Socio-Economic and Ecological Benefits of Mangrove Plantation

A Study of Community Based Mangrove Restoration Activities in Gujarat

Sponsored by

Gujarat Ecology Commission
(GEC) Gandhinagar

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MESSAGE

Socio-economic issues are some of the major issues of concern today for environment conservation and restoration. The managers make all efforts to make people understand the needs of conservation and restoration to improve social and economic conditions of all stakeholders in the specific environmental conditions.

Mangrove forests thrive in silt-rich, saline habitats worldwide, generally along large river deltas, estuaries, and coastal areas. It is characterized by low tree diversity and with a low broken canopy. Mangroves are evergreen trees and shrubs that are well adapted to their salty and swampy habitat. Thus, mangroves are not the only coastal vegetation but more appropriately they are the ecosystem which is vital for the environment as well as for nearby inhabitants. The mangrove ecosystem has the intricate mesh of roots that offers suitable habitat for the young animals. The submerged roots offer refuge to barnacles, oysters, sponges, bryozoans and variety of algae. The muddy bottoms are flourished with shrimps and mud lobsters. These benthic animals feed upon the mangrove litter and circulate the nutrients within the ecosystem.

India is bestowed by the luxurious growth of mangroves along its coasts. The Sunderbans are the largest mangrove patches in the world. Gujarat state on the western coast of India stands among the prime maritime states with the longest coastline (approx 21% of the Indian coastline) and two gulfs. The Gulf of Kachchh supports more diverse mangrove patches than the Gulf of Khambhat. In Gujarat, coastal communities are dependent on mangroves mainly for firewood and fodder. Further, the presence of mangroves increases the fishery status of the area also.

In this study an earnest attempt has been made to understand the social and environmental aspects of mangroves in Gujarat state. The study has considered various issues of social, environment and economical conditions of coastal communities. It is apparent from this study that increase in mangrove cover (leading the trend in India) along the Gujarat coast has checked the salinity ingression and favored agricultural practice. Moreover, the awareness among the coastal communities has raised the concern of conservation of the coastal treasures and will help to sustain the ecosystem on its own in future.

I congratulate Gujarat Ecology Commission to come out with such a realistic study in Gujarat. I am sure this book will open eyes of the scientific and academic community to understand the role of mangroves in livelihood enhancement of coastal communities.

Dr. S. K. Nanda, *IAS*
Principal Secretary
Forest & Environment Department
Government of Gujarat

FOREWORD

The State of Gujarat has the longest coastline among other maritime States of India which includes diverse marine flora and fauna. Mangrove forests are one among the most productive ecosystems on this planet and are important features of coastal habitats which are known for its salt tolerant characteristics as well as other tangible and non-tangible benefits to human being.

Mangrove species belong to different families. Presently 14 different species of mangroves have been reported in recent study in the State among which, *Avicennia marina* is the predominant species.

The mangrove ecosystem suffered degradation due to various reasons including natural disasters and human-animal interactions. To conserve this valuable ecosystem, Gujarat Ecology Commission (GEC) had initiated for the first time in the State, a restoration project with a Community Based Management approach. Several plantation activities as well as other developmental activities had been covered in the project.

This report deals with the assessment of social and ecological benefits accrued to the community after the implementation of the project. The study covered four different districts of Gujarat which includes Kachchh, Surat, Bharuch and Khambhat. The study is an attempt to prepare an interdisciplinary document by assessing the growth rate of planted mangroves under the REMAG project as well as benefits gained by the community in direct and indirect manner.

I am sure that this document will be useful to researchers as well as general community from interdisciplinary subjects and different industries. I congratulate the study team of Gujarat Institute of Development Research (GIDR), Ahmedabad, whose sincere efforts have resulted in the preparation of this useful document.

E. Balagurusami, *IFS*
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Thanks are due to all the Chief Executives and members of different CBOs of different mangrove villages for actively participating in the survey and focus group discussions and sharing their valuable inputs during field survey. Special thanks are also due to the village communities who spent their valuable time for sharing their views and experiences about mangrove plantations in their respective villages.

We also thank Mr. Sudhir Patel, Mr. Nilesh Patel and Mr. Babu Solanki, Post Graduate Students in Rural Management, Centre for Studies in Rural Management (CSRM), Gujarat Vidyapeeth who have helped us in collecting the information from the households as well as assisting in the biological assessment during the field survey in the mangrove villages.

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Finally, we express our thanks to Prof. Amita Shah, Director, GIDR for encouragement and support during the course of the study; to Prof. R. Parthasarathy, CEPT University, Ahmedabad and all the GIDR colleagues for their encouragement during the course of the work.

Place : Ahmedabad
Date:

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EXECUTIVE SUMMARY

Considering the wider significance of restoration of mangrove ecosystems from multiple perspectives of biodiversity conservation as well as their socio-economic importance to the coastal communities, the Gujarat Ecology Commission (GEC) had taken up the project "Restoration of Mangroves in Gujarat (REMAG)" with financial support from the India Canada Environment Facility (ICEF), New Delhi. The mangrove restoration project envisages achieving the important objectives through a multi--stakeholder approach, viz: (a) Enhanced capacity of communities to regenerate and sustainably manage mangrove resources for increased livelihood opportunities; (b) Increased support from industry in conserving and regenerating mangroves; and (c) More proactive involvement of the government in community based regeneration and conservation of mangroves

This study, titled, "Socio-Economic and Ecological Benefits of Mangrove Plantations: A Study of Community Based Mangrove Restoration Activities in Gujarat" was undertaken with the financial support from the Gujarat Ecology Commission in order to make a comprehensive assessment of the multiple benefits of mangrove ecosystems and their restoration efforts in Gujarat. The study is important and contextual as there are very limited empirical evidences as regards the impacts/ outcomes of mangrove restoration activities on the local communities in Gujarat. The important objectives of the study were to:

- Undertake a detailed mapping of the mangrove restoration activities in the study villages in order to understand the impact on the extent and spread of resource regeneration and status of the same;
- Determine whether the mangrove restoration activities have helped the coastal communities in the selected villages to improve their socio-economic status and livelihoods;
- Undertake a detailed biological assessment and valuation of the mangrove restoration activities; and
- Bring out the policy and institutional intervention mechanisms evolved for implementing the programme and their long term implications for developing a perspective Coastal Resources Management (CRM) strategy aimed at sustainable development and management of mangrove based coastal eco-systems in the villages and their scaling up in the wider context of the state.

For empirical validation of the above objectives, the study covered seven villages, viz., Lakki, Ashira Vandh, Nada, Kantiyajal, Dandi, Karanj and Tada Talav, covering 6 talukas spread over four districts, viz., Kutch Bharuch, Surat and Anand. A total number of 227 households have been covered for the study with highest representation from

Kantiyajal and Dandi Villages (50 and 47 households respectively). For valuing the direct and indirect benefits of mangroves, the study used the household survey method using a structured questionnaire in local language and conducted a biological assessment to trace the vegetative growth and biodiversity of the mangrove plantations. Focus group discussions and interactions with local NGOs were also conducted. A preliminary visit was undertaken to the study villages during October--November 2009 in order to build rapport with the CBOs and village communities prior to starting the final survey. The household survey and vegetation survey were conducted during the period December 2009 to February 2010.

The important findings and conclusions emerging from the study may be summarized as follows:

- The average size of a household is close to 6 members per family at the aggregate level, with slight variations across villages.
- The educational status of the respondents shows very disquieting scenario as larger proportion of them are illiterates in four villages, viz., Ashirawandh (94%), Lakki (76.5%), Tada Talav (46%), and Nada (44%).
- The community status of the households indicates the dominance of Koli Patel (40%), followed by Kharva (20%), Halpati (6.6%), Jatt Fakirani (15%), Devipoojak (16%), Prajapati (1.3%) and Rathod/Rajput (0.9%) communities. Dandi village has the major proportion of Kharva community with 93.6 % respondents, while people from Halpati community are only habituated with mangrove plantation work in Karanj village with almost 100 %. Lakki and Ashirawandh have almost equal number of respondents from Jatt Fakirani community with 94% and 100% respectively.
- About 30 percent of the respondents' main sources of income was fishery, followed by income from agriculture (25%), agriculture labour (15%), livestock (13.2%) and other activities (3.1%). About 14% of the respondents solely depend on the mangroves for income and occupation. Among the villages, 49 percent of the respondents from Dandi and 18 percent of respondents from Kantiyajal are depending on mangroves for earning their income.
- The occupational structure of the household members seems to be very interesting, as almost 34 percent of the households depend on mangroves for income and occupation as compared to other occupations, such as agriculture labour (22.6%), agriculture (14%), animal husbandry (11%), fisheries (10%), etc. Among the villages, the household dependence on mangroves is found very high in Dandi (55%), followed by Kantiyajal and Karanj (35% each), Tada Talav (34%), Nada (28%), Lakki (27.6%), and Ashirawandh (25%). The gender wise dependence on mangrove plantation shows

that compared to men, women are more dependent on mangroves. This is mainly due to their skill in seed collection, seed selection and other relevant operations, such as preparation of seed bed in the nursery, etc.

- An assessment based on the respondents' knowledge about the benefits of mangroves reveals that a significant proportion of the respondents are well aware of the beneficial outcomes of mangroves. For instance, 33 percent of the respondents feel that mangrove plantations prevent soil erosion and keeps soil particles intact. About 18 percent of the respondents reported that mangroves are helpful in preventing cyclones and thereby reducing the effect of heavy winds and the tidal waves. Almost 60 % of the respondents from Kantiyajal and Karanj villages have appreciated the soil protective role of mangroves. Some of the other important benefits about which the respondents have awareness are: a) green forest and tourist attraction benefits; b) increase in fish stock; and c) increase in rains.
- The activities involved in development of new plantations and upkeep of the existing mangrove plantations offered immense employment benefits to the communities in the study villages. On an average, the cumulative number of days of employment generated in all the mangrove villages in a given year seemed to be more than 20,000 mandays. The employment opportunities generated have resulted in a direct income transfer to the households in terms of wages. On an average, the annual wage income received by a household has been in the range of Rs. 7800-9000.
- The community dependence on mangroves is very high in that the level of extraction of mangroves for leaves/fodder and fuel seems to be as high as 46 percent among the communities. While 65 percent of the respondents reported extraction of leaves for fodder, 23 percent use small twigs/ timber from mangroves as fuel wood and another 5 percent collect the seeds from mangroves. The household extraction of mangroves has been notably high in three villages, viz., Ashirawandh (94 %), Lakki (88 %), and Tadatalav (72 %). Interestingly, mangrove extraction work is done mostly by women members as reported by 62 percent of the respondents. However, it is important to note that the communities are careful while cutting the mangroves as an overwhelming majority follow a selective extraction method rather than complete extraction (or destruction) of the plant.
- Fishermen are one of the important benefactors of mangroves in the study villages. The study shows that even though only 30 percent of the fishing communities are also dependent on mangroves at the aggregate level, the villages, such as Karanj, Nada, Dandi and Lakki have higher share of fishermen communities (67%, 41%, 40% and 29%, respectively). This gives us a chance to empirically validate the claim that mangroves help the fishermen communities with an increase in fish catch in

the mangrove grown areas. It has been reported by many scholars that mangrove ecosystems act as a habitat for various marine creatures, especially fish. A significant increase in the fish catch as well as types of species is being noticed in mangrove grown areas.

- The study shows that about 25 percent of the households have their farm lands adjacent to the mangroves. A decrease in crop damage was observed by many farmer respondents as a result of mangrove plantation. This has resulted in a substantial gain in agricultural income. Similarly, about 72 percent of the farmer respondents reported salinity ingression as a major problem adversely affecting their farmlands which are closer to the coastal areas. The extent of salinity ingression varied from village to village. It has been widely reported by the farmer respondents that salinity ingression has considerably reduced after mangrove plantations. In most villages, where the salinity ingression was very high and moderate before mangrove plantations, there was remarkable decline in the level of salinity ingression after the plantations have started growing. This is a notable positive outcome of mangrove plantations in the study villages.
- Use of mangroves for fodder is considered as of high economic value to the communities engaged in animal husbandry/ livestock rearing. Like many other coastal villages, the communities in the study villages also show a large dependence on animal husbandry/ livestock related activities. It is found that more than 38 percent of the households own livestock of one or the other kinds. Among the villages, households in Ashirawandh reported the highest percentage of livestock ownership (94%), followed by Lakki (82%) and Tadatalav (72%) while other three villages have lower less number of households owning livestock. Almost 92 percent of the households growing livestock reported that they increasingly depend on mangroves for extracting leaves for fodder for the cattle especially during extreme drought months. This also enabled them to make significant savings in their expenditures towards buying fodder from the open market. About 37 percent of the households reported that they were able to save a sum of Rs. 2000-5000 per annum from being spent on purchase of fodder from the market. Another 29 percent reported savings of above Rs. 8000 per annum on fodder for the livestock due to the easy availability of mangroves in their neighbourhoods.
- As a result of the increased consumption of fodder from the mangrove plantations, the communities also reflected that there was a notable increase in the quantity of milk production per cattle population which also rendered them income gains from increased sale of milk after domestic consumption. For instance, at the aggregate level, the average gain income from sale of milk increased from Rs. 623 to Rs. 1068 per household.

- Inter as well as intra-village migration has been reported as an important characteristic of the study villages as in any other parts of the country in particular. The study reveals that before establishment of mangrove plantations, almost 19 percent of the households used to migrate (with notable differences between villages, Nada village reported 34% and Tadatalav reported 33% labour migration) to other distant villages, including urban areas for work for few months (as revealed by 39%), or for a year (37%) or few days in a year (23%). The development of mangrove plantations has had significant impact on reducing the incidence of labour migration in the study villages. On the one hand, the work opportunities in mangrove plantations have induced the migrant workers to stay back in the villages and work in the mangrove plantations. On the other hand, it has been reported that in some of the villages mangrove work has already been integrated with the National Rural Employment Guarantee Act (NREGA) programme which started providing employment to the village households in terms of guaranteed work in the mangrove plantations.
- The study also undertook a detailed biological assessment to examine the vegetative growth and biodiversity dimensions of mangrove plantations in the study villages. In order to do that it assessed the species diversity, ie., the presence and abundance of species; vegetation cover and structure, and the ecological process by indirectly measuring the nutrient availability and biotic interactions. The biological assessment also brought about the diversity of the study villages in terms of presence of invertebrates, mobile fauna and other species. Among the villages, Lakki, Ashirawandh and Kantiyajal have reported the highest species richness supported by the mangrove ecosystem. The mangrove areas have been found to be quite rich in terms of other species, such as mudskippers, crabs, bivalve, gastropods, fish, and habitat for other species. As mangroves areas have achieved good growth over the past few years, they also found to be providing habitat for birds and marine reptiles, like snakes.
- The study provides a holistic view of the mangrove restoration efforts being initiated in Gujarat since the past 6-7 years under the joint initiatives of the state (through the Gujarat Ecology Commission) and the community based organisations (CBOs). Though this study is limited in coverage (7 villages of the total 22 mangrove restoration villages in Gujarat), it brings out several dimensions of the beneficial outcomes of mangrove restoration activities in place. It needs to be mentioned that the total economic valuation of the benefits derived from mangroves as attempted in the study is only indicative of the potential social and environmental benefits that could be realised in the future when mangrove plantations achieve the maximum growth.

- The study highlights the importance of evolving long-term policies and institutional intermediations required for carrying forward the development of new mangrove plantations as well as conservation/ restoration of the existing plantations. In this connection, it is important to consider that the local communities and the CBOs need to be more strengthened in terms of increased awareness, skill development, capacity building, etc so as to enable them to conserve/ restore the mangrove ecosystems for the future. Though a majority of the communities (91%) do feel that growing mangroves is important for protecting the coastal systems and livelihoods from the adverse effects of cyclones, soil erosion, etc, they still lack the motivation and incentives to conserve the resources on a sustainable basis. This is an important challenge, which needs to be addressed through policies and interventions for creating motivations for conservation and restoration.
- The fact that growth of mangrove plantations is adversely affected by industrial pollution as well as garbage deposited into the coastal waters has been identified as a serious environmental issue by the communities in Ashirawandh and Karanj villages which need proper addressing. Besides, oil spill from boats and dumping of plastics were also reported. The discharge of saline water from salt pans is also reported adversely affecting the growth of mangroves. Similarly, the closeness of a cement factory near the mangroves area is also reported as creating environmental problems for mangrove trees. The lack of inflow of freshwater (river water) due to construction of a dam is also reported affecting the growth of mangroves.
- The provision of boats for fishing is yet another important need indicated by the fishing communities. The study reveals that only 9 of the 98 fisher communities own boats for fishing (6 boats in Ashirawandh, 2 in Lakki and 1 in Nada village). In the absence of boats or inability to hire costly boats, almost 89 percent of the fishing communities walk on deep waters for catching fish. This situation needs to be addressed through arrangement for provision of fishing boats to the communities who can own and operate fishing boats on a collective basis.
- It has been observed that vast majority of the households have started using mangroves as the major source for firewood, even replacing the use of conventional woods available in the local areas. Earlier, the use of local woods was also use to be supplemented with either neem or charcoal. There are also many instances in which respondents have stopped using kerosene for cooking with the abundant availability of mangroves. These trends suggest the increasing pressure on mangroves for use of firewood other than fodder for livestock. This may invariably affect the existing stock and future growth of mangrove plantations as households prefer mangrove to other sources of fuel for cooking due to its easy availability and access. This eventuality

calls for proper mechanisms and solutions through awareness creation to arrest the excessive extraction of mangroves. As imposition of policies or regulations alone will not work in such contexts, this problem needs to be addressed through promotion of planting of suitable species of wood for cooking in the villages.

- Finally, sustainable development and restoration of mangroves essentially calls for more efforts for creating opportunities for collective action among the multiple stakeholders, like line state departments under various government portfolios, the local communities, private firms and industries who are increasingly investing in mangrove plantations, NGOs, local administration units, like the village Panchayats. This requires more frequent interactions among these stakeholders towards identifying more innovations and action plans for sustainable development and restoration of mangrove plantations in the villages. Needless to say that all these innovations and action plans should be targeted towards strengthening the capabilities of the local communities and sustaining their livelihoods without compromising on the broader goals of sustainable management of mangrove ecosystems.

Abbreviations Used

ADB	Asian Development Bank
BWS	Bhitarkanika Wildlife Sanctuary
CBO	Community Based Organization
CRM	Coastal Resources Management
CUV	Consumption Use Value
CV	Coefficient of Variation
DUV	Direct Use Value
EC	Electric Conductivity
EJF	Environmental Justice Foundation
EV	Existence Value
FAO	Food and Agriculture Organization
FDA	Forest Development Agency
FGDs	Focused Group Discussion
FSI	Forest Survey of India
GBH	Girth Breast Height
GEC	Gujarat Ecology Commission
GIDR	Gujarat Institute of Development Research
GNP	Gross National Income
GoG	Government of Gujarat
GoI	Government of India
GUIDE	Gujarat Institute of Desert Ecology
HHs	Households
ICEF	India Canada Environment Facility
INR	Indian Rupees
IRS	Indian Remote Sensing
ISME	International Society for Mangrove Ecosystems
IUV	Indirect Use Value
LISS	Low-Imaging Sensing Satellite
MBCE	Mangrove Based Coastal Eco-systems
MSSRF	M.S. Swaminathan Research Foundation
NCUV	Non Consumptive Use Value
NGO	Non-Governmental Organisation
NREGA	National Rural Employment Guarantee Act
NUV	Non Use Value
OC	Organic Carbon
OV	Option Value

PDO-ICZMP	Program Development Office for Integrated Coastal Zone Management Plan
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PIPs	Project Implementation Partners
PPP	Public Private Partnership
PSR	Pressure State Response
REMAG	Restoration of Mangroves in Gujarat
SD	Standard Deviation
TEV	Total Economic Value
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
USD / US$	United States Dollar
UV	Use Value
WPR	Work Participation Rate

Chapter - 1

INTRODUCTION

Rehabilitation of any natural ecosystem requires careful planning and active involvement of the local communities, in particular, to restore it to its original state and function. Natural resources (land, water, and other resources) occur naturally within environments that exist relatively uninterrupted by mankind. A natural resource is distinguished by the status of biodiversity that it supports and the various ecosystems that it protects. Natural resources have originated historically through various natural processes and environmental interactions and many of them are essential for our survival while some are used for satisfying our daily needs.

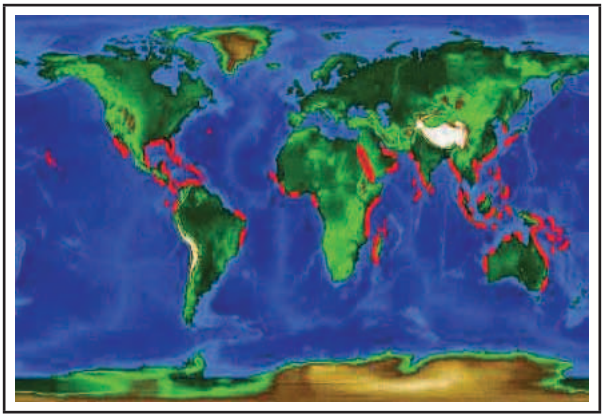
Coastal resources are an integral part of natural resources. Similarly, coastal zones form part of the coastal environment. A vast segment of the coastal communities heavily depend on the coastal and marine resources and ecosystems for their livelihoods. Coastal ecosystems (e.g., coral reefs, mangroves, and wetlands) are also one of the world's richest storehouses of biological diversity and primary productivity. However, since past several decades, the ecosystems have been threatened by various human activities and development interventions. Since about 87 percent of the population lives within 50 km of the coast, the coastal ecosystems are under severe pressure threatening the future of these ecosystems. It is estimated that about half of the world's coastal ecosystems, including mangroves face a significant risk of degradation from human activities and other development interventions. In this context, the South and Southeast Asian coastal ecosystems are perhaps among the most threatened regions.

1.1 Mangroves

Every ecosystem supports human life by giving direct or indirect benefits and services. Mangrove plantations are one among the most productive ecosystems on this planet. They serve as custodians of their juvenile stock and form most valuable biomass (Odum 1971). The term mangroves refer to an ecological group of halophytic plant species which is known as the salt tolerant forest ecosystem and provides a wide range of ecological and economic products and services, and also supports a variety of other coastal and marine ecosystems.

Mangroves occupy less than 1 % of the world's surface (Saenger, 2002) and are mainly found between the Tropic of Cancer and the Tropic of Capricorn on all continents covering an estimated 75 percent of the tropical coastline worldwide.

Map 1.1: Global Distribution of Mangroves



Source: FAO: World Atlas of Mangroves

Mangroves are one of the most valuable coastal habitats providing enormous benefits (both tangible and non-tangible) to the local communities as well as the ecology and environment surrounding them. Tangible benefits of mangroves comprise timber and non-timber products and other livelihood support systems provided (Table 1.1).

Table 1.1: Different Uses and Functions of Mangroves

Mangrove Uses	Mangrove Functions
A. Sustainable Production Uses	**B. Regulatory or carrier functions**
Timber; Firewood; Woodchips; Charcoal Fish, Crustaceans; Shellfish; Tannins; Nipa; Medicine; Honey; Traditional hunting; fishing and gathering; Genetic resources	Erosion prevention (shoreline and riverbanks); Storage and recycling of human waste and pollutants; Maintenance of biodiversity; Provision of migration habitat; Provision of nursery grounds, Nutrient Supply. Nutrient regeneration; Coral reef maintenance and protection; Habitat for indigenous people; Recreation sites
C. Conversion Uses	**D. Information Functions**
Industrial / urban land use; Aquaculture; Salt ponds; Rice fields; Plantations; Mining; Dam sites	Spiritual and religious information; Cultural and artistic inspiration; Educational, historical and scientific information; Potential information

Source: Modified after Reitenbeek (Adapted from Doherty 2004)

Non tangible benefits include ecological and social functions, such as coastal protection against wave and current abrasion, shelter and habitat for wildlife, and ecotourism. As stated above, globally, mangrove resources are seriously threatened and have disappeared during the last several decades of intensive human as well as development interactions. Human settlements, expansion of agricultural or salt-making lands,

development of industries and ports, the expansion of coastal aquaculture, have been identified as the critical factors that had resulted in depletion and degeneration of mangrove resources.

Mangroves possess several characteristics that make them structurally and functionally unique (Alongi, 2002). Mangrove forests have traditionally been utilized by the local people for a variety of purposes (Choudhry, 1997).

1.2 Importance of Coastal Plantations

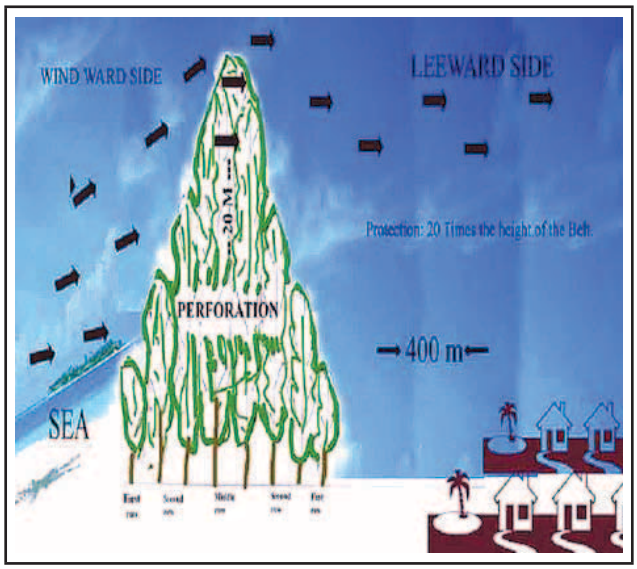
Essentially, there is a need to understand why mangroves are integral parts of coastal plantation and ecosystems. By now, it is widely known that cyclones and tsunamis mostly originate from the sea and move towards the land, the wind velocity gets reduced, reflected, deflected and dissipated, when they pass through the coastal forests, mangroves, offshore islands, coral reefs, head lands, sea cliffs, sand pits, mudflats, sand dunes, creeks etc.

Other than the above natural features, manmade structures along the coast line such as offshore platforms, sea wall constructions, harbour and plantations also help in lessening this effect. The wave-induced effects of tsunamis, hurricanes and cyclones lead to casualty of people, livestock and other living organisms as well as loss of property. These violent storms and tsunamis born at sea strike the coast with a wind speed up to 90 km per hour and create waves with a height of about 10 to 20 meters, causing severe damages as stated.

Hence, coastal habitats such as mangroves and other wetlands, coral reefs, coastal barrier islands and lagoons are often recognized by experts as the best defenses against wind, waves and erosion by deflecting and absorbing much of the energy of winds. Therefore, it is important to sustain/ preserve these natural habitats for shore protection as well as for environmental conservation. Creating a shelterbelt of trees and other vegetation along the coast would act as a first line of defense against the effect of frequent cyclonic storms and heavy winds. Some of the important reasons why mangroves need protection in the present context are:

- The coastal zone is a dynamically unstable system where natural disasters of one or the other kind like sea intrusions, cyclones, tsunami, etc., strike year after year.
- Last 300 years experienced gradual increase and unusual accumulation of CO_2 in the atmosphere mainly due to industrial activities.
- Global warming, ice melt increase in water in oceans, tidal waves
- Mangrove prop roots do not easily yield to the tidal waves and they do not let loose the soil.
- Mangroves act as coast guards, watchdogs and self-regenerating plantations.

The following model confirms the mitigating effect of mangroves on the heavy winds and high waves which actually originate from seaward side and causes damage to the surrounding environments.



Historically, mangroves have been regarded as wastelands or economically unproductive plantations. As a result, the scale of destruction of mangroves has been dramatic with many countries showing losses of 50-80 percent or more, compared to the mangrove forest cover that existed even 50 years ago. Much of the world's best mangrove ecosystems have been degraded or converted into agriculture, aquaculture, industrial or urban areas (Appendix Table 1.1). Aquaculture has been one of the major causes of mangrove loss and resulted in loss of 90 percent mangrove cover in some parts of Ecuador (e.g. Chone River estuary). The livelihoods of the local coastal communities have been diminished/or totally lost by the destruction or degradation of mangroves (Macinto and Ashton, 2003).

1.3 Restoration of Mangroves – Social & Biological Perspectives

However, of late, there have been some encouraging efforts by national governments, International NGOs and the local communities around the world to conserve, rehabilitate and manage mangroves sustainably. By and large, this is a reflection of the growing awareness towards mangroves, their importance and the tangible and non-tangible benefits that mangroves provide to the world. A vast but growing empirical research brings out the historical significance of mangrove restoration efforts and most of these studies have used inter-disciplinary social and biological perspectives in understanding the contemporary relevance of mangrove restoration activities.

The environmental importance of mangroves and their conservation has been widely demonstrated (e.g., Othman 1994, Nagelkerken et al. 2000, Kathiresan and Rajendran 2005), as well as their direct and indirect contributions to the livelihoods of millions of

coastal inhabitants (Sathirathai and Barbier 2001, Soontornwong 2006). Unfortunately, mangroves are seriously threatened ecosystems (Valiela et al. 2001), with threats coming from coastal development, conversion to aquaculture, overharvesting of trees, pollution, and global climate change (Adeel and Pomeroy 2002, Alongi 2002; Macintosh and Ashton, 2003). This highlights that there is an urgent need to find conservation strategies that lead to successful biological outcomes, while accounting for the needs of rural coastal inhabitants who depend on the resource.

There is extensive documentation that in many upland systems of South and Southeast Asia, local forest protection and management has led to an improvement of forest conditions (e.g., Agrawal and Ostrom 2001, Gautam et al. 2002, Kabir and Webb 2006). This has led to a shift in policies and action toward decentralization and local management (Webb 2008). In contrast, surprisingly little is known about the impacts of community management on coastal mangrove forests, with the exception of the Philippines, where community-based coastal management projects have existed for more than 20 years (Pomeroy and Carlos 1997, Alcala 1998, Katon et al. 2000, Walters 2000, 2003). Indeed, it has been recognized for some time that community-based coastal management shows promise, but its integration into national management systems would require significant effort on the part of governments to reorient legal and policy instruments to include local communities (Pomeroy 1995).

The issue that 'how can community management of mangroves be assessed for conservation outcomes?', has been a major botheration for researchers for long. Quantitative surveys can report biological outcomes. But when the resource is managed by local communities, it becomes all the more important to gather the socio-economic information, to explore the contextual factors associated with the varied outcomes of interaction between mangroves and local communities on the one hand as well as the interface between conservation/ restoration efforts made by the state and other agencies and the local communities on the other. In this regard, though researchers have tried to understand such interface with respect to forests and joint-forest management systems (Kijtewachakul et al. 2004, Gautam and Shivakoti 2005), there are hardly any such studies particularly in the Asian context as regards the mangroves and their interface with local communities and governance systems.

This study assumes relevance in this specific context and makes a modest attempt at understanding how the local communities consider the importance of mangrove restoration activities being carried out by the Gujarat Ecology Commission in recent years in several villages in the state. In doing so, the study uses the state of the art assessment tools to assess the tangible and non-tangible benefits of mangrove restoration activities as reflected by the local communities in the case study villages.

1.4. Mangroves- Global Scenario

There are 18 million ha (Spalding 1997) of global mangroves inhabiting in 112 countries and territories in the tropical and subtropical region. Around 34 major and 20 minor mangrove species belonging to about 20 genera in over 11 families have been recorded globally (Tomlinson 1986). Mangroves of South and Southeast Asia form the world's most extensive and diverse mangrove systems comprising 41.4 percent of global mangroves (Table 1.2). Indian mangroves make up 3.1 percent of the total global cover and are distributed along all the maritime states, except the union territory of Lakshadweep, covering an area of about 4461 sq. km along the 7,500 km long Indian coastline. The floral diversity of mangroves of India is comprised of 38 core mangrove species (Kathiresan 2003).

Table 1.2: Areal coverage of mangrove forests in the World

Region	Area (sq km)	% share
1. South and Southeast Asia	75170	41.4
2. The Americas	49096	27.1
3. West Africa	27995	15.4
4. Australasia	18788	10.4
5. East Africa and Middle East	10348	5.7
Total	**181397**	**100.0**

Source: Kathiresan, 2003

In India, the states like West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Andaman and Nicobar Islands, Kerala, Goa, Maharashtra, and Gujarat occupy vast area of Mangroves. The area under mangroves in Gujarat is the second largest along the Indian coast, after Sunderbans. Gujarat has about 23 percent of India's estimated mangrove cover of 4.88 lakh ha. Of the total mangrove cover in the state, the coastal district of Kachchh covers almost 90 percent.

1.5. Mangroves in India

The latest assessment of the Forest Survey of India (FSI) shows that mangrove cover in the country is 4639 km^2, which is 0.14% of the country's total geographic area. The very dense mangroves comprises 1405 km^2 (30.29% of mangrove cover); moderately dense mangroves is 1659 km^2 (35.76%), while open mangrove covers an area of 1575 km^2 (33.95%).

In recent years, the country has recorded an increase in mangrove cover by 58 km^2, of which Gujarat alone showed an increase of about 55 km^2. The latest status of mangrove

plantations in India is presented in Table 1.3. It shows that West Bengal has the highest share (46.4%), followed by Gujarat (22.5%), A&N Islands (13.3%) and Andhra Pradesh (7.6%). The status of mangrove cover in rest of the states has been showing slight improvements particularly in Maharashtra, Orissa, and Tamilnadu.

Mangroves of Bhitarkanika (Orissa)

Mangroves of Sundarbans (West Bengal)

Table 1.3: Trends and Status of Mangrove Plantations in India (Sq km)

State / UT	1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007	% 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	21	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**

Note: *As per the West Bengal Forest Department, mangrove area in Sundarbans is 4,200 km² (approximately) which is almost double the area estimated by FSI. This is mainly due to the difference in assessment methods. West Bengal Forest Department includes the intervening water in the mangrove cover; whereas, assessment of FSI takes into account the mangrove cover only, as discerned on the satellite image.

Source: FSI Report, 2009.

Further the report also highlights the measures taken in Orissa (which showed an increase of 4 sq km), Tamil Nadu (3 sq km) and West Bengal (6 sq km). As evident, there was a decline in mangrove cover in some states due to the tsunami which struck the Andaman and Nicobar Islands resulting in a loss of about 20 sq km of mangroves. However, the post-Tsunami period witnessed tremendous mangrove replantation and restoration efforts by the states with support from various development agencies as evident from Table 1.4.

Table 1.4: Mangrove Plantation Activities in Different States of India

Institute / Agency	State	Plantation Site	Month / Year of Plantation	Area of Plantation	Planted Species
Nature Club, Surat (with Hazira LNG Pvt. Ltd.)	Gujarat	Umra Ovara (Tapi riverbank)	Aug. – Dec. 2008	-	*Avicennia sp., Ceriops*
Forest Dept.	Goa	North Goa, South Goa	2001 – 2005	-	-
ISME (with Natural Heritage Conservation Society & Daheda Sangh)	Gujarat	Sabarmati Estuarine Area near Vadgam	2009 onwards	80 hac. (in 2009)	*Avicennia marina*
M.S. Swaminathan Research Foundation (MSSRF) (Funding: ICEF)	Andhra Pradesh	Godavari Krishna Estuary	1997-2004	520 hac.	*Avicennia marina, Avicennia officinalis and Excoecaria agallocha*
Forest Dept.	Tamil Nadu	Different Coastal Districts of T.N	2005-06	2000 hac. + 700 hac.	*Aegiceras corniculatum, Bruguiera gymnorrhiza, Rhizophora apiculata, Rhizophora mucronata and Xylocarpus moluccensis*

Source: Authors' compilation from various sources.

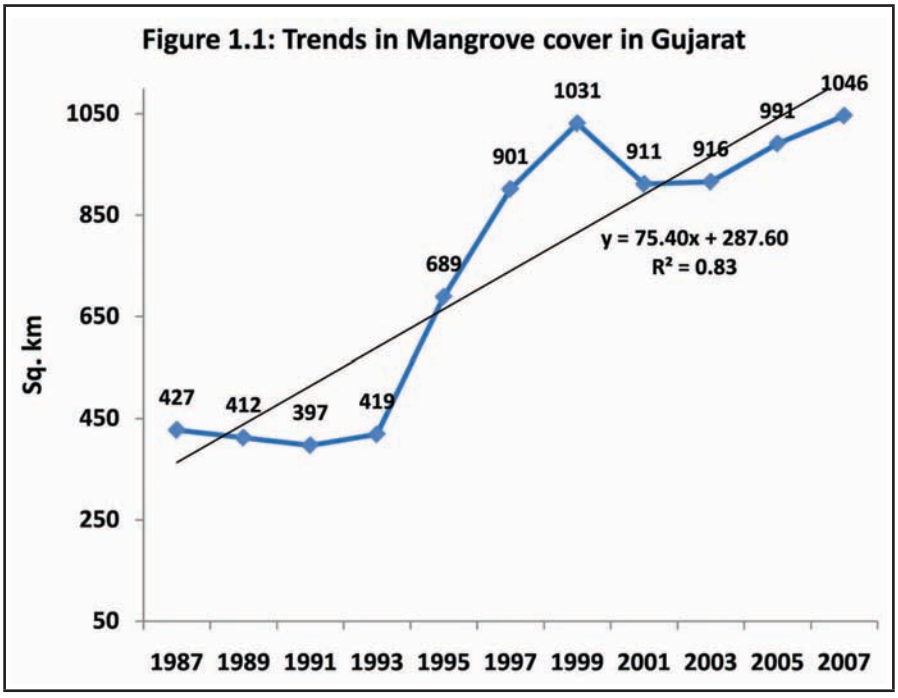
1.6. Status of Mangroves in Gujarat

Historically, Gujarat had an extensive and diverse mangrove ecosystem which had been degraded or depleted over time due to various developmental activities as well as natural disasters and anthropogenic interactions. In fact, until about 1960s, mangroves were considered as 'economically unproductive areas' and hence, they had faced destruction caused by expansion of economic as well industrial development activities (Hirway and Goswami, 2007). However, after many years of wide spread destruction and degradation, significant efforts are being made in recent years by the State Government and the International agencies to restore and regenerate the mangrove stock in Gujarat.

According to FSI report there was a constant increase in the mangrove cover in Gujarat state since 1987-1999 but in 2001 it decreased from 1031 sq km to 911 sq km (Figure 1.1). But ever since 2001 the state saw an increase of 135 sq km. The report also states that Gujarat showed an increase in mangrove cover mainly because of the plantation and protection measures taken by the state in recent years.

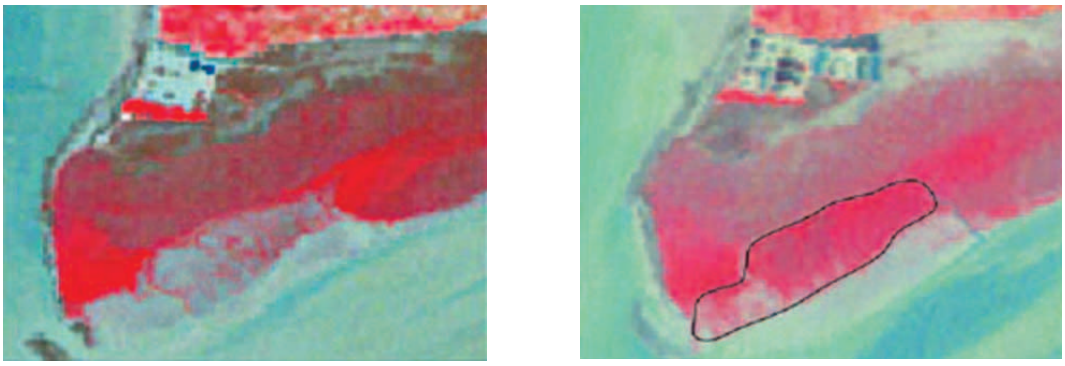
Gujarat has decided to undertake a major drive of mangrove plantation along the coastal regions of Kutch and Jamnagar under Gujarat Forestry Development Project. The state forest department has commissioned about Rs. 830 crore project for restoration and development of mangrove plantations. Accordingly, the project aims to conserve existing forest cover and also provide viable livelihood options to the tribals. The project has been envisaged for an eight-year period, starting from 2007-08 to 2014-15. The project activities is confined to the forest areas of eastern tribal belt of the state, reserved grasslands in Rajkot district, mangroves in Kori Creek, Kutch Coast, Marine National Park in Jamnagar Division.

Figure 1.1: Trends in Mangrove cover in Gujarat



Recently, over 13 different rare species of mangroves having a height of around 30 feet were found in south Gujarat, which were not covered in the FSI. These species are found along the coast in the Valsad and Navsari. This was revealed during a study taken up by the Gujarat Ecological Education Research Foundation. According to the FSI data, the maximum increase in mangrove plantation was in Ahmedabad and Kutch districts which recorded an increase of 18 sq km each. Jamnagar recorded an increase of 7 sq km, followed by 5 sq km in Bharuch (Figure 1.2). Other districts which recorded increase were Anand (3 sq km) and Vadodara (4 sq km).

Figure 1.2 : Regeneration of Mangroves, Bharuch (Gujarat)



2004 **2006**

Source: Forest Survey of India, 2009

1.6.1. Mangrove Restoration in Gujarat: Community Based Approach

As observed, in recent years, there have been efforts by the State Forest Department for reforestation of the existing degraded mangrove areas and raising plantation in new areas, as well as declaration of Protected Areas and Reserved Forests. However, the earlier efforts in this direction have been lacking in terms of a participatory approach involving local communities in the regeneration of mangroves. Considering the dependence of the coastal communities on the mangroves and the need for their participation in the regeneration of the mangrove ecosystems, the Gujarat Ecology Commission (GEC) has taken up the project "Restoration of Mangroves in Gujarat (REMAG)" with financial support from the India Canada Environment Facility (ICEF), New Delhi. The project envisages achieving the following important objectives through a multi-stakeholder approach, viz:

a) Enhanced capacity of communities to regenerate and sustainably manage mangrove resources for increased livelihood opportunities;

b) Increased support from industry in conserving and regenerating mangroves; and

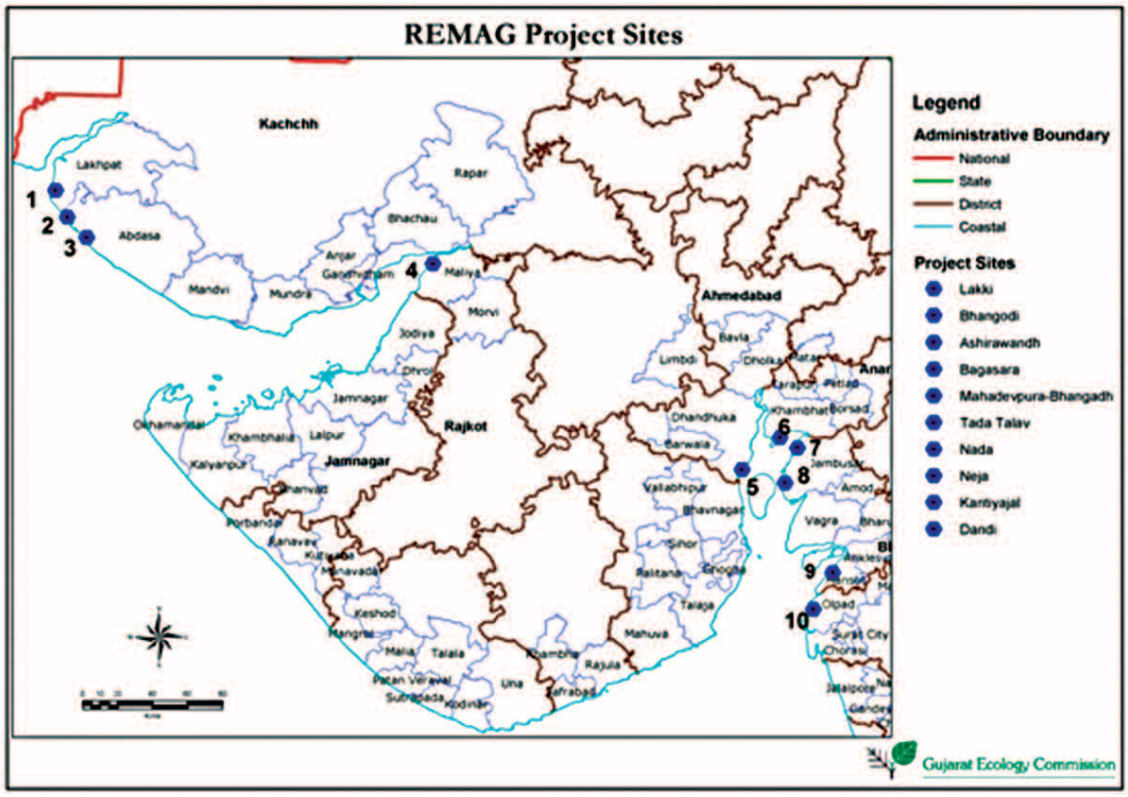
c) More proactive involvement of the government in community based regeneration and conservation of mangroves

Since the original project was over by 2007, the GEC has taken initiative to continue the restoration activities under a new institutional arrangement facilitated by public private partnership. So far, a total of more than 4000 hectares of mangroves have been restored in the state, in areas adjoining the Gulf of Kachchh and Gulf of Khambhat, covering six districts, viz. Kachchh, Ahmedabad, Anand, Bharuch, Rajkot and Surat with the involvement of the village communities in 10 sites/ villages. Gujarat Ecology Commission acts as Nodal Agency with key responsibility of preparation of Project Management Plan, Financial Management, providing trainings on both technical and social aspects to the PIPs and CBOs for smooth implementation of the project, liaising with Government departments,

industries, academic institutions and other agencies in the state, etc. The GEC has selected various voluntary organizations as its Project Implementation Partners (PIPs), namely, Vikas Centre for Development, Ahmedabad, Gujarat Institute of Desert Ecology (GUIDE), Bhuj, Mahiti Gram Vikas Sanstha, Dholera, Shri Khambhat Taluka Anusuchitjati Sahkari Kheti Tahtha Utpadak Sangh and Manav Kalyan Trust, Khedbrahma.

The Project Implementation Partners play the role of facilitators for community mobilization, formation and registration of Community Based Organizations (CBOs), helping the community in micro-planning, and implementation of the project activities. The physical implementation of the project at the grass root level is carried out by the CBOs. This includes, activities like preparation of micro-plans, undertaking activities like seed collection, nursery development, plantation, land development etc, protection of the plantations through social fencing, formation and amendment of bylaws for the utilization of the corpus funds, benefit sharing and conflict resolution.

Map 1.2: The location of REMAG project sites in Gujarat



The latest district-wise status of development of mangroves in Gujarat is presented in Table 1.5. It shows that there has been significant increase in mangrove cover in the state even during the last two years, as the total mangrove cover has increased by 30 percent from 6391 ha during 2009 to 8326 ha during 2010. Except Ahmedabad and Rajkot districts, all others have shown tremendous increase in mangrove cover during the last two years.

Table 1.5: District-wise Status of Development of Mangroves in Gujarat, 2010

District	Mangrove Area (ha)		% share
	2009	2010	
1. Ahmedabad	500	500	6.0
2. Anand	550	650	7.8
3. Bharuch	180	685	8.2
4. Bhavnagar	80	600	7.2
5. Kachchh	1261	1356	16.3
6. Navsari	30	305	3.7
7. Valsad	0	90	1.1
8. Rajkot	850	850	10.2
9. Surat	2940	3290	39.5
TOTAL	**6391**	**8326**	**100.0**

Source: Gujarat Ecology Commission, March 2010.

As observed earlier, the mangroves development activities in the state are increasingly promoted as participatory, wherein the local communities are involved at various stages of plantation development, upkeep and routine management (Table 1.6).

Table 1.6: Agency-wise status of mangrove development activities in Gujarat, 2010

Year	Area Ha.				
	ICEF	PPP Model	GOG	GOI	Total
2003-04	1250	-	-	-	1250
2004-05	560	-	-	-	560
2005-06	1101	-	-	-	1101
2006-07	1190	360	-	-	1550
2007-08	-	620	165	300	1085
2008-09	-	560	285	-	845
2009-10	-	950	985	-	1935
TOTAL	**4101**	**2490**	**1435**	**300**	**8326**
% share	**49.26**	**29.91**	**17.24**	**3.60**	**100.00**

Note: ICEF - India Canada Environment Facility, New Delhi; PPP – Public Private Partnership; GOG – Government of Gujarat; GOI – Government of India.

Source: Gujarat Ecology Commission, March 2010.

As evident from Table 1.6, of the total mangrove cover reported at 8326 ha, the ICEF has the largest contribution, followed by PPP model which accounts for about 30 percent. The state itself has carried out mangrove development activities in 17 percent of the total area reported so far. It is interesting to note that the entire mangrove plantations in the state are managed by the community based organisations (CBOs). As per the latest information

available, there are 22 CBOs engaged in mangrove development/ restoration activities in Gujarat.

Table 1.7: Community-wise distribution of mangrove plantations in Gujarat, 2010

No	Name of Community Based Organisation (CBO)	District	Ha.	% share
1	Morkantha Vistar Tavar Punsthapanane Vikas Committee	Bharuch	405	4.86
2	Jalstrav Gram Vikas Mandal, Nada	Bharuch	150	1.80
3	Shri Bhathiji Sanyukt Kheti Sahakari Mandli, Neja	Bharuch	30	0.36
4	Ashirawandh Cheriya Vikas Samiti	Kachchh	451	5.42
5	Dariya Gram Vikas Mandal, Tadatalav	Bhavnagar	680	8.17
6	Mahadevpura / Bhangadh Dariyai Vruksh Ucher Sahakari Mandli Ltd.	Ahmedabad	500	6.01
7	Lakki Cheriya Sanrakshan Samiti	Kachchh	300	3.60
8	Bhangodi Cheriya Sanrakshan Samiti	Kachchh	580	6.97
9	Bagasra Van Sanrakshan Samiiti	Rajkot	850	10.21
10	Dandi Kantha Tavar Vikas Samiti	Surat	2870	34.47
11	Karanj Tavar Vikas Samiti	Surat	450	5.40
12	Dholai Tavar Vikas Samiti	Navsari	150	1.80
13	FDA Valsad CBOs Borsi Machivad	Navsari	25	0.30
14	FDA Valsad CBOs Krishnapur	Navsari	15	0.18
15	FDA Valsad CBOs Bhat	Navsari	60	0.72
16	FDA Valsad CBOs Mendhar	Navsari	25	0.30
17	Kolak Tavar Vikas Samiti	Valsad	65	0.78
18	FDA Valsad CBOs Khatalvada	Valsad	25	0.30
19	Anklav Tavar Vikas Samiti	Bharuch	100	1.20
20	FDA Bhavnagar CBOs Kalatalav	Bhavnagar	520	6.25
21	FDA Bhavnagar CBOs Mahuva	Bhavnagar	50	0.60
22	FDA Bhuj CBOs Muvadi	Kachchh	25	0.30
	TOTAL		**8326**	**100.00**

Source: Gujarat Ecology Commission, March 2010.

Thus, from the above, it becomes evident that much of the dynamism for the development and management of mangroves in Gujarat has come with the change in development perspectives towards involvement of local community based organisations with financial support from both the state as well as private agencies. In this regard, it becomes important to examine the performance of some of these CBOs in terms of the development and

management of mangroves. This study is an effort in this direction and it makes an interim assessment of the status of mangrove restoration activities being implemented by the Gujarat Ecology Commission (GEC) in selected seven mangrove restoration sites.

Appendix Table 1.1: Main threats to mangrove ecosystems by region

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

Source: Macintosh and Ashton, 2003

Chapter - 2

Socio-Economic and Ecological Benefits of Mangroves and their valuation in International and National Contexts: A Review of Empirical Studies

This Chapter provides a comprehensive review of the empirical literature about the socio-economic and ecological benefits of mangroves and their valuation from the global as well as regional perspectives in the Asian and Indian contexts.

There was time when most people considered mangroves to be mere swamps. The term mangrove refers to an intertidal wetland ecosystem formed by the association of plants and animals which thrive in low lying coasts, river estuaries, deltas, backwaters and lagoons throughout low-lying tropical and sub-tropical latitudes. The term mangrove is also used to designate halophytic (salt living) and salt resistant marine forests comprising trees, shrubs, palms, epiphytes, ground ferns and grasses, which are associated in stands or fringes. Today, mangroves are considered to be one of the most important nursery ground for various fishery resources also having immense potential to support the livelihoods of dependent communities and protect the coastal environments from tidal attacks. Hence, mangroves have become highly important in the current context as they are highly productive ecosystems with important economic and environmental functions. In the wild, mangrove plantations serve as protection for fish, crabs, oysters, lobsters and shrimp. Their roots provide attachment surfaces for marine organisms such as colorful sponges and oysters. Mangrove forests filter out pollution, stabilize sediments, hold nutrients, protect the shoreline from erosion and provide food, nesting and nursery areas for many animals, including at least 220 fish species, 24 reptiles and amphibian species, 18 mammal species and 200 bird species.

Despite the multifunctional attributes of mangrove plantations the world over, their area have declined due to increasing pressures from human activities including over harvesting, aquaculture and coastal development interventions (Alongi 2002). Undervaluation of natural products and ecological services supported by mangrove ecosystems has been a major driving force behind mangrove destruction (Ronnback 1999; Ronnback and Primavera, 2000). In the Far East, mangroves have been extensively damaged for firewood and charcoal, used in the construction of dwellings, furniture, boats and fishing gear.

Nevertheless, towards the end of the twentieth century, scientific concerns began to focus on the unprecedented loss of naturally occurring mangroves ecosystems around the world (Walsh et al., 1975). In 1983, UNDP and UNESCO established a regional project concerned with the value of mangrove ecosystems in Asia and the Pacific. This international initiative

led to an increased appreciation of the value of mangroves and a subsequently there was an upsurge in mangrove restoration efforts the world over (Field, 1996; Kairo et al., 2001). Some of the objectives driving early mangrove reforestation efforts include: wood production for timber, poles and fuel wood; fisheries productivity; coastal protection against storms, and legislative compliance (Ong, 1982; Field, 1996; Saenger, 2002). The rationale for mangrove restoration has changed very slowly over the years from just silviculture to recognition of mangroves as a diverse resource with significant impacts on the society and ecology. The early attempts at mangrove restoration met with mixed results with some being successful, while others were ineffective from the start (Field, 1996; Erftemeijer and Lewis, 1999). Most of these attempts were not based on well-understood ecological principles and well-defined aims.

A major initiative for development and restoration of mangrove plantations has received worldwide attention since 2005 following the devastating Asian Tsunami that struck the Indian Ocean on 26 December 2004. The occurrence of the catastrophe caused a wide realization that the presence of mangrove forests might have mitigated the economic damages and loss of lives and properties caused by the disaster (EJF, 2005; Kathiresan and Rajendran, 2005; UNEP, 2005; Vermaat Thampanya 2006). Thus, immediately after the 2004 Tsunami, there has been rapid expansion of programmes in the Indian Ocean region in particular, supported by national governments, international agencies and the NGOs, that are attempting to replant and rehabilitate mangrove ecosystems as "natural barriers" to future tsunamis and other tropical storms (Barbier, 2008).

2.1. Socio-Economic and Ecological Significance of mangroves – A global perspective

Mangroves are of prime importance in view of their protective and productive values. They provide numerous tangible and intangible benefits (goods and services) to the coastal communities (Vannucci 2004). They also play a pivotal role in reducing the impact of tropical cyclones and tidal surges (Kathiresan 2003ab), which frequently occur in the coast of South Asian countries (Kathiresan and Rajendran 2005). It was reported that during the Tsunami mangroves acted as a bio-shield at some places, depending on the width and cover of mangrove area, the species mix, the density and height of trees in addition to the size and force of the tsunami (Dahdouh- Guebas et al. 2005). Similarly, during the cyclone that struck the southwest part of Bangladesh on 15th November 2007, people have observed the protective role of the Sundarbans. The role of mangroves in reducing the sea-wave energy is also documented. The density of mangrove species and their complexity and flexibility of aerial root systems influence the sedimentation and wave reduction process (Kathiresan 2003b). The mangroves also provide necessary

nutrients and habitats for a range of species of animals. The rich fisheries resources in the coast of these countries can be attributed to the presence of mangroves to some extent (Amarasinghe et al. 2002, Islam and Haque 2004, Islam and Wahab 2005).

Millions of people in South Asia earn their livelihoods by extracting mangrove resources and working in industries which use mangrove as raw material. It has been estimated that in Bangladesh and India, around 9 million people are dependent on the Sundarbans for their livelihoods (PDO-ICZMP 2004, GoI 2005). In the Impact Zone of the Bangladesh Sundarbans, around 18 percent of the households are directly dependent on the forest (Iftekhar and Islam 2004). Around 200,000 fishermen operate daily in the Sundarbans water. Another 225,000 population, which cover around 14 percent of the people residing within 10 km buffer around the Sundarbans, depend on collection of Penaeus monodon fry (Hoq 2007). In Sri Lanka, economic valuation studies were undertaken to demonstrate the economic value of the goods and services of mangrove forests. It has been estimated that in Sri Lanka, per hectare annual total economic value (TEV) of a conserved mangrove forest is US$ 12,229. Similarly, In India, Badola and Hussain (2003) have estimated values for different functions of Bhitarkanika mangrove, such as nutrient retention US$ 865 /ha/ year, offshore fishery US$ 37.97/hr, inshore fishery US$ 1.9/hr, fry collection US$ 0.2/ hr; and storm abatement US$ 116.28/household (Iftekhar, 2008).

The socio-economic importance of natural mangroves has been addressed by many scholars (Ruitenbeek, 1994; Walters, 1997; Adger et al., 2001; Barbier, 2006; Walters et al., 2008). Governments are increasingly aware of the nursery and fisheries enhancement function of mangroves. A questionnaire-based socio-economic study on the Buswang replanted mangroves in the Philippines suggested that the mangroves directly benefitted local incomes in the region to the extent of USD 564–2316 per ha per year (Walton et al., 2006a,b).

While the total extent of the economic benefit of restored mangroves is as yet unclear, the initial planting costs are a major factor in preventing more community based replanting efforts. In the Philippines, initial costs are estimated to be USD 204 per ha using volunteers (Walton et al., 2006a). However mangrove restoration cost estimates for the USA ranged between 225 and 216,000 USD per ha (Lewis, 2005). These costs thus vary very widely depending on differential labour costs (dependent on GNP of the country in question (Brander et al., 2006), site conditions and thus the effort in terms of labour required for hydrological restoration and removal of debris and weeds among other factors, and planting material types where replanting is necessary. Grant-based aid and elimination of ownership doubts through community stewardship schemes could significantly boost mangrove replanting programs around the world.

Barbier (1993; 1994) developed a methodology for valuing the socio-economic as well as environmental functions of tropical wetlands with an emphasis on their regulatory ecological functions in support or protection of economic activities. Accordingly, the study uses the concept of total economic value (TEV) which is composed of use value (UV) and non-use values (NUV). Use value (UV) is further decomposed into three concepts, viz., direct use value (DUV); indirect use value (IUV) and option values (OV). Similarly, non-use value (NUV) is further classified as existence value (EV) or bequest (legacy) value. Direct use value is further classified as consumption use value (CUV) [fishery products] and non-consumptive use value (NCU) [recreational values] – tourist attraction, etc. The indirect use value is taken to mean support for fisheries, storm protection, etc. Option values (OV) is defined as the value of increased information in the future. Finally, existence value (EV) is considered in terms of the benefits- value of (wetland assets) to future generations.

Following Barbier's approach, Sathirathai (1997) tried to estimate the total economic value of mangroves in Thailand. The study makes use of techniques of valuation to assess the foregone benefits of mangroves compared to the net returns from converting the areas into shrimp farms, which is the major competitor for mangroves. It follows the case of protected mangroves spread over 2,500 rai (400 ha) protected by the villagers. The benefits of mangroves to the villagers were also assessed. In order to assess the other important ecological function of mangroves, i.e., their roles to serve as a wind break and shore stabilizer, the study uses the replacement cost method. The replacement cost method uses the alternative costs of constructing wind belt or damming the area for protecting it from wind break or other damages. The study also showed that although shrimp farming creates enormous private benefits for those who can afford the undertaking, the net social benefits of the enterprise, taking into account its externalities in terms of mangrove destruction and water pollution, is not so economically viable. This is especially true when the forest in focus is located along the coast and serves as a nursery ground for small fish and marine life. Sathirathai (1997) also provides a broader view of the major economic benefits of mangroves, classified as direct, indirect and non-use values as conceptualized by Barbier (1993) (Table 2.1). Nevertheless, Barbier's conceptual framework needs to be appropriately modified in the present context to accommodate the implications arising from Climate Changes as well as to understand how the increasing environmental/ ecological functions of mangroves help mitigate the adverse effects of climate change.

Using Barbier's framework of valuation of mangrove ecosystems, many scholars have tried assessing the multiple use and non-use values of mangroves in different country contexts. A summary of the various studies on economic valuation of mangroves is presented in Table 2.2.

Table 2.1: Economic Values arising from the Multi-functionality of mangroves

Components/ Functions/ Diversity/ Attributes	Economic Values		
	Direct	Indirect	Non-use
I. Components			
1. Forest Resources	XXX		
2. Wildlife Resources	X		
3. Fisheries	XX		
4. Forage Resources	X		
5. Agricultural Resources	XX		
6. Water Supply		XXX	
II. Functions/ Services			
1. Groundwater discharge		XX	
2. Flood and flow control		XXX	
3. Shoreline stabilization		XX	
4. Sediment retention		XXX	
5. Nutrient retention		XX	
6. Water quality maintenance		XXX	
7. Storm protection/ windbreak		XXX	
8. Micro climatic stabilization		XX	
9. Recreation/ tourism	XX		
10. Water transport	XXX		
III. Diversity/ Attributes			
1. Biological Diversity	X	X	X
2. Uniqueness to culture/ heritage			XX

Key: X – Low; XX – Medium; XXX - High
Source: Sathirathai, 1997

As evident from Table 2.2, there are significant variations across countries in terms of the valuation of direct and indirect benefits accrued from mangrove plantations. These variations in the values realized may be due to the geographical/ locational characteristics of the mangroves and the communities' access to various use and non-use benefits of mangroves.

A study by the Conservation International on Coral Reefs, Mangroves and Seagrass compiles the results of a wide variety of economic valuation studies on coral reef and related ecosystems around the world, with a focus on the five important ecosystem functions/ goods and services. First, the Tourism Potential: as people the world over visit coral reefs

to enjoy the recreational opportunities that these ecosystems provide, including SCUBA diving, snorkeling, and glass-bottom-boat viewing. Second, Fisheries: Coral reefs and their surrounding ecosystems, including mangroves and seagrass beds, provide important fish habitat.

Table 2.2: Total Economic Value of Mangroves as estimated by various studies

Country	Direct and indirect use Values/ ha/year (US$)	Source
Egypt	149,200	Spurgeon (2002)
Indonesia	3,188	Meilani (1996)
Thailand	3,420	Sathirathai (1998)
Malaysia	61,357	Leong (1999)
Mexico	2,772	Cabrera et al. (1998)
Global	3,207	Costanza et al (1997)
Philippines	315	Walton et al. 2006
Thailand	520-667	Sathirathai (1997)
Viet Nam	315-1,085; 721 (average)	http://www.unepscs.org/Documents/RTF-E1/RTF-E.1-6%20Extracts.pdf
Malacca Straits	3.25 billion, with a net market value of $582 million	PEMSEA, 2004
Southern Thailand	27, 264 - 35,921	Sathirathai and Barbier (2004)
Sri Lanka	12229	Iftekhar (2008)
India	865 (nutrient retention); 37.97 (off-shore fishery); 1.9 (in-shore fishery); 116.28/ household (storm abatement)	Badola and Hussain (2003)
India	498.54 million (million for the state of Gujarat)	Hirway and Goswami (2007)

Source: Authors' compilation based on review of empirical studies.

Third, Coastal protection: Coral reefs serve as natural barriers to storm surges that can cause great destruction to coastlines and communities. Fourth: Biodiversity: The United Nations' Atlas of the Oceans describes coral reefs as among the most biologically rich ecosystems on earth, with about 4,000 species of fish and 800 species of reef-building corals described to date. Fifth: Carbon sequestration: Coral reefs remove carbon dioxide from the atmosphere and are thus important for the mitigation of global warming (Conservation International, 2008).

Another detailed study was attempted by Kairo et al. (2006) at Gazi bay, Kenya to examine economic benefits accrued from a 12 year old *Rhizophora sp.* which were planted under restoration scheme / project. The estimated costs of reforestation and maintenance was US$ 70.48/ha/yr, while the estimated net benefits was calculated as US$ 2902.87/ha/yr. Based on these results, the benefit to cost ratio is far greater than 1, it is justifiable for the governments in the region to promote mangrove reforestation in order to sustain the supply of mangrove goods and services.

2.2. Mangrove Restoration- Role of local communities

Assessment of local peoples' attitudes towards and participation in mangrove restoration interventions is one of the least explored aspects of mangrove restoration science (Kovacs 2000; Glaser 2003). There are several reasons that suggest for involvement of local communities in the restoration efforts. Previously, failure to consider local needs and values has brought collapse in many conservation projects (Ostrom 1990). As a result, many developing countries have initiated participatory or community-based natural resources management programs (Zorini et al. 2004). Regional coastal zone development plans are now also formulated (Olsen and Christie 2000). Local people, who were often considered as a direct cause of natural resource decline (Contreras-Hermosilla 2000), are emerging as important stakeholders in such programs (Mbilea et al. 2005). Consultation with them is becoming a pre-requisite (Pickaver et al. 2004).

Although community participation plays an important role in rehabilitation, conservation and management of mangroves, economic benefits to the local people to be derived from the planted mangroves and the newly established lands seem to be necessary in order to sustain the programs, as shown in the cases of Pangasa, Sinjai District (locally-initiated) and Dajo, Bulukumba District (governmental program). Land holding and ownership of planted mangroves are the most significant factors in utilization, conservation and management of mangroves. Since mangrove conservation requires long-term maintenance, the expectations of the local people in terms of both short-term and long-term economic benefits to be obtained from mangrove rehabilitation and conservation should be addressed. This could lead to "self-mobilization participation" and sustainable management of natural resources in coastal areas (Amri, 2005). In this regard, it has also been reported that the restoration projects often fail to fit with the wider socio-economic setting (Bandaranayake 1998) and are unable to deliver social benefits (Drew et al. 2005) due to lack of appreciation of social values and needs (Tomlinson 1986).

Further evidences suggest that in Southern Thailand, degradation of mangroves has prompted many communities to initiate local organization and collective action for

mangrove conservation (Rittibhonbhun et al. 1993), and coastal communities are interested in gaining rights to mangroves under a community forestry umbrella (Sathirathai 1997). However, skepticism persists— particularly within Thai government circles—about the capacity of local people to sustainably manage and protect mangrove forests. Research on the effects of different management models on mangrove ecosystems will inform the current debate, but to date no research has assessed the effectiveness local community management of mangroves in Thailand.

Sudtongkong and Webb (2008) brings out that community management was the principle factor in protecting, managing, and conserving the mangrove ecosystem in a manner superior to conventional state management outside of protected areas. This is an important conclusion, because most terrestrial and coastal ecosystems are outside of the protected area system, and strategies for conservation of "unprotected" ecosystems must be developed. Community-based mangrove management and protection, therefore, provides one possible mechanism to achieve the goal of mangrove ecosystem conservation (Sudtongkong and Webb, 2008).

In Thailand, a massive 5 year mangrove replanting program was launched by the Thai Government during 1991–1996 with a total budget of 750 million Baht (approx. US$ 30 million) targeting to replant 40,000 ha (Havanond, 1994; Suwannodom et al., 1998). In 1987, 21,202 ha were found to be suitable for reforestation, among which 19,642 ha were degraded forest and 1,560 ha were mudflats (ADB, 1987 in Aksornkoae, 1993). According to Suwannodom et al. (1998) the massive mangrove reforestation program cannot be evaluated as successful, except in a few cases in Southern Thailand where a community-based management approach was followed. This shows that mangrove plantation can be more effective where public private partnership has been applied. In the case of Gujarat same strategy has been applied for mangrove plantation.

2.3. Mangroves and Coastal Protection

In fact, the indirect benefits of mangroves, such as coastal protection and non-use values (option, bequest and existence values) are more difficult to measure. Since the establishment of the Buswang mangrove, storm surge damage and coastal erosion has been negligible, but in some other countries around the Indian Ocean, cases about storm associated costs have been documented (cf. Gilman et al., 2008). In India for instance, monetary losses due to repair and reconstruction costs of personal property (incl. livestock and agricultural products) ranged between 32 USD per household in mangrove protected villages to 154 USD per household in villages that were not protected by mangroves (Badola and Hussain, 2005). In the past, replacement costs have been used to estimate coastal protection value. However replacement cost associated with constructed

breakwaters generally overestimate the value. As such this should be modified by the area that requires coastal protection estimated as USD 3679 per year (Sathirathai and Barbier, 2001). Other indirect benefits include accretion of agricultural land. In the Sundarbans, Bangladesh, the planting of 150,000 ha of mixed mangrove species has enhanced the deposition of sediments to such an extent that the elevation of 60,000 ha is no longer suitable for mangrove, and can be used for agriculture worth US$ 800 ha^{-1} $year^{-1}$ (Saenger and Siddiqi, 1993).

Today there is a growing urgency to recognize the importance of conserving and restoring protective mangrove greenbelts to lessen the dangers from future catastrophes, because as sea levels rise so will the frequency and intensity of hurricanes and storm surges. Mangroves can buffer against the fury of such destructive storms, protecting those settlements located behind a healthy mangrove fringe. Thus the importance of the protective mangrove buffer zone cannot be overstated. In regions where these coastal fringe forests have been cleared, tremendous problems of erosion and siltation have arisen, and terrible losses to human life and property have occurred due to destructive hurricanes, storm surges and tsunamis. In the Mekong Delta, Soc Trang province, Vietnam, extensive planting of Rhizophora species was used as a coastal protection measure.

2.4. Mangroves and mitigation of climate change effects

Of late, there is a growing realization that mangroves act as carbon sinks and thus enables the growing regions from the ill-effects of climate changes. Mangroves are considered as nature's best ways for combating global warming because of their high capacity for sequestering carbon. This is a unique characteristic of mangrove wetlands that now requires wide attention and promotion. One of the greatest contributions that mangroves may have to offer is their great propensity to sequester carbon from the atmosphere and store this in their wetland substrate. According to the Feb. 2007 issue of National Geographic, "Mangroves are carbon factories… Measurements suggest that mangroves may have the highest net productivity of carbon of any natural ecosystem (about a hundred pounds per acre per day)…"

Despite such significance attached to mangroves, they are suffering high rates of destruction around the world, with about 35% lost already, and will be one of the first ecosystems to be affected by sea level rises as well. This is a major threat emanating from global climate change. Conserving existing mangroves and restoring the vast areas of degraded and cleared mangrove wetlands will serve as a partial solution to global warming.

Gilman et al (2008) also observe that mangrove ecosystems are threatened by climate change. The study reviews the state of knowledge of mangrove vulnerability and

responses to predicted climate change and consider adaptation options. Based on available evidence of all the climate change outcomes, it has been highlighted that the relative sea-level rise may be the greatest threat to mangroves. Most mangrove sediment surface elevations are not keeping pace with sea-level rise, although longer term studies from a larger number of regions are needed. Rising sea-level will have the greatest impact on mangroves experiencing net lowering in sediment elevation, where there is limited area for landward migration. The Pacific Islands mangroves have been demonstrated to be at high risk of substantial reductions. There is less certainty over other climate change outcomes and mangrove responses. More research is needed on assessment methods and standard indicators of change in response to effects from climate change, while regional monitoring networks are needed to observe these responses to enable educated adaptation. Adaptation measures can offset anticipated mangrove losses and improve resistance and resilience to climate change. Coastal planning can adapt to facilitate mangrove migration with sea-level rise. Management of activities within the catchment that affect long-term trends in the mangrove sediment elevation, better management of other stressors on mangroves, rehabilitation of degraded mangrove areas, and increases in systems of strategically designed protected area networks that include mangroves and functionally linked ecosystems through representation, replication and refugia, are additional adaptation options (Gilman, *et al.*, 2008).

A study by Ong in Malaysia, found that the layers of soil and peat composing the mangrove substrate have a high carbon content of 10 percent or more. Each hectare of mangrove sediment might contain nearly 700 metric tons of carbon per meter depth. In building large numbers of shrimp farms or tourist complexes, the resultant clearing of mangroves and subsequent excavation of the mangrove substrate could result in the potential oxidation of 1,400 tons of carbon per hectare per year. Again, according to Ong, “Assuming that only half of this will become oxidized over a period of 10 years; we are looking at the return of 70 tons of carbon per hectare per year for ten years to the atmosphere. This is some 50 times the sequestration rate. This means that by converting a mere 2 percent of mangroves, all of the advantages of mangroves as a sink of atmospheric carbon will be lost…”

According to the latest study by the UN’s Food and Agriculture Organization (FAO), the current rate of mangrove loss is around 1% per annum-or around 150,000 ha of new mangrove area loss per year. This translates to around 225,000 tons of carbon sequestration potential lost each year, with an additional release of approximately 11 million tons of carbon from disturbed mangrove soils each year.

Obviously, this is an immense problem requiring our concerted action. Not only we are losing the important potential for carbon sequestration offered by the mangroves, but we are also seeing the release of major quantities of polluting gases from the disturbed mangrove substrate itself. This continued clearing of mangroves for whatever reasons must now be perceived in an entirely new light…a light that illuminates far beyond the dark crevices of development for convenience and profit to a future for life and a sustainable living on this now endangered planet…this home we call our Earth.

As emerge from the above analysis, one of the ecosystem services that mangroves perform is to act as carbon sinks, but there has been very little research on their potential in this regard. In addition to this direct link, mangroves are in the front line of anticipated sea level rises; they will provide immediate protection to coastal communities from associated storm surges and erosion, but also face a severe threat from climate change. Therefore protecting and replanting mangroves (and finding incentives for governments to do this) will help protect communities from the effects of climate change.

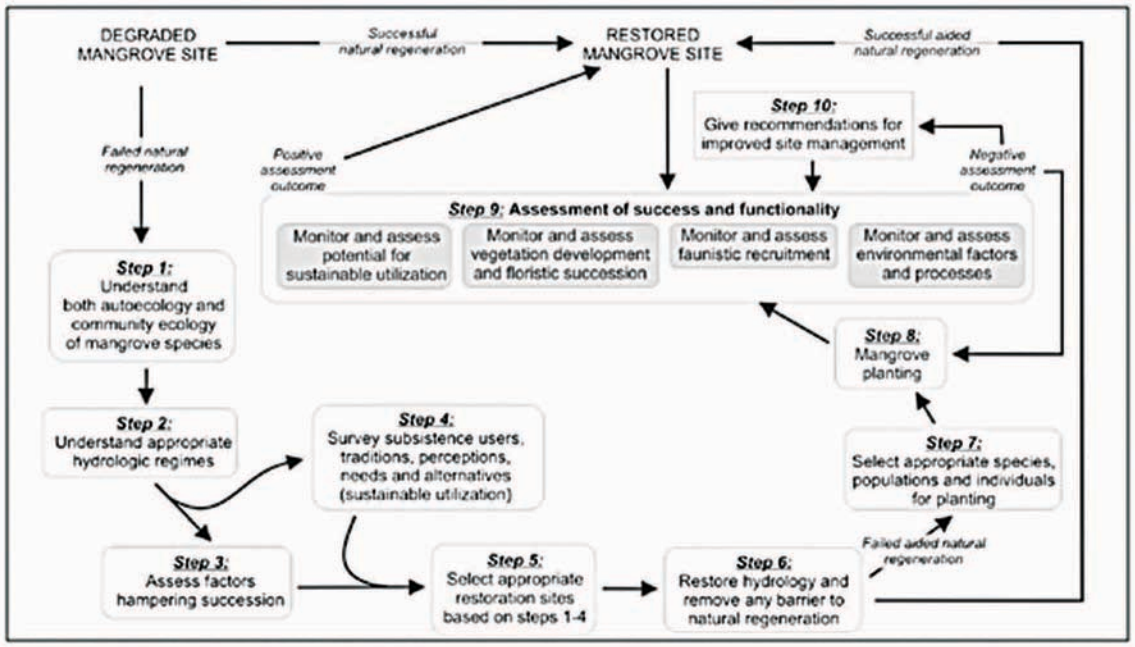
2.5. Need for evolving an effective mangrove conservation regime

The multifunctionality of mangroves and their growing importance in the context of global climate change makes it imperative to thinking in terms of an effective conservation regime for mangroves. In fact, mangroves have been seriously undervalued by those state agencies responsible for their protection and management, as is so clearly evident from the devastation taken place for mangroves over time. Based on the success stories of effective management programmes, we may have to think in terms of management regimes that would be context-specific. In this regard, it has to be determined that whether we should have “state alone”, “communities alone”, “state-community combined”, “state-private”, “private-community” based mangrove conservation regimes?.

There are empirical evidences as well as regards the problems related with different management regimes for mangroves. In many cases, it has been proved by researchers that the lack of conservation ethic, shortsighted greed and weak law enforcement from the side of the state have resulted in massive loss of the coastal mangrove wetlands, with one huge, hidden cost arising from the oxidation and release of stored mangrove carbon.

It is important to note that for effective conservation and management of the remaining mangroves it is necessary to synthesize biological and socio-economic information on mangrove processes and values, and bring this to the attention of policy-makers and the development community (Walters *et al.*, 2008). Moreover, the mangrove restoration interventions need to be designed in view of the site conditions (Chart 2.1)

Chart 2.1: Schematic Steps and Pathways presenting possible mangrove restoration Interventions depending on site conditions



Source: Bosire, et al., 2008: (modified after Stevenson et al., 1999; Bosire et al., 2006)

2.6. Socio- Economic and Ecological Benefits of mangroves – Studies in the Indian context

In this brief section, we provide a synoptic view of the various empirical studies conducted on the status and impacts of mangrove ecosystems in the Indian context in general and Gujarat state in particular. This will enable us to understand the critical information gaps that exist on the thematic area.

A brief review of empirical studies on mangroves in Indian states, including Gujarat clearly demonstrates the loss of mangrove cover as caused by various natural and human interventions and development of industries, expansion of salt pans, etc (see Hirway and Goswami, 2007 for a detailed review. In fact, marine national parks and wild life sanctuaries have been established in many locations with the intention of protecting vital/ critical habitats, such as mangroves, coral reefs and wetlands. In one such study, in the Marine National Park, Jamnagar, on the Gujarat coast, significant changes in the mangrove vegetation and coral reef area were observed during the period 1975 to 1998 (Nayak *et al.* 1989). Recent industrialisation, development of ports, etc. have again put these ecosystems under stress, as evident from recent satellite data. The earlier estimate of mangroves was 6740 sq. km. The estimate based on IRS data is 4460 sq. km, which indicates large scale degradation.

There have been several studies examining the beneficial outcomes of mangroves in the Indian context. For instance, the study by Santhakumar *et al* (2005) on the Sundarbans

indicate that the direct benefits included abundance of brackish water fish, shrimps, crabs, honey, beeswax and tannin, which provided for requirements of both local and urban consumption. The exports of dried fish, shrimps, crabs and honey brought in substantial gains in foreign exchange. The Sundarbans also acts as a buffer zone between the ocean and the interior lands (Santhakumar, *et al.,* 2005).

An earlier study by Chandrasekaran and Natarajan (1992) estimated the harvest of fish, prawn and crab harvested from the Pichavaram mangroves, between April 1981 and March 1982. As per the estimate, 245 tons of fish, prawn and crabs [85% was accounted for by prawns] was harvested in one year. Prawns are primarily detritivores [detritus eaters] and they thrive in mangrove areas that harbour large quantities of detritus imported from adjacent mangrove forests. In Andhra Pradesh, for example, an estimate by the Centre for Marine Fishery Resource Kakinada, showed that prawn catch per boat load from mangrove areas of Godavari and Krishna has been 25 percent more than in non-mangrove areas. The benchmark survey conducted by the MS Swaminathan Research Foundation (MSSRF) in Andhra Pradesh showed that the fishery resources from the Godavari mangrove wetlands supported 32,300 families from 26 hamlets in 1998. The total value of their catch was estimated at Rs. 2.53 crores per annum in 1998, or an average income per family of about Rs. 3500 per annum. The same survey revealed that about 375 tones of fodder grass was obtained from the mangrove area every year (Chatterji, undated).

Highlighting the importance of Gujarat's fishery sector in the country (20%), Saravanakumar, *et al (2009)* observes that 90 percent of Gujarat fish catch is contributed by marine fisheries. The high fishery yield of the state has been attributed to mangroves, as fish recruitment and mangrove cover are directly proportional.

The study by Selvam et al (2003) tried to map out the impact of restoration of the degraded areas of Pichavaram mangrove wetland in Tamilnadu state by comparing TM digital data of 1986 (before restoration) and LISS III digital data of 2002 (after restoration). The study indicates that the area of the mangrove forest cover has increased by about 90 percent. A science based, community-centred and process-oriented approach followed for the restoration of the Pichavaram mangrove wetland in collaboration with the Forest Department, Government of Tamil Nadu and participation of local mangrove user-communities was mainly responsible for success of the restoration efforts. This study has novelty as it uses remote sensing data as a monitoring tool to assess the effectiveness of restoration and conservation programmes of the mangrove wetland, where direct and regular physical monitoring is difficult due to marshy nature of the soil and presence of numerous tidal creeks and canals.

An interesting study by Badola and Hussain (2003) on the mangroves surrounding the Bhitarkanika mangrove ecosystem in Kendrapada district of Orissa (the second largest

mangrove forest of mainland India) tries to fill in the gap in information regarding the functions and services performed by mangroves. The study also provides information on the structure of the ecosystem, basic socio-economic patterns, use patterns and rates and their economic costs as well as an extensive survey of the attitudes of the people towards conservation and various proposed and existing alternatives in the Bhitarkanika Protected Area. The major objectives of this study are to: a) enumerate ecological functions and the key productive uses of the Bhitarkanika mangrove ecosystem; b) estimate the use values and ecological services provided by the Bhitarkanika mangroves ecosystem/Protected Area; c) quantify the extent of dependency of local communities on Bhitarkanika and identify marginalized stakeholders; d) examine the attitude of local communities towards present management and proposed alternative to mangrove resources; e) derive a predictive model to assess the extent of impact of sea level rise (at 50 cm, 1 m and 2 m) on the Bhitarkanika mangrove ecosystem.

The study revealed that people are able to appreciate the contribution of Bhitarkanika mangroves to their lives and livelihoods directly in the form of increased production of fish and prospects for better tourism. A high percentage of people (88.6%) recognized the contribution of mangroves in cyclone and flood mitigation. The people have recognized even functions such as biodiversity conservation and ground water recharge. Majority of the local populace i.e. about 89.6 percent are aware that Bhitarkanika forests have protected status and that it is a declared Wildlife Sanctuary. Staggeringly high percentages (84.3 %) of people feel that they have got a responsibility towards conservation of flora and fauna. The study of socio-demographic characteristics, economic situation, and other aspects of life in these mangrove villages reveal a high degree of resource use and dependence on mangrove resources for their livelihood. Another factor that emerges is the weak participation of the local community in the decisions and management strategies undertaken by the forest department (Badola and Hussain, 2003).

Nevertheless, despite these positive attitudes there is a high degree of resource extraction by the local people. This is because of the fact that the local people do not have any other livelihood options other than paddy cultivation and fishing. Consequently more and more mangrove areas are being converted into paddy fields. As observed during the study, the local people do pisciculture in their homesteads but they do not support or do prawn culture, by removing mangroves. Outsiders who do not have long-term stakes in the area for their livelihoods are carrying out intensive prawn culture in the area, by financing some local agencies. Intensive prawn culture has resulted in large scale removal of mangroves from the Mahanadi delta, situated south to the Bhitarkanika (Badola and Hussain, 2003).

The study by Hirway and Goswami (2007) may be considered as an important case study on the impact of mangroves on the local communities in Gujarat. The study tries

to quantify the various benefits in physical terms and monetary terms. The specific objectives of the study were to: a) study the changes in the status of mangroves in Gujarat state during the past two decades or so and to estimate the nature and extent of depletion and degradation of mangroves in physical terms; b) compile monetary value of changing status of mangroves using alternative methods; c) develop a methodology of computing value of a renewable natural resource in the process, and d) infer policy/action implications of the study for improving the status of mangroves in the state. The study was undertaken in 9 villages covering 400 households. The major share of the households surveyed were farmers (63%), followed by agricultural labourers (20%) and fishermen (13%), which together accounted for almost 96 percent of the total mangrove dependent households. The study estimated both direct use value and non-use value accrued by the mangrove dependent communities. While the direct use value (based on 2003 prices) of mangroves has been estimated at Rs. 1603 million, the indirect use value of the current status of mangroves was Rs. 2858 million per year. The total use value (direct and indirect) of mangroves was thus estimated at 7731.3 million per year for the state at 2003 prices (Hirway and Goswami, 2007).

The study by Das (2007) assesses the storm protection role of mangroves, based on data on human casualties, damages to houses and livestock losses suffered in the Kendrapada district in Orissa state during the super cyclone of October 1999. The cyclone (of T 7 category) devastated 12 of the 30 districts of Orissa causing 9,893 human casualties and 441,531 livestock deaths, and damaging 1,958,351 houses and 1,843,047 hectares of crop. The analysis incorporates meteorological, geo-physical and socio-economic factors to separate out the impact of mangrove vegetation on cyclone damage. The results indicate that the mangroves significantly reduced human death and seemed more effective in saving lives (both human as well as animals) than in reducing damage to static property. There was significant reduction due to mangroves in damage to residential houses and to big animals like cattle and buffaloes. It also observes that if the coverage of mangrove forest was 10 percent more than what it was at the time of the cyclone, human casualties would have been reduced by 12.48 percent, buffalo loss by 6.6 percent, cattle loss by 2.23 percent and fully collapsed houses by 2.21 percent. Factors like land elevation, immovable asset holdings, etc, too, had decisive effects on human casualties in the storm surge affected areas (Das, 2007). Further analysis by Das (2009) on the storm protection role of mangroves revealed that if the mangrove cover had remained at the level that it had been in the 1950s, the area would not have suffered any fully collapsed houses at all. The total protection benefits of mangroves in terms of averted damages to residential property in Kendrapada were estimated at INR 592,647,800 (USD14, 110, 662). The study suggests that mangrove forests provided protection benefits to houses to the extent of INR 975, 800 (USD 23,233) per km width of forests or INR 51,168 (USD 1218) per hectare of forests.

Thus, policy makers need to take mangrove conservation and re-planting into account in planning for tropical storms, which are expected to increase with global warming (Das, 2009).

A recent study by Mitra et al (2006) has analysed the impact of controlled mangrove regulatory regime followed by the state on the local communities surrounding the Bhitarkanika wildlife sanctuary (BWS) in Orissa. The village communities surrounding the BWS area depend directly on mangroves for fuel-wood and fodder, and indirectly the fish and prawn seedlings, for their livelihood. But the imposition of conservation strategies by the government, reducing the free rides on resources that the people had been enjoying for generations, was not taken favourably by the locals. The study observes that the restrictions for conservation lead to an economic non-sustainability of the local community. As activity substitution, i e, change in availability of one mangrove component, causes local substitution for other mangrove components [Reitenbeek 1994] such restrictions may pose a risk of aggravating other mangrove resource exploitation directly for livelihood earning. The preliminary assessment indicates a tendency of forest resource exploitation at a scale higher than sustenance livelihood requirements, among the people from villages with very low (i e, less than Rs 150) per capita monthly income (Mitra *et al.*, 2006).

The study further observes that the goal of holistic development can only be achieved by the promotion of fishery-related activities and alternative professions around the Bhitarkanika national park. It suggests that, prior to imposition of any conservation strategies, the linkages between the nature and the regional socio-economy should be given highest importance, so as to chalk out a better management option. In coastal areas, like Sundarbans or Bhitarkanika, where the scope of alternative income generation is low, such narrow conservation approaches may lead to potential disastrous consequences (Mitra *et al.*, 2006).

Thus, the above review provides a comprehensive account of the socio-economic and ecological significance of mangrove plantations in the global as well as the regional contexts of Indian states, especially, Gujarat. The review highlights that socio-economic linkages of mangrove ecosystem play a pivotal role in the management of mangrove ecosystems, especially in coastal areas, where major economic activities and livelihoods depend mainly on extraction of natural capital and the related resources. Empirical assessments from other tropical countries as discussed above also call for the need for proper resource management strategies to ensure long-term sustainability of the mangrove ecosystem in particular. Such strategies not only need critical mangrove resource valuation, but also should emphasize the biogeophysical and socio-economical linkages.

The present study assumes greater importance in this context, as it tries to understand the interactive outcomes of mangrove restoration efforts initiated by the state and carried forward by the local communities. The study also becomes important as there are very limited empirical evidences as regards the impacts/ outcomes of mangrove restoration activities on the local communities: the outcomes being employment creation, enhancement in fisheries, livestock activities, as emerge from the mangrove restoration activities. For the present study, the pioneering study by Hirway and Goswami (2007) is very important as it provides useful benchmark information on the village communities, their dependence on the mangrove resources as well as the economic valuation of direct and indirect use values of the mangroves. Further, the present study also covers some of the villages as covered by Hirway and Goswami (2007) for their study, which enables to have more useful cross comparisons of the villages at two different points of development of mangrove ecosystems in Gujarat state.

Based on the foregoing review of the empirical research on mangroves in the global and the regional perspectives of the Indian states, especially, Gujarat, it may be concluded that a comprehensive study on the dynamic interactions between mangrove restoration activities and the communities is very much relevant in the current context. Accordingly, Chapter 3 is set to discuss about the present study, its scope, objectives and methodology as well as the analytical framework being used in the present study.

Chapter - 3

About the study: Objectives, Methods and Analytical Framework

3.1. Backdrop

As observed in the previous Chapters, the REMAG project is aimed at development of mangrove plantations in the gulfs of Kutch and Khambhat, outside the conventional forest areas, i.e., in the wastelands provided by the government of Gujarat. The project was implemented by the Gujarat Ecology Commission (GEC) during 2002-2007 with financial support from the India Canada Environment Facility (ICEF). Though the original project came to a close by 2007, it was important to carry forward the mangrove restoration activities in the state in view of their socio-economic benefits to the dependent communities and the environmental and ecological functions and services provided by the mangroves. Hence, the GEC continues the mangrove restoration activities in the state with a major thrust on public-private partnership (PPP) based management/ governance regime. Under the extended REMAG programme, investments by private sector companies/ industries have also been encouraged with a commitment to cherish community participation in the mangrove development/ restoration efforts.

In view of the long-term environmental and ecological impacts as well as the socio-economic significance of the restoration initiatives, it becomes important to make a detailed post-facto assessment about the socio-economic as well as ecological benefits of the mangrove restoration activities implemented by GEC in several villages in the state. Primarily, it becomes essential to understand the economic dependence on mangroves in the selected REMAG villages. Once the dependence of communities on mangroves is established, it is pertinent to explore whether the mangrove plantations help the coastal communities to improve their economic status and livelihoods and if so, in what ways the mangroves help the local communities. In order to arrive at this, it is important to assess the various tangible and non-tangible benefits realised by the mangrove dependent communities. As mangrove development and restoration activities also cut across the domains of policies, institutions and governance regimes, it becomes all the more important to address the question that "what policy and institutional intervention mechanisms have been evolved in the post-mangrove development phase by the state (GEC), having long term implications for a sustainable development and management of coastal eco-systems in the case study villages and their scaling up in the broader state context"?

3.2. Objectives and scope

With the above intentions, the study makes an earnest attempt at understanding how different communities perceive the tangible and non-tangible benefits of the mangrove restoration activities and how mangroves have impacted on their socio-economic status and livelihoods. Alongside, the study also undertakes a detailed assessment of the biodiversity in the mangrove restoration sites. Since the restoration activities involve active participation of various stakeholders, such as the government, local communities and the private sectors, it is also important to understand whether mangrove restoration efforts are able to get the proper support in terms of policy and institutional interventions so as to motivate the local communities and strengthen as well as building capacities among them towards sustainable mangrove development outcomes. Against these concerns, the study has the following specific objectives:

- To undertake a detailed resource mapping of the mangrove restoration activities in the study villages in order to understand the impact on the extent and spread of resource regeneration and status of the same;
- To determine whether the mangrove restoration activities have helped the coastal communities in the selected villages to improve their socio-economic status and livelihoods;
- To undertake a detailed biological assessment and valuation of the mangrove restoration activities; and
- To bring out the policy and institutional intervention mechanisms evolved for implementing the programme and their long term implications for developing a perspective Coastal Resources Management (CRM) strategy aimed at sustainable development and management of mangrove based coastal eco-systems (MBCE) in the villages and their scaling up in the wider context of the state.

To explore on the above objectives, the study covers seven villages, viz., Lakki, Ashira Vandh, Nada, Kantiyajal, Dandi, Karanj and Tada Talav, covering 6 talukas and four districts. Households selected from each village are also members of community based organisations (CBO) engaged in plantation and management of mangroves in the villages. The details of the name of the villages, talukas, districts, CBOs and the number of households covered for the study are presented in Table 3.1.

Table 3.1: Distribution of sample villages and households

No.	District	Taluka	Village	Name of the CBO	No of households covered
1	Kutch	Lakhpat	Lakki	Lakki Cheriya Sanrakshan Samiti	17 (7.5)
		Abadasa	Ashira Vandh	Ashirawandh Cheriya Vikas Samiti	18 (7.9)
2	Bharuch	Jambusar	Nada	Jalstrav Gram Vikas Mandal, Nada	41 (18.1)
		Hansot	Kantiyajal	Morkantha Vistar Tavar Punsthapanane Vikas Committee	50 (22.0)
3	Surat	Olpad	Dandi	Dandi Kantha Tavar Vikas Samiti	47 (20.7)
		Olpad	Karanj	Karanj Tavar Vikas Samiti	15 (6.6)
4	Anand	Khambhat	Tada Talav	Dariya Gram Vikas Mandal, Tadatalav	39 (17.2)
Total					**227 (100)**

3.3. Data and Methodology

The total number of households covered for the study was 227 households with highest representation from Kantiyajal and Dandi Villages (22%, 21% respectively). We followed a two step procedure to select the households for the survey. Accordingly, in the first step, we had visited all the 13 village locations where GEC has implemented mangrove restoration activities (Map 3.1; Appendix 3.1).

Map 3.1: Locations showing Mangrove Restoration activities implemented by GEC in Gujarat

Discussions were held with the concerned members of the CBO from each village involving the key members of the CBOs representing the village communities. Based on the information gathered during the first round of the village visits, we have selected the seven villages for the final survey. The mangrove villages selected represented diversity in terms of growth of plantations and their beneficial outcomes. In the second step, a list of households has been prepared based on the membership register available with the CBOs. As the villages are distinct in terms of concentration of communities with uniform activity status (like fisheries, agriculture, livestock, etc), we followed the simple random sampling method for drawing the final sample of 227 households.

For collecting the data, we have prepared a structured questionnaire in Gujarati which was pilot tested in Tada Talav village for its compatibility and consistency with the specific socio-economic status of the village communities and the nature of mangrove restoration activities being followed in each village. The pilot tested questionnaire has been modified to omit irrelevant questions and include relevant ones based on the initial discussions with the CBO members and households. Data collection was administered during November 2009 – January 2010. Data collection was followed by informal interactions and FGDs involving the respondents and other key informants from the villages, especially, the elderly household members. The interviews and discussions focused on numerous aspects of the villages' relationships with the mangroves, particularly the villagers' understanding about the mangroves, its presence in the village, uses of mangroves, etc.

Broadly, the study used the 'ethno-ecological approach' in conducting the household survey. Ethnoecology as it implies is the study of the interactions between humans and the environment, with its core lying in the 'serious understanding of the native people's knowledge about the environment and about the ways they use it'. Ethnoecology also provides a common interface for anthropology and ecology and understanding such interface becomes fundamental in studies on mangroves (Hirani, 2005).

3.3.1 Household Survey

The questionnaire for household survey contained 15 sub-sections, covering aspects such as: the household profile; community dependence on the mangroves; participation in the CBO; status of extraction of mangroves; benefits of mangroves to fisheries community; benefits to farmers; benefits to animal husbandry/ livestock; mangroves impact on reducing migration; recreation benefits; awareness and perception of households towards conservation of mangroves; change in asset levels; overall status of households prior and after mangrove plantation development, etc. The selected villages are located at the periphery of the planted mangrove plantations. The number of households selected for the survey is representative of the total households in each village, the proportion being 10-15 percent. The coverage could not have been more than this as the mangrove dependence is very much localized among villagers who are living within the periphery of 5-10 kilometers.

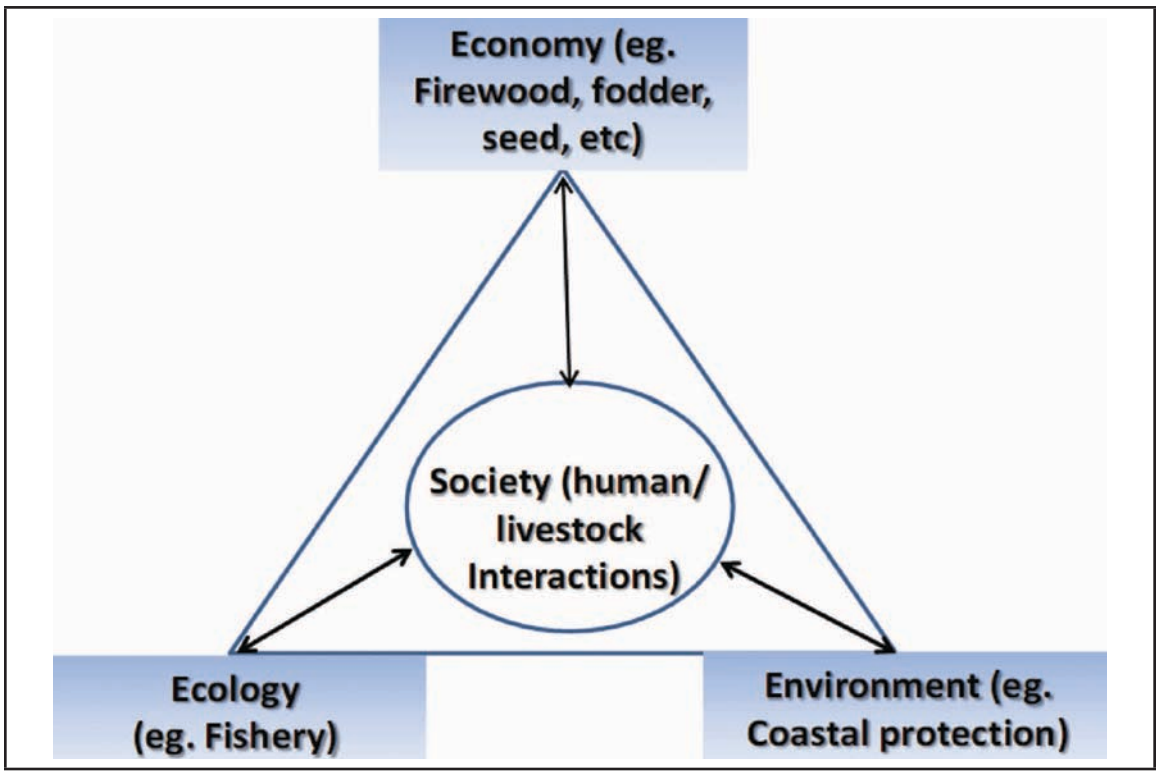
3.3.2 Vegetation surveys for biological assessment

Vegetation survey using biological assessment tools has been undertaken for all the seven selected mangrove restoration sites. This was done in order to understand the status of growth of mangroves, its vegetative cover as well as the status of biodiversity in each location. For a detailed description about the methodology for biological assessment, see Chapter 6.

3.4. Analytical Framework

The study uses the conceptual framework of the dynamic interface between economy, society, ecology and the environment (Chart 3.1).

Chart 3.1: Mangroves and its interface between Society, Economy, Ecology and Environment

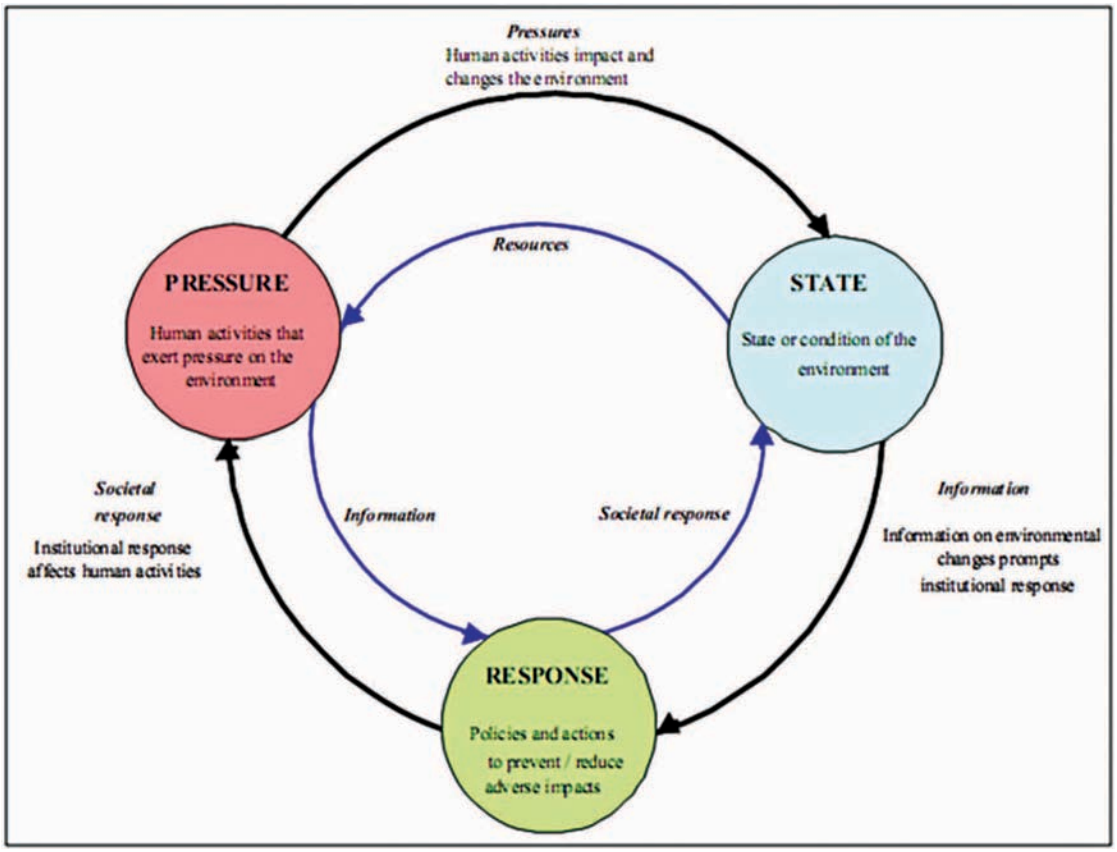


Accordingly, we consider that the ongoing mangrove restoration activities interact with the economy, society, ecology and the environment. The mangrove development/ restoration programmes by itself are a joint outcome of participation between the state and the local communities. First, mangroves provide economic benefits in terms of firewood, fodder for cattle, etc. Second, mangroves offer ecological functions in terms of enhancing the fish stock in the surrounding areas where mangroves grow as well as other coastal resources. From the environmental angle, mangroves protect the coastal environments from heavy tides, winds, sea level rise, etc. The human/ livestock interactions with the mangroves may

prove to be beneficial as well as detrimental for the success or demise of the mangrove ecosystems, which calls for proper planning and policies leading to effective institutional and environmental governance regime for the sustainable management of mangrove ecosystems.

The sustainable mangrove restoration programme as we perceive here may be an outcome of long-drawn processes of degradation of the ecosystems as arising from the "pressures" exerted by human activities as well as natural hazards as widely reported from mangrove growing regions (Chart 3.2).

Chart 3.2: Mangrove Restoration as seen from the Pressure-State-Response framework



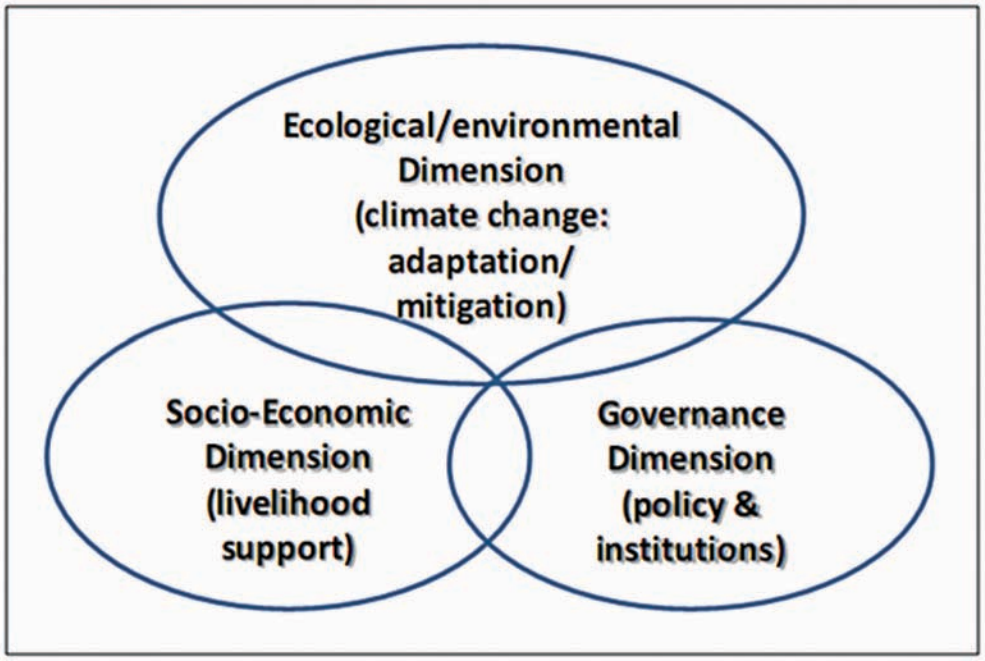
Source: Based on Friend, A.; Rapport, D (1979): Towards a Comprehensive Framework for Environmental Statistics: a Stress-Response Approach, Statistics Canada.

In this case, the PSR framework as shown in Chart 3.2 states that human activities exert pressure (such as pollution emissions or land use changes) on the environment (mangrove ecosystem), which can induce changes in the state of the quality and quantity of the ecosystem. Society representing the state or the civil society then responds to the changes in the pressures or the state (of the ecosystem) with development and restoration policies/ programs intended to prevent, reduce or mitigate pressures and/or environmental degradation caused to the mangrove ecosystems. Thus, the PSR framework highlights

these (causal) linkages, and helps decision-makers and the public to see environmental and other interconnected issues underlying mangrove restoration activities. The ongoing mangrove restoration activities in the study regions could be viewed from the perspective of the PSR framework as discussed above.

Taking cue from the above two frameworks, it may be observed that the process of sustainable development/ restoration and management of mangroves calls for the integration of three crucial dimensions (Chart 3.3). First, the socio-economic dimension of restoration strategies helps the local communities to build up and strengthen their livelihoods.

Chart 3.3: Mangrove restoration: Socio-Economic, Environmental and Governance Dimensions



Second, the ecological/environmental dimension of mangrove restoration strategies signifies the increasing importance of mangroves as a 'bio-shield' against the threats emerging from climate change and its induced environmental consequences. Third, the governance dimension underlines the importance of policies and institutions for effective governance of mangrove ecosystems. This dimension essentially sets out the way in which mangrove restoration practices are implemented at the grass roots level and the extent to which the restoration activities promote joint action as well as co-ordination between the various actors, like the state, the local communities and the local other actors in the specific context of the REMAG villages in Gujarat.

Appendix 3.1: List of village locations where GEC has implemented mangrove plantation activities

Sr. No.	Name of District	Name of Taluka	Name of Village	Name of Community Based Organisation (CBO)
1	Kutch	Lakhpat	Lakki	Lakki Cheriya Sanrakshan Samiti
2		Abdasa	Bhangodi	Bhangodi Cheriya Sanrakshan Samiti
3		Abdasa	Ashira Vandh	Ashirawandh Cheriya Vikas Samiti
4	Rajkot	Maliya	Navlakhi	
5		Maliya	Bagsara	Bagasra Van Sanrakshan Samiiti
6	Ahmedabad	Dhandhuka	Mahadevpura	Mahadevpura / Bhangadh Dariyai Vruksh Ucher Sahakari Mandli Ltd.
7		Dhandhuka	Bhangadh	
8	Bharuch	Jambusar	Nada	Jalstrav Gram Vikas Mandal, Nada
9		Jambusar	Neja	Shri Bhathiji Sanyukt Kheti Sahakari Mandli, Neja
10		Hansot	Kantiya Jal	Morkantha Vistar Tavar Punsthapan ane Vikas Committee
11	Surat	Olpad	Dandi	Dandi Kantha Tavar Vikas Samiti
12		Olpad	Karanj	Karanj Tavar Vikas Samiti
13	Anand	Khambhat	Tada Talav	Dariya Gram Vikas Mandal, Tadatalav

Source: Gujarat Ecology Commissio

Chapter - 4

Socio-Economic Profile of the Sample Households

4.1. Socio-economic and demographic profile of the villages

This chapter provides the socio-economic profile of the study villages and the sample households. The study covered 7 villages, viz., Lakki and Ashirawandh from Kachchh district, Nada and Kantiyajal from Bharuch district, Karanj and Dandi from Surat district and Tada Talav from the Anand district. Table 4.1 provides a summary of the demographic and socio-economic profile of the study villages and respondent households based on the Census 2001. However, Census data could be obtained only for 4 villages, viz. Dandi, Karanj, Nada and Kantiyajal. The village data reveals that the average household size is close to 5 members per household with an exception only in the case of Kantiyajal village (4.04). The average household size of all the four villages combined shows a figure of 4.76 members per household.

Table 4.1: Demographic and Socio-economic profile of the select study village

Indicators	Dandi	Karanj	Nada	Kantiyajal	Total
1. Total HH (No)	583	309	547	291	1730
2. Total Population (No)	2902	1477	2674	1177	8230
3. HH size (No/ HH)	4.98	4.78	4.89	4.04	4.76
4. Male %	50.28	51.66	53.85	52.42	51.99
5. Female %	49.72	48.34	46.15	47.58	48.01
6. SC (%)	0.00	2.84	1.38	0.34	1.01
7. ST (%)	0.00	33.51	9.39	21.92	12.20
8. Literacy (%)	75.57	65.67	49.44	69.92	64.50
9. Literacy – (Male %)	81.43	71.17	62.64	79.42	72.98
10. Literacy - (Female %)	69.65	59.80	34.04	59.46	55.30
11. Illiterate (% of Population)	24.43	34.33	50.56	30.08	35.50
12. Illiterate (Male %)	18.57	28.83	37.36	20.58	27.02
13. Illiterate (Female %)	30.35	40.20	65.96	40.54	44.70
14. Total Workers (% of total population)	28.05	50.10	50.04	62.79	44.12
15. Male workers (%)	46.95	58.85	60.69	63.05	56.02
16. Female workers (%)	8.94	40.76	37.60	62.50	31.23

Source: Census Data, 2001

Males dominate in the total population with a relative share of 52 percent and the share of ST population has been as high as 33.5% percent in Karanj, 22% in Kantiyajal, and about 9.4 percent in Nada village. The presence of SC population is only marginal. While the overall literacy rate is 65 percent, Nada village reports the lowest status in literacy (49%). Literacy among females has been significantly lower than literacy among males. Nada has the lowest percentage of female literates (34%) while rest of the villages report reasonable proportion of female literates. Nevertheless, the gender gap in literacy is an important point need attention. This is also corroborated by the higher proportions of female illiterates as high as 66 percent in Nada village. Work participation rate (WPR) at the aggregate level has been 44 percent with significant differences among the villages, with highest WPR reported from Kantiyajal village (63%). Dandi village shows the lowest WPR (28%), which is mainly due to the very low levels of work participation among females (8.94%). Nada village also reports lower levels of female work participation 37.6%. In Kantiyajal village, women work participation rate (62.5%) is almost on par with male work participation rate (63.05%).

4.2. Socio-Economic Characteristics of Sampled Households

The 227 sample households covered in the study are drawn from five districts and 7 villages which lie along the coastal belt of Gujarat as described in Chapter 3. If seen from the district scenario, almost 40 percent of the sampled households are from Bharuch district, followed by 27 percent from Surat, 17 percent form Anand and 15 percent from Kachchh (Table 4.2). The over-representation of households in some villages has been due to the higher dependence of the communities in those villages.

Table 4.2: Distribution of Number and Percentage of Sample Households

District	HHs (No)	% share	Village	HHs (No)	% share
Kachchh	35	15.42	Lakki	17	7.49
			Ashirawandh	18	7.93
Surat	62	27.31	Karanj	15	6.61
			Dandi	47	20.70
Bharuch	91	40.09	Nada	41	18.06
			Kantiyajal	50	22.03
Anand	39	17.18	Tadatalav	39	17.18
Total	227	100.00	Total	227	100.00

Source: Village Survey, December 2009 - February 2010

4.2.1. Education status

The educational status of the respondents is presented in Table 4.3. It shows very disquieting scenario in terms of higher proportion of illiterates in four villages, viz., Ashirawandh (94%),

followed by Lakki (76.5%), Tada Talav (46%), and Nada (44%). Only Dandi village shows an exception here with the lowest ratio of illiteracy at 4.3 percent. Kantiyajal and Karanj villages also report reasonably higher rates of illiteracy among the respondents. Dandi village has higher proportions of respondents with primary education (40.4%), followed by Tada Talav (38.5%) and Kantiyajal (20%). In terms of secondary education, Karanj and Kantiyajal villages show higher proportions (53.3% and 50% respectively). Ashirawandh village has no respondent with educational status beyond the primary education. In terms of tertiary or above secondary education, only Dandi has a reasonably good standing (19%) compared to rest of the villages.

Table 4.3 Education status of Sampled Households (village wise Percentage distribution)

Village	Educational Status (% of respondents)				
	Illiterate	Primary	Secondary	Above Secondary	Total (N)
1. Lakki	76.5	11.8	11.8	0.0	100.0 (17)
2. Ashirawandh	94.4	5.6	0.0	0.0	100.0 (18)
3. Karanj	33.3	6.7	53.3	6.7	100.0 (15)
4. Dandi	4.3	40.4	36.2	19.1	100.0 (47)
5. Nada	43.9	19.5	34.1	2.4	100.0 (41)
6. Kantiyajal	20.0	20.0	50.0	10.0	100.0 (50)
7. Tadatalav	46.2	38.5	15.4	0.0	100.0 (39)
All Villages	**36.6**	**24.7**	**31.7**	**7.0**	**100.0 (227)**

Note: Primary – 1-6 classes; secondary – 7-10 classes; Above secondary (class 11 and above).
Source: Village Survey, December 2009 - February 2010.

Overall scenario of educational status shows that highest proportion of respondents is illiterate (37%) as compared to those with primary (25%), secondary (32%) and tertiary education (7%).

4.2.2. Community status

Table 4.4 presents the community status of the respondents. It shows the concentration of certain communities in the villages.

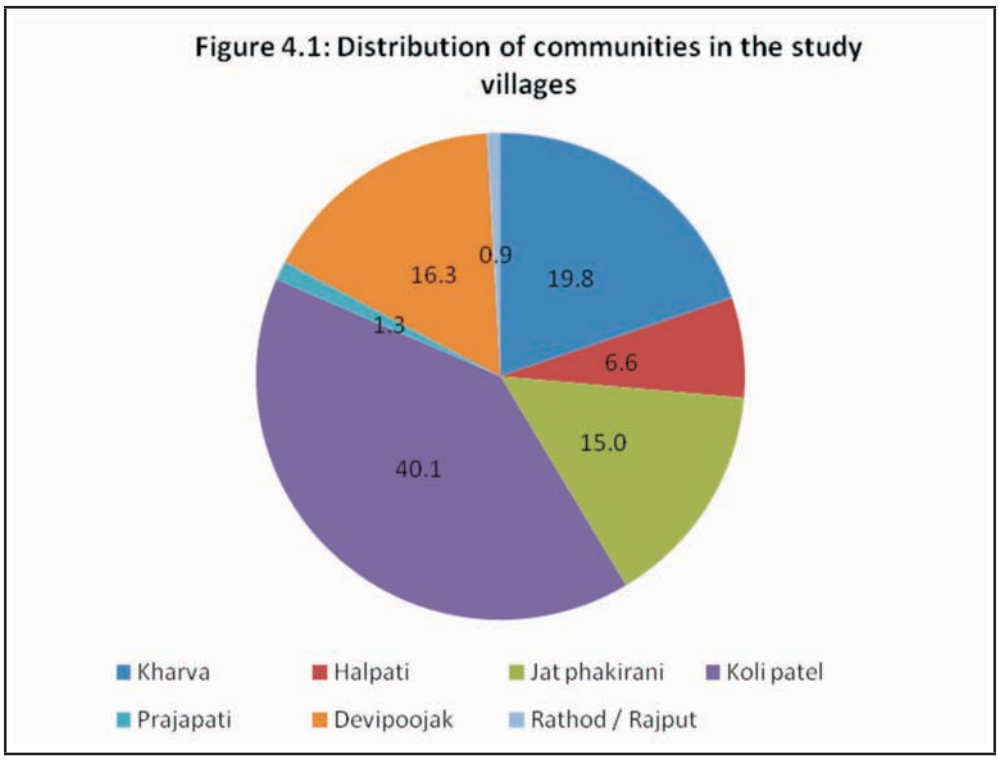
Table 4.4 Caste wise percentage distribution of sample households by village

Caste	Kharva	Halpati	Jat Fakirani	Koli patel	Prajapati	Devipoojak	Rathod/ Rajput	Total (N)
Lakki	5.9	0.0	94.1	0.0	0.0	0.0	0.0	100.0 (17)
Ashirawandh	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0 (18)
Karanj	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0 (15)
Dandi	93.6	0.0	0.0	0.0	0.0	6.4	0.0	100.0 (47)
Nada	0.0	0.0	0.0	48.8	0.0	46.3	4.9	100.0 (41)

Kantiyajal	0.0	0.0	0.0	74.0	6.0	20.0	0.0	100.0 (50)
Tadatalav	0.0	0.0	0.0	87.2	0.0	12.8	0.0	100.0 (39)
All villages	19.8	6.6	15.0	40.1	1.3	16.3	0.9	100.0 (227)

Source: Village Survey, December 2009 - February 2010

For instance, Dandi village is primarily occupied by Kharva communities (94%) with a smaller proportion of population belonging to devipoojak community. While Karanj village is dominated by Halpati communities, Lakki and Ashirawandh villages are dominated by Jat Fakirani communities (94% and 100% respectively. The Koli Patel community has significant presence in Tada Talav (87%), followed by Kantiyajal (74%) and Nada (49%). Similarly, Devipoojak community has greater presence in Nada (46%), Kantiyajal (20%) and Tada Talav (13%) villages. Only three villages have the significant presence of more than one community, viz, Nada, Kantiyajal and Tada Talav. Overall scenario of community status indicates the dominance of Koli Patel (40%), followed by Kharva (20%), Devipoojak (16%), Jat Fakirani (15%) and Halpati (6.6%) communities (Figure 4.1).



4.2.3. Household composition and economic activism

The composition of households is important to understand the strength of the households in terms of economically active population. Accordingly, Table 4.5 presents the household composition characterized by presence of women members and children as well as economically active population.

Table 4.5. Household composition of the respondents and presence of economically active population

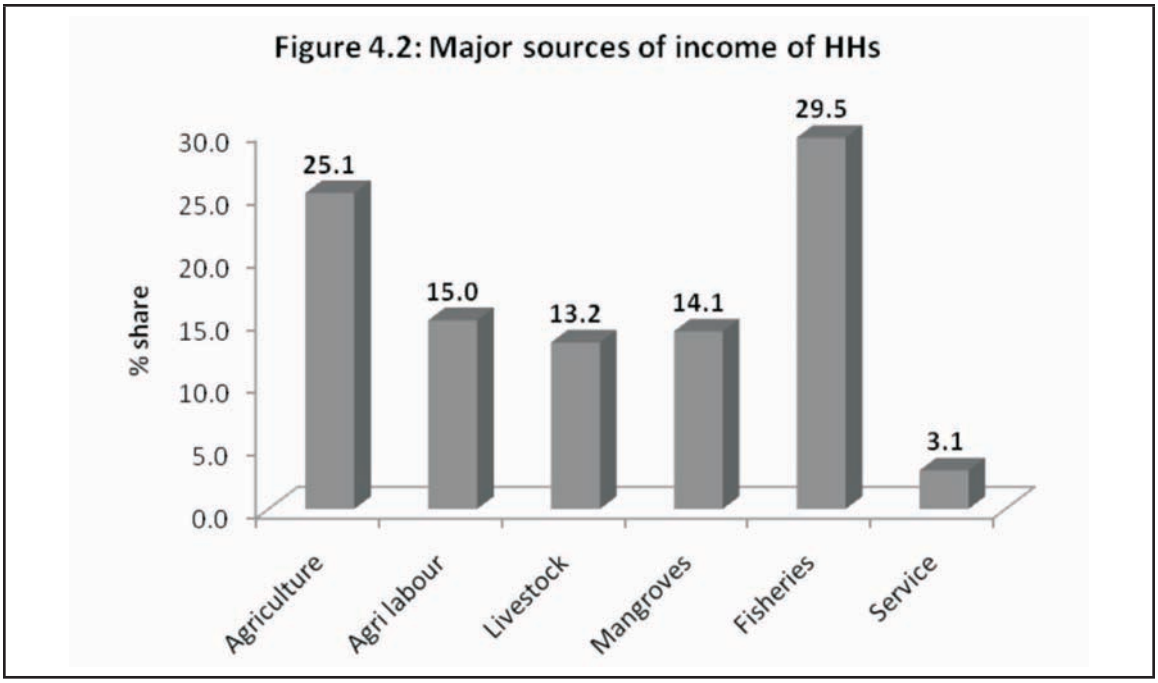
village	Total (No. of Persons)	HH size	Female	Children	Economically active population (%)		
					Male	Female	Total
Lakki	96	5.6	52.5	36.5	37.93	37.5	37.7
Ashirawandh	176	9.8	53.4	34.1	18.52	27.4	23.3
Karanj	81	5.4	49.2	24.7	41.94	40.0	41.0
Dandi	280	6.0	48.1	16.1	22.13	36.3	28.9
Nada	226	5.5	46.3	34.1	35.00	33.3	34.2
Kantiyajal	233	4.7	48.2	27.0	34.09	46.3	40.0
Tadatalav	262	6.7	49.4	35.9	38.82	42.2	40.5
Total	1354	6.0	49.1	29.1	31.08	37.8	34.4

Source: Village Survey, December 2009 - February 2010

It may be observed from Table 4.5 that the average size of a household is close to 6 members per family at the aggregate level, though there are notable variations across villages. For instance, Ashirawandh village has the highest household size of about 10 members in the family, followed by Tadatalav (6.7), Dandi (6), Lakki (5.6) and the lowest at Kantiyajal (4.7). The higher family size in Ashirawandh reflects the higher prevalence of joint families in this village compared to other villages. Only in two villages, viz., Lakki (52.5%) and Ashirawandh (53.4%) that the females outnumber men. Proportion of children in the households is above 34 percent in 4 villages (Lakki, Tadatalav, Ashirawandh and Nada), while it is very low at 16 percent in Dandi Village. In terms of economically active population, women have an edge over male family members at the aggregate level, where women account for 38 percent of the active total population compared to men (32%). In four villages women outnumber males in terms of economic activism. That is, share of women in economically active population is as high as 46 percent in Kantiyajal, followed by Tadatalav (42%), Dandi (36%), and Ashirawandh (27%).

4.2.4. Respondents' Main sources of income

The major sources of income of the respondents are presented in Figure 4.2, which shows that at the aggregate level about 30 percent of the respondents are engaged in fisheries, followed by 15 percent pursuing agriculture, 14 percent working as agricultural labourers. Interestingly, 14 percent of the respondents have reported their exclusive dependence on mangroves and another 13 percent depend on animal husbandry/ livestock rearing. Looking at the pattern occupational distribution, it may be surmised that a vast majority of the respondents will have a close dependence on mangroves for various activities that they are engaged in.



The village-wise status of main sources of income of the respondents is presented in Table 4.6. Accordingly, agriculture forms the main source of income for respondents from Tadatalav (49%), followed by Kantiyajal (36%), Nada (34%) and Ashirawandh and Lakki villages (17% each). Large share of respondents from Karanj, Nada, Tadatalav and Kantiyajal villages work as agricultural labourers to earn their livelihoods. Animal husbandry/ livestock form the dominant source of income for respondents in Ashirawandh (56%) and Lakki (53%) villages. It is very important to note that fishery forms one of the major sources of livelihood in all the villages with the highest proportion of respondents from Karanj village (67%), followed by Dandi (40%), Nada (41.5%), Lakki (29.4%), Kantiyajal (18%), Ashirawandh (17%) and Tadatalav (10.3%).

Table 4.6 Percentage Distribution of sources of income by village

Source of income	Lakki	Ashiraw andh	Karanj	Dandi	Nada	Kantiyajal	Tadata lav	Total
1. Agriculture	17.6	16.7	0.0	0.0	34.1	36.0	48.7	25.1
2. Agri labour	0.0	0.0	33.3	0.0	24.4	20.0	23.1	15.0
3. Animal husbandry	52.9	55.6	0.0	0.0	0.0	8.0	17.9	13.2
4. Mangroves	0.0	0.0	0.0	48.9	0.0	18.0	0.0	14.1
6. Fisheries	29.4	16.7	66.7	40.4	41.5	18.0	10.3	29.5
7. Service	0.0	11.1	0.0	10.6	0.0	0.0	0.0	3.1
All villages (N)	100.0 (17)	100.0 (18)	100.0 (15)	100.0 (47)	100.0 (41)	100.0 (50)	100.0 (39)	100.0 (227)

Source: Village Survey, December 2009 - February 2010

Yet another interesting observation is that about 49 percent of the respondents from Dandi and 18 percent of the respondents from Kantiyajal are dependent on extraction of mangroves for earning their incomes, which highlights the importance of mangroves to village communities.

4.2.5. Main sources of economic activity of the households

It will be appropriate to see the occupational structure of the households of the respondents. In this regard, Table 4.7 shows the distribution of households in terms of various occupations engaged by the household members across the study villages. Quite interestingly, a major proportion of the household members (34%) are dependent on mangroves in all the villages with the highest dependence reported from Dandi (55%), followed by Karanj and Kantiyajal (35% each), Tadatalav (33.6%), Nada (28.4%), Lakki (27.6%) and Ashirawandh (25%).

Table 4.7 Percentage distributions of household members by economic activity, village-wise

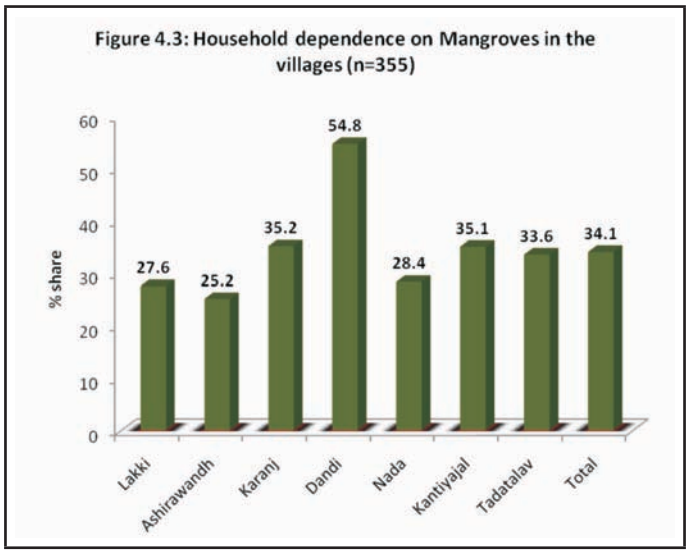
Occupation	Lakki	Ashirawandh	Karanj	Dandi	Nada	Kantiyajal	Tadatalav	Total
1. Agriculture	16.3	25.2	0.0	0.0	12.4	16.6	20.6	14.3
2. Agri-labour	18.4	1.9	38.0	4.0	25.2	33.6	27.1	22.6
3. Mangroves	27.6	25.2	35.2	54.8	28.4	35.1	33.6	34.1
4. Non-agri labour*	7.1	1.9	1.4	0.8	0.5	0.0	0.0	1.1
5. Fishery - full time	8.2	4.7	19.7	19.8	5.5	4.3	0.0	7.0
6. Fishery - Part time	3.1	5.6	0.0	7.1	4.1	1.4	2.3	3.3
Fishery Total	11.3	10.3	19.7	26.9	9.6	5.7	2.3	10.3
7. Animal husbandry	19.4	26.2	4.2	0.0	6.0	8.5	16.4	11.1
8. Others@	0.0	9.3	1.4	13.5	17.9	0.5	0.0	6.5
Total (No)	**98**	**107**	**71**	**126**	**218**	**211**	**214**	**1045**

Note: *Casual work / Digging work / Relief work / labour in coal factory, Labour work in building construction, Painting, Salt work, Service @Hotel work, Salt work, Driver, coast guard, Do clean canal, Masson work, welder, shop keeper, Tailor

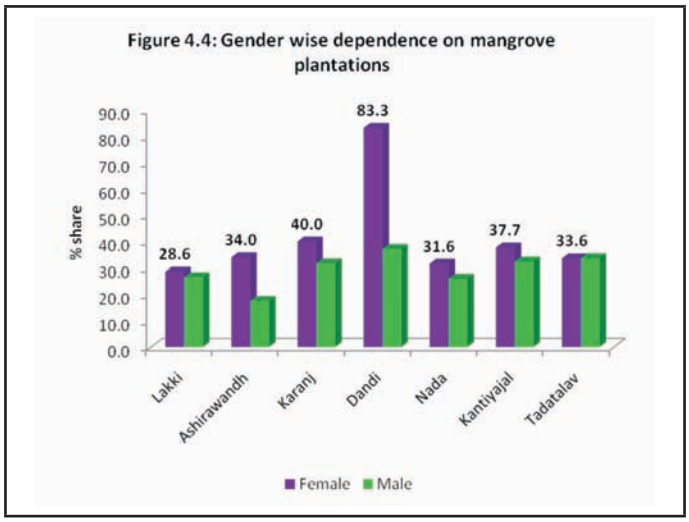
Source: Village Survey, December 2009 - February 2010.

Most people depend on mangroves for plantation work as in all the villages reasonable amount of work is being carried out for gap filling or planting of fresh mangrove stock, which provides employment to the household members apart from the respondents. A significant share of households also depend on fisheries especially in five villages, viz., Dandi (27%), Karanj (19.7%), Lakki (11%), Ashirawandh (10.3%) and Nada (9.6%).

Livestock rearing becomes another major activity for the households in Ashirawandh (26%), Lakki (19.4%) and Tadatalav (16.4%). While agriculture forms another important activity of the households in Ashirawandh (25%), Tadatalav (21%), Kantiyajal and Lakki (16% each), significant proportion of household members are also work as agriculture labourers, especially in villages, such as Karanj (38%), Kantiyajal (33.6%), Tadatalav (27%), Nada (25%) and Lakki (18%). From this it may be concluded that full time or part-time work in mangroves as well as fishing activity are the two main important activities of the household members in the study villages. Dependence on mangrove plantations for livelihood itself constitutes a major source of livelihood for the family members (Figure 4.3).



More importantly, the gender-wise dependence on mangrove plantations in the villages shows a very interesting trend in terms of higher dependence among women compared to men in all the villages, except Tadatalav where both men and women show almost same level of dependence (Figure 4.4).



4.2.6. Land ownership status

Ownership of landed assets is an important socio-economic indicator of any rural household. The survey results show that only 35 percent of the respondents have own agricultural land which otherwise reveals that almost 65 percent of the households are landless in the study villages (Table 4.8).

Table 4.8 Ownership of agriculture land among the Households, village wise

Village	% of Ownership of agriculture land			Land close to mangrove sites (% HHs)
	Own land	Landless	Average land size (ha.)	
1. Lakki	47.1	52.9	6.28	25.0
2. Ashirawandh	77.8	22.2	4.84	42.9
3. Karanj	0.0	100.0	0.00	0.0
4. Dandi	2.1	97.9	0.46	0.0
5. Nada	36.6	63.4	3.67	66.7
6. Kantiyajal	40.0	60.0	3.10	80.0
7. Tadatalav	56.4	43.6	4.80	36.4
All village (N)	35.2 (80)	64.8 (147)	4.27	52.5 (42)

Source: Village Survey, December 2009 - February 2010

As evident, households in Karanj are virtually landless, followed by the presence of higher proportions of landless households in Dandi village (98%). Nada and Kantiyajal villages also have sizeable proportion of landless households (36.6% and 40% respectively). The average holding size is reported to be as high as 6.28 ha in Lakki, followed by Ashirawandh (4.84 ha) and Tadatalav (4.8 ha). Lowest size of landholding is found in Dandi (0.46 ha).

Nevertheless, it is important to highlight here that almost whole of the agriculture land owned by the respondents are in the dry zone and do not have access to irrigation. This implies that the households are disadvantaged in terms of lack of access to irrigated agriculture. In effect, only five of the seven villages have some land to fall back, as the households from Karanj and Dandi villages do not have own farm lands. Further probing about the location of agriculture land close to the mangrove sites reveals that majority of households in four villages have their farm lands close to the mangrove locations.

Thus, the foregoing Chapter gives a brief account of the household profile, their dependence on mangroves for earning livelihoods as well as their landholding and occupational structure. In Chapter 5 we try to explore the tangible and non-tangible benefits of mangroves to various communities in the study villages.

Chapter - 5

Economic Assessment of the multiple benefits of mangroves and their restoration in Gujarat – Empirical analysis

In this Chapter, we make a detailed account of the tangible and non-tangible benefits of mangrove plantations and the beneficial outcomes of their restoration efforts in the study villages in Gujarat. While the analysis draws important clues from the analytical framework (as discussed in Chapter 3) for the economic analysis, it needs a special mention that the analysis is incomplete in view of the fact that the mangrove plantations are in the initial stages of their growth. Given this, any attempt to make an economic assessment to capture the entire stream of socio-economic and ecological/ environmental benefits would be far from complete and inaccurate. Hence, the results of the economic analysis we attempt here may only be taken as useful indications or guidelines reflecting the potential tangible and non-tangible future benefits of mangroves that would accrue to the local communities.

In the initial section of the Chapter we try to provide a holistic view of the mangrove development process in the villages, awareness/ knowledge of the households/ communities about mangroves, their dependence on mangroves for various activities and benefits, their participation in mangrove restoration work, etc. Much of this information has been gathered to examine the respondents' understanding about the mangroves and their relevance in the local setting as an important source of livelihood to them and the future generations.

5.1. Mangrove Development and Community Dependence

At the outset, it may be observed that GEC as a nodal agency in implementing mangrove restoration activities in the study villages has been engaged in efforts to impart basic training and generate awareness among the local communities about all aspects of mangrove development. Accordingly, the GEC seems to have arranged several campaigns and awareness programmes to motivate the local communities to actively participate in the conservation/ restoration activities. Taking into consideration of all these capacity building efforts initiated by the GEC in the study villages, we have tried to get a feel about how the communities respond to even simple/ rudimentary questions, such as 'what is a mangrove', 'have you seen mangroves earlier', etc. Based on these questions we tried to develop a perspective that the communities are well aware of the 'livelihood resource' in question.

5.1.1. Knowledge about mangroves and their functions

Almost 97 percent of the respondents started sharing their experience with a positive note that they have seen mangrove plantations much before they were first planted in their respective villages. This viewpoint of the respondents is further strengthened as an overwhelming proportion of respondents of all villages claimed that they have seen mangroves since their childhood (62%) or since the past 20-25 years (16%). This question was further probed to understand whether 'mangrove existed in the villages prior to GEC's mangrove development activities'?. For this, almost 89 percent of the respondents observed that the villages had mangroves even prior to the recent development interventions by the GEC. It was only in two villages, viz., Tadatalav and Lakki that a significant proportion of respondents (38.5% and 18% respectively) viewed that mangroves did not exist in the villages prior to GEC's project. The above views of the respondents seem to be reasonable and justified as vast tracts of the pre-existing mangroves in many of the Gujarat villages have been decayed or degraded by cyclones or other human or animal induced destructive activities.

Table 5.1 presents some interesting reflections from the respondents about the mangroves and their important functions in the context of coastal villages in particular. About 33 percent of the respondents feel that mangroves helps in preventing soil erosion in coastal areas and holds the soil particles intact. Almost 60-62 percent of the respondents from Kantiyajal and Karanj villages have appreciated this 'soil protective' role of mangroves.

Table 5.1: Percentage distribution of respondents based on knowledge about mangroves and their importance (n = 220)

Knowledge about Mangroves	Lakki	Ashira wandh	Karanj	Dandi	Nada	Kantiy ajal	Tadat alav	Total (N)
1. Prevents soil erosion/keeps soil particles intact	6.3	0.0	60.0	41.3	23.7	62.0	10.8	33.2 (73)
2. Prevent cyclones / reducing effect of heavy winds/ prevent tidal waves	6.3	22.2	13.3	32.6	13.2	6.0	24.3	17.7 (39)
3. Green forest / tourist attraction	0.0	16.7	0.0	8.7	10.5	2.0	24.3	9.5 (21)
4. Increases fish stock	0.0	0.0	6.7	8.7	0.0	0.0	0.0	2.3 (5)
5. Increases rain	0.0	11.1	0.0	2.2	0.0	0.0	0.0	1.4 (3)
6. Don't know/ can't say anything	37.5	16.7	13.3	6.5	15.8	4.0	2.7	10.5 (23)
7. Others*	50.0	11.1	20.0	8.7	15.8	20.0	24.3	19.1 (42)
No. of Households	16	18	15	46	38	50	37	220

Note: * Getting income activity, multiple benefits, safety of coastal villages, etc

Source: Village Survey during December 2009 – February2010

Besides, 41 percent of respondents from Dandi and 24 percent of respondents from Nada also hold that mangroves help reducing the adverse effects of soil erosion.

The positive effects of mangroves in protecting coastal areas from cyclones/ heavy winds and tidal waves have been reported by almost 18 percent of the respondents at the aggregate level. This benefit has been highlighted by many respondents from Dandi (32.6%), followed by Tadatalav (24.3%), and Ashirawandh (22%) villages, while a significant number from Karanj and Nada villages (13%) have also appreciated this 'wind/ tidal protective' role of the mangroves. The role of mangroves has also been highlighted as offering green forest cover as well as patches of tourist attraction by a significant number of respondents from Tadatalav (24%), Ashirawandh (17%), Nada (10.5%) and Dandi (8.7%). At the same time, a vast segment of respondents have expressed their lack of awareness as regards the beneficial role of mangroves as they felt that they can't say anything about it. About 37 percent of the respondents from Lakki expressed their inability in defining mangroves and their beneficial roles, followed by 17 percent in Ashirawandh and close to 16 percent in Nada village. There are some other positive impacts of mangroves as highlighted by the respondents that mangroves help in increasing fish production, increasing rain, etc.

5.1.2. Mangroves and Community Organisations

The initiatives for development/ restoration of mangroves in the REMAG villages have coincided with the formation of community based organisations (CBOs) in each village in order to carry forward the programme for the benefit of the village communities.

While all the beneficiary households are invariably members of the CBOs, it has been reported that about 25 percent of the respondents covered in the study are holding some of the key positions of the executive committee of the CBO. The percentage also varied across villages. For instance, in Ashirawandh, almost 50 percent of the respondents are holding one or the other key positions in the CBO. Whereas in Dandi and Nada, only 11 and 17 percent (respectively) of the respondents have reported that they hold some key positions in the CBO. In other words, almost 75 percent of the respondents covered in the study are ordinary members of the CBOs.

Ongoing mangrove plantation activity by LNG Ltd. – GEC at Nada, Bharuch

Of the total respondents, about 42 percent have reported that they have visited mangrove restoration sites either in other states or locations within Gujarat. This percentage is found very high in Dandi and Karanj villages, where almost 67-68 percent of the respondents have obtained the chance of visiting mangrove restoration/ plantation sites in other states/ within Gujarat. In other villages, the proportion of respondents who visited other mangrove locations are 50 percent in Ashirawandh; 32 percent in Kantiyajal and Nada; 29 percent in Lakki and 26 percent in Lakki village. Of the 195 (85%) respondents who have reported visiting mangroves in different locations within Gujarat, 20 percent reported that they visited mangrove location in Karanj, while another 15 percent reported visiting Dandi village as a 'training and education visit' to mangroves. Similarly, of the total respondents

9 percent (17 nos) have been able to visit mangrove locations in West Bengal (24%), Orissa (41%) and Karnataka (12%). This shows that the communities have received opportunities to visit the mangrove plantations and thereby enhance their level of understanding about the plantations and their importance to the coastal communities in particular.

5.2. Mangroves: The Employment and Income Transfer Effects

One of the important benefits of the mangroves in the study villages is in terms of generation of employment to the communities as plantation development requires lots of labour inputs right from the sowing at the nursery to planting, vacancy filling, etc. As the survey was pertaining to the year 2009, based on recall method, we have first tried to gather the information for the latest years, i.e., 2008 and 2009 about the employment benefits received by the communities. Accordingly, it has been found that almost 94 percent of the respondents have received work in mangrove plantations during 2008. The percentage responses varied only slightly across villages. While all the respondents received work from Kantiyajal, Dandi and Karanj villages, almost 95 percent of respondents from Tadatalav and Ashirawandh received work in mangroves during 2008. Only in two villages, viz., Lakki and Nada that percentage response has covered around 81-82 percent. The status of availability of employment received by the respondents and their household members for the year 2008 is presented in Table 5.2.

Table 5.2: Employment received by the sample households during 2008

Village	Number of household members received employment during 2008			
	Male	Female	Total	Female (%)
1. Lakki	11	12	23	52.2
2. Ashirawandh	10	17	27	63.0
3. Karanj	13	12	25	48.0
4. Dandi	27	41	68	60.3
5. Nada	28	23	51	45.1
6. Kantiyajal	30	38	68	55.9
7. Tadatalav	33	35	68	51.5
Total	**152**	**178**	**330**	**53.9**

Source: Village Survey, December 2009- February 2010.

The Table reveals that there were a total of 330 members from all the villages who received employment in mangrove plantations during the year 2008. There was also great work participation among the female family members as well (54%). For instance, the share of female family members who received employment was more than 50 percent in five of the seven villages, viz., Ashirawandh (63%), Dandi (60%), Kantiyajal (56%), Lakki (52%), and Tadatalav (52%). More importantly, the employment effect was such that in most households at least two female and male members have received work in mangrove

plantations during 2008. In many cases, if work is not available in their own villages, the households use to go to the next village to get work in mangrove plantations.

Mangrove plantations require large number of workers at three different stages. In the first stage, labourers are required to prepare nursery by filling plastic bags with mud and sowing the seed of mangroves. Mostly, this work is being performed during monsoon as mangrove seed is easily available during this period. Moreover, the success of germination is also very high if sowing is dong during monsoon. In the second stage, the mangrove saplings are to be properly cared until they reach the stage of field planting. In the third stage, the plants are taken from the nursery to the coastal area for final planting. The whole process may take 3 to 4 months which generates employment opportunities to the local communities. Mostly there takes place inter-village movement of labourers in view of the shortage of labour experienced during this critical period of mangrove development and planting.

Based on the above, it may be observed that work in mangroves also generated significant employment opportunities to the respondents and their households during 2009 also as evident from Table 5.3. Accordingly, it may be seen that almost 91 percent of the respondents reported to have received employment opportunities in mangroves during 2009. If we classify the number of days of work received by the respondents at the aggregate level, it may be observed that an overwhelming majority of them have received work for 41-60 days (38%) during the year, followed by 26 percent reporting work for 61-90 days; 17.5 percent reporting availability of work for 26-40 days, etc (Figure 5.1).

Table 5.3: Distribution of respondents according to working days generated by mangrove plantations in the study villages during 2009

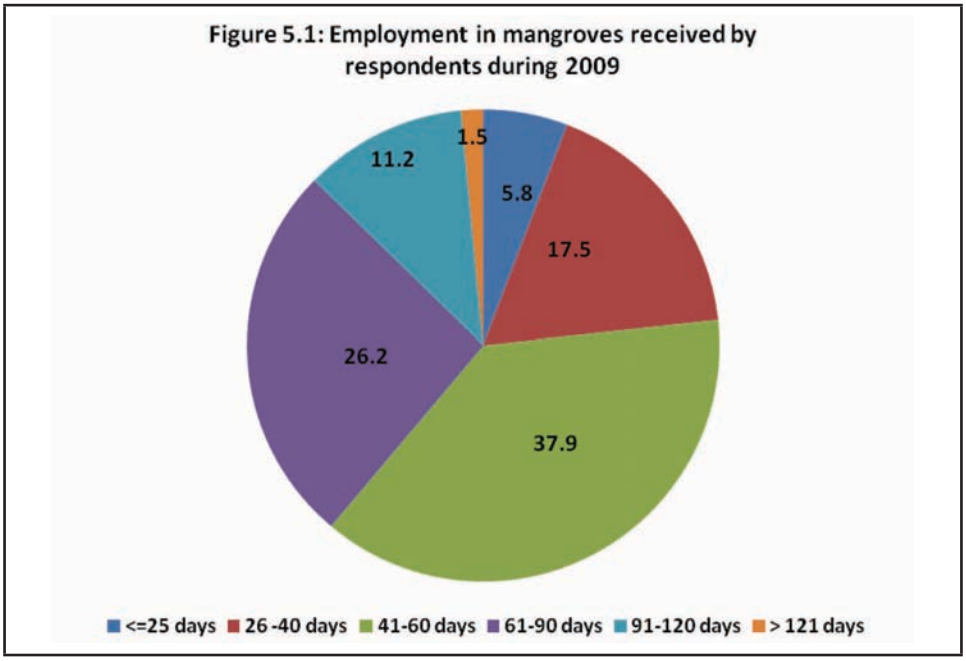
Village	Number of days of work reported by respondents (%)						Total (No.)
	< 25	26 -40	41-60	61-90	91-120	> 121	
1. Lakki	7.1	7.1	35.7	35.7	14.3	0.0	100 (14)
2. Ashirawandh	0.0	0.0	50.0	6.3	43.8	0.0	100 (16)
3. Karanj	0.0	14.3	35.7	14.3	35.7	0.0	100 (14)
4. Dandi	21.1	39.5	23.7	13.2	2.6	0.0	100 (38)
5. Nada	0.0	2.6	35.9	41.0	12.8	7.7	100 (39)
6. Kantiyajal	2.0	24.0	58.0	14.0	2.0	0.0	100 (50)
7. Tadatalav	5.7	14.3	22.9	51.4	5.7	0.0	100 (35)
Total	**5.8**	**17.5**	**37.9**	**26.2**	**11.2**	**1.5**	**100 (206)**

Note: Figures in parentheses represent the percentages to total number of respondents.

Source: Village Survey, December 2009- February 2010.

While about 44 percent of the respondents from Ashirawandh village reported that they received work between 91-120 days during 2009, 36 percent of the respondents from Karanj also reported the same number of days. Similarly, 51 percent of respondents from

Tadatalav reported that they received 61-90 days of work in mangrove plantations. In short, it may be summarized that mangrove plantations have generated reasonable number of employment to the dependent communities in all the villages and in most cases, majority of the respondents have received employment for more than 60 days during 2009.



On the other hand, the wage distribution according to different ranges of wages reveals that a vast majority of the respondents (53%) have received a daily wage in the range of Rs. 80-100 at the aggregate level (Table 5.4).

Table 5.4: Village wise Percentage Distribution of respondents according to wages received for working in mangroves during 2009

Village	Wage rates (Rs./day)				Total HHs (N)
	< 60	60-80	80-100	>100	
1. Lakki	0.0	7.1	92.9	0.0	14
2. Ashirawandh	0.0	50.0	50.0	0.0	16
3. Karanj	0.0	28.6	64.3	7.1	14
4. Dandi	21.1	5.3	68.4	5.3	38
5. Nada	5.1	41.0	53.8	0.0	39
6. Kantiyajal	90.0	2.0	8.0	0.0	50
7. Tadatalav	14.3	5.7	80.0	0.0	35
Total	**29.1**	**16.5**	**52.9**	**1.5**	**206**

Source: Village Survey, December 2009- February 2010.

While more than 16 percent received daily wages in the range of Rs. 60-80, 29 percent of the respondents reported wages in the lower range of below Rs. 60 per day. However,

wage rate above Rs. 100 is prevalent only in two villages, viz., Karanj and Dandi where a smaller proportion of respondents (7.1% and 5.3% respectively) receive wages above Rs. 100 per day.

Based on the recall method, we have tried to estimate the employment generated in the villages through work in mangrove plantations during the last six years. It has been found that on an average about 120 days of employment has been generated under the mangrove plantation development programme in all the villages. On an average, the cumulative number of days of employment generated in all the mangrove villages in a given year seemed to be more than 20,000 mandays as evident from Table 5.5. The cumulative employment generated by development of mangrove plantations has been 1.38 lakhs with highest number of employment generation (mandays) reported from Tadatalav (0.42 lakhs), followed by Ashirawandh (0.25 lakhs) and Kantiyajal (0.23 lakhs). Dandi village had the lowest number of employment generation (9768 mandays).

Table 5.5: Total Employment generated in the villages under the mangrove plantation development programmes (Mandays)*

Year	Lakki	Ashirawandh	Dandi	Nada	Kantiyajal	Tadatalav	Overall
2002	3380	4615	0	4078	4382	7220	23675
2003	3420	4525	0	2437	4448	7490	22320
2004	3440	4385	1540	2242	4250	7235	23092
2005	3110	4265	1895	3472	3836	6700	23278
2006	3020	4025	3071	3224	3224	6830	23394
2007	2760	3695	3262	2830	3269	6260	22076
Total	**19130**	**25510**	**9768**	**18283**	**23409**	**41735**	**137835**

Note: *For Karanj village, year wise data are not available, as plantation started from 2008.

Source: Village Survey, December 2009- February 2010.

If we consider the income transfer to the households through employment generation in mangrove plantations, it may be observed that the average wage income received by a household has been in the range of Rs. 7800-9000 as evident from Table 5.6. Apparently, the income transfer through employment generation has been on the increase in all the villages. Among the villages, the highest income transfer per household was reported from Ashirawandh village (Rs. 14820), followed by Lakki (Rs. 12577), and Tadatalav (Rs. 10327). Though the average number of employment generation has been very high in Kantiyajal and Nada villages (as observed from Table 5.5), the income transfer per household has been lower in these two villages due to the lower wage rates received by the household members.

Table 5.6: Average earnings of the households from employment in mangroves (Rs./annum)*

Year	Lakki	Ashirawandh	Dandi	Nada	Kantiyajal	Tadatalav	Overall
2002	12389	15266	0	6002	3498	9871	7836
2003	12545	14948	0	5735	3806	10308	7925
2004	12919	14760	3585	5728	3984	10153	8372
2005	12689	13875	4065	6975	4106	9959	8471
2006	12946	15156	5230	8359	4091	10743	9258
2007	11974	14941	5337	8002	4361	11015	9111
Total	**12577**	**14820**	**4728**	**6822**	**3954**	**10327**	**8735**

Note: * For Karanj village, year wise data not available, as plantations started from 2008.

Source: Village Survey, December 2009- February 2010.

Thus it is evident from the above analysis that development of mangroves helps the local communities in terms of creating employment opportunities especially in the initial phase which leads to significant amount of income transfer to the households.

5.3. Tangible Benefits of Mangroves to the Village Communities

It may be observed that prior to development of mangrove plantations, the village communities have been mainly engaged in farming, fishing, livestock and agriculture labour related activities. Given this, it is needless to say that the introduction of mangroves would have provided immense opportunities to the communities to enhance their livelihood status by engaging themselves into various activities promoted by the plantation programmes.

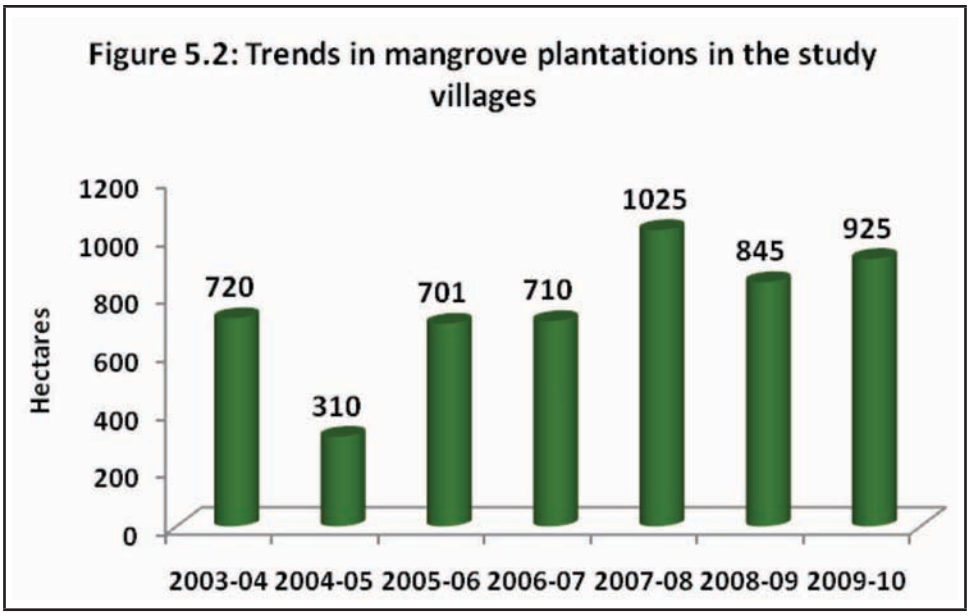
However, there is a caveat. It needs to be mentioned here that more than 80 percent of the mangrove plantations have been planted after 2005-06 (Table 5.7, Figure 5.2) and thus the plantations are very young in terms of plant growth and other characteristics.

Table 5.7: Trends in Mangrove Plantations in the Study villages in Gujarat (Hectares)

Year	Lakki	Ashirawandh	Karanj	Dandi	Nada	Kantiyajal	Tadatalav	Total
2003-04	0	40	0	0	50	80	550	720 (13.8)
2004-05	100	60	0	150	0	0	0	310 (5.9)
2005-06	100	151	0	450	0	0	0	701 (13.4)
2006-07	100	0	0	610	0	0	0	710 (13.6)
2007-08	100	0	0	915	0	10	0	1025 (19.6)
2008-09	0	0	225	610	0	10	0	845 (16.1)
2009-10	70	0	275	75	100	305	100	925 (17.7)
Total	**470**	**251**	**500**	**2810**	**150**	**405**	**650**	**5236 (100)**

Note: Figures in parentheses are respective percentages.

Source: Gujarat Ecology Commission, March 2010.



This being so, the benefits (tangible or non-tangible) realised by the local communities may be lower given the growth potential of these plantations. In view of this the economic assessment of their benefits would not be complete and comprehensive at this stage. In fact, the stream of benefits accrued from such plantation systems grows with age and hence whatever economic assessments we attempt at the early stages of plantation growth would be able to give only certain indications as regards their potential future benefits under well managed conditions.

In what follows, we make a detailed assessment of the major economic benefits derived by the communities from the mangrove plantations in the study villages. It is widely known that small-scale wood harvesting is one of the most ubiquitous forms of resource use in the tropics (Awasthi et al. 2003; Murali et al. 1996; Nepstad and Schwartzman 1992; Smiet 1992; Ticktin 2004; Uma Shankar et al. 1998a, 1998b). Particularly, mangrove forests are a valued source of wood products for many coastal communities (Christensen 1982; FAO 1994; Hamilton et al. 1989; Jara, 1987; Kunstadter et al. 1986; Lacerda 1993). Most mangrove tree species produce wood that is extremely hard and also burns hot. Mangrove wood is often preferred as cooking fuel and for construction of fish traps, wharves, fences and roofing (Brown and Fischer 1918; Lacerda 1993).

5.3.1. Mangrove Extraction for fodder and fuel wood

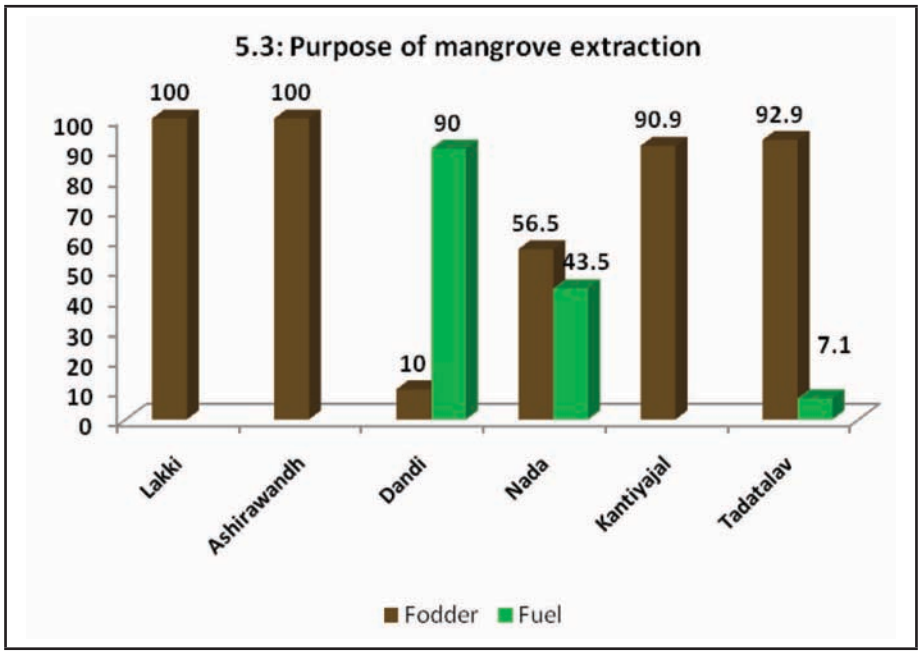
In order to understand the status of extraction of mangrove plants in the villages, the households were asked to respond if they cut the mangroves (leaves or stumps) and it was reported that about 46 percent of the communities cut the mangrove plants for various household uses. The responses varied between villages with households from three villages, viz., Ashirawandh (94%), Lakki (88%) and Tadatalav (72%) showing higher

percentage responses for mangrove extraction. Since mangrove plants are very recently planted in Karanj village, no extraction is reported from that village. It is also important to note that the extraction of mangroves has been done mostly by women members of the households (62%) at the aggregate level with significant differences between villages. Particularly, the presence of women in mangrove extraction is found very high in four villages, viz., Dandi (90%), Tadatalav (86%), Ashirawandh (76%) and Nada (52%).

Table 5.8: Status of extraction of mangroves by households in the villages

Village	Cut mangroves (HHs)	Don't cut (HHs)	Total (HHs)	Cut mangroves (%)	Share of females in cutting mangroves
1. Lakki	15	2	17	88.2	26.67
2. Ashirawandh	17	1	18	94.4	76.47
3. Dandi	10	37	47	21.3	90.00
4. Nada	23	18	41	56.1	52.17
5. Kantiyajal	11	39	50	22.0	27.27
6. Tadatalav	28	11	39	71.8	85.71
Total	**104**	**123**	**227**	**45.8**	**62.50**

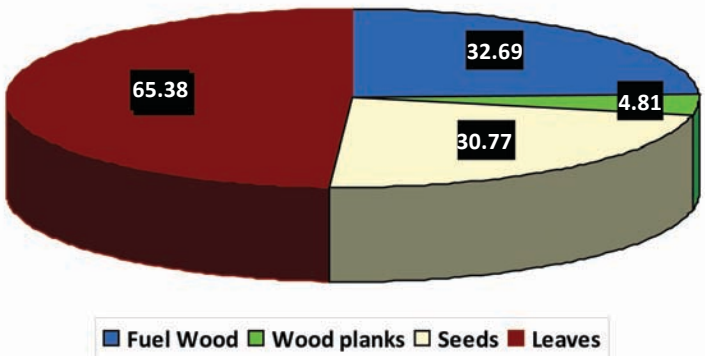
Source: Village Survey, December 2009- February 2010.



The main purpose of mangrove extraction as revealed by majority of the respondents (80%) is for fodder (mostly as leaves), followed by for use of wood as fuel (23%), seed (5%) across the villages (Figure 5.3). A smaller proportion of respondents from Kantiyajal and Nada villages also extract mangroves for sale (9.1% and 4.3% respectively) as firewood or fodder. However, it is important to note that the communities are careful while cutting the mangroves as an overwhelming majority follow a selective extraction method rather than

complete extraction (or destruction) of the plant. For the question, 'what are the different products you extract from mangroves', a vast majority of the respondents had multiple responses suggesting that they cut the leaves (65.38%), then use it for fire wood (33%), collect the seeds (31%) and use wood planks (4.81%) as evident from Figure 5.4.

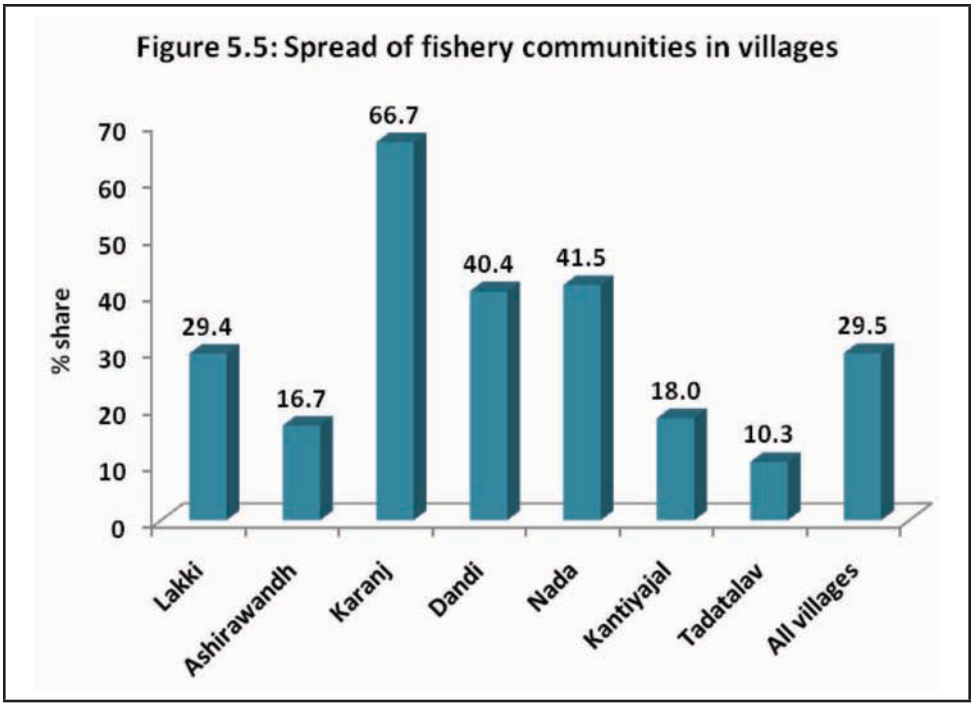
Figure 5.4: Community Extraction of mangroves for multiple uses



5.3.2. Benefits to Fisheries Community

From Chapter 4, it was evident that fishing is one of the major activities of the households in the study villages. Even though the share of households dependent on fisheries is only about 30 percent at the aggregate level, there are significant differences between villages in terms of community dependence on fishery activity (Figure 5.5). For instance, in Karanj village, almost 67 percent of the households depend on fisheries, followed by 41 percent in Nada, 40 percent in Dandi and 29 percent in Lakki village. This makes it imperative to examine the specific benefits that the fishery communities receive from the mangrove plantations.

Extraction of mangrove items by local community
(Extraction of mangrove leaves for fodder)



It is evident from Table 5.9 that on an average the mangrove locations are located atleast five kilometres away from the villages, with notable differences across villages. While Karanj village which has the highest number of fishery community is located in about 2 kilometres radius from the mangroves, the other two dominant fihsery villages, viz., Dandi and Nada are located in a distance of more than 3 kilometres and 5.5 kilometres respectively.

Table 5.9: Distance between villages and mangroves sites

Village	Mean distance (kms)	N	Std. Dev.	Minimum distance (kms)	Maximum Distance (kms)	SE Mean
Lakki	4.16	16	2.501	1	9	0.625
Ashirawandh	4.25	18	1.101	3	7	0.260
Karanj	2.23	15	1.147	1	5	0.296
Dandi	3.37	47	3.165	0.3	13	0.462
Nada	5.48	41	1.541	1	10	0.241
Kantiyajal	3.18	49	1.074	1	5	0.153
Tadatalav	5.96	39	2.589	2	15	0.415
Total	**4.21**	**225**	**2.435**			

Source: Village Survey, December 2009- February 2010.

As there is a considerable distance between the dwellings and the mangrove plantations, it becomes important to understand how the fishery communities go to the mangrove locations to catch fish. Hardly very few (3%) fisher respondents have own boats to catch

fish. Majority of them (89%) walk into the deep waters to reach the mangrove locations to catch fish and the rest (8%) hire boats from neighbours for catching fish. Hiring a boat to catch fish is quite expensive for most of the households, as they have to either share half of fish catch with the boat owner or give one fourth of the fish catch to the boat owner. As these sharing arrangements mostly result in considerable losses, the fisher-folks end up in walking through the deep water and catch the fish.

In majority of the cases, the households go with one or two family members for catching fish. Almost 54 percent of the total fisher community respondents (95 nos) make daily trips to catch fish, while about 28 percent make monthly trips, about 10 percent go for catching fish in fortnightly intervals and the rest go on weekly intervals. As evident from the responses of the communities, there was significant increase in the catch as well as type (species) of fish available after mangroves have started growing in the areas. The species-wise catch of fishery as reported by the communities is presented in Table 5.10.

Table 5.10: Names of main species of fish catch reported from mangrove plantation areas

Name of Fish species	Percentage of respondents reporting the species type (multiple responses)							
	Lakki	Ashira wandh	Karanj	Dandi	Nada	Kantiyajal	Tadatalav	All villages
1. Mugra	100.0	40.0	18.2	0.0	20.0	0.0	40.0	22.1
2. Gol	44.4	40.0	9.1	0.0	15.0	0.0	0.0	12.6
3. Boi	55.6	60.0	54.5	20.0	60.0	10.0	80.0	42.1
4. Jinga	22.2	40.0	81.8	70.0	70.0	60.0	60.0	62.1
5. Karchla	11.1	40.0	45.5	56.7	60.0	40.0	60.0	48.4
6. Levta	11.1	10.0	90.9	63.3	75.0	80.0	80.0	61.1
7. Kagadi	0.0	10.0	0.0	0.0	0.0	0.0	0.0	1.1
8. Sheval	0.0	0.0	9.1	0.0	0.0	0.0	0.0	1.1
9. Bumla	0.0	10.0	18.2	46.7	30.0	0.0	20.0	25.3
10. Shimla	11.1	20.0	9.1	6.7	0.0	0.0	20.0	7.4
11. Dhangda	11.1	0.0	9.1	3.3	0.0	0.0	0.0	3.2
12. Paplet	22.2	70.0	9.1	3.3	10.0	0.0	0.0	13.7
13. Chhodi	44.4	40.0	0.0	10.0	25.0	0.0	20.0	17.9
14. Chheri	22.2	30.0	9.1	0.0	5.0	0.0	0.0	7.4
15. Mugri	44.4	30.0	9.1	10.0	10.0	0.0	0.0	13.7
16. Fish	0.0	0.0	0.0	20.0	10.0	0.0	0.0	8.4
All species (N)	9	10	11	30	20	10	5	95

Source: Village Survey, December 2009- February 2010.

As evident from the Table, about 16 species of fish were named by the respondents from five of the seven villages, which points to richness of species diversity as caused by the growth of mangrove plantations.

During the course of the survey, a general impression we could gather was that there was significant increase in the fish catch in all the villages following the introduction of mangrove plantations. In order to verify this, we have gathered the information as regards the quantity of the fish catch as well as the value realised for the fish before and after the mangrove plantations. Though this information has certain limitations as they are based on recall method, we could find significant differences in total quantity and the volume of the fish catch as reported by the communities after development of mangrove plantations. The differences in quality and value of the fish catch as reported by the respondents are furnished in Table 5.11.

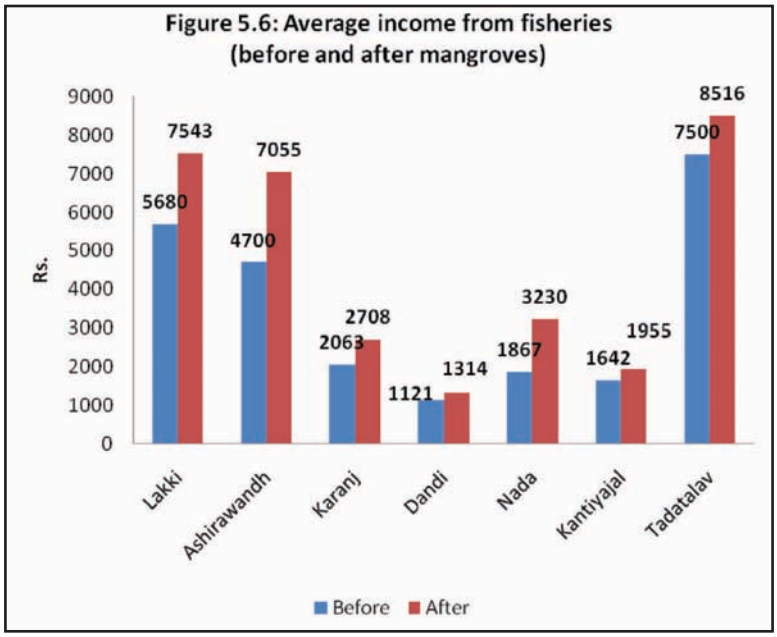
Table 5.11: Changes in quantity of fish catch reported by households before and after mangroves

Village	Quantity of the fish catch (Kgs)		
	Before mangroves	After mangroves	% change
1. Lakki	39390	44467	12.89
2. Ashirawandh	10493	16115	53.58
3. Karanj	18690	20543	9.91
4. Dandi	1058	2576	143.59
5. Nada	10985	13394	21.93
6. Kantiyajal	1520	3618	138.03
7. Tadatalav	1800	3780	110.00
Total	11916	14368	20.58

Source: Village Survey, December 2009- February 2010.

It was found that there was about 21 percent increase in the fish catch after mangroves have been planted with highest increase in quantity of fish reported from Dandi and Kantiyajal villages (143%, 138% respectively), followed by Tadatalav (110%), Ashirawandh (54%), Nada (22%) and Lakki (13%) villages. Even though mangrove plantations are relatively new to be established in Karanj village, there was some increase in the fish catch between the two periods. Thus, the fishery households could gain financially after mangroves have been planted in the villages, as evident from the nominal increase in average income realised from fisheries before and after mangrove plantations (Figure 5.6).

The increased fish catch caused by mangrove plantations has enabled the fisher households to earn more from the sale of fish to the open market. The average income gain was about 24 percent at the aggregate level. Highest income gain was reported from Nada (42%), followed by Ashirawandh (33%), Lakki (25%), Kantiyajal (16%), Dandi (15%) and Tadatalav (12%).



Catch of Mudskipper

A Fisherwoman family at Coastal Area of Tadatalav (Drying of fish)

5.3.3. Mangroves and benefits to farmer community

The data show that only 25 percent of the households have their farm lands adjacent to the mangroves. This signifies the impact of salinity ingression or winds from the coastal areas on the agriculture practises and the livelihoods of a smaller segment of farmers who have their agricultural lands close to the coastal areas. In Ashirawandh, almost 33 percent of the households having farm lands reported that their farm lands are close to the coastal areas. In Kantiyajal 32 percent have their farm lands close to coastal areas. Besides by 24 percent of farmer respondents in Nada, 21 percent in Tadatalav and 12 percent in Lakki have reported that their agricultural lands are somewhat closer to the coastal areas. Majority (33%) of the farmer respondents grow cotton and other crops, such as wheat (15%), Tur (12%), Jowar (9.8%), Bajra (6.5%), moong (5.4%) and various other crops in the farmlands closer to the coastal areas.

It has been reported by 72 percent of the farmer respondents that the salinity ingression is very high in the farmlands closer to the coastal areas. The extent of salinity ingression varied from village to village. While farmers from Dandi and Nada villages reported very high levels of salinity ingression to farm lands, the salinity ingression is reported as moderate to high in rest of the villages, viz., Tadatalav (74%), Kantiyajal (69%), Lakki (65%) and Karanj (53%). However, it has been widely reported by the farmer respondents that salinity ingression has considerably reduced after establishment of mangrove plantations as evident from Table 5.12. In most villages, where the salinity ingression was very high and moderate before mangrove plantations, there was remarkable decline in the level of salinity ingression after the plantations have started growing. This is a notable achievement as caused by the mangrove plantations in the study villages.

Table 5.12: Village wise Impact of mangrove plantation on reduction of salinity ingression and crop damage

	Percentage of respondents reporting that	
	Mangroves reduced salinity ingression in crop lands	Mangroves reduced the crop damage due to winds
1. Lakki	58.82	82.4
2. Ashirawandh	44.44	55.6
3. Karanj	40.00	20.0
4. Dandi	68.09	19.1
5. Nada	68.29	53.7
6. Kantiyajal	76.92	68.0
7. Tadatalav	71.43	71.8
Total	**65.92**	**58.41**

Source: Village Survey, December 2009- February 2010.

As evident from Table 5.12, about 66 percent of the respondents reported that mangrove plantations reduced salinity ingression in crop lands. Highest proportion of farmers in four villages, viz., Kantiyajal (76.9%), Tadatalav (71%), Nada (68.3%) and Dandi (68%) have reported that planting mangroves has been immensely beneficial in terms of reduction in salinity ingression. Farmers in other three villages also have experienced a reduction in salinity ingression due to mangrove plantations.

More importantly, we have further clarified to understand whether mangroves help in terms of reducing the impacts on crop damage caused by salinity ingression?. To this question, the responses seem to be very much encouraging as an overwhelming majority of the respondents in Lakki (82%), Tadatalav (72%) and Kantiyajal (68%) have reported that mangrove plantations have been highly beneficial in terms of reducing the impact of crop damages caused due to wind and tidal waves before planting the mangroves. However,

due to paucity of data, we could not estimate the extent of monetary benefits accrued to the farmers due to the reduction in crop damage due to mangrove plantations. These two important positive externalities, viz., a) the extent of crop land saved from salinity ingression due to mangrove plantations; and b) the increase in the quantity of crop saved from crop damage as caused by mangrove plantations need further empirical analysis.

Thus, from the above, it could be observed that there has been significant aversion of crop damages in all the villages as a result of establishment of mangrove plantations which had caused a substantial gain in agricultural income for the communities. On the other hand, it had also resulted in substantial savings of income for the farmers as they were not required to make investments for saving their smaller farms from salinity ingression or wind erosion. Though the impact has been visible, we could not gather authentic farm level crop information to substantiate this point further. This needs to be further explored in terms of gathering more farm level information about the crop loss averted by planting mangroves as well as the resultant gain in farm income across the study villages.

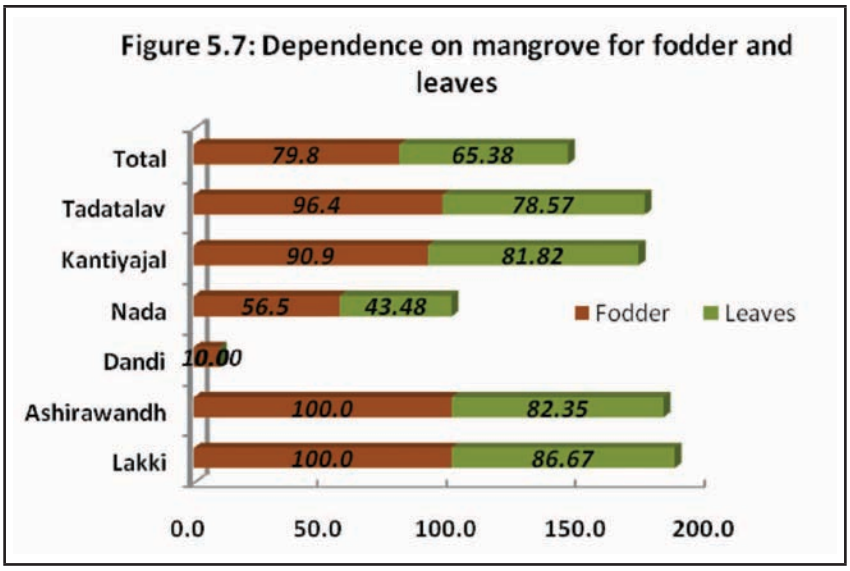
5.3.4. Mangroves and benefits to Animal Husbandry/ Livestock

Use of mangroves for fodder is considered to be one of the major direct use values to the communities engaged in animal husbandry/ livestock rearing. Like many other coastal villages, the communities in the study villages also show a large dependence on animal husbandry/ livestock related activities. Through the data gathered from the villages, it has been observed that more than 38 percent of the households own livestock of one or the other kinds (Table 5.13). Among the villages, households in Ashirawandh reported the highest percentage of livestock ownership (94%), followed by Lakki (82%) and Tadatalav (72%) while other three villages have lower less number of households owning livestock. As already observed in the foregoing sections, the communities have shown greater dependence on mangroves by extracting the leaves and the bark/ sprouts etc for feeding their cattle as further evident from Figure 5.7.

Table 5.13: Ownership of animals / livestock in the villages

Village	HHs Owning livestock		Total (N)	Households own livestock (%)
	Yes	No		
1. Lakki	14	3	17	82.35
2. Ashirawandh	17	1	18	94.44
3. Karanj	2	13	15	13.33
4. Dandi	0	47	47	0.00
5. Nada	11	30	41	26.83
6. Kantiyajal	15	35	50	30.00
7. Tadatalav	28	11	39	71.79
All village	**87**	**140**	**227**	**38.33**

Source: Village Survey, December 2009- February 2010.



The increased dependence of the communities owning livestock on the mangroves for extracting leaves and fodder resulted in a majority (92%) admitting that mangroves have benefited them and their livestock at times of crisis, especially during extreme drought months. This also resulted in a significant saving in their expenditures towards buying fodder from the open market. This has been evident from the extent of savings in fodder costs as reported by a sub-sample of 59 households growing livestock from the five villages as presented in Table 5.14.

Table 5.14: Savings in fodder costs due to availability of mangroves in the villages

Village	% of Saving in fodder cost reported due to mangroves (Rs./ annum)				HHs reporting (N)
	Below 2000	2000-5000	5000-8000	Above 8000	
1. Lakki	9.1	18.2	36.4	36.4	11
2. Ashirawandh	14.3	21.4	7.1	57.1	14
3. Nada	44.4	22.2	22.2	11.1	9
4. Kantiyajal	14.3	71.4	0.0	14.3	7
5. Tadatalav	5.6	55.6	22.2	16.7	18
All	**15.3**	**37.3**	**18.6**	**28.8**	**59**

Source: Village Survey, December 2009- February 2010.

The Table clearly shows the extent of savings that the households could make in their annual expenditure towards buying fodder from the open market. For about 37 percent of the households, the fodder collected from the mangroves enabled them to save a sum of Rs. 2000-5000 from being spent on purchase of fodder from the market. About 29 percent of the households reported savings of above Rs. 8000 per annum on fodder for the livestock due the availability of mangroves in their neighbourhoods. The maximum

gain in savings of above Rs. 8000 has been reported by about 57 percent of the households in Ashirawandh village, followed by 36 percent in Lakki village.

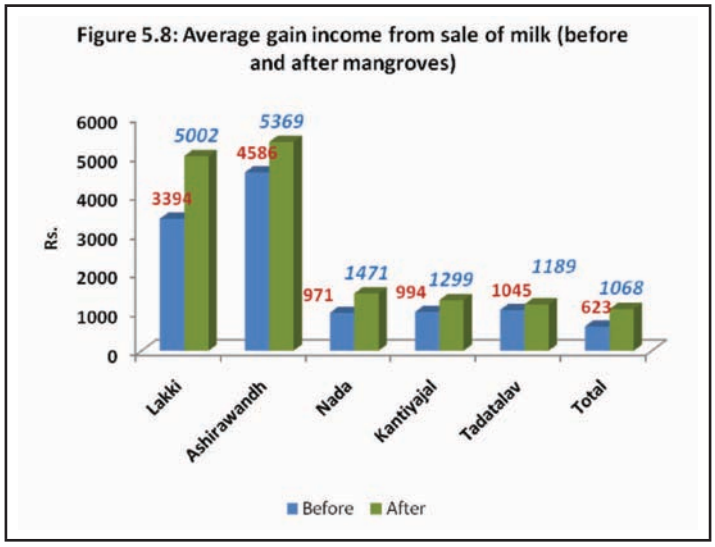
As evident from Table 5.15, the respondents owning livestock reported considerable savings in the cost of fodder as realised by a notable reduction in the purchase of fodder from the open market after establishment of mangroves in all the villages. At the aggregate level, mangroves helped to reduce the purchased fodder consumption by 24 percent. The highest reduction in open market fodder consumption was noticed among households in Lakki village (41%), followed by Ashirawandh (32%), Tadatalav (17%), and Nada (13%), with Nada reporting only marginal reduction in purchased fodder consumption by the households.

As a result of the increased consumption of fodder from the mangrove plantations, the communities also reported that there was a notable increase in the average milk production per cattle population which also rendered them income gains from increased sale of milk in the open market (Figure 5.8).

Table 5.15: Reduction in purchased fodder consumption by households after mangrove plantations

Village	Descriptives	Annual Quantity of fodder purchased (Kg.)		% decrease in quantity of fodder purchased from market
		Before mangroves	After mangroves	
1. Lakki	Mean	222.27	131.11	-41.0
	Std. Deviation	214.93	72.19	
2. Ashirawandh	Mean	227.38	154.62	-32.0
	Std. Deviation	211.79	144.65	
3. Nada	Mean	21.71	18.86	-13.2
	Std. Deviation	4.72	4.18	
4. Kantiyajal	Mean	28.83	28.00	-2.9
	Std. Deviation	9.72	10.10	
5. Tadatalav	Mean	79.77	66.31	-16.9
	Std. Deviation	142.12	119.79	
Total	Mean	117.97	89.59	-24.1
	Std. Deviation	170.94	114.31	

Source: Village Survey, December 2009- February 2010.



5.3.5. Mangroves and reduction in labour migration

Inter as well as intra-village migration has been reported as an important characteristic of the study villages as in any other parts of the country in particular. Accordingly, the rural workers migrate to the next village or urban areas in search of employment for few months and return to the villages after completion of the work. From the household survey it has been observed that almost 19 percent of the households use to migrate (with notable differences between villages, Nada village reported 34% and Tadatalav reported 33% labour migration) for few months (as revealed by 39%), or for a year (37%) or few days in a year (23%).

Table 5.16: Reasons indicated by households for the decline in labour migration (multiple responses)

Village	Opportunities for work in mangroves (%)	Mangrove plantation carried out by NREGA (%)	All of the above (%)	HHs reporting migration
1. Lakki	50.0	50.0	0.0	2
2. Ashirawandh	66.7	33.3	0.0	3
3. Karanj	0.0	100.0	0.0	1
4. Dandi	57.1	57.1	0.0	7
5. Nada	30.8	61.5	7.7	13
6. Kantiyajal	0.0	100.0	0.0	1
7. Tadatalav	53.8	53.8	0.0	13
All village	**45.0**	**57.5**	**2.5**	**40**

Source: Village Survey, December 2009- February 2010.

The pattern of migration is also interesting in that in most cases either more than two family members (33%) or two members (30%) or at least one member of the household (28%) use to migrate in search of employment. Incidentally, the development of mangrove plantations has had significant impact on reducing the incidence of labour migration in the study villages. On one hand, the work opportunities in mangrove plantations have induced the migrant workers to stay back in the villages and work in the mangrove plantations and on the other hand, it has been reported that in some of the villages mangrove work has already been integrated with the National Rural Employment Guarantee Act (NREGA) programme which started providing employment to the village households in terms of guaranteed work in the mangrove plantations as also evident from Table 5.16. Thus, the above results underlie the increasing importance of mangrove plantations as major sources of employment opportunities to the communities, which help them avoiding the unintended migrations to nearby villages or urban areas in search of employment.

To summarise the Chapter, our analysis of the tangible and non-tangible benefits of mangrove plantations in the study villages reveal that:

1. The activities involved in development of new plantations and upkeep of the existing mangrove plantations offered immense employment benefits to the communities in the study villages. On an average, the cumulative number of days of employment generated in all the mangrove villages in a given year seemed to be more than 20,000 mandays. The employment opportunities generated have resulted in a direct income transfer to the households in terms of wages. On an average, the annual wage income received by a household has been in the range of Rs. 7800-9000.

2. The next important direct tangible benefit realised by the communities related to the extraction of mangroves for various uses. It was found that about 46 percent of the communities cut the mangrove plants for various household uses. The responses varied between villages with households from three villages, viz., Ashirawandh (94%), Lakki (88%) and Tadatalav (72%) showing higher percentage responses for mangrove extraction. It is also important to note that the extraction of mangroves has been done mostly by women members of the households (62%) at the aggregate level with significant differences between villages. Particularly, the presence of women in mangrove extraction is found very high in four villages, viz., Dandi (90%), Tadatalav (86%), Ashirawandh (76%) and Nada (52%). At the aggregate level, the multiple responses as regards the important purposes of mangrove extraction revealed that a vast majority (65.38%) cut the mangrove leaves (65.38%), followed by its use for fire wood (33%), collection of seeds (31%) and use wood planks (4.81%).

3. Fishing is found an important economic activity in all the villages, though there are notable differences in the proportion of households engaged in fisheries. The survey results reveals significant differences in total quantity and the volume of the fish catch as reported by the communities after mangrove plantations. It was found that there was about 21 percent increase in the fish catch after mangroves have been planted with highest increase in quantity of fish reported from Dandi and Kantiyajal villages (143%, 138% respectively), followed by Tadatalav (110%), Ashirawandh (54%), Nada (22%) and Lakki (13%) villages. The increased fish catch caused by mangrove plantations has enabled the fisher households to earn more from the sale of fish to the open market. The average income gain was about 24 percent at the aggregate level. The highest increase in income was reported from Nada Village where the average household income from fishery was Rs. 3230 after mangroves compared to Rs. 1867 before mangroves were planted. In Ashirawandh, the household income from fisheries was Rs. 7055 after mangroves compared to Rs. 4700 before mangroves were planted.

4. An important benefit realised by the farmer communities surrounding the mangrove villages as revealed by the study is the reduction in salinity ingression into farm lands and the reduction in crop damage caused by salinity ingression as well as winds and tidal waves. About 66 percent of the respondents reported that mangrove plantations reduced salinity ingression in crop lands. Besides, an overwhelming majority of the respondents in Lakki (82%), Tadatalav (72%) and Kantiyajal (68%) have reported that mangrove plantations have been highly beneficial in terms of reducing the impact of crop damages caused due to wind and tidal waves before planting the mangroves. However, due to paucity of data, we could not estimate the extent of monetary benefits accrued to the farmers due to the reduction in crop damage due to mangrove plantations.

5. The positive benefits of mangrove plantations realised by the households growing livestock have been in terms of the savings in income as they are able to use the fodder/ leaves from mangroves for feeding their cattle and thereby avoid purchasing fodder from the open market. The study reveals that for about 37 percent of the households, the fodder collected from the mangroves enabled them to save a sum of Rs. 2000-5000 from being spent on purchase of fodder from the market. About 29 percent of the households reported savings of above Rs. 8000 per annum on fodder for the livestock due the availability of mangroves in their villages. Feeding the cattle on the mangroves also yielded beneficial to the communities as it resulted in an increase in quantity of milk due to the quality of fodder as compared to the fodder bought from the market.

6. A final positive impact of mangrove plantations as reported from the villages has been the reduction in seasonal out-migration of the communities in search of employment outside as mangrove plantations offer them employment opportunities in the villages.

Chapter - 6

Biological Mapping of the Mangrove Ecosystems in the study villages

This Chapter aims at providing a comprehensive assessment of the biological mapping of mangrove ecosystems in the study locations. The objective of the assessment is understand the: b) Species diversity; b) Vegetation structure; and c) the Ecological process of the mangroves. Based on this assessment, we may be able to measure indirectly the nutrient availability and the biotic interactions. It may also provide us guidelines as regards the uniformity and diversity in growth of the restored/ developed mangrove plantations and the restoration success achieved.

6.1 Preface

Success criteria of the plantation projects in general are determined based on the planting survivability and information regarding the habitat use by fauna. The Society for Ecological Restoration (2004) listed the following nine attributes for a restored site:

1. Similar diversity and community structure in comparison with reference sites
2. Presence of indigenous species
3. Presence of functional groups necessary for long term stability
4. Capacity of the physical environment to sustain reproducing populations
5. Normal functioning
6. Integration with the landscape
7. Elimination of potential threats
8. Resilience to natural disturbance and
9. Self sustainability.

For testing the success of any mangrove restoration, a long-term monitoring programme is required. The monitoring period needs to be even longer in a dynamic social environment. Most frequently, success of restoration is judged by the area under plantation/tree cover. We maintain species diversity or plant trees to maintain ecosystem functions. It should be noted that depending on ecosystems of interest and degree of disturbance, functional redundancy varies. It is quite likely that the floral assemblage of a mangrove may have a low functional redundancy, which raises a further concern, since large scale mangrove restorations in Southeast Asia continue with few species (Saenger and Siddiqi 1993) that hardly meet the functional requirement of the ecosystem and seldom can be considered as mangrove restoration. Lewis (2005) observed that this type of restoration can hardly

qualify as a successful mangrove restoration. Interestingly, if we consider the area under tree cover the same project may qualify as a successful project. The potential for silent ecological disasters remains.

As such it is important to evaluate the key ecological parameters of both structural and functional components while measuring the restoration success. Ruiz-Jaen and Aide (2005) suggested three simple but effective measures for assessing restoration success:

(i) Species diversity - this can be measured by the presence and abundance of species,

(ii) Vegetation structure - this can be measured by vegetation cover and

(iii) Ecological process - this can be measured indirectly by measuring nutrient availability and biotic interactions. Depending on available resources, one can choose from the above mentioned parameters to monitor restoration success.

6.2 Materials and Methods

A Sample survey was made during January and February 2010 at 7 different sites of Gujarat where mangrove plantation have been carried out by GEC. Following parameters were evaluated for biological assessment to check the ecological status as well as social dependency on the mangrove resources.

Table 6.1 Different parameters for biological assessment

Ecological Status	Sign of Resource Dependency
a. Plant Density b. Sapling Density c. Pneumatophore Density d. Tree Height e. Tree Girth f. No. of Branches g. Canopy Cover	Cutting / Lopping Grazing

6.2.1 Data collection (Vegetation surveys for biological assessment)

A Vegetation survey using biological assessment tools has been undertaken for all the seven selected mangrove restoration sites. This was done in order to understand the status of growth of mangroves, its vegetative cover as well as the status of biodiversity in each location.

Five (perpendicular to the shoreline) transact lines, were drawn at each site. The length depended on the vegetation type (dense and sparse zonation pattern). On each transect line a 100 m^2 vegetation plot (10m x 10m) was marked out. A second replicate 100 m^2 quadrate was made on the same transect line at each site at every 100 m distance. Within

each 100 m^2 quadrate, the species-wise numbers of saplings were determined. Tree height was recorded using an extendable measuring tape cum pole. GBH (Girth Breast Height at 1.3 m height) was measured for each counted tree in particular sample plot.

At each sample plot, 3 sub plots (1x1m) were laid down to calculate the status of pneumatophores and available biodiversity with special reference to molluscan, crustacean and fish etc. The abundance of seedlings and undergrowth species were available at each site. However, it is important to state here that in Kantiyajal the plant growth is very luxuriant with thick patches of plant density. Therefore, the enumeration of girth of plants and number of pneumatophores was unable to carry out.

Box 6.1: Definition: Tree, Sapling, Seedling, Undergrowth species and Biodiversity

Tree:
Trees of more than 2 m height were considered for measurement of numbers and Girth at a breast height of 1.3 m.

Sapling & Seedling*:
Saplings between 1-4 m and seedlings below 1 m are counted species wise for numbers

Undergrowth Species*:
Salinity plays a key role in the growth of the undergrowth species. Therefore, the values of salinity are found influencing the undergrowth vegetation as positively or negatively as well as high or poor diversity. It can also be concluded that the rich diversity of undergrowths of healthy individuals might be indicative of the healthy mangrove forest of the low saline zone and poor diversity of undergrowths, as well as their stunted growth might be indicative of the ill mangrove forest of the high saline zone. Naturally undergrowth species cannot tolerate frequent tidal flooding and strong salinity. The undergrowth species are growing in a suitable environment and related to salinity.

Biodiversity:
In the broader context, Biodiversity is the variation of life forms within a given ecosystem, biome, or on the entire Earth. Biodiversity is often used as a measure of the health of biological systems. But in the present study, no. of benthic individuals of major groups (molluscan, crustaceans, Fish etc.) was considered as term 'biodiversity'. It was recorded to know the ecological status of each site.

***The high abundance and occurrence of seedlings and undergrowth of species did not allow for statistical analysis, therefore they were excluded from further data analysis.**

Forest canopy gaps are common in mangroves and usually result after disturbances such as selective harvesting and natural mortality of trees (Duke 2001). Canopy gaps drive the gap phase regenerative cycles in mangrove forests (Clarke and Kerrigan 2000; Duke 2001; Imai et al. 2006; Lo´pez-Hoffman et al. 2007).

Normally, densiometer is used for taking measurements of canopy cover. However, in present case, we used gridded mirror method for rapid measurement of canopy cover in each sample plot. For that 10 equal squares are made on a mirror. Then the mirror was fixed on a particular angle/ dimension to closely look at the canopy spread over the grids on the mirror. Some of the squares reflect leaf image and other remain blank. Then we counted the percentage of squares with green leaf image. Mangrove cover has been categorized into very dense (canopy density of more than 70%), moderately dense (canopy density between 40-70 %) and open (canopy density between 10-40%) (FSI Report, 2009).

At each site, soil samples were collected from 3 different places, randomly from the transect location from a depth of 30–50 cm using a PVC pipe. Sampling was done during low tide. The soil samples were put into labeled, airtight plastic bags and taken to the laboratory to analyze basic physico-chemical properties.

6.2.2 Data analysis & Results

(A) Growth status of Planted species

One of the key aspects of evaluating the success of mangrove plantation is related with the growth of planted species. In present case, growth of plant is measured by six key parameters, (i) Height of plant, (ii) Girth of plant, (iii) Density of plant/sapling, (iv) Number of branches, (v) Pneumatophore Density and (vi) Canopy cover.

A summary of the vegetation characteristics at each site is shown in Table 6.2.

Table 6.2 Summary of vegetation characteristics*

Site	Approx. Age of Plantation	Overall density of Trees (No. per ha)	Avg. Height of Trees (m)	Avg. Girth of Trees (cm)	Avg. No.of branches (No. per tree)	Overall Sapling Density (No./sq m)	Overall Pneumato phore density (No./sq m)
Tada Talav	8 years	160	2.54	15.31	6.75	5.6	31.2
Karanj	2 years	-	-	-	-	3.2	12.1
Dandi	6 years	-	-	-	-	7.6	23.3
Lakki	8 years	400	3.13	40.28	6.17	1	40
Ashira-wandh	8 years	360	2.77	35.64	5.72	10.23	32.1
Nada	8 years	120	1.74	18.58	2.75	4.3	3.3
Kantiyajal	8 years	550	3.27	NA	4.89	0	NA

* All enumerations and statistics presented here, are restricted to a single species of mangroves viz. *Avicennia marina*.

Source: Biological Assessment of Present Study

Figure 6.1: Status of Sapling and Tree Density

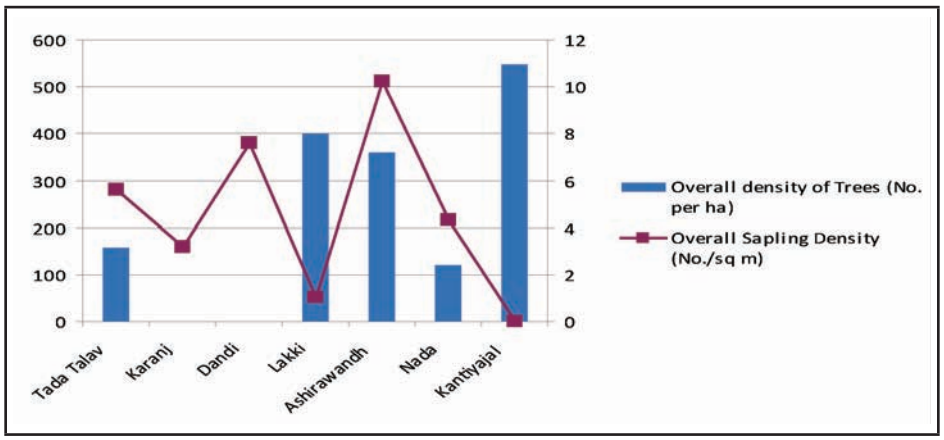


Figure 6.1 highlights, site wise overall status of saplings and tree densities. It shows quite interesting trend in terms of its numbers. For example, in Dandi site, as plantation is just started, no trees were recorded which is having more than 2 m height, while at the same time, it could be observed that this site stands with higher density of saplings. Certainly these will achieve good height and settle as a tree in near future. In case of Lakki and Kantiyajal, the low abundance of sapling is understandable as the sites are quite rich with mature trees and thus outcompeting the saplings. Ashirawandh, however, is an exceptional case in having both saplings and trees in relatively higher numbers. It could be depends on its climatic condition as well as soil properties (See section 6.2.2.B)

The restoration site in Kantiyajal, which has approximately 8 years old plantation, has the tallest and mature trees. The maximum height of 6 m was recorded at Kantiyajal. Other 8 years old plantation at Lakki (Kachchh) and Kantiyajal (Bharuch) show the next highest mean height. Ashirawandh and Tadatalav also showed quite good height of trees which are about 2.77 m and 2.54 m, respectively. In case of Nada, the average height of the plants is recorded as 1.74 m, the shortest among all the sampled areas.

Among all the sites, mean GBH was ranged from 15.31 to 40.28 cm. At Lakki and Kantiyajal the growth of planted species is much dense and expanded that girth size could not be easily measurable. So the content of above table clearly indicates that the planted species of *Avicennia marina* obtained the highest growth at Lakki and Kantiyajal. One of the reasons for it is that at Lakki and Kantiyajal the plantation are approximately 8 years old.

In the Table 6.2, the data on average number of branches indicate that at Tadatalav and Lakki plant has maximum number of main (leading) branches, which shows expanded dense growth of tree. If we consider the total no. of trees then the density is highest at Kantiyajal (approx. 550 no./ha), followed by Lakki (400 no./ha) and Ashirawandh (360 no./ha). In the case of Karanj, Dandi and Tadatalav plants are still in sapling stage, as plantation is just 2 to 6 years old. In Lakki approx. 1 sapling per m^2 was found as planted

species achieved quite excellent growth with more straight and tall trees. Ashirawandh leads with highest no. of saplings with 10.23 / m^2, even though this site has quite good patch of mangrove trees with density of 360 no. of trees / ha. This may be due to better nutrient components of sediment of this site, as Ashirawandh site is richer in nutrients like Organic Carbon, Phosphorous and Potassium with compare to other remaining sites (Table 6.6).

During field survey it was also noted that there was a significant increase in pneumatophore height and density to seawards sides as tree density significantly increases towards the sea. This increase may be due to an increase in anoxic mud and silts an environment in which the trees find it more difficult to grow; each successful tree will need a greater area of substrate to survive and for that it requires an increase in pneumatophore numbers and density. The presence of taller and more abundant pneumatophores rising above the mud will help transport oxygen to the submerged roots.

Box 6.2: Pneumatophores

Mangrove roots not only support the plant in unstable soil and to withstand currents and storms, but also breathe air. To avoid suffocation in the oxygen poor mud, mangrove trees snorkel for air. They develop aerial or air-breathing roots. All aerial tree roots have on their surface, special tiny pores to take in air (lenticels). Only air can get through the lenticels, not water or salts. All aerial roots also contain large air spaces (aerenchyma). These not only transport air, but also provide a reservoir of air during high tide when all the aerial roots may be underwater. The specialized roots are important sites of gas exchange for mangroves living in anaerobic substrata. The exposed surfaces may have numerous lenticels (loose, airbreathing aggregations of cells; Tomlinson, 1986). *Avicennia* possesses lenticel-equipped pneumatophores (upward directed roots) through which oxygen passively diffuses. The lenticels may be closed, partially opened or fully opened, depending on environmental conditions (Ish-Shalom-Gordon and Dubinsky, 1992).

The function of aerial roots are to absorb air or/and to provide structural support in the soft mud. Roots for absorbing nutrients are tiny and emerge near the muddy surface. Aerial roots can take on different forms. *Avicennia* develop shallow cable roots which spread out from the trunk. Along these cable roots emerge short pencil-like roots (left) called pneumatophores (meaning “air carrier” in Greek). A 3-metre tall *Avicennia* can have 10,000 pneumatophores.

Again Lakki (40/m^2), Ashirawandh (32.1/m^2) and Tadatalav (31.2/m^2) have the highest no. of pneumatophores. The no. of pneumatophores depends on availability of mature trees. The existence of pneumatophore can be available to those areas in which as much as mature trees are there. Because as trees mature, they need more respiration and survival rate. So, In Lakki and Ashirawandh, no. of trees support the density of pneumatophores.

As per the canopy measurement, Lakki and Kantiyajal are categorized into very dense mangrove areas, Ashirawandh site can be placed into moderately dense mangrove area while Nada, Karanj and Dandi are categorized into Open mangrove area. It should be noted here that Karanj and Dandi have just the 2 to 5 years old plantation of mangrove trees, so that plants are still in sapling stage. So no measurement could be taken for canopy status.

The estimates of Standard Deviation (SD) and Coefficient variation (CV) for the various indicators of plant growth have been done in order to understand the variability in height, density and girth of the plants. As a thumb rule, higher values of coefficient of variation suggest greater variability in growth of plants, suggesting the lack of uniformity in growth of the plantation across the sample plots. Each subplot of every transect line was considered for the final estimation of the SD and CV. The calculation was made for parameters like height, girth size and no. of branches of the particular tree in this case.

In Nada and Tadatalav, no trees were recorded in the first transect line. So measurement could not be applied there. Table 6.3 indicates that Kantiyajal site has the maximum no. of trees per subplot. Moreover, the table indicates that Ashirawandh is showing the lowest variation in values per subplots. It means that trees are growing uniformly and that is why it is having almost similar height in each subplot. Coefficient Variation values varies from 7.69 to 21.78 in Ashirawandh site. On the opposite side, Lakki represents the highest variation with 10.88 to 37.22 between different growth values of trees (Table 6.3). The main reason behind this is the dense forest type structure of planted mangrove trees. In Lakki, near creek side, trees are grown very abundantly, while at inner side, at some points they are patchy.

Table 6.4 indicates the overall readings of girth size values of each sample plot in different transect lines. Lakki has very large difference in this value of growth of planted trees. The girth size varies from 6.15 % to 80.47 % among different subplots located on different transect lines. The lowest Coefficient Value of girth size was recorded in the second subplot of fifth transect line, which clearly indicates that plants have minor variation in girth size. At the same time, first subplot of first transect line having 80.47 % CV value in girth size, which shows the highest variability in growth of trees near creek area, as measurement was started from that point.

Table 6.3: Plot wise detail mapping of growth status of planted species (Height)*

Transect	Sample plot	Param-eter	Height (m) (No. of trees)				
			Tadatalav	Kantiyajal	Nada	Lakki	Ashirawandh
1	1	Avg.	-	3.09 (10)	-	3.39 (5)	1.70 (3)
		SD	-	0.65	-	0.92	0.17
		CV %	-	21.00	-	27.20	10.19
	2	Avg.	-	3.47 (7)	-	2.85 (2)	1.95 (3)
		SD	-	0.62	-	1.06	0.15
		CV %	-	17.90	-	37.22	7.69
2	1	Avg.	-	2.7 (5)	2.40 (2)	2.91 (6)	2.04 (5)
		SD	-	0.47	0.42	0.80	0.35
		CV %	-	17.57	17.68	27.42	16.93
	2	Avg.	2.1 (3)	3.66 (5)	-	2.86 (5)	1.95 (3)
		SD	0.79	0.58	-	0.77	0.15
		CV %	37.80	15.77	-	26.88	7.69
3	1	Avg.	2.8 (3)	3.75 (4)	-	3.20 (3)	2.65 (3)
		SD	0.31	0.62	-	0.51	0.48
		CV %	11.35	16.65	-	15.93	18.20
	2	Avg.	-	-	2.40 (2)	3.90 (2)	2.66 (4)
		SD	-	-	0.42	0.42	0.58
		CV %	-	-	17.68	10.88	21.78
4	1	Avg.	-	3.3 (5)	-	2.64 (5)	2.70 (4)
		SD	-	0.47	-	0.74	0.42
		CV %	-	14.37	-	28.20	15.71
	2	Avg.	2.4 (2)	2.7 (7)	-	3.70 (3)	4.00 (3)
		SD	0.42	0.55	-	1.14	0.46
		CV %	17.68	20.29	-	30.70	11.46
5	1	Avg.	3 (2)	4.5 (5)	-	3.20 (3)	3.47 (7)
		SD	0.85	0.76	-	0.75	0.45
		CV %	28.28	17.00	-	23.59	13.07
	2	Avg.	-	3.3 (6)	-	3.37 (2)	3.60 (5)
		SD	-	0.87	-	0.74	0.47
		CV %	-	26.35	-	22.03	13.18

* In Karanj and Dandi, no trees were recorded. - Not recorded

Table 6.4: Plot wise detail mapping of growth status of planted species (Girth)*

Transect No.	Sample plot	Param-eter	Girth (cm)			
			Tadatalav	Nada	Lakki	Ashirawandh
1	1	Avg.	-	-	43.40	8.00
		SD	-	-	34.93	1.00
		CV %	-	-	80.47	12.50
	2	Avg.	-	-	50.00	8.16
		SD	-	-	28.28	0.76
		CV %	-	-	56.57	9.36
2	1	Avg.	-	32	34.66	12.00
		SD	-	0	16.67	5.34
		CV %	-	0	48.09	44.49
	2	Avg.	16	-	41.6	10.66
		SD	4	-	9.18	1.15
		CV %	25	-	22.07	10.83
3	1	Avg.	15	-	29.60	22.66
		SD	4.08	-	7.76	16.17
		CV %	27.22	-	26.22	71.34
	2	Avg.	-	32	51.00	20.00
		SD	-	0	15.56	9.13
		CV %	-	0	30.50	45.64
4	1	Avg.	-	-	26	31.25
		SD	-	-	13.56	8.54
		CV %	-	-	52.17	27.33
	2	Avg.	17.5	-	56.66	68.33
		SD	3.54	-	32.15	4.73
		CV %	20.20	-	56.73	6.92
5	1	Avg.	17.5	-	37.00	66.14
		SD	6.36	-	6.24	5.18
		CV %	36.37	-	16.88	7.83
	2	Avg.	-	-	57.50	68.80
		SD	-	-	3.54	3.27
		CV %	-	-	6.15	4.75

* Due to expanded growth of mangroves girth measurement could not be possible in site Kantiyajal.
- Not recorded

Table 6.5 shows the overall status of growth of trees with respect to the branching pattern. Number of branches indicates the actual growth status of a tree. The branching pattern indicates that at every subplot, the plantation show more or less similar pattern in terms

of number of branches. Only in Lakki village that higher variability (CV) in the number of branches has been observed especially in the case of transect lines 1 and 4 (sample plots 1 and 2) as compared to other locations and sample plots.

Table 6.5: Plot wise detail mapping of growth status of planted species (No. of Branches)

Transect No.	Sample plot	Param-eter	No. of Branches				
			Tadatalav	Kantiyajal	Nada	Lakki	Ashirawandh
1	1	Avg.	-	6.0	-	9.80	4.33
		SD	-	1.48	-	5.89	2.52
		CV %	-	24.69	-	60.11	58.12
	2	Avg.	-	5.28	-	6	6.00
		SD	-	1.38	-	1.41	1.41
		CV %	-	26.14	-	23.57	23.57
2	1	Avg.	-	4.2	4.5	4.16	5.40
		SD	-	1.30	0.71	1.60	1.14
		CV %	-	31.04	15.71	38.51	21.11
	2	Avg.	5.66	5.4	-	5.40	5.66
		SD	0.58	1.14	-	1.67	2.52
		CV %	10.20	21.11	-	30.99	44.46
3	1	Avg.	8	5.75	-	4.60	5.33
		SD	2.16	1.71	-	1.70	1.15
		CV %	27.00	29.70	-	36.96	21.66
	2	Avg.	-	-	4.5	5.50	7.00
		SD	-	-	0.71	2.12	2.16
		CV %	-	-	15.71	38.57	30.86
4	1	Avg.	-	4.0	-	6.8	4.25
		SD	-	1.40	-	5.49	1.89
		CV %	-	34.93	-	80.76	44.54
	2	Avg.	8.5	4.28	-	9.66	6.00
		SD	0.71	0.76	-	5.03	1.00
		CV %	8.32	17.66	-	52.10	16.67
5	1	Avg.	6	5.40	-	4.00	6.42
		SD	1.41	1.14	-	1.00	1.99
		CV %	23.57	21.11	-	25.00	30.97
	2	Avg.	-	4.00	-	4.50	6.00
		SD	-	1.10	-	2.12	1.87
		CV %	-	27.39	-	47.14	31.18

- Not recorded

(B) Nutrient in Sediments

The results of study of soil parameters in relation to plant growth for all the different mangrove plantation sites in the study districts are presented and discussed in this section. Basic soil chemical properties are described in terms of Total Carbon, Nitrogen, Available Phosphorus, Available Potassium, pH and Salinity. Table 6.6 presents the summary of chemical properties of sediments of different sapling sites. The chemical properties such as pH, Organic Carbon, Total Nitrogen, Available Phosphorous and Potassium of sediments differ among the sites.

Table 6.6: Soil Characteristics for each village site

Village	EC	pH	Organic Carbon %O.C	Organic Matter (%)	Nitrogen %	Available P_2O_5 kg/ ha	Available K_2O kg/ha
Lakki	11.95	7.44	0.34	0.58	0.03	52.36	2041.09
Ashirawandh	18.47	7.55	0.66	1.14	0.06	122.88	3129.73
Karanj	10.51	8.21	0.22	0.38	0.02	59.58	3105.54
Dandi	10.00	8.22	0.20	0.35	0.02	37.93	3012.35
Nada	11.11	8.01	0.10	0.17	0.01	60.39	2678.59
Kantiyajal	13.46	7.76	0.19	0.33	0.02	50.27	3147.65
Tadatalav	14.87	7.90	0.10	0.17	0.01	53.30	2611.84

Source: Sediment Analysis of Present Study

pH levels were similar, at about 7 to 8 at all sites.

In mangroves, approximately half of the nutrient and carbon stocks can be seen in the sediments. Higher quantity of Organic Carbon (0.66 %) was found in soil collected from Ashirawandh. However, no major difference was found in other sites which represent the value between 0.10 to 0.34 %. The organic carbon content of the soil was generally low values ranging between 0.10 to 0.66 %.The low values of organic carbon content is attributed to rapid mineralization and depletion due to intensive demand for nutrients by the macro fauna and flora.

The other parameters like Phosphate and Potassium shows the highest mean value of 122.88 kg/ha and 3129.73 kg/ha at Ashirawandh respectively. Although Kantiyajal site is rich with more potassium value of 3147.65 kg/ha. Now if we compare these readings with the Badola & Hussain (2003) on mangroves of Bhitarkanika National Park, Orissa then it shows quite similar values in case of available P_2O_5 and available K_2O.

The Table 6.7 shows the comparison of physiochemical parameters and nutrient value of sediment of present study sites of 2-6 years old mangrove plantations with fully mature mangrove stands of Bhitarkanika National Park in eastern Coast. In the above context, the two sites are quite different in chemical properties of their sediments.

Table 6.7 Comparison of soil characteristics of two different mangrove sites (Natural forest and planted mangroves)

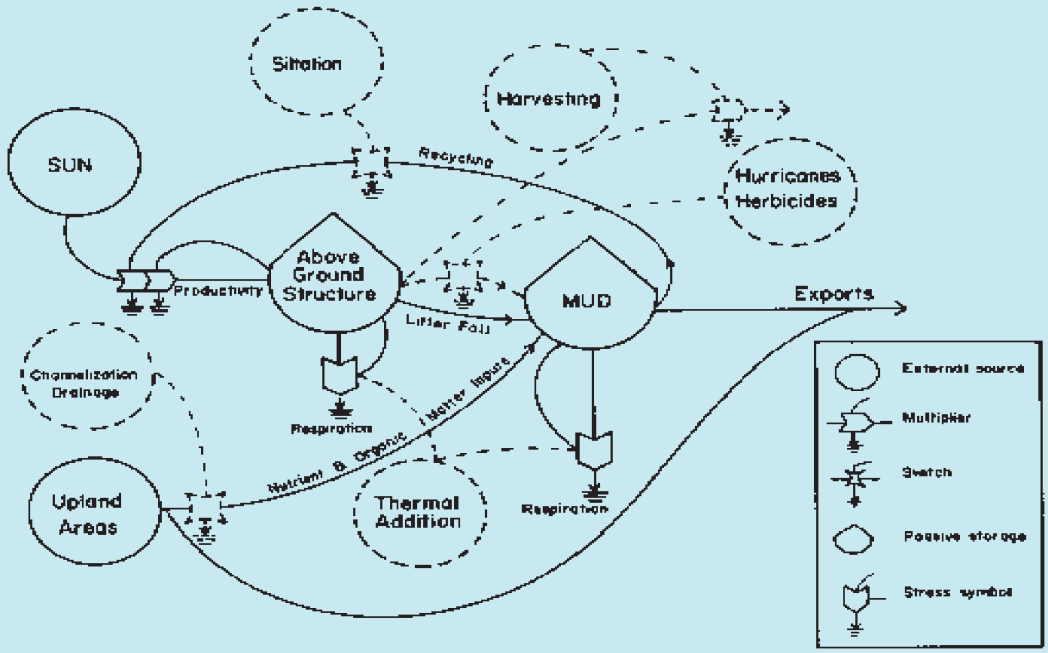
Parameters	Present Study (Avg. Value)	Hussain & Badola (2008)
EC	12.91 (ds/m)	2.64 (mho)
pH	7.87	7.58
Organic Carbon	0.26 (%)	25,326.67 ± 1,429.81 (kg/ha)
Nitrogen	0.02 (%)	2,907.00 ± 177.46 (kg/ha)
Available P_2O_5 (kg/ha)	62.39	28.11 ± 3.23
Available K_2O (kg/ha)	2818.11	1,564.55 ± 100.89

The differences in the values, to a certain extent, are due to the differences in species composition and also age of mangrove stands. The inflow organic and inorganic materials (mainly from surface runoff due to rains) into the mangrove estuaries also determine the nutrient status of sediments, which in turn support the growth of the plants.

In terms of consistency in the measured units two parameters viz. Phosphorous and Potassium, can be compared for two sites. Interestingly, the present plantation sites were recorded higher values of these two nutrients in the sediment. Due to lack of supporting runoff and other sedimentation data in the two sites, restrict our interpretation and need further exploration. Neverthless, the present study sites are very well comparable with the natural grown forest.

Nitrogen fixation in mangroves can occur at high rates but imported nitrogen is required to meet the demand of primary production of the forests. Very little nitrogen is lost from undisturbed mangroves via denitrification or in tidal exchange due in part to the high efficiency of internal cycling within tree tissues and sediments. Although there is evidence for net uptake of carbon and nutrients by mangrove ecosystems, there is exchange among mangroves and adjacent regions with mangroves providing important carbon and nutrient subsidies to coastal waters. Phosphorus is also sequestered in salt flats due to evaporation of seawater, rain and fresh water inputs. (Woitchik et al. 1997)

Box 6.3: A simple energy model illustrating the major storage and flows in a mangrove ecosystem. (Potential stresses are distinguished by dashed lines. In essence, the model is a series of differential equations graphically depicted using the ecological circuit language created by H. Odum.)



(C) Status of Biodiversity

The mangroves are complex and detritus-based ecosystems. Mangrove forests and associated salt flats and salt marsh support a diverse and abundant fauna. The wastes produced by mangroves (leaves, stems, flowers etc.) are rapidly degraded into small particles, known as detritus, which supports many detritus feeding fauna like amphipods, herpacticoid, copepods, molluscs, crustacean larvae, prawn and small fishes (Dam Roy, 1997). While invertebrates and fishes are highly diverse groups that are abundant in mangrove habitats, many species of reptiles (including turtles, crocodiles and lizards), birds and mammals also use mangroves as habitat.

Many species of mobile fauna access mangrove and associated habitats seasonally when the tide permits, while others are resident. The mangrove – salt marsh/salt flat habitat can be viewed as a complex connected mosaic of habitats that are intermittently accessible to mobile fauna with affinities to reefs and other subtidal habitats. These mobile fauna also have a role in the transfer of materials between habitats through grazing, predation, and excretion. The contribution of animals to material exchange between mangroves and other adjacent habitats could be similar to or exceed the exchange of particulate and dissolved material with tidal flow. Some of the most conspicuous fauna in mangrove forests, due to their burrows, are crabs and mud lobsters.

Crabs perform critical ecological functions, influencing forest structure by consuming propagates, aiding in processing of leaf litter, oxygenating the sediments, and contributing to surface friction and thus to slowing water movement that facilitates fluxes of nutrient and other materials between mangrove sediments and tidal waters. Crabs are consumed by large predatory fish but also produce copious larvae, which are an important food source for many juvenile fish utilizing mangroves. Mangroves also support a wide diversity of other invertebrates.

Crab and its habitat

Arboreal residents in mangroves are also highly diverse and abundant. These include spiders, ants, beetles and other insects, bats and birds. Some are specialists on mangrove flora (eg leaf miners, wood borers, Seed and insect feeders) and many have important effects on forest growth, structure and recruitment. During present study different species of plants and marine creatures and their habitat distribution were recorded at each site from landward to seaward side at mangrove area.

Lakki, Ashirawandh and Kantiyajal were represented the highest species richness among all different site.

Table 6.8 shows the present status of species in different areas.

Table 6.8: Present Status of Biodiversity in Mangrove Restoration Area

	TadaTalav	Lakki	Ashirawandh	Karanj	Dandi	Nada	Kantiyajal
Crustacean							
Crabs	++	++++	+++	+++	++	++	++++
Prawns	++	+++	++	++	+	+	++
Molluscan							
Gastropods	++	++++	+++	+++	+++	+++	++++
Bivalves	++	+++	++	++	+	+	+++
Snake	+	-	-	-	-	-	+
Birds	-	++	+	-	-	-	++
Mudskipper	+++	++++	++++	++++	+++	++++	+++
Other Fish	++	+++	++	++	++	++	+++

- Absent, + Satisfactory, ++ Good, +++ Excellent, ++++ Quite rich

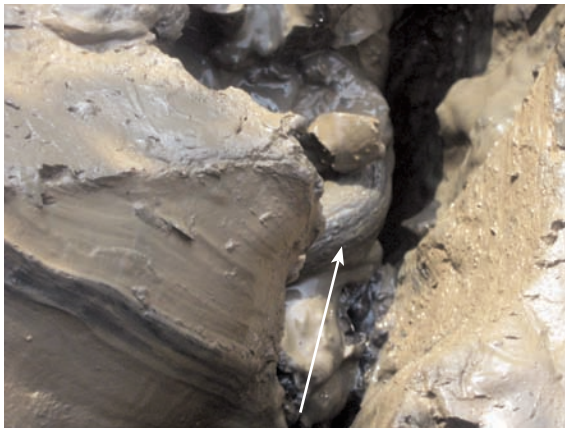
Mudskipper is the species which was highly noticed during the field work. As mudskipper is highly adapted to survive in mangrove ecosystem, the abundant number of this species is due to the mangrove plantation work in these areas. Mangrove ecosystem also supports different habitat ground to other groups of animal also. It was observed during this study that the areas where planted mangroves have achieved quite good growth in such areas birds also preferred to build their nest.

Plate : 6.1 Available Biodiversity in Mangrove Ecosystem

Molluscan

Molluscan

Tail of Snake



Snake

Crab

Mudskipper

Plat 6.2 Growth Status of Mangrove Plantation

Site : Lakki

Site : Ashirawandh

Site : Karanj

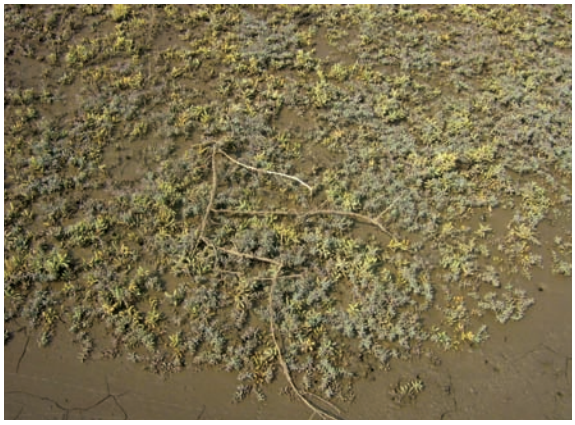
Site : Dandi

Site : Nada

Site : Kantiyajal

Site : Tada Talav

Plat 6.3 Mangrove associated flora



6.3 Results and Discussion

- Quantitative analysis was undertaken to assess the status of ecological parameters determining the success criteria of the mangrove plantations.
- Quantitative analysis included growth status of planted species (i.e. No. of Plants, No. of Saplings, Status of Pneumatophores, Height of Plant, Girth of Tree, No. of Branches, Canopy Measurement etc.), while ecological parameters showing the status of biological diversity as well as soil characteristics of each area.
- Transect lines were drawn perpendicular to the shoreline. The length depends on the vegetation type. On each transect line two different 100 m^2 vegetation plots

(10 m x 10 m) were marked out to determine number of saplings and total number of tree species as well as the growth of each tree. Now in one sample plot 3 more sub plots (1 x 1 m) were scratched out to calculate the status of Pneumatophores and available biodiversity.

- At the end of biological assessment, Lakki and Ashirawandh from Kachchh and Kantiyajal from Bharuch come out as the most productive site among all 7 different sites. Kantiyajal having tree density of 550 no. per ha. which leads to Lakki which is having 400 no. per ha. And finally Ashirawandh represent with 360 no. of trees per ha. These figures show quite satisfactory status of plantation.
- *Avicennia marina* was the only species of mangrove which was planted thoroughly at each site. Although recent plantation of *Rhizophora mucronata* was observed at Lakki site near the edge of the creek.
- Kantiyajal and Lakki represent the highest mean height of 3.27 and 3.13 m respectively. Trees were much expanded in Kantiyajal. So girth size could not be easily measurable. On the other hand Lakki and Ashirawandh showing mean GBH value at about 40.28 and 35.64 cm correspondingly. Avg. no. of branches helps us to identify the growth pattern of planted tree. Except Nada all other centers indicate equivalent average of no. of branches which ranges from 4.89 to 6.75. All these plantation sites shows very expanded growth.
- Measurement could not be possible for such parameters like density, height, girth size, avg. no. of branches for village site Karanj and Dandi, as plantation has started from last 2 to 5 years in these areas and planted mangrove species has just reached up to the sapling level.
- Canopy measurement was taken by adopting a crude method by using mirror.
- As per the canopy reading Lakki and Kantiyajal are categorized into very dense mangrove areas with having canopy cover density of 80 %, while Ashirawandh come under the moderately dense mangrove area which is showing the canopy cover density of 50 %. And finally the remaining other sites like Nada, Karanj and Dandi can be approach to Open canopy area, among which Nada is having 20 % of canopy cover density, whereas canopy measurement could not applied at Karanj and Dandi, as plantation is very recent in these area and that is why mangrove plants are still in their growing stage and reached up to the sapling stage.
- Pneumatophores (aerial roots) provide support to mangrove plant and also a good sign of gas exchange. There was a significant increase in pneumatophore height and density from landwards to seawards as tree density significantly increases towards the sea. Lakki, Ashirawandh and Tada Talav are having the highest no. of pneumatophores.

- To scrutinize the soil characteristics of each site, soil samples were collected 3 times randomly from different transects lines at each site during low tide from a depth of 30–50 cm using a soil corer. In the laboratory parameters such as pH, EC, Organic Carbon (%), Nitrogen (%), Available P_2O_5 kg/ha, Available K_2O kg/ha were analyzed.
- pH levels were similar at every site between 7 to 8. The content of organic carbon in the soil was generally low values ranging between 0.10 to 0.66 %. The low values of organic carbon content is attributed to rapid mineralization and depletion due to intensive demand for nutrients by the macro fauna and flora. Higher quantity of Organic Carbon (0.66 %) was found in soil collected from Ashirawandh. The other parameters like Phosphate and Potassium shows the highest mean value of 122.88 kg/ha and 3129.73 kg/ha at Ashirawandh respectively. Though Kantiyajal site is more rich with having more potassium value of 3147.65 kg/ha. Organic matter (%) and Nitrogen could obtain from the value of Organic Carbon. The highest organic matter was found at Ashirawandh with 1.14 %.
- If we compare these soil values with the status of plants growth of each site then it highlight that Ashirawandh, Lakki and Kantiyajal are having quite superior growth of planted *Avicennia* species and as the result of that they are also indicating good amount of nutrient value. Tada Talav and Nada are also representing a fairly good amount of no. of pneumatophores and have quite satisfactory growth and this leads to increase the nutrient value of soil. Certainly, Karanj and Dandi have also been covered by large plantation area and plants are growing adequately.
- There are many plant and animal species which live within the mangrove community and depend on this unique habitat for their continued existence. The biological status indicates the actual status of success ratio of plantation. So survey was also made to evaluate the status of biodiversity in specific area.
- Lakki, Ashirawandh and Kantiyajal stand for having maximum biomass and biodiversity in mangrove ecosystem. Crabs, gastropods, bivalve groups of animals are abundant in this complex ecosystem. Also planted mangrove trees perform as a habitat ground for marine birds. Furthermore mangrove ecosystem is a home for marine reptiles such as snake also. One live mud snake was found at Kantiyajal site near the creek while the same species of dead snake was found at Tada Talav during the low tide at upper tidal zone. So entirety all 7 sites are quite rich in having diversity of such groups of animals like crab, gastropods, bivalve, reptiles, fish and other groups of animals. This may be due to the plantation activity carried out in such areas by Gujarat Ecology Commission.

Chapter - 7

Development and Restoration of Mangroves: Future Perspectives

This Chapter tries to provide an overview of the scenario of development and restoration practices that exist in the study villages. The analyses presented in the foregoing chapters clearly demonstrate that though mangroves have existed in most of the villages prior to the launching of the REMAG by the ICEF and its continuation under the GEC initiatives, majority of the communities have been less enthusiastic about the mangrove plantations as a potential source that would help them to make their livelihoods surrounding this resource. But, the increasing natural hazards in terms of frequent occurrence of tidal winds, typhoons, salinity ingression in crop lands and the devastating Tsunami have made the communities realise that mangroves have immense potential which makes their need for restoration and further development to save livelihoods and livestock from further catastrophe of the sorts experienced.

Certainly, the above realization among the communities enabled them wholeheartedly to cooperate and participate in the mangroves development/ restoration efforts initiated in Gujarat state by the ICEF and later continued by the GEC and the Forest Department and other stakeholders, such as the NGOs and industries. Initially, the communities' engagement in mangrove development and restoration activities has been promulgated by the employment opportunities generated by the development process. As time passed, the increasing evidences as emerge from the study reveal that the communities are convinced about the potential of mangroves as something much beyond the scope of employment generation alone. This being so, the communities are also very much enthusiastic about thinking in terms of future conservation goals to be set as an important development agenda in their village action plans. Nevertheless, achieving these goals call for many accompanying developments in terms of provision of infrastructures, capacity building, skill development, empowerment, opportunities for participation in restoration efforts and the collective action among the communities as well as various other stakeholders.

In this backdrop, rest of the Chapter tries to situate the status of development of mangrove plantations in the study villages and discuss the need for evolving a rightful perspective towards the future course of protecting the mangrove ecosystems in a multi-stakeholder participatory framework.

The empirical analysis presented in Chapter 5, titled, "Economic Assessment of the multiple benefits of mangroves and their restoration in Gujarat" bring out that even though the

mangrove plantations are in their initial stages of growth, the tangible and non-tangible benefits realised by the communities have been significant. This makes it imperative that the existing mangrove plantations need to be conserved and new plantations be developed along with the regeneration of degraded mangrove areas in the villages. As we see from the analysis, all the village communities have benefited from the mangrove plantations one way or the other. For instance, one of the major beneficiary of mangrove are the fishing communities belonging to Kharva, Halpati, Jatt Fakirani and Devipoojak and most of these communities are present in all the study villages. Similarly, the communities, such as Koli Patel, Prajapati and Rajput who are traditionally engaged in agriculture and animal husbandry activities are also present in five of the seven villages.

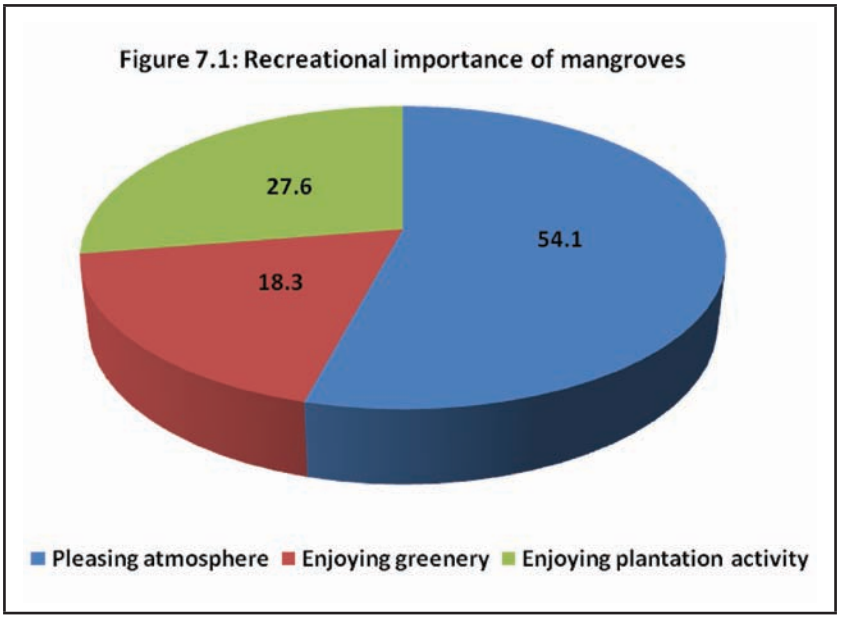
In order to know what the communities understand about the importance of restoration of mangroves and their efforts towards protecting mangroves, we had incorporated certain qualitative questions in the field survey instrument. These questions were pertaining to the perceptions of the communities in regards to the recreational values and their awareness and perceptions of future conservation needs. These leader questions were also combined with some related questions such as: a) the frequency of recreational visits to the mangrove locations; b) the number of family members per visit; c) time spent per visit; and d) the knowledge about tourists visiting the mangrove locations. Similarly, the question relating to the community member's awareness and perceptions of future conservation of mangroves was probed along with questions about the ecosystem services provided by mangroves, such as reduction in cyclones and the actions needed as well as the ideal institutional mechanisms for protecting the mangrove systems for future, etc.

7.1. Mangroves and Recreational benefits

The study reveals that almost 75 percent of the respondents give importance to mangroves as having recreational values. Majority of the respondents (70-100%) feel very much pleased to visit the mangrove locations other than their routine visits to gather fodder (leaves, seeds, small twigs, etc) for their cattle and fuel wood from the mangroves. The response was exceptionally high (100%) in Ashirawandh, followed by Tadatalav (79%) and Dandi (75%) villages. Only in Lakki village the response was less (59%) as the mangrove site in this village is located in the creek in the area bordering Pakistan. Looking to the security reasons, the entry of the communities to the mangrove location is restricted in Lakki village in terms of fishing timings as well as recreation uses. Moreover, as the area is sensitive and is protected by the Border Security Force (BSF), the entry is restricted through authorization by the Forest Department. This causes inconveniences to the communities as even the routine visits are to be properly documented through entry pass.

As Figure 7.1 shows, majority (54%) of the respondents indicated that they visit the mangroves to get the experience of a very pleasing atmosphere. While about 28 percent of

the respondents visit the plantation locations to enjoy the plantation activities, another 18 percent visit the mangroves to enjoy the feel of the greenery provided by the mangroves.

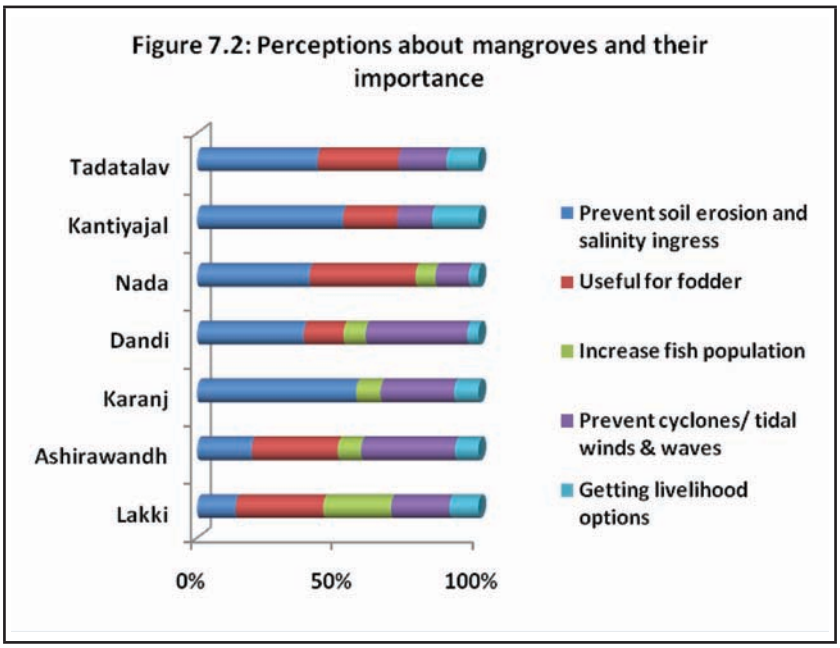


In majority of the cases (76%), the visit to the mangrove locations has been with family members as only 24% of the respondents reported that they visit the mangrove locations alone. Further segregation of visit to mangroves with respect to the family members who accompany the respondents, it was observed that 32% visit locations with spouse, followed by 15% with childrens, 9% with their parents, 14% with friends and 6% with brothers. This shows that mangroves have been visited by the respondents as a recreational site besides their routine visits to gather the fodder or earning employment. Moreover, most of the respondents have been visiting the locations with their family members which would be indicative of a source of strengthening the family ties in the villages.

In regard to the question on the visit of tourists or other persons, including government officials to the mangrove locations, about 82% of the respondents from all villages reported that they know about various personnel visiting the mangrove locations on a regular basis. The responses were in the range of 76-92% with some exceptions from Lakki village where only 65 percent reported about the visit of the personnel to the mangrove location in the village. Regarding the type of visitors as identified by the respondents, about 46% reported that the visitors were government officials who could be project implementers or officials from NGOs or other agencies who visit the mangroves to know its development status or progress. While 28% of the respondents identified the visitors as local tourists, 25 percent reported that the visitors were researchers engaged in research on various aspects of mangroves.

7.2. Awareness and perceptions on future conservation of mangroves

Almost all of the village communities (92%) have reflected that growing mangroves is an important activity that needs more emphasis in the years to come in view of the changing climatic scenarios and the threats encompassing the rural livelihoods. In this regard, the responses have been diverse in terms of the variety of perceptions that the communities attach with mangrove restoration activities ongoing in the villages. The communities rate the importance of future conservation of mangroves as evident from the multiple responses showing the multiple benefits that they accrue and visualize from the future conservation efforts (Figure 7.2).

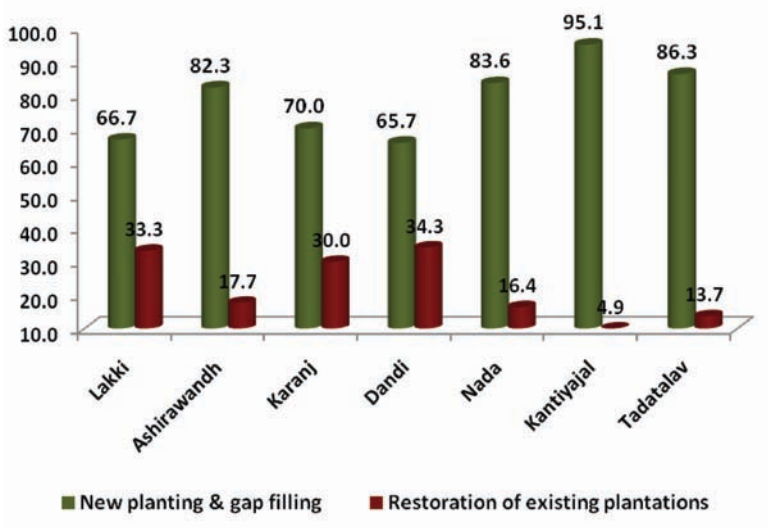


The analysis shows that 72 percent of the respondents value mangroves for their benefits in terms of prevention of soil erosion and salinity ingress in the agriculture lands surrounding the coastal village. About 45 percent consider the fodder benefits as important aspect of mangroves, while 36 percent consider the importance of mangroves as effective barrier against cyclones/tidal winds and waves. Further, when about 16 percent of the respondents strongly support for the multiple livelihood options provided by mangroves, about 11 percent report the incremental benefits accrued from increase in fish production as mangroves provide habitat for multiplication and survival of fish stock.

Nevertheless, though the impacts have been quite visible and encouraging on several fronts, a large number of respondents feel that the situation needs further improvements from the perspective of achieving sustainable mangrove restoration outcomes in the long run. For instance, almost 89 percent of the respondents from the Ashirawandh village feel the urgency of improving the situation. This feeling is also quite wide-spread in all the

villages as 87 percent of the respondents in the Tadatalav agree to this view, followed by Kantiyajal (82%), Lakki (71%), Nada (68%), Karanj (67%).

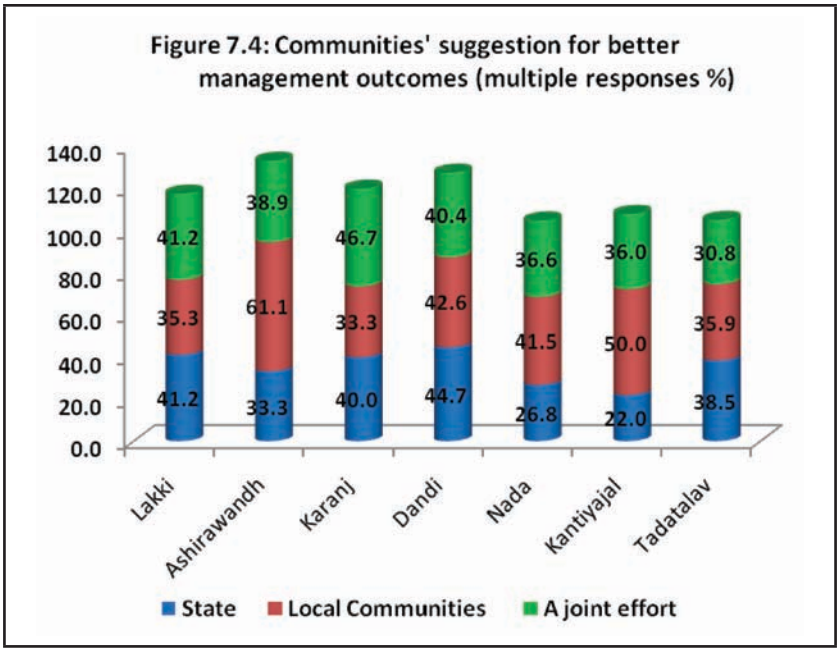
Figure 7.3: Suggestions from communities for increasing mangrove cover(%)



The question then posed to the communities was how the situation can be improved further in their respective villages?. As evident from Figure 7.3, the respondents reflected that the situation can be improved through developing new mangrove plantations along with gap filling as well as efforts for restoring the existing plantations. In all the villages, an overwhelming majority of the respondents have indicated the need for expanding the mangrove cover in the villages through new plantations, including vacancy filling on a priority basis.

7.3. Perspective Towards better Management Outcomes

The communities' suggestions for improvements in the existing situations have been further clarified with respect to the specific management interventions that could result in better management outcomes in development and restoration of mangrove plantations in the villages. There were multiple responses to this question which suggest that majority of the respondents opt for an effective management regime under the control of either communities themselves or a joint management regime with joint participation in development and restoration from the local communities, the State and the NGOs or other stakeholders. This is further evident from Figure 7.4.



Notably, the Figure also underlies that management of mangrove plantations may not work effectively if they are left to be governed by the communities alone. This is evident from at least three villages, viz., Tadatalav, Lakki and Karanj, where the percentage responses for community management option were seem to be very low as compared to the other two options of management by the State and the joint management. However, this finding needs further investigation in regard to the success and failure of different management regimes for mangroves in the study villages.

The respondents were asked to make suggestions for measures or activities for improving the status of mangrove restoration and management practices in the villages and there were several suggestions as presented in Table 7.1. The eight responses as presented in the Table have been classified in terms of activities/measures that are of high priority (XX), second priority (X) and less important (N), based on the percentage responses revealed by the respondents. Accordingly, the measures/activities that were indicated by more than 25 percent of the respondents in each village have been included as high priority and those activities that were indicated by 5-25% of the respondents have been classified as 'second priority' and those below 5% were included as less important.

Table 7.1: Respondents' suggestions for measures/ activities for better management outcomes

	Activities/ measures	Lakki	Ashira wandh	Karanj	Dandi	Nada	Kantiyajal	Tada talav
1.	Increase awareness on mangroves	XX	XX	XX	XX	XX	XX	XX
2.	Effective functioning of CBOs	X	XX	XX	N	N	X	X

3.	Community participation	X	X	XX	X	X	XX	X
4.	Propagate mangrove benefits	X	XX	XX	N	N	N	N
5.	More planting of mangroves	X	N	N	X	N	N	N
6.	Support from Government	X	X	X	X	X	N	N
7.	Employing official watchmen	N	N	N	XX	N	N	X
8.	Ban on cutting of mangroves	N	N	N	X	N	N	N

Note: XX – High priority; X – Second priority; N – Less important.

Accordingly, the Table indicates that in all the villages, a majority of the respondents felt the need for increasing the awareness about mangroves among the local communities in particular. More number of respondents have also indicated the need for improving the functioning efficiency of CBO's (Ashirawandh and Karanj), increasing community participation (Karanj and Kantiyajal), further propagation of benefits of mangroves (Ashirawandh and Karanj) and employing official watchmen (Dandi) as actions/measures were clubbed with high priority. It is also important to note that almost six of the eight activities/ measures suggested were considered important by the communities in order to improve the governance efficiency or achieving better management outcomes of mangrove restoration activities in the villages.

Having made such suggestions for further improvements in the development and management of mangrove plantations, the communities have also been highly appreciative of the institutional role played by the GEC in all the villages and the furtherance of GEC efforts by the Forest Department and the local NGOs in some of the villages. More importantly, majority of the respondents in Kantiyajal and Nada villages have felt that some of the development interventions, such as the Kalpasar project and expansion of industrialisation activities may seriously affect the prospects of mangrove development and restoration activities. For instance, 94 percent of the respondents from Nada and 80 percent of the respondents from Kantiyajal village have observed that the Kalpasar project would adversely affect the mangrove plantation and restoration efforts. Similarly, a significant number of respondents from Ashirawandh and Karanj villages have raised apprehensions about the adverse impacts of industrial pollution (and effluents) as well as salt pans on the growth and regeneration of mangroves in these villages. These eventualities call for more concrete efforts towards conserving mangroves through joint action among various stakeholders, including the Department of Forests and Environment, the Industries Department, GEC and others.

The fact that growth of mangrove plantations is adversely affected by industrial pollution as well as garbage deposited into the coastal waters has been identified as a serious environmental issue by the communities in Ashirawandh and Karanj villages which need proper addressing. Besides, oil spill from boats and dumping of plastics were also

reported. The discharge of saline water from salt pans is also reported adversely affecting the growth of mangroves. Similarly, the closeness of a cement factory near the mangrove area is also reported to be creating environmental problems for mangroves. The lack of inflow of freshwater (river water) due to construction of a dam is also reported affecting the growth of mangroves.

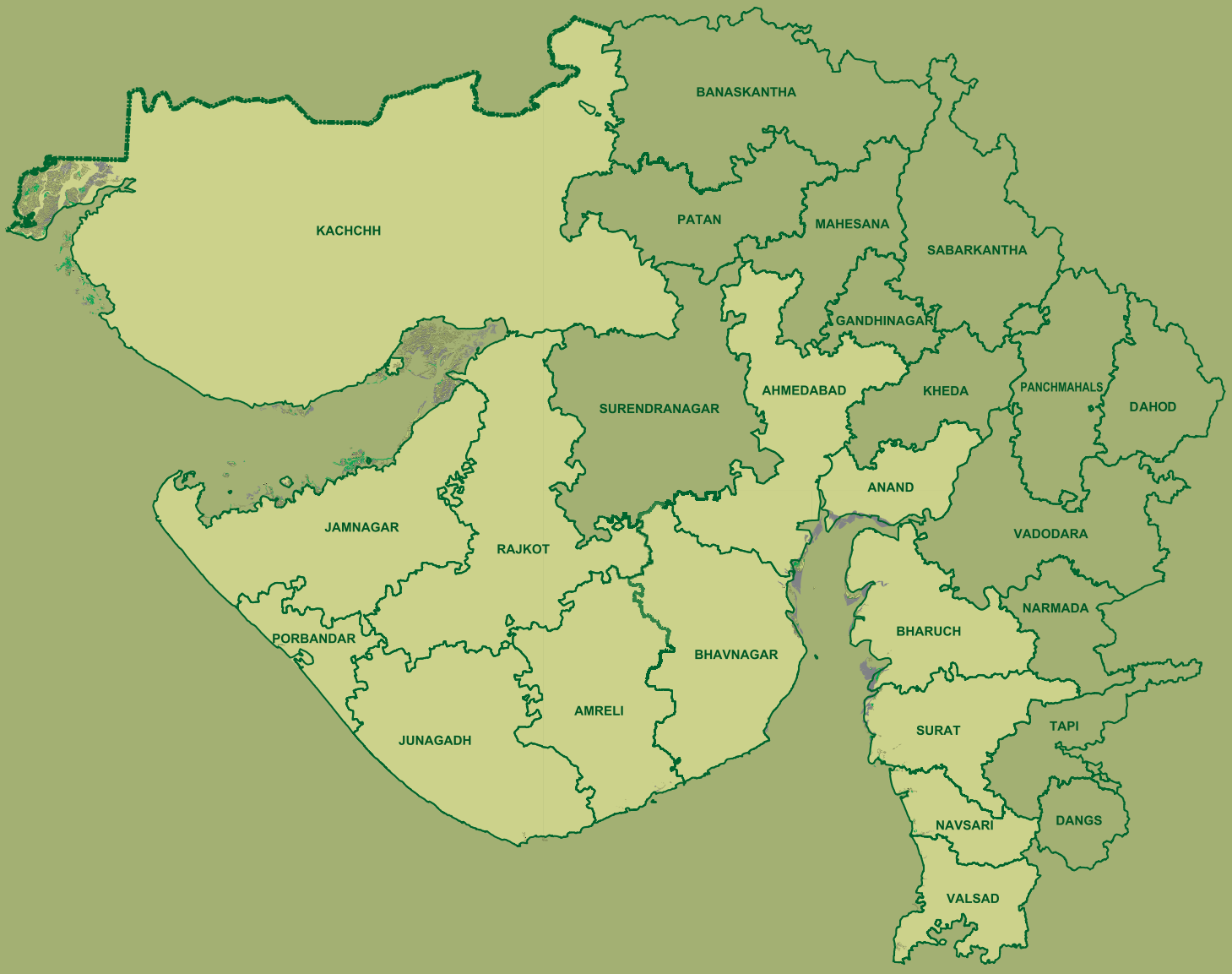
Lack of access to infrastructure facilities in the villages has been indicated as a major problem by the communities. It is important to note that the mangrove restoration efforts will have more sustainable impacts if the communities are provided with the public utility services and infrastructure facilities that will keep them connected through increased group interactions and creation of a social space for mangrove development and restoration activities in the village development plans. This calls more efforts from the various stakeholders engaged in promotion of mangroves for launching joint actions plans for providing public utilities, especially, provision of potable water and sanitation facilities on a permanent basis. The shortage of potable water has been indicated as a major problem by few of the communities. Majority of the households depend on unprotected well water, rainwater, lake, pond and lagoon. Only about 5 percent of the households use protected wells. So is the case with sanitation facilities. In the absence of sanitation facilities, defecation occurs in the open, which leads to contamination of drinking water sources with fecal matter.

The provision of boats for fishing is yet another important need indicated by the fishing communities. The study reveals that only 9 of the 98 fisher communities own boats for fishing (6 boats in Ashirawandh, 2 in Lakki and 1 in Nada village). In the absence of boats or inability to hire costly boats, almost 89 percent of the fishing communities walk on deep waters for catching fish. This situation needs to be addressed through arrangement for provision of fishing boats to the communities who can own and operate fishing boats on a collective basis.

It has been observed that majority of the households have started using mangroves as the major source for firewood, even replacing the use of conventional woods available in the local areas. Earlier, the use of local woods used to be supplemented with either neem or charcoal. There are also many instances in which respondents have stopped using kerosene for cooking with the abundant availability of mangroves. These trends suggest the increasing pressure on mangroves for use of firewood other than fodder for livestock. This may invariably affect the existing stock and future growth of mangrove plantations as households prefer mangrove to other sources of fuel for cooking due to its easy availability and access. This eventuality calls for proper mechanisms and solutions through awareness creation to arrest the excessive extraction of mangroves. As imposition of policies or regulations alone will not work in such contexts, this problem needs to be

addressed through promotion of planting of suitable species of wood for cooking in the villages.

Finally, sustainable development and restoration of mangroves essentially calls for more efforts for creating opportunities for collective action among the multiple stakeholders, like line state departments under various government portfolios, the local communities, private firms and industries who are increasingly investing in mangrove plantations, NGOs, local administration units, like the village Panchayats. This requires more frequent interactions among these stakeholders towards identifying more innovations and action plans for sustainable development and restoration of mangrove plantations in the villages. Needless to say that all these innovations and action plans should be targeted towards strengthening the capabilities of the local communities and sustaining their livelihoods without compromising on the broader goals of sustainable management of mangrove ecosystems.


BANASKANTHA
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SURENDRANAGAR
ANAND
JAMNAGAR
VADODARA
RAJKOT
NARMADA
BHARUCH
PORBANDAR
BHAVNAGAR
AMRELI
SURAT
TAPI
JUNAGADH
NAVSARI
DANGS
VALSAD

Chapter - 8

Summary of Findings and Conclusions

Historically, Gujarat had extensive and diverse mangrove ecosystems which were degraded or depleted over time due to various developmental activities as well as natural disasters and anthropogenic interactions. In fact, until about 1960s, mangroves has faced serious destruction caused by expansion of economic as well industrial development activities promoted by the state government. However, after many years of wide spread destruction and degradation, significant efforts are being made in recent years by the State Government and the International agencies to restore and regenerate the mangrove plantations in Gujarat in particular. The renewed interests and initiatives towards restoration of mangrove systems has become much more widespread especially after the devastating Asian Tsunami that stuck the Indian coasts in 2004, where mangroves have been found to be highly effective in reducing the adverse effects.

Considering the wider significance of restoration of mangrove ecosystems from multiple perspectives of biodiversity conservation as well as their socio-economic importance to the coastal communities, the Gujarat Ecology Commission (GEC) has taken up the project "Restoration of Mangroves in Gujarat (REMAG)" with financial support from the India Canada Environment Facility (ICEF), New Delhi.

The mangrove restoration project envisages achieving the important objectives through a multi-stakeholder approach, viz: (a) Enhanced capacity of communities to regenerate and sustainably manage mangrove resources for increased livelihood opportunities; (b) Increased support from industry in conserving and regenerating mangroves; and (c) More proactive involvement of the government in community based regeneration and conservation of mangroves

Since the original project was over by 2007, the GEC has taken initiative to continue the restoration activities under a new institutional arrangement facilitated by public private partnership. So far, a total of more than 4000 hectares of mangroves have been restored in the state, in areas adjoining the Gulf of Kachchh and Gulf of Khambhat, covering Six districts, viz. Kachchh, Ahmedabad, Anand, Bharuch, Rajkot and Surat with the involvement of the village communities in 10 sites/ villages. The GEC acts as Nodal Agency with the key responsibility of preparation of Project Management Plan, Financial Management, providing trainings on both technical and social aspects to the PIPs and CBOs for smooth

implementation of the project, liaising with Government departments, industries, academic institutions and other agencies in the state, etc. To create better restoration outcomes, GEC has selected various voluntary organizations as its Project Implementation Partners (PIPs), namely, Vikas Centre for Development, Ahmedabad, Gujarat Institute of Desert Ecology (GUIDE), Bhuj, Mahiti Gram Vikas Sanstha, Dholera, Shri Khambhat Taluka Anusuchitjati Sahkari Kheti Tahtha Utpadak Sangh and Manav Kalyan Trust, Khedbrahma.

This study, titled, **"Socio-Economic and Ecological Benefits of Mangrove Plantations: A Study of Community Based Mangrove Restoration Activities in Gujarat"** was undertaken with the financial support from GEC in order to make a comprehensive assessment of the multiple benefits of mangrove ecosystems and their restoration efforts in Gujarat. The study is important and contextual as there are very limited empirical evidences in regards to the impacts/outcomes of mangrove restoration activities on the local communities in Gujarat. The important objectives of the study were to:

- Undertake a detailed resource mapping of the mangrove restoration activities in the study villages in order to understand the impact on the extent and spread of resource regeneration and status of the same;
- Determine whether the mangrove restoration activities have helped the coastal communities in the selected villages to improve their socio-economic status and livelihoods;
- Undertake a detailed biological assessment and valuation of the mangrove restoration activities; and
- Bring out the policy and institutional intervention mechanisms evolved for implementing the programme and their long term implications for developing a perspective Coastal Resources Management (CRM) strategy aimed at sustainable development and management of mangrove based coastal eco-systems in the villages and their scaling up in the wider context of the state.

For empirical validation of the above objectives, the study covered seven villages, viz., Lakki, Ashira Vandh, Nada, Kantiyajal, Dandi, Karanj and Tada Talav, covering 6 talukas spread over four districts, viz., Kutch Bharuch, Surat and Anand. A total number of 227 households have been covered for the study with highest representation from Kantiyajal and Dandi Villages (50 and 47 households respectively). We followed a two step procedure to select the households for the survey. Households selected from each village are also members of community based organisations (CBO) engaged in plantation and management of mangroves in the villages.

The mangrove restoration programme in the study villages was studied using the pressure, state and response (PSR) frame work. The study used the conceptual framework of the dynamic interface between economy, society, ecology and the environment and tried at examining the socio-economic, ecological impacts of mangroves and the governance aspects of their restoration efforts in the study villages. Logically, the socio economic dimension helps us understand how the local communities strengthen their livelihood with the benefits derived from mangrove plantations. The ecological dimension signifies the increasing importance of mangroves as a bio shield while the Governance dimension highlights the importance of the policies and institutions for effective governance of mangrove ecosystems and their restoration. The governance dimension sets out the way in which mangrove restoration practices are implemented at the grass root level.

For valuing the direct and indirect benefits of mangroves, the study used the household survey method using a structured questionnaire in local language and conducted a biological assessment to trace the vegetative growth and biodiversity of the mangrove plantations. Focus group discussions and interactions with local NGOs were also conducted. A preliminary visit was undertaken to the study villages during October- November 2009 in order to build rapport with the CBOs and village communities prior to starting the final survey. The household survey and vegetation survey were conducted during the period December 2009 to February 2010.

The important findings and conclusions emerging from the study may be summarized as follows:

- The average size of a household is close to 6 members per family at the aggregate level, with slight variations across villages.
- The educational status of the respondents shows very disquieting scenario as larger proportion of them are illiterates in four villages, viz., Ashirawandh (94%), Lakki (76.5%), Tada Talav (46%), and Nada (44%).
- The community status of the households indicates the dominance of Koli Patel (40%), followed by Kharva (20 %), Halpati (6.6 %), Jatt Fakirani (15 %), Devipoojak (16 %), Prajapati (1.3 %) and Rathod / Rajput (0.9 %) communities. Dandi village has the major proportion of Kharva community with 93.6 % respondents, while people from Halpati community are only habituated with mangrove plantation work in Karanj village with almost 100 %. Lakki and Ashirawandh have almost equal number of respondents from Jatt Fakirani community with 94 % and 100 % respectively.
- About 30 percent of the respondents' main sources of income was fishery, followed by income from agriculture (25%), agriculture labour (15%), livestock (13.2%) and other activities (3.1%). About 14% of the respondents solely depend on the mangroves

for income and occupation. Among the villages, 49 percent of the respondents from Dandi and 18 percent of respondents from Kantiyajal are depending on mangroves for earning their income.

- The occupational structure of the household members seems to be very interesting, as almost 34 percent of the households depend on mangroves for income and occupation as compared to other occupations, such as agriculture labour (22.6%), agriculture (14%), animal husbandry (11%), fisheries (10%), etc. Among the villages, the household dependence on mangroves is found very high in Dandi (55%), followed by Kantiyajal and Karanj (35% each), Tada Talav (34%), Nada (28%), Lakki (27.6%), and Ashirawandh (25%). The gender wise dependence on mangrove plantation shows that compared to men, women are more dependent on mangroves. This is mainly due to their skill in seed collection, seed selection and other relevant operations, such as preparation of seed bed in the nursery, etc.
- An assessment based on the respondents' knowledge about the benefits of mangroves reveals that a significant proportion of the respondents are well aware of the beneficial outcomes of mangroves. For instance, 33 percent of the respondents feel that mangrove plantations prevent soil erosion and keeps soil particles intact. About 18 percent of the respondents reported that mangroves are helpful in preventing cyclones and thereby reducing the effect of heavy winds and the tidal waves. Almost 60 % of the respondents from Kantiyajal and Karanj villages have appreciated the soil protective role of mangroves. Some of the other important benefits about which the respondents have awareness are: a) green forest and tourist attraction benefits; b) increase in fish stock; and c) increase in rains.
- One of the important economic benefits of the mangroves in the study villages is in terms of generation of employment to the communities as plantation development requires lots of labour inputs right from the sowing at the nursery to planting, vacancy filling, etc. As the survey was pertaining to the year 2009, based on recall method, we have first tried to gather the information for the latest years, ie., 2008 and 2009 about the employment benefits received by the communities. Accordingly, it has been found that about 65-81 percent of the respondents have reported that they and their household members have received employment in mangrove plantations during the last 6-7 years ever since mangrove plantations have been established in their villages. They also have reported that they use to go to the next village to work in mangroves if work was not available in their own villages. The employment intensity of mangrove plantations is quite high as the plantation work is to be completed during the specific time period when the tides are low or non-existent. The work participation has been found to be relatively higher among females, as women employment generated was about 54 percent of the total employment generated by the mangrove plantations.

- The activities involved in development of new plantations and upkeep of the existing mangrove plantations offered immense employment benefits to the communities in the study villages. On an average, the cumulative number of days of employment generated in all the mangrove villages in a given year seemed to be more than 20,000 mandays. The employment opportunities generated have resulted in a direct income transfer to the households in terms of wages. On an average, the annual wage income received by a household has been in the range of Rs. 7800-9000.
- It may be noted that prior to the development of mangroves, the village communities have been mainly engaged in farming, fishing, livestock and agriculture labour related activities. It is needless to say that the introduction of mangroves has provided immense opportunities to the communities to enhance their livelihoods by engaging themselves into various activities promoted by the plantation programmes.
- The community dependence on mangroves is very high in that the level of extraction of mangroves for leaves/fodder and fuel seems to be as high as 46 percent among the communities. While 65 percent of the respondents reported extraction of leaves for fodder, 23 percent use small twigs/ timber from mangroves as fuel wood and another 5 percent collect the seeds from mangroves. The household extraction of mangroves has been notably high in three villages, viz., Ashirawandh (94 %), Lakki (88 %), and Tadatalav (72 %). Interestingly, mangrove extraction work is done mostly by women members as reported by 62 percent of the respondents. However, it is important to note that the communities are careful while cutting the mangroves as an overwhelming majority follow a selective extraction method rather than complete extraction (or destruction) of the plant.
- The study uses the widely accepted total economic valuation (TEV) method for valuation of the tangible and non-tangible benefits of mangroves in the study villages. However, the total tangible and non-tangible values thus estimated in the context of the study villages are limited by the fact that more than 80 percent of the mangrove plantations have been planted after 2005-06 and hence, the plantations are yet to achieve sufficient growth to yield their full potential. In view of this, the valuation as done in the study report may only be reckoned as broad indicators.
- Fishermen are one of the important benefactors of mangroves in the study villages. The study shows that even though only 30 percent of the fishing communities are also dependent on mangroves at the aggregate level, the villages, such as Karanj, Nada, Dandi and Lakki have higher share of fishermen communities (67%, 41%, 40% and 29%, respectively). This gives us a chance to empirically validate the claim that mangroves help the fishermen communities with an increase in fish catch in the mangrove grown areas. It has been reported by many scholars that mangrove ecosystems act as a

habitat for various marine creatures, especially fish. A significant increase in the fish catch as well as types of species is being noticed in mangrove grown areas.

- Regarding the diversity of fish species, the respondents identified 16 fish species in the mangrove areas. In order to examine whether mangroves has resulted in an increase in fish catch, we have gathered information about the quantity of fish catch realised by the farmers before and after mangroves. Though this information has certain limitations as they are based on recall method, the study reveals significant increase in the quantity of fish catch as reported by the communities after mangrove plantations. There was an increase of about 21 percent in the total fish catch in all the villages. The highest increase in fish catch was observed in Dandi (144%), followed by Kantiyajal (138%), Tadatalav (110%) and Ashirawandh (54%). Since mangrove plantations are relatively new in Karanj village, the increase in fish catch was rather small as compared to other villages.
- The study shows that about 25 percent of the households have their farm lands adjacent to the mangroves. In order to examine whether mangroves have benefited the farmer communities in terms of protecting their farm lands from salinity ingression or crop damage due to winds carrying dusts, the study has incorporated some relevant questions in this regard. A decrease in crop damage was observed by many farmer respondents as a result of mangrove plantation. This has resulted in a substantial gain in agricultural income. Similarly, about 72 percent of the farmer respondents reported salinity ingression as a major problem adversely affecting their farmlands which are closer to the coastal areas. The extent of salinity ingression varied from village to village. However, it has been widely reported by the farmer respondents that salinity ingression has considerably reduced after mangrove plantations. In most villages, where the salinity ingression was very high and moderate before mangrove plantations, there was remarkable decline in the level of salinity ingression after the plantations have started growing. This is a notable positive outcome of mangrove plantations in the study villages. However, though the impact has been positive and visible, we could not gather authentic farm level crop information to substantiate this point further. This needs to be further explored in terms of gathering more farm level information about the crop loss averted by planting mangroves as well as the resultant gain in farm income across the study villages.
- Use of mangroves for fodder is considered as of high economic value to the communities engaged in animal husbandry/ livestock rearing. Like many other coastal villages, the communities in the study villages also show a large dependence on animal husbandry/ livestock related activities. It is found that more than 38 percent of the households own livestock of one or the other kinds. Among the villages, households in Ashirawandh

reported the highest percentage of livestock ownership (94%), followed by Lakki (82%) and Tadatalav (72%) while other three villages have lower less number of households owning livestock. Almost 92 percent of the households growing livestock reported that they increasingly depend on mangroves for extracting leaves for fodder for the cattle especially during extreme drought months. This also enabled them to make significant savings in their expenditures towards buying fodder from the open market. About 37 percent of the households reported that they were able to save a sum of Rs. 2000-5000 per annum from being spent on purchase of fodder from the market. Another 29 percent reported savings of above Rs. 8000 per annum on fodder for the livestock due to the easy availability of mangroves in their neighbourhoods. Maximum gain in savings of above Rs. 8000 has been reported by about 57 percent of the households in Ashirawandh village, followed by 36 percent in Lakki village. At the aggregate level, mangroves helped to reduce the purchase of fodder from the open market by 24 percent. The highest reduction in fodder purchase was reported by households in Lakki village (41%), followed by Ashirawandh (32%), Tadatalav (17%), and Nada (13%).

- As a result of the increased consumption of fodder from the mangrove plantations, the communities also reflected that there was a notable increase in the quantity of milk production per cattle population which also rendered them income gains from increased sale of milk after domestic consumption. For instance, at the aggregate level, the average gain income from sale of milk increased from Rs. 623 to Rs. 1068 per household. Among the villages, the highest gain income from milk was reported from Ashirawandh (Rs. 4586 to Rs. 5369), followed by Lakki (Rs. 3394 before mangroves to Rs. 5002 after mangroves), Kantiyajal (Rs. 994 to Rs. 1299), Nada village (from Rs. 971 to 1471), and Tadatalav (Rs. 1045 to Rs. 1189).
- Inter as well as intra-village migration has been reported as an important characteristic of the study villages as in any other parts of the country in particular. The study reveals that before establishment of mangrove plantations, almost 19 percent of the households used to migrate (with notable differences between villages, Nada village reported 34% and Tadatalav reported 33% labour migration) to other distant villages, including urban areas for work for few months (as revealed by 39%), or for a year (37%) or few days in a year (23%). Reportedly, labour migration involved outward movement of either more than two family members (33%) or two members (30%) or at least one member of the household (28%) in search of employment. Incidentally, the development of mangrove plantations has had significant impact on reducing the incidence of labour migration in the study villages. On the one hand, the work opportunities in mangrove plantations have induced the migrant workers to stay back

in the villages and work in the mangrove plantations. On the other hand, it has been reported that in some of the villages mangrove work has already been integrated with the National Rural Employment Guarantee Act (NREGA) programme which started providing employment to the village households in terms of guaranteed work in the mangrove plantations.

- The study also undertook a detailed biological assessment to examine the vegetative growth and biodiversity dimensions of mangrove plantations in the study villages. In order to do that it assessed the species diversity, i.e., the presence and abundance of species; vegetation cover and structure, and the ecological process by indirectly measuring the nutrient availability and biotic interactions. The average height of the mangrove plantations aged 6-8 years ranged between 1.7 meters to 3.3 meters with a maximum height of 6 meters in Kantiyajal village. The height of the plants appeared to be less varying across sample plots studied as evident from the lower values of coefficient of variation. The mean GBH at all the sites ranged from 15.31 to 40.28 cm. The average number of branches ranged from 4 to 6 per plant. An analysis of soil (mud) samples was carried out in order to determine the differences if any, in the soil characteristics between mangrove soils and non-mangrove soils. Different sites exhibited strong gradient in topography, ground biomass, canopy height and species distribution. The chemical properties such as pH, Organic Carbon, Total Nitrogen, Available Phosphorus, and Potassium of mangrove forests were significantly different across different sites. If we compare the soil values with the status of plants growth of each site, it was found that Ashirawandh, Lakki and Kantiyajal villages have achieved good growth of the planted Avicennia species high nutrient values of soil.
- The biological assessment also brought about the diversity of the study villages in terms of presence of invertebrates, mobile fauna and other species. Among the villages, Lakki, Ashirawandh and Kantiyajal have reported the highest species richness supported by the mangrove ecosystem. The mangrove areas have been found to be quite rich in terms of other species, such as mudskippers, crabs, bivalve, gastropods, fish, and habitat for other species. As mangroves areas have achieved good growth over the past few years, they also found to be providing habitat for birds and marine reptiles, like snakes.
- The study provides a holistic view of the mangrove restoration efforts being initiated in Gujarat since the past 6-7 years under the joint initiatives of the state (through the Gujarat Ecology Commission) and the community based organisations (CBOs). Though this study is limited in coverage (7 villages of the total 22 mangrove restoration villages in Gujarat), it brings out several dimensions of the beneficial outcomes of mangrove restoration activities in place. It needs to be mentioned that the total economic

valuation of the benefits derived from mangroves as attempted in the study is only indicative of the potential social and environmental benefits that could be realised in the future when mangrove plantations achieve the maximum growth.

- The study also dwells upon the importance of evolving long-term policies and institutional intermediations required for carrying forward the development of new mangrove plantations as well as conservation/restoration of the existing plantations. In this connection, it is important to highlight that the local communities and the CBOs need to be more strengthened in terms of increased awareness, skill development, capacity building, etc so as to enable them to conserve/restore the mangrove ecosystems for the future. Though a majority of the communities (91%) do feel that growing mangroves is important for protecting the coastal systems and livelihoods from the adverse effects of cyclones, soil erosion, etc, they still lack the motivation and incentives to conserve the resources on a sustainable basis. This is an important challenge, which needs to be addressed through policies and interventions for creating motivations for conservation and restoration.
- Majority of the local communities reflect that a joint effort between the state and the local communities would be a better model for conserving mangrove systems. Hence, it is necessary that the local communities should be empowered to act as the chief custodians of mangrove conservation/ restoration efforts with more chances for creative interactions between the state, local development agencies and the local political and administrative bodies. The local bodies (Village Panchayats) in the mangrove restoration areas should be encouraged to evolve long term agenda with allocation of adequate financial resources for conserving/ protecting the mangrove ecosystems from being degraded/ damaged by any local development or human induced interventions. In this regard, it needs a special mention that a major segment of the local communities in Nada and Kantiyajal villages in particular, are apprehensive of the development projects, such as the Kalpasar and setting up of industries, which may hamper the future course of development and restoration of mangrove ecosystems.
- The fact that growth of mangrove plantations is adversely affected by industrial pollution as well as garbage deposited into the coastal waters has been identified as a serious environmental issue by the communities in Ashirawandh and Karanj villages which need proper addressing. Besides, oil spill from boats and dumping of plastics were also reported. The discharge of saline water from salt pans is also reported adversely affecting the growth of mangroves. Similarly, the closeness of a cement factory near the mangroves area is also reported as creating environmental problems for mangrove trees. The lack of inflow of freshwater (river water) due to construction of a dam is also reported affecting the growth of mangroves.

- Lack of access to infrastructure facilities in the villages has been indicated as a major problem by the communities. It is important to note that the mangrove restoration efforts will have more sustainable impacts if the communities are provided with the public utility services and infrastructure facilities that will keep them connected through increased group interactions and creation of a social space for mangrove development and restoration activities in the village development plans. This calls more efforts from the various stakeholders engaged in promotion of mangroves for launching joint actions plans for providing public utilities, especially, provision of potable water and sanitation facilities on a permanent basis. The shortage of potable water has been indicated as a major problem by few of the communities. Majority of the households depend on unprotected well water, rainwater, lake, pond and lagoon. Only about 5 percent of the households use protected wells. So is the case with sanitation facilities. In the absence of sanitation facilities, defecation occurs in the open, which leads to contamination of drinking water sources with fecal matter.
- The provision of boats for fishing is yet another important need indicated by the fishing communities. The study reveals that only 9 of the 98 fisher communities own boats for fishing (6 boats in Ashirawandh, 2 in Lakki and 1 in Nada village). In the absence of boats or inability to hire costly boats, almost 89 percent of the fishing communities walk on deep waters for catching fish. This situation needs to be addressed through arrangement for provision of fishing boats to the communities who can own and operate fishing boats on a collective basis.
- It has been observed that vast majority of the households have started using mangroves as the major source for firewood, even replacing the use of conventional woods available in the local areas. Earlier, the use of local woods was also use to be supplemented with either neem or charcoal. There are also many instances in which respondents have stopped using kerosene for cooking with the abundant availability of mangroves. These trends suggest the increasing pressure on mangroves for use of firewood other than fodder for livestock. This may invariably affect the existing stock and future growth of mangrove plantations as households prefer mangrove to other sources of fuel for cooking due to its easy availability and access. This eventuality calls for proper mechanisms and solutions through awareness creation to arrest the excessive extraction of mangroves. As imposition of policies or regulations alone will not work in such contexts, this problem needs to be addressed through promotion of planting of suitable species of wood for cooking in the villages.
- Finally, sustainable development and restoration of mangroves essentially calls for more efforts for creating opportunities for collective action among the multiple stakeholders, like line state departments under various government portfolios, the

local communities, private firms and industries who are increasingly investing in mangrove plantations, NGOs, local administration units, like the village Panchayats. This requires more frequent interactions among these stakeholders towards identifying more innovations and action plans for sustainable development and restoration of mangrove plantations in the villages. Needless to say that all these innovations and action plans should be targeted towards strengthening the capabilities of the local communities and sustaining their livelihoods without compromising on the broader goals of sustainable management of mangrove ecosystems.

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ANNEXURE

ગુજરાત ઇન્સ્ટીટ્યુટ ઓફ ડેવલપમેન્ટ રિસર્ચ, ગોતા, અમદાવાદ

મેન્ગ્રુવના વાવેતરથી સામાજીક, આર્થિક અને પર્યાવરણમાં થતા ફાયદાઓ :
સામુદાયિક જૂથ દ્વારા ગુજરાતમાં થયેલ મેન્ગ્રુવ વાવેતરની કામગીરીનો અભ્યાસ

1.1 મેન્ગ્રુવ વાવણીનું ગામ	
1.2 શરૂઆતની વાવણીનું વર્ષ	

I. કુટુંબની વિગત

1.3 તાલુકાનું નામ: _____ 1.4 જિલ્લાનું નામ:_____

ઉત્તરદાતાનું નામ: _____

1.5 જાતિ: _____ (પુ- 1, સ્ત્રી- 2) 1.6 ઉંમર: _____

1.7 અભ્યાસ: _____ 1.8 મુખ્ય વ્યવસાય: _____

1.9 જ્ઞાતિ: _____ 1.10 ધર્મ: _____ ફોન નં._____

1.11 તમારી પાસે ખેતીલાયક જમીન છે? હા 1 ના 2

(જમીનનું એકમ : વિઘા / એકર / ગૂંઠા)

નં.	જમીન	પિયત	બિનપિયત	કુલ જમીન
1.12	પોતાની જમીન			
1.13	ભાગે લીધેલ જમીન			
1.14	ભાગે આપેલ જમીન			
1.15	મીઠાનું અગર			
1.16	અન્ય (જણાવો)_____			

કુટુંબના સભ્યોની વિગત અને આર્થિક પ્રવૃતિ

કુટુંબના સભ્યની સંખ્યા: પુરુષ: _____ સ્ત્રી: _____ બાળક: _____

નં.	*આર્થિક પ્રવૃત્તિ*	*રોજગારી મેળવતા કુટુંબના સભ્યોની સંખ્યા*	
		પુરુષ	સ્ત્રી
1.17	ખેતી		
1.18	ખેતમજૂરી		
1.19	ખેતી સિવાયની મજૂરી (સ્પષ્ટ કરો) _____		
	_____		
	_____		
1.20	માછીમારીની *પ્રવૃત્તિ-પાર્ટ ટાઇમ*		
	ફુલ ટાઇમ		
1.21	પશુપાલન		
1.22	અન્ય (જણાવો)_____		

II. મેન્ગ્રુવ વિકાસ અને ઘરનો આર્થિક આધાર

2.1 તમે મેન્ગ્રુવ જોયા છે? હા 1 ના 2 ખબર નથી 3

2.2 જો હા, તો તેના વિશે તમે શું જાણો છો? _____

2.3 તમે સૌથી પહેલા મેન્ગ્રુવ છોડ/ઝાડ કયાં જોયા હતા?

ગામમાં	1 → 2.6 પૂછો
ગામ બહાર	2
બીજા રાજયમાં	3
અન્ય	4

2.4 તમે સૌથી પહેલા મેન્ગ્રુવ છોડ/ઝાડ કયારે જોયા હતા? _____

2.5 તમને યાદ છે કે તમારા ગામમાં મેન્ગ્રુવના ઝાડ હતા? હા 1 ના 2 ખબર નથી 3

2.6 જો હા, તો કેટલા વર્ષ પહેલા? _____

2.7 જયારે જીઇસીએ તમારા ગામમાં મેન્ગ્રુવનું વાવેતર શરૂ કર્યું ત્યારે શું પહેલીથી જ મેન્ગ્રુવ તે વિસ્તારમાં સારા એવા પ્રમાણમાં અસ્તિત્વ ધરાવતા હતા? હા 1 ના 2 ખબર નથી 3

2.8 જો ના, તો શું થયું હતું? _____

2.9 તમે અથવા તમારા કુટુંબના કોઇ સભ્યો છેલ્લા વર્ષમાં (2008) મેન્ગ્રુવ વાવવાના કામમાં રોકાયેલા હતા?

હા 1 ના 2 → 2.14 પૂછો

2.10 જો હા, તો તમે કોન્ટ્રાકથી કે દૈનિક વેતનથી કામ કર્યુ હતુ?

કોન્ટ્રાકથી	1
દૈનિક વેતનથી	2
બન્નેથી	3

નં	વિગતો	પુરુષ	સ્ત્રી
2.11	રોજગારી મેળવેલ સભ્યો		
2.12	મેળવેલ કામના દિવસો		
2.13	મેળવેલ દૈનિક વેતન અથવા કોન્ટ્રાકથી		

2.14 પહેલેથી જ તમને મેન્ગ્રુવ વાવણીનું નિયમિત કામ મળ્યું હતું? હા 1 ના 2

2.15 જો હા, તો વિગતો આપો (ઓછામાં ઓછી છેલ્લા 3-4 વર્ષની)

વર્ષ	કુટુંબના કેટલા સભ્યોને તેમાં કામ મળ્યુ? કામના દિવસો		દૈનિક વેતન અથવા કોન્ટ્રાક્ટ
	પોતે	કુટુંબના સભ્યો	
2007			
2006			
2005			

2004			
2003			
2002			

2.16 તમે આ વર્ષે (2009) મેન્ગ્રુવમાં કામ કર્યુ હતુ?
હા 1 ના 2 → 2.19 પૂછો

2.17 જો હા તો કેટલા દિવસ કામ મળ્યુ? _____

2.18 મજૂરીનો દર શું હતો?_____

2.19 જો કામ ના મળ્યુ હોય તો કેમ? _____

2.20 તમે મેન્ગ્રુવના વિસ્તારમાં કોઇ પણ પ્રકારના કામ માટે કેટલા દિવસના અંતરે જાઓ છો?
_____
_____

2.21 મેન્ગ્રુવ વિસ્તારમાં ચાલતા જઇ શકાય તેમ ના હોય તો ત્યાં તમે કેવી રીતે જાઓ છો?
_____

III. ગામની મેન્ગ્રુવની વાવણીની સ્થિતિ: (મૂળભૂત વિગતો)

3.1 મેન્ગ્રુવની વાવણી કોના દ્વારા થઇ? (*)	3.2 ગામથી મેન્ગ્રુવ વાવેતર વિસ્તાર સુધીનું કેટલું અંતર છે? (કિ.મી અને ચાલતા બન્ને લખો)	3.3 વાવણી હેઠળનો કુલ વિસ્તાર(હેકટર/ વિઘા/એકર/ કિ.મી)	3.4 મેન્ગ્રુવનો કુદરતી વિકાસ(#)	3.5 વાવેલ મેન્ગ્રુવની જાત	3.6 વાવણીની હાલની સ્થિતિ (@)

(*) જીઇસી/સ્થાનિક સંસ્થાઓ/જંગલખાતુ (#) ઘટ્ટતા, ગીચતા/છુટુ છવાયુ.
(@) સૌથી શ્રેષ્ઠ- 1, સારુ- 2, બહુ ખરાબ નહિ -3, ઘણુ ખરાબ- 4, ખબર નથી -5

IV. સી. બી. ઓમાં ભાગીદારી: (સામુદાયિક સંસ્થામાં ભાગીદારી):

4.1 તમે સી. બી. ઓ (મંડળી) ના સભ્યો છો? હા 1 ના 2

4.2 જો હા તો કઇ સી. બી. ઓ (મંડળી) ના સભ્ય છો? _____

4.3 આ સી. બી. ઓ. (મંડળી)ની સ્થાપના કયારે થઇ હતી?_____

4.4 તમે સી. બી. ઓ. (મંડળી) ની કમીટીના સભ્ય છો? હા 1 ના 2

4.5 જો હા, તો કયા હોદા પર છો? _____

4.6 કેટલા સમયથી છો? _____

4.7 તમે ગુજરાતમાં અથવા બીજા રાજયમાં મેન્ગ્રુવ વાવેતર વિસ્તારની મુલાકાત લીધી છે?
હા 1 ના 2

4.8 જો હા, તો ગુજરાતમાં કઇ જગ્યાએ? _____

4.9 જો હા, તો બીજા કયા રાજયમાં? _____

V. મેન્ગ્રુવની કાપણીના સ્તરો

5.1 તમે મેન્ગ્રુવની કાપણી કરો છો? હા 1 ના 2

5.2 જો હા, તો કાપણી કોણ કરે છે? પુરુષ 1 સ્ત્રી 2 બન્ને 3

5.3 કાપવાનો મુખ્ય હેતુ શું છે?

વેચાણ માટે	1
ઘાસચારા માટે	2
બળતણ	3
બધાજ માટે	4
છોડ/ઝાડ સારા વિકાસ માટે	5
અન્ય _____	6

5.4 તમે કાપણી માટે કઇ પધ્ધતિ અપનાવી છે?

પસંદ કરાયેલ (ડાળી)	1
મૂળમાંથી કાપવું	2
બન્ને રીતે	3

5.5 તમે મુખ્યત્વે તેમાથી કયા પ્રકારની પેદાશનો ઉતારો કરો છો?

બળતણનું લાકડું	1
લાકડી	2
બીજ	3
પાંદડા	4
અન્ય _____	5

તમે છેલ્લા વર્ષમાં મેન્ગ્રુવમાં કરેલી કામગીરીની વિગત આપો?

ક્રમ	5.6	5.7	5.8	5.9 ફાળવેલ દિવસો	
નં.	ઋતુ	પ્રવૃત્તિ	કોણ ભાગ લે?	મજૂરી માટે	પોતાના ઉપયોગની વસ્તુ મેળવવા માટે
1	શિયાળો				
2	ઉનાળો				
3	ચોમાસુ				

VI. માછીમાર સમુદાય માટે મેન્ગ્રુવની વાવણીના ફાયદાઓ.

નં.	સ્થિતિ	મેન્ગ્રુવની વાવણી પહેલા (_____)	મેન્ગ્રુવની વાવણી પછી (2009)
6.1	આ વ્યવસાય સાથે સંકળાયેલ કુટુંબના સભ્યોની સંખ્યા		
6.2	કિનારાથી માછલી પકડવા માટેનું અંદાજીત અંતર		
6.3	મુખ્યત્વે માછલીની કઇ જાતો મળે છે		
6.4	મુસાફરી (ખેપ)/મહિના અથવા વર્ષ		
6.5	વર્ષ/મુસાફરી (ખેપ)/પકડાયેલ માછલીનો જથ્થો (કિ.ગ્રા.)		
6.6	બજારમાં વેચેલ માછલીનો જથ્થો (કિ.ગ્રા.)		
6.7	બજારમાં વેચલ માછલીમાંથી થતી વાર્ષિક આવક (રૂ.)		

6.8 તમારી પાસે તમારી પોતાની માલિકીની બોટ છે? હા 1 ના 2

6.9 જો ના, તો તમે માછલી પકડવા કેવી રીતે જાઓ છો?

ભાડાની બોટ લઇને 1
જેની પાસે બોટ છે તેની સાથે 2
ઉંડા પાણીમાં ચાલીને 3
અન્ય_____ 4

6.10 જો તમે ભાડાની બોટમાં જાઓ છો, તો તેનો કેટલો દર કલાક/દિવસ પ્રમાણે હોય છે?

_____
_____

6.11 મેન્ગ્રુવનું લાકડુ કુદરતી રીતે તણાઇને આવે તો તેનો બળતણ તરીકે ઉપયોગ કરો છો?
હા 1 ના 2

VII. ખેડૂત સમુદાય માટે મેન્ગ્રુવની વાવણીના ફાયદાઓ

7.1 તમારી પાસે મેન્ગ્રુવ વિસ્તારની ઘણી નજીકમાં ખેતીલાયક જમીન છે? હા 1 ના 2

7.2 જો હા, તો કેટલી જમીન છે? _____

7.3 જો હા, તો કયા પાક ઉગાડો છો?_____

7.4 જો ના, તો મેન્ગ્રુવ વાવણી થયા પછી ખેતીમાં કયા ફાયદા થયા?

નં.	સ્થિતિ	મેન્ગ્રુવની વાવણી પહેલા. (_____)	મેગ્રુવની વાવણી પછી.(2009) વધી છે -1, ઘટી છે 2 કંઇ ફરક નથી-3 ખબર નથી4
7.5	ખારાશનું પ્રમાણ વધુ-1, મધ્યમ-2, ઓછું-3,કંઇ નહિ-4		
7.6	પવન ફુંકાવાના કારણે ખેતીલાયક જમીનમાં નુકશાન વધુ-1, મધ્યમ-2, ઓછું-3,કંઇ નહિ-4		
7.7	મેન્ગ્રુવ વિસ્તારની નજીકમાં કુલ ખેતી લાયક વિસ્તાર (હેકટર/એકર/વિઘા)		
7.8	પાકનું ઉત્પાદન વધું-1, મધ્યમ-2, ઓછુ-3, કંઇનહિ-4		
7.9	માટી/રેતીનું ધોવાણ વધું-1, મધ્યમ-2, ઓછુ-3, કંઇનહિ-4		
7.10	ખેતીની આવક વધી-1, મધ્યમ-2 ઓછી-3 કંઇનહિ-4		
7.11	વરસાદના દિવસો (કુલ દિવસ)		

VIII. મેન્ગ્રુવ વાવણી ના પશુપાલનમાં થતા ફાયદા.

8.1. તમે પશુપાલન કરો છો? હા 1 ના 2

8.2 જો હા, તો કયા પશુઓ છે.

ક્રમ.	પશુ	પશુઓની સંખ્યા		
નં.		મેન્ગ્રુવ વાવણી પહેલા (_____)	મેન્ગ્રુવ વાવણી પછી (2009)	આ ફરક હોવાનું કારણ
1	ગાય			
2	ભેંસ			
3	બળદ			
4	બકરી			
5	ઉંટ			
6	મરઘી			
7	અન્ય _____			
8	અન્ય _____			

8.3. તમે એવુ અનુભવો છો કે મેન્ગ્રુવની વાવણી પશુપાલન પ્રવૃત્તિ માટે ફાયદાકારક છે?
હા 1 ના 2

8.4 તમે પશુઓને ખવડાવવા માટે બીજા ઘાસચારાની જગ્યાએ મેન્ગ્રુવનો ઉપયોગ કરો છો?
હા 1 ના 2

8.5 જો હા તો, સામાન્ય રીતે તમે વર્ષ દરમ્યાન કેટલા પાંદડાઓ ભેગા કરો છો_____
(વર્ષ દરમ્યાન ભેગા કરેલ પાંદડાઓના જથ્થાની વિગત લેવી)

_____

_____

8.6 મેન્ગ્રુવનાં પાંદડાનો ઘાસચારા તરીકે ઉપયોગ કરવાના કારણે, બજારમાંથી ઘાસચારો ખરીદવાના ખર્ચમાં તમે કેટલી બચત કરી શકયા હતા? _____
_____

તમે બીજા કયા ફાયદાઓ (પ્રત્યક્ષ/પરોક્ષ) મેળવો છો?

ક્રમ. નં.	ફાયદાઓ (પ્રત્યક્ષ/પરોક્ષ)	મેન્ગ્રુવ વાવણી પહેલા (_____)	મેન્ગ્રુવ વાવણી પછી (2009)
8.7	દૂધાળા ઢોરની સંખ્યા		
8.8	અંદાજીત ઢોરોની કિંમત		
8.9	ઘાસચારાનો જથ્થો (કિ.ગ્રા)		
8.10	ઘાસચારાનો ખર્ચ (રૂપિયામાં)		
8.11	દૂધનું ઉત્પાદન (લિટરમાં)		
8.12	બજારમાં દૂધનું વેચાણ (લિટરમાં)		
8.13	વાર્ષિક આવક (રૂપિયામાં)		

IX. મેન્ગ્રુવ અને સ્થળાંતર પર અસર:

9.1 તમે અથવા તમારા કુટુંબના કોઈપણ સભ્યોમાંથી થોડા વર્ષ પહેલા રોજગારીના હેતુથી આ ગામમાંથી બીજે સ્થળાંતર કરીને જતા હતા? હા 1 ના 2

9.2 જો હા, તો વર્ષમાં કેટલા દિવસો/મહિના? _____

9.3 કેટલા સભ્યો સ્થળાંતર કરે?_____

9.4 તમને એવુ લાગે છે કે હમણાના થોડો વર્ષોમાં સ્થળાંતર ઓછુ થવામાં મેન્ગ્રુવની વાવણી મદદરૂપ બની હોય?_____

9.5 સ્થળાંતર ઓછુ થવાનું કારણ:

ગામમાં રોજગારીની તકો વધવાથી	1
ગામમાં પાણીની અછત દૂર થવાથી	2
NREGA* દ્વારા મેન્ગ્રુવની વાવણીનું કામ થવાથી	3
NREGA*દ્વારા અન્ય _____ કામ થવાથી	4
ઉપરના બધા કામની તકો થવાથી	5
અન્ય_____	6

***NREGA= [(નેશનલ રૂરલ એમ્પ્લોયમેન્ટ ગેરંટી એકટ) રાષ્ટ્રીય ગ્રામીણ રોજગાર બાંહેધરી અધિનિયમ.]**

X. ભાગે લીધેલ / ભાગે આપેલ ખેતીમાં મેન્ગ્રુવની અસર

10.1 તમને એવુ લાગે છે કે મેન્ગ્રુવની વાવણી થવાથી ગામમાં ખેતીલાયક જમીન ભાગે લેવામાં/ભાગે આપવામા વધારો થયો છે? હા 1 ના 2

10.2. જો હા, તો તમે જમીન ભાગે લીધી છે ? હા 1 ના 2

10.2.1. જો હા, તો તમે જમીન ભાગે આપેલ છે? હા 1 ના 2

વિગત	ભાગે લીધેલ જમીન	ભાગે આપેલ જમીન
10.3 કેટલી જમીન (વિઘા/એકર)		
10.4 કઈ શરત પર? પાકનો ભાગ ટકામાં (%) રૂપિયા (વિઘા/એકર)		
અન્ય _____		

XI. મેન્ગ્રુવના છોડ અથવા વૃક્ષનો ઉપયોગ

11.1 મેન્ગ્રુવના છોડ/વૃક્ષનો ઘાસચારો અને બળતણ સિવાય અન્ય કંઈ ઉપયોગ કરો છો?
હા 1 ના 2

11.2 જો હા, તો તેના બીજા કયાં ઉપયોગ છે? _____
_____
_____

XII. મનોરંજનની કિંમત.

12.1 તમને મેન્ગ્રુવ વિસ્તાર જોવામાં/ત્યાં કામ કરવામાં આનંદ આવે છે?
હા 1 ના 2 ખબર નથી 3

12.2 જો હા, તો કયા પ્રકારનો આનંદ આવે છે?
1. _____
2. _____
3. _____

12.3 આનંદ મેળવવાના હેતુથી તમે મેન્ગ્રુવ વિસ્તારની મુલાકાત લો છો?
હા 1 ના 2

12.4 જો હા, તો કયારે?
અઠવાડિક 1
મહિને 2
જયારે ઈચ્છે ત્યારે 3
અન્ય _____ 4

12.5 તમે તમારા કુટુંબના સભ્યો સાથે મેન્ગ્રુવ વિસ્તારમાં જાઓ છો?
હા 1 ના 2

12.6 જો હા, તો કુટુંબના સભ્યોમાંથી કોણ સાથે આવે? _____

12.7 તે મુલાકાત દ્વારા તમને શું ફાયદા થાય છે?

ઢોર ચરાવવા	1
માછીમારી	2
વિસ્તારની સુંદરતાનો આનંદ માણવા	3
ઉપરના બધા	4
અન્ય _____	5

12.8 તમે મુલાકાત લો છો ત્યાં કેટલો સમય પસાર કરો છો? _____

12.9 તમે જાણો છો કે આ સ્થળની મુલાકાતે કોઈપણ પ્રવાસી આવે છે?

હા 1 ના 2 ખબર નથી 3

12.10 જો હા, તો તેઓ કોણ છે?

સંશોધક વ્યક્તિ	1
સરકારી અધિકારીઓ	2
સ્થાનિક પ્રવાસીઓ	3
ઉપરના બધા	4
ખબર નથી	5
અન્ય _____	6

XIII. જાગૃકતા અને મેન્ગ્રુવના રક્ષણ માટે ભવિષ્યનો ખ્યાલ:

13.1 મેન્ગ્રુવ ઝાડોનો ઉછેર અગત્યનો છે? હા 1 ના 2 ખબર નથી 3

13.2 જો હા, તો કેમ? _____

13.3 જો ના, તો કેમ?_____

13.4 તમે કયારેય દરિયાઇ વાવાઝોડાની મુશ્કેલી અનુભવી છે?

હા 1 ના 2 ખબર નથી 3

13.5 આ અસર ઓછી કરવા મેન્ગ્રુવ મદદરૂપ છે?

હા 1 ના 2 ખબર નથી 3

13.6 તમને એવુ લાગે છે કે મેન્ગ્રુવની આજુબાજુના વિસ્તારમાં રહેતા લોકોને મેન્ગ્રુવના વૃક્ષના ઘટાડાને કારણે કોઇ અસર થાય છે?

હા 1 ના 2 ખબર નથી 3

13.7 જો હા, તો કેમ?_____

13.8 જો ના, તો કેમ? _____

13.9 હમણાનાં વર્ષોમાં મેન્ગ્રુવના પ્રમાણમાં વધારો અથવા ઘટાડો થયો છે?

હા 1 ના 2 ખબર નથી 3

13.10 જો હા, તો વધારો અથવા ઘટાડો થવાના કારણો નોંધો.

મેન્ગ્રુવ ઘટવાના કારણો	મેન્ગ્રુવ વધવાના કારણો
1	1
2	2
3	3
4	4
5	5

13.11 તમને એવુ લાગે છે કે આ પરિસ્થિતિ (વધારો/ઘટાડો) માં સુધારો કરી શકાય તેમ છે?
હા 1 ના 2 ખબર નથી 3

13.12 જો હા, તો તે સુધારો કેવી રીતે થઇ શકે? (તેના સૂચનો આપો)
1._____
2._____
3._____
4._____

13.13 મેન્ગ્રુવની અસરકારક જાળવણી કોણ કરી શકે?
સરકાર 1
સ્વૈરિછક સંસ્થાઓ 2
સ્થાનિક સમુદાય 3
બધાનો સહિયારો પ્રયાસ 4
અન્ય _____ 5

13.14 તમારા ગામમાં એવી કઇ પ્રવૃત્તિ કરવામાં આવે કે જેથી મેન્ગ્રુવની ભવિષ્યમાં જાળવણી થઇ શકે?
1. _____
2. _____
3. _____

13.15 તમારા ગામમાં સ્થાનિક સમુદાયો દ્વારા કોઇપણ રક્ષણાત્મક કામગીરી થઇ છે?
હા 1 ના 2 ખબર નથી 3

13.16 જો હા, તો તે કઇ છે?
1._____
2._____
3._____

13.17 કઇ એજન્સીઓએ તેનો અમલ કર્યો?
1. _____
2. _____
3._____

13.18 તમે તેમા ભાગ લો છો? હા 1 ના 2

13.19 જો હા, તો કઇ પ્રવૃત્તિમાં ભાગ લો છો?
બધી જ પ્રવૃત્તિઓમાં 1
પસંદગીની પ્રવૃત્તિઓમાં 2

13.20 GEC સિવાય એવી કોઇ બીજી સંસ્થાઓ છે જેમનો દ્વારા તમારા ગામમાં મેન્ગ્રુવની વાવણી/ફેરરોપણી કરવામાં આવી હોય?

હા 1 ના 2 ખબર નથી 3

13.21 જો હા, તો કઇ સંસ્થાઓ?_____

13.22 શું તમને એવું લાગે છે કે GEC દ્વારા કરવામાં આવતી મેન્ગ્રુવ વાવણીની પ્રવૃત્તિઓમાં અન્ય કોઇ કારણસર અવરોધ આવ્યો હોય?

હા 1 ના 2 ખબર નથી 3

13.23 જો હા, તો કયાં?

કલ્પસર પ્રોજેકટ 1
અન્ય સ્થાનિક ઔધોગિક વિકાસ 2
અન્ય_____ 3

XIV. અસ્કયામતોમાં ફરક

ક્રમ નં.	**સુવિધાઓ**	**મેન્ગ્રુવ વાવણી પહેલા**	**મેન્ગ્રુવ વાવણી પછી (2009)**	**આ ફરક હોવાનું કારણ**
14.1	ઘર કાચુ-1, પાકુ-2, બન્ને-3			
14.2	સ્વચ્છતા બાથરૂમ-1 જાજરૂ-2 શોષ ખાડો-3 અન્ય ___ 4			
14.3	રસોડાનો ચૂલો માટીનો ચૂલો-1 પ્રાઇમસ-2 અન્ય _____ 3			
14.4	રસોઇ માટેનું બળતણ લાકડું-1 ગેસ-2 ગોબર ગેસ-3 બાયોગેસ પ્લાન્ટ-4			
14.5	વિજળી હા 1 ના 2			
14.6	પીવાના પાણીની વ્યવસ્થા પોતાનો નળ-1 ટયૂબવેલ-2 કુવો-3 હેન્ડપંપ-4 જાહેર નળ-5 અન્ય _____6			
14.7	પંખો હા 1 ના 2			
14.8	ટેલિફોન/મોબાઇલ હા 1 ના 2			
14.9	ટી. વી. હા 1 ના 2			
14.10	ફ્રીજ હા 1 ના 2			
14.11	CD /DVD ટેપ રેકોર્ડર હા 1 ના 2			
14.12	બે પૈડાનું વાહન હા 1 ના 2			

14.13	ટ્રેકટર હા 1 ના 2			
14.14	અન્ય હા 1 ના 2			

XV. આર્થિક સ્થિતિની સરખામણી: (આવક અને ખર્ચ)

15.A. આવક

ક્રમ. નં.	પ્રવૃત્તિનું નામ	પહેલાની આવક (_____)	હાલની આવક (2009/10)	આ ફરક હોવાનું કારણ
15.1	ખેતીમાંથી			
15.2	ખેતમજૂરીમાંથી			
15.3	મેન્ગ્રુવની વાવણીના કામમાંથી			
15.4	પશુપાલન-દૂધ ઉત્પાદનમાંથી			
15.5	માછીમારીમાંથી			
15.6	અન્ય મજૂરી, પ્રવૃત્તિમાંથી			

15.B. ખર્ચ:

નં.	ખર્ચ	પહેલાનો ખર્ચ (_____)	હાલનો ખર્ચ (2009/10)	આ ફરક હોવાનું કારણ
15.7	ખોરાક માટે			
15.8	ખેતી માટે			
15.9	પશુપાલન માટે			
15.10	શિક્ષણ માટે			
15.11	આરોગ્ય માટે			
15.12	સામાજીક પ્રંસગો માટે			
15.13	અન્ય _____			
	અન્ય _____			
	અન્ય _____			

અન્વેષકનું નામ :_____

નિરીક્ષકની સહી:_____

મુલાકાતની તારીખ: _____

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