential source of food and income for the coastal communities, and so healthy mangroves ensure a better catch for the fishermen. There is plenty of evidence across the world that suggests that catch is plentiful in reef areas close to the mangroves. But where mangroves have been cut down, the fishes too have become scarce.


Black-necked Stork

Apart from directly supporting marine life by providing food and shelter to sea animals, mangroves are vital to safeguarding the health of coral reefs and sea grass beds. They trap sediments often containing toxic materials that would otherwise choke and kill the fragile coral reef colonies. The roots filter out the run-off from the coasts, allowing the sediments to be removed before the water enters the sea.


Coral






Carbon Sinks and Global Warming

Among the less obvious roles of mangroves is that they have a far-reaching effect on mitigating the effects of global warming. They not only serve as carbon sinks in tropical and subtropical coastal regions, but they also protect communities in these parts from storms and surges associated with global warming. Coastal studies that have analysed the carbon budget of mangroves have found that mangroves are highly effective carbon sinks. These trees absorb carbon dioxide, thus taking carbon out of circulation and reducing the amount of greenhouse gas in the environment. Studies on their photosynthesis, sap flow and other processes in leaves have shown that mangroves have an exceptional ability to assimilate carbon. Mangrove habitats are responsible for carbon sequestration where much of the carbon ends up in forest sediments and remains there for thousands of years. Nearly 38% of the biomass of mangrove forests is below the ground, which represents a potentially vital carbon sink. When mangroves are removed for other purposes, the region changes from being a carbon sink to a carbon source, liberating the accumulated carbon back into the atmosphere, at rates much faster than it was sequestered. Thus, mangroves are crucial carbon-storage assets, and their demolition has an adverse effect on the carbon balance of a region.

Mangroves as carbon sinks






Timber and Plant Products

Mangroves are cherished by a host of communities who turn to it for their sustenance and livelihood. Where mangroves flourish, they cater to a huge portion of the daily needs of the people living around it. Fishermen, woodcutters, pastoralists, honey gatherers and many other coastal communities all depend on the bounty of the rich mangrove forests. Mangroves provide access to sea food, fruits, fodder, medicines and several raw materials for the coastal poor. These communities visit the forests regularly, by boats and on foot, braving hostile terrains to access and harvest the mangroves and its products. Mangrove wood is also valuable as it is resistant to rot and insects. Communities living around mangrove areas use this wood for construction of their homes and boats as well as for fuel. Mangrove leaves are valued by pastoralists as they are a rich source of nutrition for livestock compared to grasses.

Mangroves used for fuel wood

Leaf collection






MANGROVES IN INDIA AND ACROSS THE WORLD






Mangroves are to be found in more than two-thirds of the thin fringes of the saltwater coastal areas of tropical and subtropical Africa, Asia, Australia, and North and South America. Mangrove propagules and fruits have buoyancy and can float around with the help of tidal currents until they find a suitable place to take root. This adaptation has led to the dispersing of mangroves in different parts of the world. As such, mangroves are present in 124 countries and territories in tropical and subtropical regions (FAO, 2007). However, despite their large spread, mangrove forests are not uniformly distributed.

Nearly 64% of the mangrove cover is concentrated in only nine countries including Indonesia, Australia, Brazil, Nigeria, Mexico, Malaysia, Cuba, Myanmar and India. The mangroves of South and South-east Asia constitute the world's most extensive and diverse mangrove systems. The Indian share in the global mangrove cover is about 3.1%.

Propagules

Global Mangrove Distribution






The Sunderbans is the largest single tract of tidal mangrove forest in the world. It covers parts of India and Bangladesh, and lies on the vast delta of the Bay of Bengal. This freshwater swamp is served by Rivers Ganges, Brahmaputra and Meghna that drain into the bay. The forest can be approached by boats, being intersected as it is by a complex network of waterways, mudflats and small islands. It is one of the largest reserves for endangered Royal Bengal Tiger and is in fact among the only remaining haunts for this big cat. The dense woodland is also home to other fauna such as birds, spotted deer, crocodiles and snakes.

Sundarbans





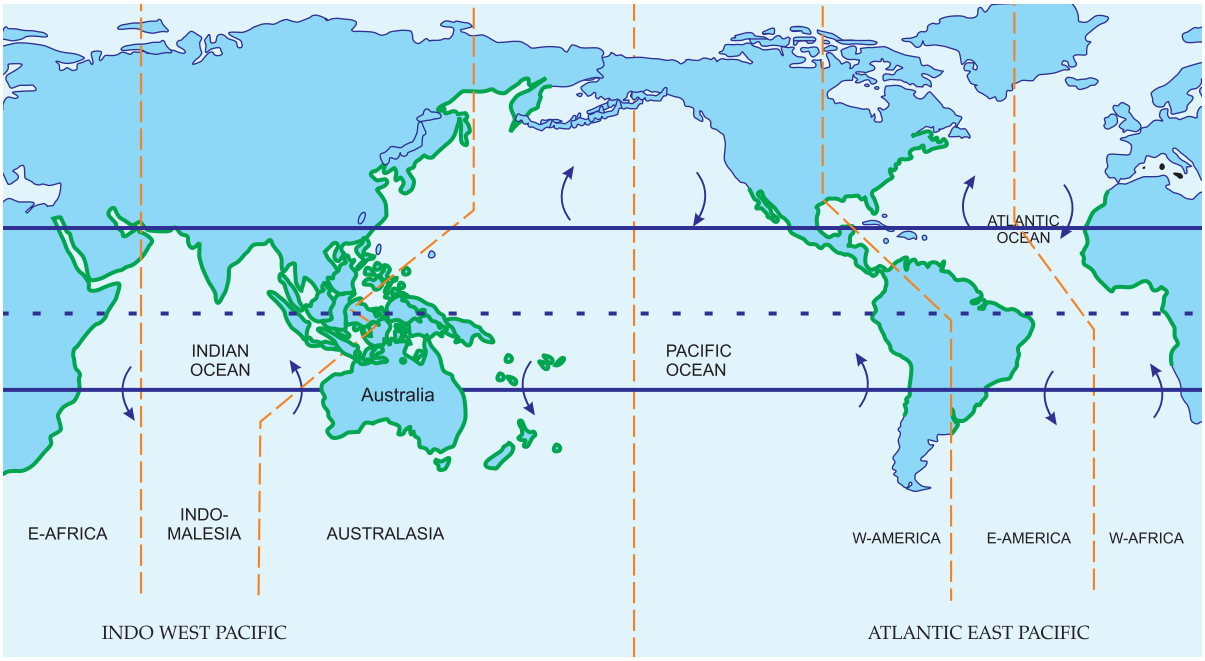

Major Mangrove Areas of the World

1. Indo-Malaysia
2. Australia
3. Western America
4. Eastern America
5. Western Africa
6. Eastern Africa


Mangrove nursery


Mangroves in south Gujarat

Major Mangroves Areas



(heavier lines show mangrove biogeographic regions)

Source: Duke (1992)






The Indian Coastline

The Indian coastline lies within the boundaries of the Tropics, and includes the west coast, the east coast and the Lakshwadeep & Andaman coast. The Indian sub-continent forms a major physical division between the Arabian Sea and Bay of Bengal, leading to differences in the western and eastern coasts. There is a difference between the Bay of Bengal and the Arabian Sea in that the former experiences a clockwise circulation of major currents during both, north-east and south-west monsoon. There is also a major difference in the salinity of both waters. In the Arabian Sea, evaporation exceeds precipitation and runoff, leading to the formation of highly saline water masses that flow southwards.

Mangroves in India are distributed along all the maritime states except for the Union Territory of Lakshadweep. They cover an area of about 4,639 sq km along the Indian coastline that extends through 7,500 km. The mangrove-rich states include West Bengal, Gujarat, Orissa, Andhra Pradesh, Tamil Nadu, Andaman & Nicobar Islands, Kerala, Goa and Maharashtra. Sunderbans in West Bengal has the most extensive and dense mangroves, followed by Gujarat. According to FSI data, in the period between 1987 and 2009, the country has recorded an increase in mangrove cover by 593 sq km. Gujarat in the same alone showed an increase of 619 sq km. The state has about 23% of India's estimated mangrove cover of 4639 sq km.

Andaman






The coastal area in India is dynamic and is prone to natural disasters. A stark case in point is the tsunami of 2004 which ravaged parts of the country. The entire east coast of India, the Gujarat coast on the west, and the islands of Lakshadweep and Andaman & Nicobar are frequently faced with cyclonic conditions. At times the cyclones have been known to cause large-scale damage to lives and property. Gujarat and Orissa had to grapple with immense losses during the cyclones of 1998 and 1999, thus underscoring the need for mangroves to safeguard the vulnerable coastlines.

Mangrove Cover in India

(Area in Sq Km)

Sr. No.	State/UT	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total
1.	Andhra Pradesh	0	126	226	352
2.	Goa	0	20	2	22
3.	Gujarat	0	182	876	1058
4.	Karnataka	0	3	0	3
5.	Kerala	0	3	3	6
6.	Maharashtra	0	69	117	186
7.	Orissa	82	97	43	222
8.	Tamil Nadu	0	16	23	39
9.	West Bengal	1038	881	236	2155
10.	Andaman & Nicobar	283	261	73	617
11.	Daman & Diu	0	0.12	1.44	1.56
12.	Puducherry	0	0	1	1
	Total	**1403**	**1658.12**	**1601.44**	**4662.56**

Source: FSI (2011)






Trends in Mangrove Plantations in India

(Sq Km)

State/UT	1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2009	% Share
Andhra Pradesh	495	404	399	378	383	383	397	333	329	354	353	**7.6**
Goa	0	3	3	3	3	5	5	5	16	16	17	**0.4**
Gujarat	427	412	397	419	689	901	1031	911	916	991	1046	**22.5**
Karnataka	0	0	0	0	2	3	3	2	3	3	3	**0.1**
Maharashtra	140	114	113	155	155	124	108	118	158	186	186	**4.0**
Orissa	199	192	195	195	195	211	215	219	203	217	221	**4.8**
Tamil Nadu	23	47	47	47	21	21	21	23	35	36	39	**0.8**
West Bengal	2076	2109	2119	2119	2119	2123	2125	2081	2120	2136	2152	**46.4**
A&N Islands	686	973	971	966	966	966	966	789	658	635	615	**13.3**
Puducherry	0	0	0	0	0	0	0	1	1	1	1	**0.0**
Kerala	0	0	0	0	0	0	0	0	8	5	5	**0.1**
Daman & Diu	0	0	0	0	0	0	0	0	5	1	1	**0.0**
Total	**4046**	**4255**	**4244**	**4256**	**4533**	**4737**	**4871**	**4482**	**4448**	**4581**	**4639**	**100.0**

Source: FSI (2011)

Mangrove restoration






Gujarat Coast

Gujarat is located on the west coast of India between 200 2`-240 41` N and 680 8`-740 23` E, and has the Tropic of Cancer passing through the districts of Kachchh and Surendranagar. The state has a long coastline of 1,650 km, constituting over 21% of the Indian coastline and the longest among all states. There are two major indentations in Gujarat's coast – the Gulf of Kachchh and the Gulf of Khambhat. Of the total wetland area of 27,175 sq km in the state, coastal wetlands comprise as much as 92.3%. These coastal stretches are rich in biodiversity and have the Marine National Park and four sanctuaries located along it. Broadly, Gujarat's coast has been divided into five major regions that include the Gulf of Kachchh, the Gulf of Khambhat, the Saurashtra Coast, the South Gujarat Coast and the Rann of Kachchh.

The coast of Gujarat is of strategic economic significance, serving as the natural gateway to India. Due to its proximity to the Gulf countries, it supports the shipping requirements to north-western India in a big way. There are 41 ports located along the coastline that cater to the cargo of maritime countries such as Africa, the Middle East and Europe. The entire northern India along with some parts of central India serves as the hinterland to these ports.

District-wise Mangrove Cover

(Area in sq km)

District	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total	Change w.r.t. 2009 assessment
Ahmedabad	0	1	29	30	3
Amreli	0	0	1	1	1
Anand	0	0	0	0	-3
Bharuch	0	21	22	43	1
Bhavnagar	0	6	13	19	6
Jamnagar	0	28	131	159	2
Junagadh	0	0	1	1	1
Kachchh	0	118	660	778	3
Navsari	0	0	1	1	0
Porbandar	0	0	0	0	0
Rajkot	0	1	1	2	0
Surat	0	7	13	20	3
Vadodara	0	0	2	2	-2
Valsad	0	0	2	2	-3

Source: FSI (2011)






During the handling of the wide variety of dry and liquid cargo at the ports, various pollutants in low dosage get released in the surrounding marine ecosystems. These pollutants have a chronic impact in differing degrees at the different marine locations. They affect the biotic and abiotic components, changing water quality and the physio-chemical attributes of the specific sites. The impact of pollution on the physical and biological functions and water quality are closely interlinked and influence each other. Dredging and the alteration of physical processes around the ports have been major factors that have had a deep impact on the marine ecosystems through the increase in turbidity and decrease in productivity of the region.

Past records and oral accounts by locals from coastal villages reveal that historically, there were mangroves of good quality all along the coastline of Gujarat. The vegetation map of Kathiawad prepared by the French Institute of Pondicherry in 1960 shows dense mangrove forests at Kandla, southern coast of Gulf of Kachchh and western coast of Gulf of Khambhat. Working plans of Jamnagar and Kachchh indicate that in the past, mangrove forests used to once thrive there. The Imperial Gazetteer of India, Vol. XVIII (1908), mentioned that in Navanagar State (now Jamnagar), mangrove swamps lined the shores of the Gulf, affording large supplies of firewood and pasture. Avicennia marina has been the dominant species from the beginning although Rhizophora and a few other species have also been recorded.

Industrial activity along the coast






While the most extensive mangrove cover were found along the coasts of Kachchh, Jamnagar and Bharuch districts, Bhavnagar and Surat too were known to have substantial cover. The entire coastline in the southern coast of Gulf of Kachchh in Jamnagar and Rajkot districts, from Okha to Navalakhi and Surajbari, was lined with thick mangrove forests. Now, only isolated and sparse patches remain, and these are restricted to small islands in the Marine National Park. The coastal mudflats in this stretch are now largely devoid of vegetation.

Regrettably, most of the state's mangrove forests were subject to degradation over the years, both in terms of loss of mangroves and loss of species. Gradually, Avicennia marina came to replace all other species of mangroves. The total mangrove cover in the state is about 1,046 sq km, which though impressive, is concentrated only in the two districts of Kachchh and Jamnagar. The Kori creek, situated on the north-western tip of the Gulf of Kachchh, alone accounts for nearly 68% of the state's mangrove cover. The mangroves here are an isolated patch that have survived through the years as they are very distant from any human habitation and directly served by the Indus delta. Recently however, there have been reports of degradation here too, due to biological reasons. The cyclone of 1999 also uprooted a large number of trees. The mangroves of Kachchh district which form the majority of the state's mangrove cover are dominated by the single species of Avicennia marina and this species too is susceptible to destruction and degradation.

Mangrove cover in Tadatalav






MANGROVES UNDER THREAT






While mangroves can survive incredibly harsh conditions posed by saline and swampy coastal terrain, they have been very vulnerable to threats posed by human development, industrial activity and aquaculture. Estimates indicate that in the last decade alone, over 35% of the world's mangroves have already been lost and in certain Asian countries, this loss is nearly 50%. The annual global rate of decline in mangrove forest cover is approximately 2%. The consequences of mangrove deforestation have been shrinking catch, degradation of clean water supplies, soil salinity and erosion and release of greater quantum of carbon dioxide in the atmosphere.

World over, humans have proved to be the greatest threat to mangroves. Human action has either been directly responsible for the decimation of mangroves or indirectly responsible, through the harming of its fragile ecosystem. Aquaculture and tourism have been the primary culprits in most countries for the degradation. Other activities that have led to the loss of mangrove tracts have been over-harvesting of fuelwood and timber; clearing of land for coastal development and agriculture; damming of rivers leading to altering of water course and soil salinity; and pollution from fertilisers, pesticides, toxic chemicals and oil spills.

Mangrove degradation due to anthropogenic pressure






In India, almost all mangrove areas are in severely degraded conditions with very little vegetation. They have been vanishing fast since the beginning of the 20th century. Most of the pressure on mangroves along the western coast of the country has come from agriculture and urban development. Shrimp farming in the southern coasts have also been responsible for the loss of mangroves since the 1990s. Although shrimp farming often does not take place in the mangrove areas, the habitat has nevertheless suffered.

In the aftermath of the 2004 tsunami, there has been acute awareness, especially among affected nations, of the crucial role mangroves played in saving human life and property. In regions where mangrove cover was healthy, the forests had reduced the impact of the tsunami by reducing the height and the velocity of the powerful waves, and also by distributing the water among canals and creeks and thus decreasing the level of inundation. Where mangroves had been destroyed, the powerful waves had come far inland, and had destroyed homes and farms, swiftly washing away lives and livelihoods. Countries including India, Indonesia, Sri Lanka and Thailand were hit hardest by the tsunami, and also lost a great deal of their mangrove cover to the calamity.


Check dams in upstream areas


Salt pans


Devastation by tsunami






Mangrove Degradation in Gujarat

There was a time when Gujarat had extensive and diverse mangrove cover. Unfortunately, through the ages, anthropogenic pressures and natural calamities took their toll and mangrove-rich regions either got depleted or degraded. In fact, after Independence, until 1960s, mangroves were regarded as wastelands and economically unproductive areas, and were readily sacrificed for economic and industrial development.

It has largely been human pressures that have led to the degradation of mangroves in Gujarat. These pressures have been of three kinds – those related to the search for fuel and fodder, the absence of natural regeneration due to decreased fresh water flow, and the clearance of large tracts of mangrove forests for development activities.

The loss of mangroves in the state has had a direct negative consequence for marine fisheries, as the habitat provides nutrients and breeding grounds to many fish species. Several of the State's rich fishing grounds, especially in the Gulf of Kachchh, are directly or indirectly dependent on mangroves for their sustained yield. Degradation of mangroves poses a serious threat to this resource and to the dependent fishing community. It is also leading to increased soil erosion in coastal villages such as Kantiyajal, as the protective barrier between the sea and the land is lost. The damage caused by cyclones is also increased due to absence of mangroves, although severe cyclones often cause destruction of mangroves. The natural barrier to the salt-laden winds is also lost due to destruction of mangroves leading to increased spread of soil salinity which adversely affects agricultural production. This leads to declining livelihood opportunities among agricultural labourers and marginal workers of villages.

Mangroves used as fuelwood in Navsari






Reduced Natural Regeneration: Loss in mangrove diversity has been one of the factors leading to reduced natural regeneration of mangroves. Fresh water inflow has dwindled considerably, causing increased salinity. No major rivers except Indus with its reduced annual flows, pour fresh water in the Gulf of Kachchh. As a result, only hardy species like Avicennia marina, with high salt tolerance, have survived. Similarly, in the Gulf of Khambhat, fresh water inflows from some of the major rivers like Sabarmati and Mahi have reduced due to construction of dams for irrigation in the upstream areas.

Another aspect that seems to have played a role in the degradation of mangroves in the Gulf of Khambhat is the erosion of the shoreline due to violent sea actions. Frequent cyclones have also taken their toll and the two consecutive cyclones 1998 and 1999 uprooted large number of trees and killed many others by blocking the pneumatophores with thick layers of sand and mud.

The trampling of camels over young seedlings while grazing as also the over-exploitation of seeds by local communities have also been responsible for the reduced natural regeneration of mangroves. Improved awareness in the use of mangroves will create better chances of protecting the seeds and seedlings, and will allow them to mature into trees.

Camel herds in Kachchh






Causes of Mangrove Degradation in Gujarat

Fuel and Fodder: The Maldharis are a nomadic pastoral community that travel with their herds of cattle or camels from place to place. The over-exploitation of mangroves for fodder and fuel-wood by local communities including the Maldharis is a complex problem with several inter-related causes. Due to increasing government control of natural resources, the people living around mangroves have lost control over the management of common property resources in their areas. Earlier, their traditions and customs ensured the proper stewardship of natural resources but now, these age-old safeguards have unfortunately broken down. The result has been unproductive village commons, and when accompanied by frequent droughts, the pressures on mangroves for fodder and fuel-wood have only been accentuated.

Compared to other common lands, mangrove regions have an advantage, in that cattle are unable to brave the damp, muddy conditions for free-grazing. This advantage is, however, lost in case of camels, as they can freely move about and can even cross the creeks when there are low tides. A mere one instance of free roaming by hordes of camel can often devastate large mangrove areas, as their feet trample the pneumatophores, blocking respiration. When Maldharis set out with their large camel herds, the damage to mangroves is thus, immense. For feeding cattle, the people visit the mangrove forests to collect the protein-rich mangrove leaves. These leaves are usually preferred over other grasses as fodder due to their high nutritive value. The village folk cut the leaves and pack them in large bundles that they haul on their heads.

Although the people realise that their unregulated use of mangroves is detrimental to the forests, they are often helpless to do anything about it as they have no official control over these areas. The problem is further aggravated by repeated droughts where the people have nowhere else to go for their fuel and fodder needs. The lack of knowledge and awareness of the ecological functions of mangroves among communities also contributes to the indiscriminate exploitation of mangroves.


Mangroves for fuel wood

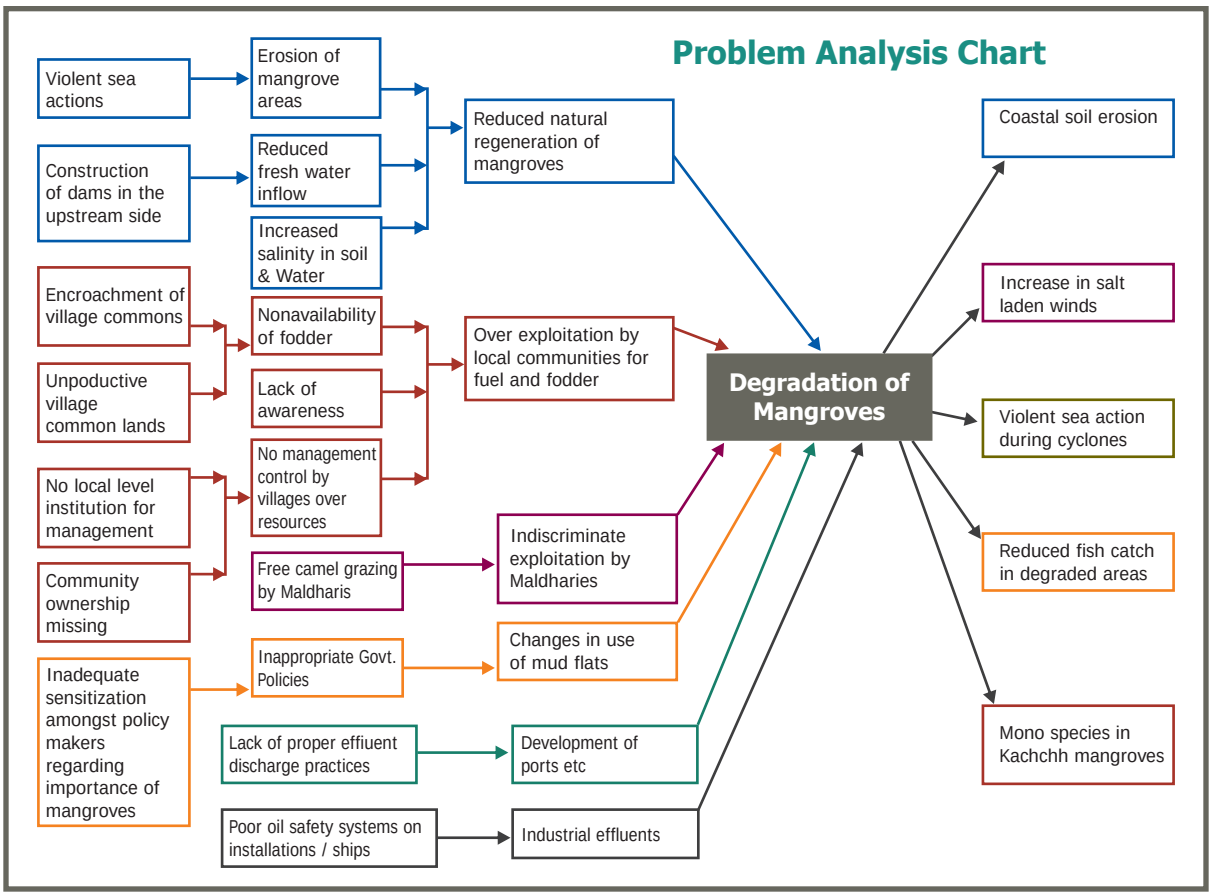

Open grazing






Diversion of Mangrove Lands for Other Purposes: Due to their strategic location by the sea, coastal lands are often in high demand by an assortment of agencies. These lands are of great economic significance, being valuable for the development of ports, industries, salt pans, tourism and other purposes. Mangrove lands are thus in direct competition with an array of agencies who want to use the same space for commercial gains.

This has been especially true for Kachchh and Jamnagar districts where large mangrove areas have been transferred to various industries. For instance, port development in these districts has blocked the creeks, thus reducing the water flows in mangroves. The ecosystem has also suffered from port and industrial activity with threats from oil spills and pollution. Insufficient understanding of the ecological functions of the mangroves is largely responsible for such diversions. Location of ports and industries in the vicinity of mangrove areas has also caused damage to mangroves due to dredging and bunding activities as well as construction of roads and other infrastructure. There is also a great influx of migrant labourers around industrial and port activities, further increasing the anthropogenic pressures on existing mangroves.



Source: GEC






Coastal Erosion in Gujarat

The Ministry of Environment and Forests (MoEF), Government of India commissioned a study with the help of Institute of Ocean Management (IOM) and Integrated Coastal and Marine Area Management (ICMAM) to identify micro level shoreline changes in Gujarat. The study involved analysis of time series satellite images from 1980 onwards upto 2009. A total of 14 districts including Valsad, Navsari, Bharuch, Vadodara, Anand, Ahmedabad, Bhavnagar, Jamnagar, Rajkot, Kachchh, Porbandar, Junagadh and Amreli were studied and classified as Stable Coast, Low Erosion Coast, Medium Erosion Coast and High Erosion Coast.

Based on the study, of the State's total coastline of about 1,600 km, 732.80 km, constituting 45.8% is erosion-prone. High erosion area comprises 5.3% of the coastline and is largely concentrated in Kachchh. Medium erosion and low erosion areas constitute 10.6% and 29.9% of the shoreline respectively.

Shoreline Erosion in Gujarat

District	High Erosion (km)	Medium Erosion(km)	Low Erosion (km)
Kachchh	62.3	115.6	132.7
Jamnagar	12.9	13.5	64.5
Junagadh			100.3
Amreli		5.2	21
Bhavnagar		5.2	59.8
Ahmedabad		2.8	11.3
Kheda			8.9
Bharuch	6.2	21	27.5
Surat		6.9	11.2
Valsad	3.1		40.9
Total Erosion (km)	84.5	170.2	478
Total Coastal Length of Gujarat State = 1600 km % of Gujarat coastline under erosion	5.3%	10.6%	29.9%
Total Erosion along Gujarat Coast = 45.8%			

Source: Integrated Coastal and Marine Area Management






MANGROVE RESTORATION THROUGH PUBLIC PRIVATE PARTNERSHIP






Data from the Forest Survey of India (FSI) indicates that Gujarat saw a steady increase in its mangrove cover in over a decade between 1987 and 1999. But in 2001, the mangrove cover decreased marginally from 1031 sq km to 911 sq km. Thereafter, since the turn of the millennium, there has been an increase in mangrove cover in Gujarat due to the concerted plantation and protection measures of the state.

Despite recent improvements in mangrove restoration, the state still has large areas throughout the coast that have a potential for mangrove regeneration. GEER Foundation has estimated that Gujarat has about 63,720 ha spread across the coasts of 10 districts where mangrove regeneration is possible. All these areas, along with the adjoining areas with existing mangroves, can be regenerated as well as restocked and developed as community forests.

Need for Mangrove Restoration

- **Ecological and Livelihood Security:** Mangroves form one of the most important ecosystems of coastal and marine areas. They safeguard the ecological security of the coastal belt and also provide livelihood opportunities to coastal communities, especially fishermen and pastoral families.
- **Long Coastline:** Gujarat has the longest coastline of nearly 1,650 km in the country and has the greatest mangrove cover on the Western coast. There is thus a need to pursue conservation activities to protect this fragile ecosystem.
- **Increased Degradation:** Due to the arid/semiarid climate in the state, there has been an ever-increasing dependency over this natural resource by local communities. Further, coastal erosion, pollution and anthropogenic pressure are also on the rise with large tidal-amplitude and reduction in the fresh-water inflow into the sea. This has adversely affected the survival of mangroves, leading to their degradation.

Mangroves in Kachchh






Challenges to Mangrove Conservation

The broad challenges to mangrove conservation are an interplay of anthropogenic pressures, natural factors, managerial issues and policy and legal framework.


Polluted beach in Dandi

1. **Anthropogenic Pressures:** Human activities have greatly jeopardised mangroves. Some of the major anthropogenic pressures include deforestation; coastal area development; over-exploitation of mangroves by local communities; pollution; sedimentation; oil spills and changes in land use.


Crowded coasts

2. **Natural Factors:** The natural threats that most commonly put mangroves at risk include rise in sea level; increased salinity; temperature rise; soil erosion; storms, surges, cyclones, typhoons and hurricanes; and harmful pathogens.

3. **Managerial Issues:** There is a general dearth of knowledge and understanding about mangrove ecosystems, and this has been an impediment in protecting the forests from degradation. There are also very real field-level problems in protecting mangroves as mangrove habitats are by nature inaccessible and hazardous to work in.

4. **Policy and Legal Framework:** Mangroves need the backing of a committed and long-term conservation policy and legal framework, given that it is one of the least understood and researched ecosystems. The recent Coastal Regulation Zone Notification of 2011 seeks to protect India's natural resources in coastal areas.






Past Efforts and Introducing the Community-based Approach

Gujarat's progress in mangrove restoration has been possible due to the active participation of the state's institutional mechanism. The state has not only taken measures for the reforestation of the degraded mangrove areas, but also for expanding mangrove cover into new areas. However, in the state's initial efforts, there was one major lacuna in that it did not include the local communities in the regeneration efforts.

Recognising that local communities were important stakeholders in mangrove forests as they are dependent on these coastal trees for their livelihoods as also to fulfil their various needs, GEC found it imperative to seek their participation in its mangrove restoration initiatives. While local communities turn to mangroves for its abundant resources, they can also be the long-term key players in ensuring its well-being.

Traditionally, local people, especially fishermen and pastoral groups, have been directly dependent on mangroves for their livelihood, fodder and fuel. Mangroves also provide protection to agricultural fields in coastal areas by preventing soil erosion and salinity ingress. Therefore, farmers too have a very important stake in the protection and regeneration of mangroves.

There has also been growing global awareness that conservation of natural resources cannot be done in isolation, without including the very people who have a large stake in those resources. It was thus clear that no mangrove regeneration effort, except perhaps in some desolate and remote areas, could make any headway without active involvement and participation of the local people. Moreover, while Gujarat's performance in mangrove restoration has been good, it is pertinent to note that most of the recovery of mangroves in the Gulf of Kachchh - natural as well as afforested - has been recorded on the isolated, sparsely populated interior areas where camel grazing and biotic pressures have been less.

Village local doing mangrove restoration






To bring about participatory management of mangroves, GEC deemed it vital that local community-based institutes and organisations were vested with long-term control and responsibility for regeneration and management of mangrove areas. Only such decentralised institutions could experiment with and develop different systems for preservation, regeneration and sustainable use of mangroves that were well suited to local conditions. This would also entail working out suitable arrangements with communities such as the Maldharis for the regulated access and usage of mangroves.

The pioneering initiative with a community-based approach by GEC began in 2002 with the project 'Restoration of Mangroves in Gujarat (REMAG)'. Financial support for REMAG was extended by India Canada Environment Facility (ICEF), New Delhi. The five-year project was the state's first attempt to design a multi-stakeholder initiative that involved the communities and also drew on the support of the industry. The project, through the proactive role of the government, enhanced the capacity of communities to regenerate and sustainably manage mangrove resources for increased livelihood opportunities, and it went a step ahead and also encouraged the private sector to participate in conservation and regeneration. REMAG was completed in 2007, after having being implemented in the project sites of Lakki, Bhangodi, Ashirawandh, Bagasara, Madhavpura-Bhangadh, Tadatalav, Nada, Kantiyajal and Dandi. Over the four years of its implementation for mangrove development, REMAG successfully covered an area of more than 4,100 ha.

Mangrove Restoration Sites under REMAG

Sr. No.	Area	Taluka/District
1.	Ashirawandh	Abdasa/Kachchh
2.	Bhangodi	Abdasa/Kachchh
3.	Lakki	Lakhpat/Kachchh
4.	Bagasara	Maliya/Rajkot
5.	Mahadevpura	Dhandhuka/ Ahmedabad
6.	Tadatalav	Khambhat/Ananad
7.	Neja	Jambusar/Bharuch
8.	Nada	Jambusar/Bharuch
9.	Kantiyajal	Hansot/Bharuch
10.	Dandi	Olpad/Surat






Mangrove Restoration through Public-Private Partnership

After REMAG drew to a close in 2007, there was still a pressing need to continue with the mangrove restoration activities with community participation. GEC thus extended the programme, but in the renewed efforts, it laid a major thrust on industry involvement. It sought investments by the private sector in mangrove development works and encouraged them to work alongside community-based organisations.

The need to involve the private sector was spurred by the fact that industry would always be the engine that would lead the economy, and for this reason, its activities would continue to have environmental impacts. Although some of the impacts would be inevitable, it was strongly felt that industry could nevertheless play a crucial role in supporting conservation efforts and could be a part of the solution to the threats mangroves are facing.

However, in including the private sector in its new project, GEC was keenly aware that activities of the industry alone were not detrimental to the health of mangroves. Coastal areas the world over, because of the opportunities they present and their strategic location, have known to thrive with human activity. Growing populations, increased impoverishment and overcrowded coasts have also altered mangrove habitats. The role of the communities in safeguarding the mangroves, therefore, was no less important, and the project continued to seek them out as it had done in REMAG.

In the new project now brought together all stakeholders on a common conservation plank. By adopting the public-private partnership (PPP) model in mangrove restoration, it sought to create alliances between the industry, public agencies and local communities to promote an ecologically and socially responsible sustainable project.

Community participation






Project Objectives

- *To contribute towards increased understanding and acceptance of the need to protect, conserve and regenerate mangroves by local communities, government and coastal industries.*
- *To facilitate capacity building of coastal communities and government for community-based mangrove regeneration as part of integrated coastal zone management.*

Monitoring of nursery

Project Area

In 2001, GEC through REMAG project had initiated the Community Based Mangrove Restoration Programme across ten locations situated in six coastal districts of the state through village-level community based organisations. In addition to this, in 2004-05 through 2009-10, eight new locations were included in the PPP project with the financial support of major industrial houses. Based on the availability of area, GEC extended its mangrove restoration activities in the locations identified during REMAG programme such as Kantiyajal in Bharuch district, Dandi in Surat Distict, Ashirawandh in Kachchh district and Tadatalav in Anand district.

New Project Sites

Sr. No.	Area	Taluka/District
1.	Kolak	Paradi/Valsad
2.	Dholai	Gandevi/Navasari
3.	Mendhar	Jalalpore/Navasari
4.	Karanj	Olpad/Surat
5.	Kathpore	Hansot/Bharuch
6.	Ankalav	Hansot/Bharuch
7.	Tuna	Anjar/Kachchh






Project Strategy

Implementation of the Project was done in a systematic and sequential manner after a synthesis of biological and socio-economic information on mangrove processes and values. As socio-economic linkages of the mangrove ecosystem were pivotal to the management of mangroves, communities were brought on board and consulted during every major step in project implementation. Restoration efforts in partnership with each private sector player were tailored to the specific site conditions.

There were three overall dimensions in developing mangrove restoration strategies for project implementation. These included:

(i) Socio-economic dimension that focused on helping local communities to build and strengthen their livelihoods;

(ii) Ecological dimension that sought to increase the importance of mangroves as bio-shields; and

(iii) Governance dimension that focused on building stable and strong institutions for the effective governance of mangrove ecosystems.


Ceriops propagules

Approach

Community-based Organisations: The CBOs have been the main implementing agency at grass root level, being facilitated by GEC for technical know-how as well as capacity building. The community has been empowered to take all the decisions with respect to plantation, restoration and management activities and guidelines have also been formulated to further assist them.

Fund Management: To create transparency in the management of funds for mangrove plantation activities, grants are released by GEC using RTGS facilities in bank accounts that have been specially created for CBOs for project purposes. The CBO account is managed by three signatories of which two signatories including one male and one female are CBO representatives.






Project Partners

Three major stakeholders have been involved in mangrove restoration, conservation and management activities. One of the objectives of this tripartite arrangement is to bring all the stakeholders on one platform for conserving vital ecosystem.

- **Community:** The various local communities dwelling near mangrove regions are the primary stakeholders and are directly or indirectly dependent on this fragile coastal ecosystem. Their capacities to sustainably manage the mangroves were enhanced through training programmes throughout the project.
- **Industry:** Over 20 prominent industries were involved in the mangrove plantation effort such as Adani, LNG Petronet. Tata Power, Shell Hazira Gas, Niko Resources, etc. The main role of the private sector partners has been the funding and monitoring of various activities under the programme as well as making a long-term commitment to conserve the mangroves.
- **GEC:** GEC, on behalf of the government has anchored the entire programme. Its main role in this endeavour is to facilitate the community and industry in restoring mangroves by providing the technical support. GEC also plays the role of coordinator to implement the programme successfully.

Meeting with stakeholders






Inclusion of Communities and Use of Village Commons

To a large extent, mangrove restoration with community participation was possible because the people willingly embraced the project. In social forestry projects, it is generally the village commons that are used for plantation activities. Due to increasing pressure on land, these common lands are now shrinking and locals are usually reluctant to use them for social forestry initiatives. However, in the case of mangroves, the villages accepted the need for plantation on village commons and the panchayats gave their full cooperation. The steps that were taken to include the communities were:

- **Formation of Community Based Organisation:** GEC field staff and the staff of the Programme Management Unit gathered the details about the area at the start of the restoration activities through Participatory Rural Appraisal (PRA) Exercise and focus group discussions ([FGD). Site visits were also made to the mangrove areas. Thereafter, meetings were held with the village leaders and key decision makers. GEC team used to impart the programme details to the community by organizing Gramsabhas and audio-visual shows. The Gramsabha, through the passing of a resolution, was then used to form the Community Based Organisation for mangrove conservation activities.
- **Composition of CBO:** One male and one female member of the each family in the village are members in the general body of CBO. General body members select the executive body of the CBO which is responsible for the day-to-day activities of the CBO. These CBOs are later registered under the Society Registration Act, 1860.
- **Capacity Building of CBO:** Once the CBO was formed GEC, imparted various types of onsite and offsite trainings to it through subject experts and exposure visits. Technical training was imparted and in addition to this, various training sessions were held on group organization and management, record keeping and accounting.
- **Mobilisation:** GEC designed various communication campaigns to mobilize and sensitize the community for the mangrove conservation and management. The campaigns were designed in accordance with the requirement of the programme as well as considering general perception of community. Various tools such as mangrove yatra, poster presentation, audio-visual shows, street plays, mangrove mela etc were intensively used to sensitize all stakeholders.






Project Implementation

The major stages in project implementation included the following:

- **Site Selection:** The technical suitability of the proposed land for mangrove development was gauged through the assessment of physico-chemical properties of soil and water, land elevation and the tidal pattern. Field visits were made by technical teams as part of the feasibility study and additionally, socio-economic details of the villages were also collected. Factors like labour availability and access to the site were also considered. After technical and socio economic data was collected through GIS-based maps, Rapid Rural Appraisals, Participatory Rural Appraisals and Baseline Surveys, site selection was done with the consent of private sector partners and communities.
- **Awareness Generation and Training:** A complete strategy was developed by GEC for creating awareness generation among different stakeholders over the different stages of project implementation. The key target group was the local communities, but efforts were also made to disseminate information and spread awareness among private sector organisations, NGOs, government functionaries and other groups. Once communities came on board and began to participate in the project, training activities were taken up to develop their capacities to implement and manage the project.

Mangrove yatra






- **Species Selection:** Keeping in view the ecological suitability, the potential native mangrove and associated species for plantation were identified and selected. Significantly, efforts were made to introduce species diversity wherever possible. Avicennia marina was the predominant species selected for widespread plantation after considering the present coastal environmental conditions and climatic factors like rainfall, annual ambient temperature range and aridity. The aridity in most project sites and extreme fluctuation of annual temperature render it difficult for other mangrove species to survive. Moreover, Avicennia marina is the most easily available species around all plantation sites. However, other species such as Ceriops tagal and Rhizophora mucronata were planted on a limited scale in several regions on an experimental basis.

- **Plantation Activities:** Appropriate techniques were formulated and adopted with the active support of different stakeholders. Local communities carried out the actual plantation work, while GEC and other project partners extended support and training, and monitored the work.

- **Sustainability:** The long term conservation and monitoring of the developed mangrove forests is being carried out by local communities. Since they have been closely involved in the actual plantation of mangroves and extract the resources from these forests, they have a direct stake in safeguarding the restored mangroves. A Corpus Fund created with each CBO during project implementation will also help the communities to look after the mangrove forests. Additionally, even after the project is completed, GEC will continue to be associated with the communities through other activities, just as it is still involved with the communities in the REMAG project.

Community preparing the ground for plantation






Technical Models

During the course of project implementation, different technical models were tried in order to evolve the most cost effective one. Adopting several models also ensure better results and survival rates. Based on the experience gained from REMAG project, the following models were been adopted:

Nursery-raised Seedlings: This model was adopted due to its capacity to give better survival rate. Nursery beds were prepared in the inter-tidal belts of the selected areas. The nursery operations typically started in monsoon, from July, and continued till November-December. The transplantation of nursery-raised plants was done in January-February.

Nursery-raised plantation

Seed sorting






Raised Earthen Mound Technique: This model was one of the preferred options due to its cost-effectiveness. The model is also easy to implement in cases where large areas are to be brought under mangrove cover. This technique has proved to be effective in terms of survival rate in adverse ecological conditions.

Direct Dibbling: This method can be employed at places where tidal current is low. It is also a method that can be used to cover maximum area in a limited time frame. The gaps, if any, are filled through nursery-raised seedlings. This model has proved to be cost-effective and result –oriented.

Propagules Plantation: Propagules of different species have been planted to increase the biodiversity of mangroves in certain areas.

Ground preparation for nursery plantation






PRIVATE SECTOR PARTNERS IN MANGROVE RESTORATION






The PPP project of GEC marks the first attempt in the country where as many as 21 industries have come together for the singular purpose of mangrove conservation. They have collectively contributed around Rs. 500 lakh to regenerate an area of about 4900 ha with the support of the community.


Introducing species diversity

The mangrove restoration project has partnered with the state's leading industries having a presence in coastal areas. The industries contributed to mangrove restoration in two crucial aspects – by providing the much needed funds to scale up restoration work, and by helping in the monitoring of the newly created plantations.

Benefits to Private Sector Participation

Industries in Gujarat showed great willingness to join hands for mangrove restoration and conservation for a number of reasons:

- **Need for a stable environment:** Since coastal areas are fragile, industries need to ensure that stability is maintained around their area of operation. Mangroves as bioshields help towards this objective.
- **Legal obligations:** Since industrial activities have environmental implications on the coastal ecosystems, industries have legal commitments towards conserving the environment. The companies, by partnering with the mangrove restoration project, were also fulfilling their legal obligations.
- **Balancing of environmental concerns and development:** Although development and economic growth often take place at the cost of the environment, it is possible to offset some of the damage caused by taking proactive measures to protect the environment where possible. Private sector companies involved themselves in looking for appropriate sites for mangrove restoration and some went on to even expand their plantation areas as the project continued.






- **Responsibility to the environment:** The industries partnering in the project are some of the largest in the state, and are quite aware of their responsibilities towards the environment around them. Some of them have been regularly involved in other environment-related projects.
- **Working with local communities:** As industries have their operations in a region over a long-term, they need to forge positive and strong relationships with local communities and the larger society. Working on environment protection helps strengthen these relationships as local communities are heavily dependent on it.

Monitoring by Private Sector

Monitoring mangrove sites was not easy, as many of them were located far away from the company's area of operations. For instance, a company may be located in Jafrabad, but the restoration site may be about 150 km away, in Bhavnagar. Yet, company personnel gave their full support and visited the sites and the communities regularly to ensure the healthy growth of new mangroves. In the initial project phase, there were instances when the unique requirements of mangrove plants were not fully understood by all partners and they attempted to select project sites close to their industrial units for ease of work. Unfortunately, some of these sites were not suitable and the saplings did not survive. In such cases, the partners were admittedly disheartened, but it was nevertheless a learning experience for all stakeholders. Later, as the project progressed, there were partners who were enthused by the restoration activities, derived immense satisfaction from it, and went ahead and did much more than they were legally bound to do. They expanded their project area through their own initiative, provided better monitoring tools through tracking growth through satellite images and even engaging third party monitoring agencies. Above all, by working with multiple stakeholders, there was increased sensitivity among private sector units towards the environment and communities around them.

Dandi






Sr. No.	Name of Company	Name of Site	Year of Plantation	Area covered in ha	Total Area covered in ha
1	NIKO Resources Ltd., Vadodara	Name of Site	2006-07	100	250
		Dandi, Dist. Surat	2007-08	150	
2	Gujarat Maritime Board, Gandhinagar	Dholai, Dist. Navsari	2006-07	30	120
		Magdalla, Dist. Surat	2007-08	30	
		Ghogha, Dist. Bhavnagar	2007-08	30	
		Jakhau, Dist. Kachchh	2006-07	30	
3	Gujarat Mineral Development Corporation, Ahmedabad	Nanicher, Dist. Kachchh	2007-08	30	30
4	Mundra Port & Special Economic Zone Ltd, Adani, Ahmedabad	Dandi, Dist. Surat	2006-07	200	700
			2007-08	200	
			2008-09	200	
			2010-11	100	
5	Adani Petronet Pvt. Ltd,	Dandi, Dist. Surat	2010-11	100	100
6	Gujarat Pipavav port Ltd., Mumbai	Dandi, Dist. Surat	2007-08	100	500
			2008-09	25	
			2009-10	75	
		Kantiyajal, Dist. Bharuch	2009-10	300	
7	Bayer Crop Science, Bharuch	Kantiyajal, Dist. Bharuch	2007-08	10	10
8	Essar Bulk Terminal Ltd., Hazira, Surat	Dandi, Dist. Surat	2008-09	100	300
		Ankalva, Dist. Bharuch	2009-10	100	
			2010-11	100	
9	Essar Steel Pvt. Ltd.,	Dandi, Dist. Surat	2010-11	100	100
10	Hazira LNG Private Limited, Hazira, Surat	Karanj, Dist. Surat	2008-09	150	300
			2009-10	150	
11	GSPC Pipavav Power Co. ltd., Gandhinagar	Kantiyajal, Dist. Bharuch	2008-09	10	110
		Karanj, Dist. Surat	2010-11	100	
12	Ambuja Cement Limited, Ahmedabad	Karanj, Dist. Surat	2008-09	25	150
			2009-10	125	
13	Gujarat Heavy Chemical Limited, Sutrapada	Rohino Island, Bhavnagar	2008-09	50	100
		Tarsara, Bhavnagar	2010-11	50	
14	Pipavav Shipyard	Kantiyajal, Dist. Bharuch	2009-10	5	5
15	Petronet LNG, Dahej	Nada, Dist. Jambusar	2009-10	50	350
		Ankalva, Dist. Bharuch	2010-11	100	
			2011-12	200	
16	ABG Shipyard, Dahej	Nada, Dist. Jambusar	2009-10	50	100
		Ankalva, Dist. Bharuch	2010-11	50	
17	Ultatech Cement Ltd.	Rohino Island, Bhavnagar	2009-10	20	100
		Tarsara, Bhavnagar	2010-11	20	
			2011-12	60	
18	Anjan Cement (Jaypee Group)	Muhadi, Kachchh	2009-10	25	100
			2010-11	75	
19	Larsen & Tourbo Company	Karanj, Dist. Surat	2010-11	100	100
20	Coastal Gujarat Power Ltd., TATA Power	Kantiyajal, Dist. Bharuch	2010-11	500	800
			2011-12	300	
21	KRIBHCO	Kantiyajal, Dist. Bharuch	2010-11	100	100
22	India Rayon	Madhavad Kotda, Dist. Junagadh	2010-11	25	50
			2011-12	25	
23	Kandla Port	Nakti Creek, Dist. Kachchh	2010-11	30	200
			2011-12	70	
		Satsaida Bed, Dist. Kachchh	2011-12	100	
				Total	**4675**






Private Sector on Mangrove Restoration: Sharing Experiences

Hazira LNG & Port Company


Company outlet

In an effort to develop the ecology and environment of surrounding villages, the Hazira LNG & Port Company undertook the project in the four villages of the Hazira peninsula. Funded and supported by the Group's companies over a period of five years, the programme has resulted in the development of 1235 ha of mangrove plantation and non-mangrove plantations all of which have brought bio-diversity to the area. More than 6,000,000 mangrove and 35,000 non-mangrove saplings were planted in the four villages, not only leading to improved ecology of the area, but also benefiting the fisher folk and other rural families. The entire plantation area is under social fencing with the village environment committees ensuring that no animals destroy the newly planted saplings and no foraging for fuel or feedstock takes place till the forests reach a self-sustaining level of maturity. In order to ensure plant survival, a corresponding effort has also been undertaken on developing terrestrial resources to provide alternatives for fodder and water. Over the last seven years, the Hazira Group of Companies has worked with village communities, the Gujarat government, NGOs and academic institutes to re-vegetate the mudflats of the Hazira peninsula, including a partnership with GEC for 300 ha of mangrove plantation.


Hazira LNG Port & Company






When it came on board, Hazira LNG & Port Company had an initial target of raising 400 ha of mangroves to meet their legal commitment. However, once it began the plantation work, the company went far beyond its original mandate and raised more than 1,200 ha of mangroves. Of the total plantation area, GEC partnered with the company for 300 ha, while the remaining area was taken up by the company's own efforts.

Celebration of World Mangrove Day


Plantation at Karanj






Petronet LNG Limited

Petronet LNG Limited (PLL), a company promoted by the Government of India, is engaged in the import of Liquefied Natural Gas (LNG) and setting up of LNG Terminals in the country. It is a joint venture company promoted by the Gas Authority of India Limited (GAIL), Oil and Natural Gas Corporation Limited (ONGC), Indian Oil Corporation Limited (IOC) and Bharat Petroleum Corporation Limited (BPCL), each having 12.5% equity share, totaling to 50%. In addition, GDF International (GDFI), a wholly owned subsidiary of Gaz de France, a French national gas company, holds 10% and the Asian Development Bank (ADB) holds 5.2% of the equity. The balance of the equity 34.8% is held by financial institutions and the public.

PLL is operates an LNG Terminal of 10 MMTPA at Dahej. It has also initiated work on other terminals that are at different stages of readiness. There are plans to further increase the capacity of the Dahej plant and another jetty is being constructed there.

Petronet LNG Ltd






PLL initiated mangrove plantation activities with the help of the State Forest Department in the Dahej area in 2007. However, due to the high current, the survival rate was less. Later, with the help of GEC, the company expanded its plantation efforts to other areas.

In its restoration efforts, PLL also tried to bring about diversity in mangrove cover and began working with the species Avicennia marina, Ceriops tagal and Rhizophora mucronata. Propagules were planted both under the shade of Avicennia marina as well as in open area. It was found that survival of new species was better under the shade and new species were unsuccessful in some locations. The growth of Avicennia marina was impressive with the trees attaining growth of 6-7 feet in certain regions.

Plantation by PLL at Ankalva

Originally, as part of Coastal Regulation Zone clearances, PLL was required to raise 100 ha of mangroves. However, the company later entered into MoU with GEC to regenerate an additional 550 ha. Of this over 350 ha have already been regenerated and the remaining work is under progress. "As a company, we feel proud to be part of such noble activity. It gives us tremendous pleasure to serve for the benefit of society and the nation as a whole," says an official from Petronet LNG Limited on mangrove restoration.






PLL and Mangrove Plantation

Phase	Financial Year	Covered Area	Location	Status
I	2007-08	2 ha.	Dahej, Bharuch	Completed, but uprooted due to high tidal currents.
II	2008-09	6 ha.	Dahej, Bharuch	Completed & surviving well
III	2009-10	50 ha.	Nada Village, Jambusar, Bharuch	Completed & surviving well
IV	2010-11	100 ha.	a) 50 ha. - Nada Village, Jambusar, Bharuch b) 50 ha. - Anklav Village, Hansot, Bharuch	Completed & surviving well Completed & surviving well
V	2011-12	200 ha.	Anklav Village, Hansot, Bharuch	Proposed
VI	2012-13 *	200 ha.	Anklav Village, Hansot, Bharuch	

*Proposed for the current FY 2012-13


Ceriops tagal for diversity






Ambuja Cements Limited

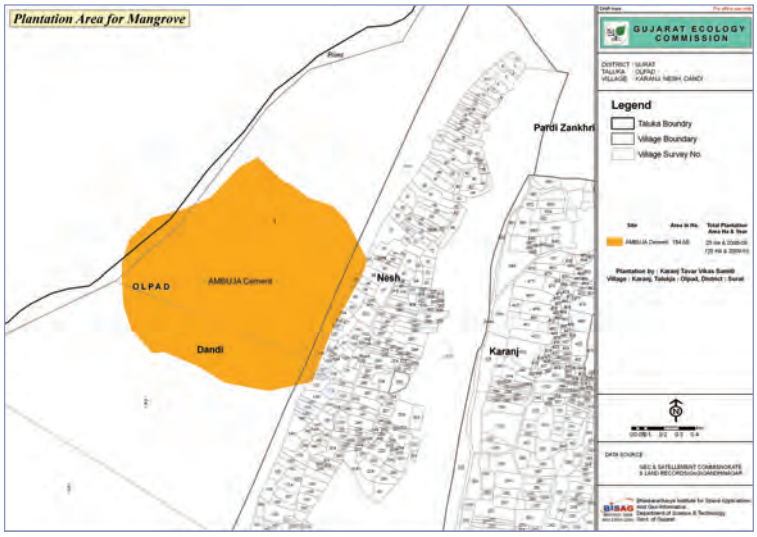

Plantation

Ambuja Cements Limited, with its unit in Ambujanagar, in Kodinar taluka, Junagadh started its production in 1986 with a capacity of 0.7 million TPA. It manufactures Ordinary Portland Cement and Pozzolana Portland Cement and has been the first company to introduce the concept of bulk cement movement by sea in India. This has resulted in speedier transportation and has brought many coastal markets within easy reach. ACL has a port terminal at Muldwarka, in Junagadh which is an all-weather port that handles ships with 40,000 DWT (Dead Weight). The port has a fleet of ten ships with a capacity of 20500 DWT to ferry bulk cement to the packaging units. The company has bulk cement terminals at Surat, Panvel and Galle in Sri Lanka.


Site selection visit





Our Mission - Give back more than we use

"The issue of environment protection is a major concern in all sectors of society. Gujarat has been ahead not only in industrialization but also in caring for the environment. As a part of its commitment towards environment protection and sustainable development, Ambuja Cements Ltd has carried out the mangrove plantation project in Karanj Village in Olpad Taluka, Surat in about 150 ha under the PPP model." – Vilas Deshmukh, Unit Head, Ambuja Cements Ltd






GSPC Pipavav Power Company Limited

GSPC Pipavav Power Company Ltd. (GPPC) is a Special Purpose Vehicle set up by Gujarat State Petroleum Corporation (GSPC) along with Gujarat Power Corporation Ltd. (GPCL) to establish a power project catering to energy requirements in Gujarat. GPPC is in the process of setting up 702 MW gas-based combined cycle power plant power project at Kovaya Village, in Rajula taluka, Amreli. The plant is in advanced stages of completion and both units are likely to be commissioned by the end of 2012.


Transporting seeds


Plantation


Nursery visit






Coastal Gujarat Power Limited – A Tata Power Company

Coastal Gujarat Power Limited (A Tata Power Company) is a 4000 MW Ultra Mega Power Project (UMPP) at Tunda Vandh village, in Mundra, Gujarat. It is India's First UMPP and has five units of 800 MW each. The company was established in 2006, as a special purpose vehicle (SPV) to implement the Mundra Ultra Mega Power Project. The company has its genesis in the Government of India initiative in 2005 that envisaged “Power for All by 2012”. Accordingly, to stimulate the required capacity addition, GOI encouraged coal-based UMPP that would provide cheaper power through economy of scale and use of super critical technology. The company is spread over 1,200 ha in Tunda Vandh and is linked by air, sea, rail and road networks.

CGPL Plant






In line with its attempts towards biodiversity conservation and environmental protection, CGPL has aimed to develop mangroves on 1000 ha of land. It has partnered with GEC for technical support and works closely with the CBOs, engaging in their capacity building, to cover vast tracts of land with mangrove plantations.

"In the company's efforts towards protecting the environment, this famous quote by Robert Lynd is very apt –There is nothing in which the birds differ more from man than the way in which they can build and yet leave landscape as it was before." - Krishnakumar Sharma, CEO, CGPL


Plantation by CGPL


Monitoring by CGPL






Essar Bulk Limited


Plantation by staff members

Essar is located in South Gujarat at a distance of about 20 kms from Surat. The potential of Hazira site for the development of a deep-water port was known since several years. Essar Bulk Terminal Ltd (Hazira I) is a 30-MMTPA, all-weather, deep draft dry bulk port and terminal in Hazira, Gujarat, that handles iron ore, coal, limestone, break bulk cargo such as pipes and coils and project cargo. It is regulated by the Gujarat Maritime Board. Hazira I is located in the Gulf of Khambat, on the west coast of India in Surat and is connected by a 30-kilometre state highway to National Highways 8 and 6. The port and terminal is close to the Mumbai-Delhi railway line.

The company identified mangroves as one of the key ecosystems which lead to the better management of the coastal zone. It thus decided to take measures and initiatives for coastal environmental integrity and also to fulfill compensatory eco-restoration with coastal communities in a phased manner in Aankalva village in Hansot taluka, Bharuch. It has undertaken to develop mangroves over 400 ha of land.

Celebrating World Environment Day






Narmada Cement Jafrabad Works

"Coastal mangrove ecosystems are the natural nursing grounds for hundreds of aquatic species including economically important fish and shellfish. Mangroves play an important role in controlling erosion caused by flooding and storm surges. They also act as a barrier during cyclones and protect the coastline. Thus it is necessary to conserve the existing mangroves and plant mangroves wherever we can. Mangroves will also help in reducing the impact of sea level rise anticipated due to global warming and will protect the adjacent farming lands." - D.M. Shah, Manager (Environment Cell) NCJW (Unit of UltraTech Cement Limited)

View of jetty from NCJW






COASTAL COMMUNITIES






Coastal communities dwelling in project villages come from low economic strata, with some villages such as Lakki and Ashirawandh in Kachchh also having very high illiteracy levels. The average size of households is about six members, but there are variations, where for example, Ashirawandh has an average family size of 10 members. The larger family size in Ashirawandh is due to the greater prevalence of joint families in this village. The villagers of project sites belong to different social communities that predominantly include Kharva, Halpati, Jat Fakirani, Koli Patel, Prajapati, Devipoojak, Rathod and Rajput castes. For instance, the Kharvas are largely to be found in Dandi, while the Halpatis dominate Karanj village. Lakki and Ashirawandh both have Jat Fakiranis, whereas Tadatalav has Koli Patels in large numbers.

Livelihood and Assets

The livelihood pursuits of the coastal communities depend much on their location of residence, their landholding pattern and proximity to the sea and mangroves. Regardless of their occupation, majority of the households depend on mangroves in one way or the other.

Fishermen

Pastoralists






Major Sources of Income

The occupations of project communities can be classified into the following broad categories:

- Farm-based livelihoods, either as independent farmers or agriculture labour
- Pastoralists
- Fishermen
- Mangrove workers
- Service-based occupations


Kachchh pastoralist

Agriculture is a significant source of income for the villagers of Tadatalav, Kantiyajal and Nada. The people of these villages have some landholdings and these are very close to mangrove sites. Thus, although while many of the villagers here may not directly depend on mangroves for their livelihood, the mangroves serve as a protective belt, safeguarding their valuable agricultural land from erosion and salinity ingress. Notably, most of the farm land owned by project households are in the dry zone with no access to irrigation.


Leaf collection in Kachchh







Fisherwoman

The Kachchhi villages of Ashirawandh and Lakki depend on animal husbandry and livestock rearing for their income. A large number of households in these villages too own land, and these plots are close to mangrove sites. Amongst all occupations, fisheries is by far the most popular, and Karanj, Dandi and Nada have a high proportion of inhabitants engaged in this livelihood. As most of the households from the three villages do not have any land assets, fishing is the only recourse they have to sustain themselves. Nearly all other project villages too have people dependent on fishing in their midst, either as part-time or full-time fishermen.

As mangrove plantation also involves a reasonable amount of work through seed collection, nursery raising, planting activities and gap filling, it too presents good employment options in the project area. Most mangrove workers are women who engage in mangrove-related work either on part-time or full-time basis. In fact, the dependence on mangrove plantations for livelihood constitutes a major source of income for family members across villages.


Fishing in mangrove areas






Awareness Generation and Knowledge of Mangroves

Interactions with local villagers typically started with a simple question – whether they had seen mangroves in their villages earlier. Most of the locals had some memory of these forests. Mangroves had been a part of their childhood years, and several had known of the forests even upto the last two decades. Almost all villages with the exception of Tadatalav and Lakki knew that some form of mangroves still continued to survive in their vicinity even before GEC began restoration work.

The most common perception of the utility of mangroves was its association with the prevention of soil erosion. Villagers from Kantiyajal, Karanj and Dandi were especially aware that mangroves protected their coasts from getting washed and swept away by waves and wind. However, other knowledge of mangroves and its benefits was limited. Significantly, despite the large number of fishermen in the project villages, very few knew how mangroves supported the breeding of fish in their ecosystem.

The first step GEC took to bring local communities on board was to build their confidence in the project and provide them with information on mangroves. The people had skewed knowledge of this coastal habitat, and so GEC began holding group discussions and meetings with village folk and its elders over the first two months of entry into each village. These discussions were further strengthened through audio-visual presentations in the evenings where people would gather and watch short films on the importance of mangroves.

Hon. Forest & Environment Minister with CBO member






As more interest began to be elicited, the discussions became more intense, and communities were urged to play an active role in mangrove restoration. Street plays and wall slogans also began to be added to the awareness campaign to reinforce through entertainment, the need for conservation and restoration. Since the project was being implemented in the wake of the cataclysmic tsunami, that catastrophe was also used to drive home the fact that mangroves were imperative as bio-shields in the dynamic coastal areas. In general, awareness generation activities went on for nearly six months before actual training and restoration work commenced. Once the community was ready to become a partner in the project, community-based organisations were formed in the villages.

Various wall slogans across villages on the theme of environment protection

Building Confidence

For communities grappling with poverty, protecting mangroves is rarely the foremost concern in their mind. They have more pressing and immediate problems such as fetching their daily supply of water, feeding their families and animals, and earning their livelihood. Persuading communities that they need to spend time protecting and planting mangroves was not going to lead anywhere without first addressing some of their more basic needs. The project therefore focused on different entry-point activities that were aimed at bringing people together, building their confidence, and creating assets they needed.

For instance, the region of Kachchh is as enigmatic and enchanting as it is harsh. Extreme weather and existential hardships stalk the people throughout the year. The region is a paradox with the sea, grasslands, rocks, hills, deserts and marshes all found alongside each other. Ashirawandh is a village that was once dotted with thorns and scrubs and had few amenities to boast of. There were no schools for children to attend, and drinking water, fetched from tankers, came with a price tag of Rs 20 for 200 litres. The people of Ashirawandh are Maldharis owning herds of buffaloes. With no water for their livestock, the women had to do daily treks through dry and dusty tracts with their herds to search for fodder and water. As grasslands began shrinking, they started turning to the next easy alternative to feed their animals – the mangroves. However, these too got denuded and they had to move deeper and deeper into the marshes to fetch leaves for the buffaloes.

Entry point activity at Dandi (Surat)






When GEC approached the people of Ashirawandh, they knew their priorities. They were in grave need of drinking water, a school and provision for fodder. A solution for drinking water was created by building a water reservoir of 20,000 liters. It was like an oasis in an arid landscape and considerably lessened the daily woes of the people. A cattle trough too was created to provide water for the village livestock. Along with a godown for fodder and grass plots that were also established, the Maldhari folk of Ashirawandh now had enough provisions for their animals and were no longer compelled to migrate for water and fodder. As illiteracy of their children was also a mounting concern, GEC helped the people build a school in the village.


Village campaign

Once the people of Ashirawandh began to see these new developments in their village, they willingly began to come forward to restore mangroves. They made themselves available and volunteered their time for the plantation activities. Importantly, they began to see that as their mangroves grew in expanse, salinity ingress became less, their cattle began giving more milk and they were less vulnerable to natural calamities. Before the project began, there used to be about 150 animals in their village, and as the project progressed, the livestock population had already more than doubled. This alone was a clear indication of the economic prosperity of the people.

Hon. Minister of State, Forest & Environment at environment campaign






The Task of Restoring Mangroves


Micro planning

Working in swampy areas to plant mangroves is very different from afforestation activities on dry land. To say the least, mangrove plantation calls for a lot more grit, determination, dedication and effort. The window of opportunity for carrying out plantation activities is much smaller, being dependent on tidal movements. The terrain too is difficult, as the workers have to plod and wade through swamps.

Work for plantation activities typically begins with micro planning. Local communities such as fishermen and pastoralists are called together and an action plan is prepared. Micro planning is done jointly with CBO members, field staff of GEC and the industry partner. Care is taken to include details such as tidal patterns, local festivals and people's availability before finalising the plan. In most regions, it has been the women who have volunteered for the rigorous plantation work rather than the men. The men go in pursuit of their livelihood while the women take on plantation work to earn supplemental income.


Women preparing nursery






The story was similar in South Gujarat, in the villages of Tada Talav, Dandi and Kantiyajal. As mangroves began to recede, agricultural land began to get washed away by the rampaging wind and sea. As much as 40% of farms were lost in the region due to wind and wave action. Fishermen too had to face the consequences of mangrove loss. The catch was no longer available in the waters near the shore and they had to go deep into the sea to get their fish. The entire local economy was adversely hit and heavy rains and tides during the monsoon period aggravated the situation still further. Coastal erosion continued at an unprecedented pace and the people found it harder and harder to earn their living.


Solar lights in Dandi

GEC explained the link between mangroves, erosion and fishing and the necessity of managing a balance between the three. It told the people that the mangroves would not only shield their farms and reclaim their land, but would also make fishing easier. The village folk would not be forced to enter into the more dangerous and difficult deep sea fishing. It began by creating fodder plots and a fishing pond for the people. Like Ashirawandh, as people began to understand the importance of mangroves, they started coming forward for restoration work. In fact, in Dandi, the entire plantation activities were managed solely by women.


Community initiative to protect mangroves






After the micro planning exercise, the first step is collecting the mature mangrove seeds from local mangrove forests and those in nearby areas. Unlike other terrestrial trees and plants where seeds can be collected and stored for later use, time is of essence in mangrove seed collection. The collection season is for about four months between August and November. After being collected from the forests, they survive for only a day and cannot be stored. They have to be immediately treated, have their capsule removed, and stored in water overnight. Thereafter, the seeds have to be sown in polythene bags for nursery development. Villagers involved in seed collection are paid by the kilogram, and they work from morning to evening during the collection period.

Training is given for mangrove plantation to supervisors and mangrove workers. Most of the restoration work has been done through nursery development, which requires knowledge of the right techniques to be used in preparing the beds, creating an embankment, filling up of bags at the right time and with the right soil, placement of the bags, and various other aspects. After the nursery beds have been prepared and raised, the next training is given for seedling transplantation. Mangrove workers need to know how to dig the soil where the seedlings are to be planted, how to remove the poly bags without hurting the fragile seedlings, and how to plant the seedlings in the pits.

Mangrove workers sorting propagules






In mangrove plantation, tidal movements dictate much of the daily working schedule. Thus, while preparing the nursery and doing the transplantation, a close watch is kept on the sea. The women go out to the sites when the tide is low and they can cross the creek. The low tide period lasts for about four hours, so they have to ensure that they reach the site, finish their work and return within this short period. They do not have the luxury of choosing the time they want to work. Crossing the creek is difficult business and is best done by experienced coastal folk. If the women miss the low tide period, the creek that may stretch for 3 km, can rapidly fill up with water upto ten feet high. At this height, there is danger not only of drowning, but also of being bitten by poisonous sea snakes. Walking and working through this swampy terrain is also arduous as trudging through knee-deep mud with head-loads of plants is difficult and slow.

Working in swampy areas

Preparing plantation site






Although mangrove seedlings mature fast, when they are very young, they need a great deal of care and protection for them to survive. Powerful tidal movements can be fatal and can wash them away before the seedlings have a chance to take root and anchor themselves firmly in the soil. Embankments built by the communities thus are one measure to safeguard the new plants and protect them from high tides. The arrangement of the polythene bags in the nursery bed is also of critical importance. The plants depend on this arrangement for support to withstand wave action, tidal force, absorbing nutrients and dealing with regular tidal washing. Improper arrangement of the bags could lead to water stagnation and could cause harm to the seedlings.


Careful arrangement of saplings

Once the transplantation of the seedlings is done at the actual restoration site, regular visits are made by industry partners, GEC field personnel and mangrove workers to monitor the growth of the trees. Gap filling is done by villagers wherever required when plants do not survive.


Rhizophora propagules






Formation of CBOs by GEC Since 2003-2010-11

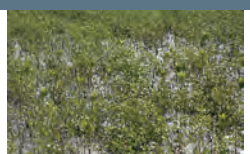
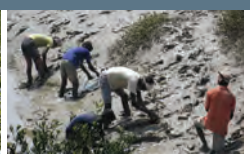
Sr. No.	Community Based Organisation	Village/Taluka/District
1.	Kolak Tawar Vikas Samiti	Kolak/Pardi/Valsad
2.	Dholai Tawar Vikas Samiti	Dholai/Gandevi/Navsari
3.	Mendhar Tawar Vikas Samiti	Mendhar/Gandevi/Navsari
4.	Dandi Kantha Tawar Vikas Samiti	Dandi/Olpad/Surat
5.	Karanj Tawar Vikas Samiti, Karanj	Karanj/Olpad/Surat
6.	Mor Kantha Tawar Punasthapan ane Vikas Committee	Kantiyajal/Hansot/Bharuch
7.	Aanklava Tavar Vikas Samiti	Ankalava/Hansot/Bharuch
8.	Katpor Tavar Vikas Samiti	Katpor/Hansot/Bharuch
9.	Jalstrav Gram Mandal	Nada/Jambusar/Bharuch
10.	Shri Bhathiji Sanyukt Kheti Sahakari Mandli	Neja/Jambusar/Bharuch
11.	Dariya Kantha Gram Vikas Mandal	Tadatalav/Khambhat/Anand
12.	Mahadevpura Bhangadh Dariyai Vruksh Ucher Sahakari Mandal Ltd	Mahadevpura/Dhandhuka/ Ahmedabad
13.	Madhwad kotda Tavar Savardhan Samiti	Madhwad Kotda/Kodinar/Junagadh
14.	Bagasara Cheriya Vikas Samiti	Bagasra/Maliya/Rajkot
15.	Tuna Dariya Kantha Vistar Vikas Samiti	Tuna/Anjar/Kachchh
16.	Ashirawandh Cheriya Vikas Samiti	Ashirawandh(Jakhau)/Abdasa/Kachchh
17.	Bhangodi Cheriya Vikas Samiti	Bhangodi/Abdasa/Kachchh
18.	Lakki Cheriya Vikas Samiti	Lakki/Lakhpat/Kachchh






PROJECT BENEFITS



In all, the combined efforts of various agencies and stakeholders in the state has brought more than 15,000 ha under mangrove cover in 15 different locations along the coast of Gujarat by employing various scientific and traditional techniques. The average survival rate has been over 60%, with the maximum plant height of 5ft at present. As a result of the long-term mangrove plantation activities, the mangrove coverage in the state has steadily increased from 944 sq km in 2005 to 1044 sq km in 2009 and 1058 sq km in 2011. Based on these results, it is evident that the innovative approach of involving the community and other stakeholders has resulted in the increase of the mangrove cover in the state.

Community Based Mangrove Regeneration in Gujarat (2003-04 to 2011-12)

Year	Area (Ha.)					
	ICEF	PPP Model	GOG	GOI	ICZMP	Total
2003-04	1250	—	—	—	—	1250
2004-05	560	—	—	—	—	560
2005-06	1101	–-	—	—	—	1101
2006-07	1190	290	–-	—	—	1480
2007-08	—	550	165	300	—	1015
2008-09	—	560	285	—	—	845
2009-10	—	900	965	—	—	1865
2010-11	—	1520	1100	—	1150	3895
2011-12	—	855	500	—	2100	3555
Total	**4101**	**4675**	**3015**	**300**	**3250**	**15341**

ICEF India Canada Environment Facility, New Delhi
PPP Corporate Funding
GOG Government of Gujarat
GOI Government of India
ICZMP Integrated Coastal Zone Management Programme






Improved Biological Parameters of the Mangrove Ecosystem

A biological assessment of project impact on the mangrove ecosystem was undertaken to study three criteria – species diversity, vegetation structure and ecological processes of the mangroves. One of the key aspects involved in the success of mangrove restoration has to do with the growth of the planted species.

There have been remarkable changes observed in the vegetation and other conditions at different sites. In Tadatalav in Khambhat for instance, 3.30 lakh cumt sediments were trapped within the span of five years by the plantation (550 ha) raised during the programme.

Parameters for Biological Assessment

The various biological assessment parameters that were used for gauging the health of the newly developed mangrove sites included:

- ***Plant density***
- ***Sapling density***
- ***Pneumatophore density***
- ***Tree height***
- ***Tree girth***
- ***Number of branches***
- ***Canopy cover***

Rhizophora species






The assessment results varied for each site as plantations are at different stages of growth and the local condition of each site is different. In Dandi, since the plantations are fairly recent, the tree height is not tall, but there is a high density of saplings. As these saplings grow, their height will increase and there will be mature trees in the region in the future. Lakki and Kantiyajal were already rich with mature trees, and therefore, these sites show less sapling density but have good tree density. The restoration site in Kantiyajal has the tallest and most mature trees of all project sites. Ashirawandh has both, trees and saplings in high numbers, and along with Tadatalav, the trees in both villages are of good height.

In terms of pneumatophores density, the presence of taller and more abundant pneumatophores rising above the mud imply better transport of oxygen to submerged roots and the prevalence of mature trees. Accordingly, Lakki, Ashirawandh and Tadatalav have the highest number of pneumatophores.

With regard to canopy measurement, Lakki and Kantiyajal can be categorised as very dense mangrove areas while Ashirawandh can be regarded as a moderately dense mangrove area. Nada, Karanj and Dandi can be termed as open mangrove areas. Since Karanj and Dandi have rather young plantations, it is still too soon to be able to take their canopy measurement.

Awifs Image 2000

Awifs Image 2007

Satellite imagery shows change in mangrove cover between 2000 to 2007 at Kantiyajal village of Bharuch district.






Soil characteristics across sites were studied to assess the differences between mangrove soils and non-mangrove soils. There was variation in terms of gradient in topography, ground biomass, canopy height and species distribution across sites. Moreover, the chemical properties such as pH, organic carbon, total nitrogen, available phosphorus and potassium were significantly different in the sites. Considering the soil values and the status of plants growth of each site, it was found that Ashirawandh, Lakki and Kantiyajal exhibited good growth of Avicennia marina due to the high nutrient value of the soil.

The biological assessment also inquired into the diversity of species in the study villages. It studied the presence of invertebrates, fauna and other species. Among the villages, Ashirawandh, Lakki and Kantiyajal again reported the highest richness of species supported by the mangrove ecosystem. The mangrove forest areas were found to be rich in species such as mudskippers, crabs, bivalves, gastropods and fish along with other numerous species. These areas were also a favourable habitat for birds, marine reptiles and snakes.

Darter

Marine catch around mangroves






Crabs and Mudskippers


Crab

Mangrove forests support a stunning faunal diversity, and the most prominent among the fauna are the crabs and mudskippers. Crabs are known to play a vital role in the health of mangrove habitats. They help aerate the dense mangrove soil by making burrows and facilitating the process of decomposition and mineralisation. They consume propagates, process the leaf litter, oxygenate sediments, and slow down the movement of the water flowing through the swamps. While they are prey for the large fish, they also produce copious larvae – an important food source for the many juvenile fish that use the mangroves as a safe haven.

Mudskippers are also unique fish with their special ability to adapt to mangroves. They get their name from the behaviour they display. They live in mangrove swamps and when the tide is out, they skip across the mud using their tails like springs. Generally, fish take in oxygen with the help of gills, but mudskippers can also breathe through their damp skin. This adaptation allows it to survive even when it is not in water.

Both, crabs and mudskippers have been abundantly found due to mangrove plantation efforts in Gujarat, and fisherfolk have now been able to considerably augment their income with their new catch. In Kantiyajal for example, mudskippers and crabs are now easy to find during the low tide phases. Mudskippers fetch around Rs. 42 per kilo while crabs are sold for about Rs. 300 per kilo. It is common now for fishermen of this village to get a catch of 3-4 kg of mudskippers and some crabs too, and thus, it is not too hard to have an earning of Rs. 200 during a single fishing expedition.






Mangrove Biodiversity

To increase the diversity of mangroves, biodiversity plots have been created in project areas on an experimental basis, where five different species were planted and grown. Species like Rhizophora mucronata and Ceriops tagal have been successfully rehabilitated with the indigenous knowledge of community. Other species of mangroves currently shows good survival rate with excellent growth in sites in Surat, Bharuch and Navasari. In all, 1185 ha have been covered with new mangrove species.

Empowerment of Community in Management of Mangroves

Eighteen CBOs were formed and strengthened by GEC during the span of eight years in various villages situated along the coastline of Gujarat and in close proximity of mangroves. These all villages were having direct dependency over this resource by one or other way. The CBOs were empowered to manage the mangroves in a sustainable manner. Now, as a result of the capacity building, there are over five community mangrove experts who have been associated in large scale mangrove plantation activities and are aware about all technical details of mangrove plantation activities.

Plantation through earthen mound technique

Rhizophora plantation






Mangrove Benefits to Village Communities

Whether it is the farmers, the fishermen or pastoralists, mangroves have proved to be beneficial to a large cross-section of village communities. They have enhanced rural income through the vast array of direct or indirect benefits. The most visible benefits of mangroves have been in areas where mangroves are stabilising and maturing.

A. Employment Generation

Developing mangrove plantations requires a great deal of labour inputs, right from sowing at the nursery to planting, vacancy filling and maintenance. The entire process takes about 3-4 months and there is inter-village movement of workers to compensate for labour shortage during the critical phases of mangrove development. In general, the plantation work can be divided into three stages that include:

1. **Nursery preparation:** Here, the workers prepare the nursery by filling plastic bags with mud, and then sowing the seeds in these bags. Most work on nursery preparation is done in the monsoon as mangrove seeds are most abundantly found at this time. The chances of germination are also high in this period.

Nursery beds






B. Fuel, Fodder and Household Use


Livestock in mangrove-rich areas

Mangroves are used by village communities for multiple uses. These trees have nutrient-rich leaves, and hard, durable wood that also burns well. They are therefore used for providing fuel and fodder, and the wood is used for an assortment of purposes such as crafting fish traps, fences, roofs and wharves. As LPG as an alternative cooking fuel is now widely available, the use of mangroves for fuel wood is now very limited, and is largely restricted to Dandi and Nada villages.

The most dominant use of mangroves is for fodder. Pastoral communities assert that mangroves have been vital to them and their livestock, especially during times of crisis in the extreme drought periods. After the restoration work, there has been enough fodder available to them locally, and they have been able to garner significant savings by not having to buy fodder from the open market.

Mangrove extraction is an activity that is highly women-centric, and it is notable that after project interventions, they are very careful while cutting the trees. There is an encouraging tendency to follow the selective extraction method rather than the complete extraction of the plant.


Leaf collection for fodder without damage to mangroves






2. Care of Saplings: After the sowing of seeds, there is a waiting period where the seeds germinate into young saplings. The workers at this time look after the saplings to ensure that they grow well and mature enough to be planted on the field.

3. Transplantation: In this final stage, the plants are carefully taken from the nursery for final planting on the ground. The plants have to be handled with utmost care and the ground too needs to be prepared properly for successful transplantation.

According to studies, villagers put in about 41-60 days of work for mangrove development, and a few even worked upto 91-120 days in a year. In most areas, the daily wages were in the range of Rs. 80-100. Findings show that the project helped the local communities in creating employment opportunities especial in the initial phase. Earlier, the people were largely engaged in farming, fishing, livestock and labour-related activities. With the introduction of mangrove works, sizeable opportunities were created to enhance their household income.

Transporting plantation material



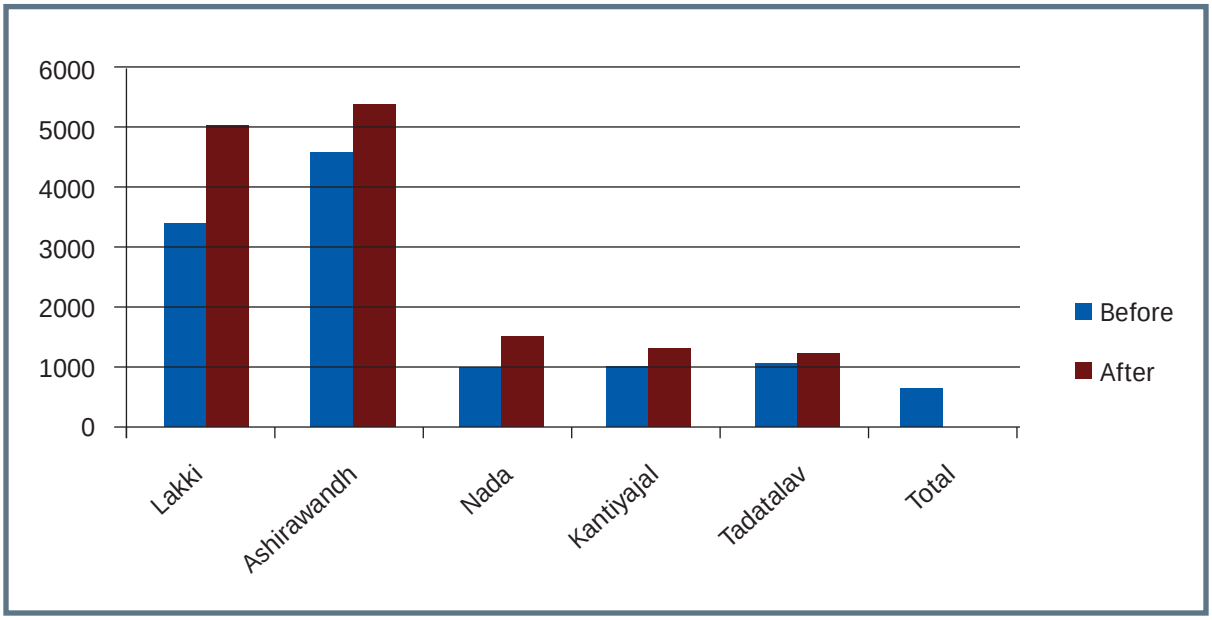



A small survey was undertaken among pastoral households to assess the extent of annual savings due to availability of mangroves. On an average, mangroves helped reduce purchased fodder consumption by 24%. Lakki saw the highest reduction in open market fodder consumption, followed by Ashirawandh, Tadatalav and Nada. The livestock-owning households also reported that their milk sales had increased after their animals started consuming greater quantities of mangrove-based fodder.

Savings in Fodder Expenditure Due to Mangrove Availability

Village	% of Saving in Fodder Cost (Rs./annum)			
	Below 2000	2000-5000	5000-8000	Above 8000
Lakki	9.1	18.2	36.4	36.4
Ashirawandh	14.3	21.4	7.12	57.1
Nada	44.4	22.2	2.2	11.1
Kantiyajal	14.3	71.4	0.0	14.3
Tadatalav	5.6	55.6	22.2	16.7
Total	**15.3**	**37.3**	**18.6**	**28.8**

Average Increase in Income from Sale of Milk Before and After Mangrove Restoration








C. Increase in Fish Catch

Fishing is widespread among coastal communities, and is a favoured livelihood choice where the people dwell relatively close to the sea. Most project villages live about 5km from the waters, but Karanj is one exception where it is merely 2 away. Dandi and Nada are also in close proximity to the sea, and thus, there is a high proportion of fishermen in these three villages. The households in project villages are poor and overwhelmingly few own boats to take out to sea and catch fish. Nearly 90% of them get their catch by engaging in the risky task of walking in deep waters. Those who are slightly better off, hire boats to do the same. When boats are taken on hire, there is an understanding that about a quarter of the catch would be handed over to the boat owner. Trips to the sea are usually made daily, either alone or in pairs. When mangrove cover started to increase with the project, the fishermen gained in two distinct ways. Not only did they have more catch, but they also caught more types of species. Overall, there was an increase of about 21% in the fish catch in project area after mangrove restoration, resulting in an increase in earnings by about 24%. Nada recorded maximum increase in earnings.

Improved variety of local fish

Some of the popular fish species now being caught around mangrove areas:

• Mugra	• Jinga	• Kagadi	• Shimla	• Chhodi
• Gol	• Karchla	• Sheval	• Dhangda	• Chheri
• Boi	• Levta	• Bumla	• Paplet	• Mugri

Fishing in mangrove region



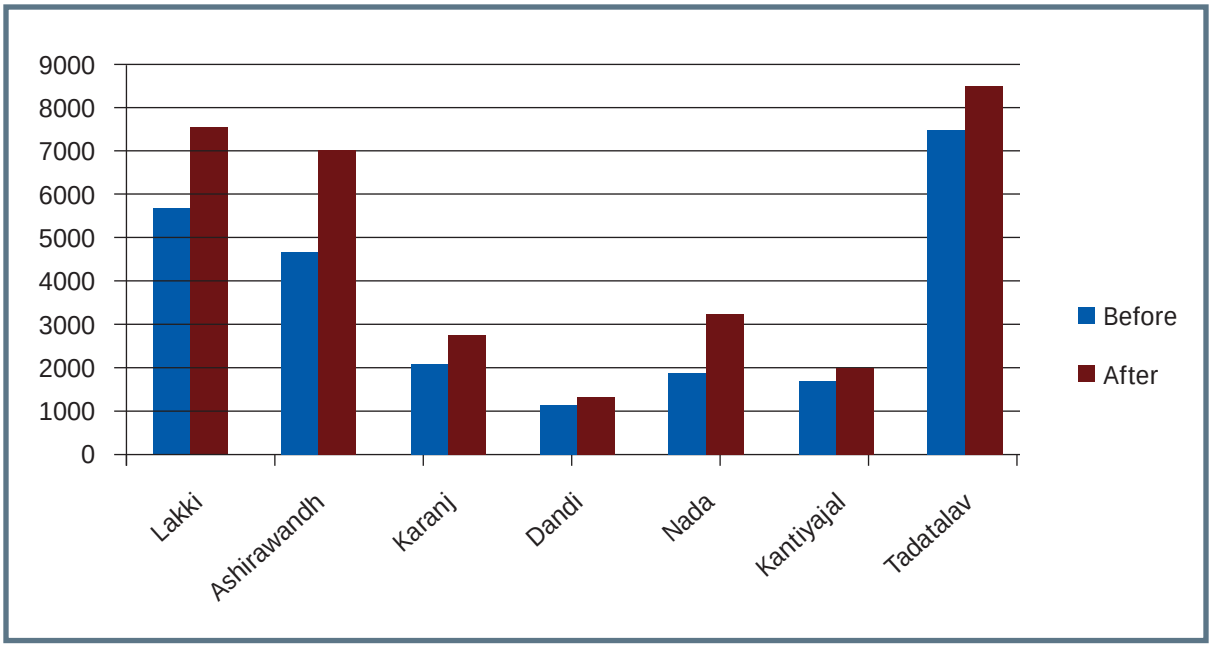



Changes in Quantum of Fish Catch Due to Mangrove Restoration

Village	Quantity of fish catch (kg)		% Change
	Before mangroves	After mangroves	
Lakki	39390	44467	12.89
Ashirawandh	10493	16115	53.58
Karanj	18690	20543	9.91
Dandi	1058	2576	143.90
Nada	10985	13394	21.93
Kantiyajal	1520	3618	138.03
Tadatalav	1800	3780	110.00
Total	**11916**	**14368**	**20.58**

Source: Village Survey, December 2009 – February 2010

Average Increase in Income from Fisheries through Mangrove Restoration








D. Protection of Farm Lands

Farmers having their lands adjacent to the coast have long been vulnerable to the impact of salinity ingression and winds. They grow crops such as cotton, wheat, millets and pulses and have routinely had to fear decreasing land productivity. Salinity ingression has been an acute problem in Dandi and Nada villages in particular, and has also affected villages such as Tadatalav, Kantiyajal, Lakki and Karanj considerably. In most of these villages, once the mangrove belt along the coast increased with restoration efforts, the farmers reported a remarkable decline in the level of salinity ingression. There was also an accompanying reduction in crop damage from the effects of wind and waves. It has been difficult to estimate the monetary benefits accrued by the farmers due to mangrove plantations, but there is strong empirical evidence to suggest that increased mangrove cover has led to twofold benefits – that of reduced salinity ingression and reduction in crop damage.

E. Reduction in Distress Migration

Nearly 19% of the rural households in project villages have been known to migrate to other villages or urban areas in search of work for a few months every year. When they migrate, it is either alone or with some family member. Due to mangrove restoration, opportunities for work within villages increased, and migrant workers have been induced to remaining in their villages. Apart from the project, the National Rural Employment Guarantee Act (NREGA) has also integrated mangrove restoration under its fold, thus allowing more migrant labour force to avail of employment opportunities locally.

Increased yield due to farm protection