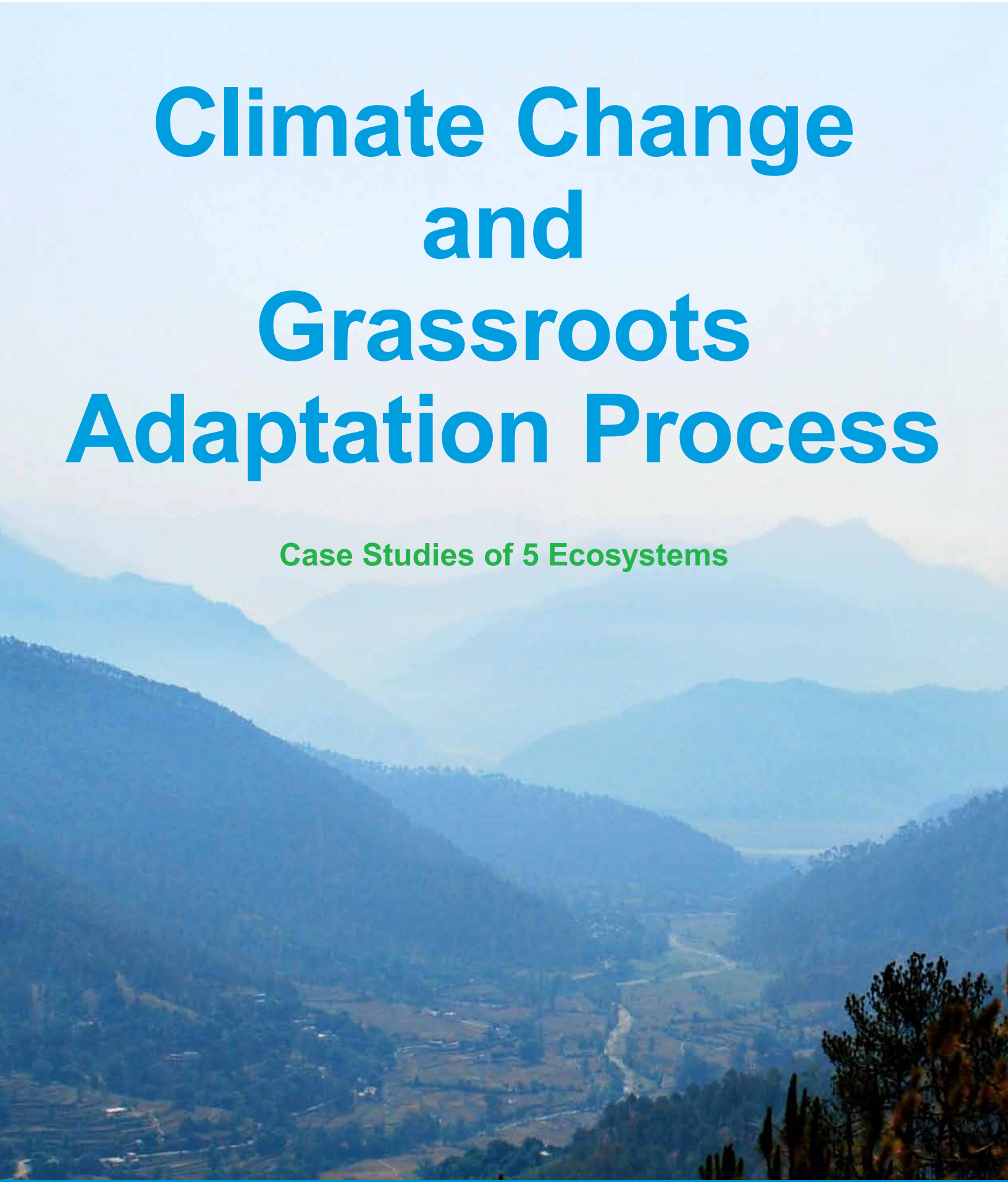
# Climate Change and Grassroots Adaptation Process

## Case Studies of 5 Ecosystems



INECC

Indian Network on Ethics and Climate Change

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This document has been prepared by
Indian Network on Ethics and Climate Change (INECC)

INECC

INECC is a national network comprising individuals and organization representatives interested in the climate issue from a micro-macro perspective. It connects the issues of climate change to larger sustainable development and social justice concerns. In this context INECC perceives policy changes in favour of communities who are most impacted by the climate crisis.

Laya, a CSO based in Visakhapatnam, Andhra Pradesh, India, is the Secretariat of INECC.

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# INTRODUCTION

This study was the outcome of the Climate Change related Vulnerability Assessments undertaken earlier by INECC, which pointed out the need for understanding and strengthening local adaptive responses to Climate Change from an ecosystem perspective. The five ecosystems studied are situated in the states of Karnataka, Andhra Pradesh, West Bengal, Maharashtra and Uttarakhand in India. The focus of the study was to address the following:

- To establish a baseline understanding of farmers' and fishers' traditional wisdom that encompasses relevant knowledge and skills acquired from experience about climate risk management, local adaptation practices and their potential to counterbalance future climate impacts in their local contexts;
- To assist them in identifying alternative, technically viable options for livelihood adaptation in the context of continuously changing socio-economic and climatic conditions;
- To enable them to respond to short-term climate variability and extreme events, which can serve as the basis for reducing vulnerability to longer-term climate change.

The findings, interpretations, and conclusions expressed in this report are based on the feedback shared by stakeholders including farmers and fishers, their community leaders, local CSOs and the observations of the study team. We hope that this study is a small yet daunting endeavour in assisting the Indian government's efforts to strengthening climate resilience by adopting practices that enable vulnerable ecosystem communities to protect existing livelihood systems, diversify their sources of income, reexamine their livelihood strategies. We also hope that the insights from the study will complement and support the Indian government's developmental objectives and effectively support farmers and fishers in the most sensitive ecosystems.

# BACK TO ORGANIC FUTURE!

# Arid Ecosystem



## GEOGRAPHICAL LOCATION:

H. D. Kote Taluk, Mysore,
Karnataka

## PROJECT FACILITATOR:

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## ADAPTATION PROCESS:

Ragi cultivation technique based on System of Rice Intensification (SRI)

## BENEFICIARIES:

Adivasi and non-adivasi communities of
Antharasanthe, N Balaththur,
& Hirehalli, H. D. Kote Taluk

## INITIATION: 2010

## Context:

Studies have shown that about 65% of agriculture in India takes place in arid regions[1].

- H D Kote[2] taluk boasts of 4 major reservoirs (Kabini, Taraka, Nugu, and Heballa) but has no irrigation facility. Beginning with the Kabini dam in the 1970s, the adivasi communities have witnessed 4 major displacements. The community also continues to face the repercussions of the Wildlife Protection Act, where they are being asked to leave their forest dwellings;
- H.D. Kote taluk is also one of the most backward taluks in the State and experiences acute power shortage, among other problems. There is huge migration of the population to nearby areas in search of work;
- A majority of the population consists of small and marginal farmers. Importance given to cash crops (sugarcane, ginger, turmeric, BT cotton) has affected the cultivation of food crops and brought about a change in cropping and consumption patterns. Owing to the high costs of cultivation, a majority of the farmers have leased out their land for cash crops and work as wage labourers. Some even migrate to nearby states in search of work. Millet cultivation, which formed 80% of their produce 30 – 50 years ago, has decreased to 20% in the last 20 years. Increasing subsidies on wheat and rice and fluctuating market forces that help farmers procure more profit for cash crops is seen as the main reason for this decline. Consumption of rice is also considered to be associated as means to upward mobility in their society;
- 10% of the population belong to adivasi communities. As the land given to them, when they were displaced, is fallow and the fact that they are not agriculturists by profession make them heavily dependent on the Public Distribution System (PDS). The quantity of the food grains, distributed in this system, and the nutrition content is very low. The community is also prone to mass migration in search of work.

## Pipal Tree and the Adaptation Process

Pipal Tree, a CSO based in Bangalore, India, which works with the adivasi and non-adivasi communities of Antharasanthe, N Balaththur and Hirehalli) realised that the secure future of agriculture belonged to the cultivation of crops that require less water and are not heavily dependent on irrigation. The answer was in reviving the cultivation of millets. Towards this end, Pipal Tree collaborates with the Global Rural Adaptation Initiatives Network (GRAIN) and the Millet Network of India (MINI).

The intervention in agriculture was taken up in 2008. The erratic rainfall patterns and the resulting land fertility problems prompted a study in climate change and its impact. Awareness programmes related to climate change and adaptation processes were taken up in the year 2010 as part of the Millet Campaign.

Why Millets?

- Cultivated on low fertility soil and arid regions;
- Cultivated using biofertilizers like vermicompost and farm manure;
- Majority of millets are pest free;
- Used for multi-cropping;
- Includes multiple security - food, nutrition, fodder, fibre, livelihood and ecology;
- Easy adaptation to climate change.

## Pipal Tree's Local Adaptation to Climate Change







**Millets**[3] **–** Intensifying the cultivation of millets like *ragi (finger millet), jola (sorghum/great millet), navane (foxtail millet), same (little millet), sajje (pearl millet*), etc.

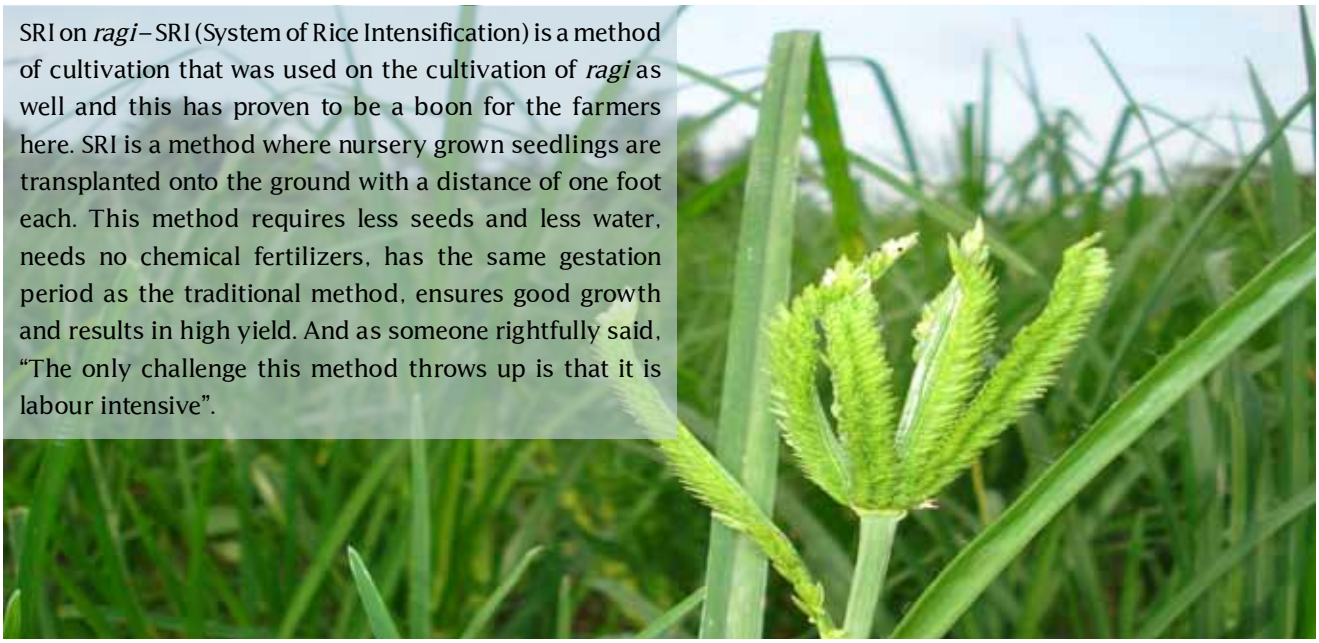
**Diversified agriculture development –** Strengthening the intervention by integrating principles of organic farming[4], kitchen gardens[5], seed banks[6], and capacity building.

**Policy Advocacy Action –** Influencing government policies concerning millet cultivation and advocating for the inclusion of millets in the Public Distribution System (PDS) and the midday meal schemes in government schools and Anganwadis.

**Budakattu Krishikara Sangha (BKS) –** Joining hands with organisations such as the BKS, which was founded in 1982 by Karayaiah Bharatwadi, a bonded labourer of Bharatwadi village in Honsur taluk. The members of this organisation belong to the tribal communities in the region, such as the Yeravas, Betta Kurubas and Soligas. The BKS meets regularly to strategies and solve the problems faced by the tribal communities of the region. They also disseminate information about government schemes and help them approach the concerned authorities.

**Azolla –** Training farmers in cultivating this aquatic fern. This is widely used as a biofertilizer due to its nitrogen-fixing ability. It increases productivity both in crops and in livestock when used as fodder.

SRI on *ragi* – SRI (System of Rice Intensification) is a method of cultivation that was used on the cultivation of *ragi* as well and this has proven to be a boon for the farmers here. SRI is a method where nursery grown seedlings are transplanted onto the ground with a distance of one foot each. This method requires less seeds and less water, needs no chemical fertilizers, has the same gestation period as the traditional method, ensures good growth and results in high yield. And as someone rightfully said, "The only challenge this method throws up is that it is labour intensive".



"We do not depend on the market anymore for vegetables as we grow our own in our kitchen gardens. Pipal Tree helps us with seeds and saplings for the garden. We still work as wage earners but our children may have a better future than us as they are being educated here." – Somamma, Antharasanthe, H D Kote.

## Notes :-

1. Prof. B. K.Chandrasekhar's report "The Karnataka Climate Change Action Plan" (2011) states that there will be a 12.5% decrease in south-west monsoon by the year 2035.
2. H D Kote consists of 114 hadis (tribal settlements). The region is home to adivasi communities such as Jenu Kuruba, which forms the majority and inhabit around 84-85 hadis, Yarava (4-5 hadis), Betta Kuruba (the most forward of them all inhabiting around 3 to 4 hadis), Beda (deemed tribals and inhabit around 4 hadis) and Soligas (inhabit around 3 to 4 hadis). The adivasi population is around 25,000 while the non-adivasi form a majority at 2,50,000.
3. Millet cultivation is being promoted currently in 5 panchayats – Chakkodanahalli, N Balathur, Antharsanthe, Hirehalli, and Nooralakuppe.
4. Organic Farming – Promoting a production system that supports the use of green manure, bio - fertilizers, vermicompost and other traditional cropping methods that is against the use of chemicals. This method is sustainable in the long run, and prevents the pollution of ground water owing to better nutrient retentive abilities. According to a report released by the Food and Agriculture Organization of the United Nations (FAO), organic agriculture contributes to mitigating the greenhouse effect and global warming through its ability to sequester carbon in the soil. The more organic carbon is retained in the soil, the more the mitigation potential of agriculture against climate change is higher.
5. Kitchen Gardens – Training farmers to maintain small sustainable kitchen gardens/ vegetable plots/ nutrition gardens for domestic consumption, thus enhancing nutrition security.
6. Seed Banks – Promoting traditional methods of storing seeds for the next round of cultivation. This ensures quality seeds, preserves local varieties from extinction, increases biodiversity, lowers farmers' dependency on commercial seed banks, enhances livelihood security, and reduces the cost of cultivation.

# FORESTS FOREVER!
# Forests Ecosystem

GEOGRAPHICAL LOCATION:

Pathakota, East Godavari District, Andhra Pradesh

PROJECT FACILITATOR:

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ADAPTATION PROCESS:

Package of Practices (PoP) for Sustainable Agriculture and renewable decentralised energy alternatives

BENEFICIARIES:

Adivasi communities of Pathakota and Daragedda Panchayats, Y. Ramavaram Mandal, East Godavari District

INITIATION: 2005

## Context:

Pathakota cluster has a total of 19 villages consisting of 610 households.

Existing adivasi communities in and around Pathakota are Konda Reddy, Bhagata, Kondhu, Konda Dora, Konda Gouda, Konda Kammari, Konda Kummari, Konda Poraja, Koya Dora, Porangi Porja, Porja and Valmiki.

A large part of the region is covered by forests with a high level of biodiversity. This region was once a hotbed of naxalite activity so much so that even today there is a taboo on high level officers entering the region. Hence it is an area relatively untouched by external forces.

Major livelihood activities are farming and collection of Non-Timber Forest Produce (NTFP). Other livelihood activities include agri-products, sale of fuelwood, bamboo handicrafts and land labour.

Average landholding per family is 6 acres. A considerable percentage of farmers have only 1-3 acres of land. Crops grown are maize, *ragi, sama, dry paddy* (in rainfed slope lands), and pulses like red gram, black gram, and *nelachikkudu (rajma).*

So far as the day to day livelihood is concerned, the social groups, to a great extent have moved away from their distinctive social traits. From being shifting cultivators on hill slopes they are now into various stages of settled agriculture. However, they are still largely dependent on the forest ecosystem with little migration and external services. Though there is no outside pressure (mining/industry/ organized logging etc.) major livelihood resources show tell tale signs of vulnerability.

Lifestyle is fast changing and the next decade is likely to see the emergence of an educated semi-educated young tribal generation, mostly detached from their traditional practices and values. Will the already degraded resources in climate changing times meet their needs and aspirations?

## Major Changes in Climate

- Erratic rainfall characterised by a switch between periods of drought and heavy downpour; less frequent and spread too thinly over a very short period;
- Depleting groundwater levels;
- Perennial streams turning seasonal;
- Steady increase in temperatures owing to deforestation.

## Climate Change and its Impact

With perennial streams, which are sources of drinking water and alternate sources of irrigation, turning seasonal and the decreasing levels of ground water, farmers are forced to give up the cultivation of food crops like millets and pulses and switch to cash crops that require less water. This will affect food security in the long run and increase the cost of living. Need for fertile and cultivable land increases pressure on forest land and eventually leads to deforestation that triggers a change in rainfall pattern. With a decrease in yield, farmers turn helplessly towards moneylenders to rescue them out of dire straits. This only gives rise to newer problems – debt with no guarantee of repayment.

Deforested hills of Pathakota

## Local Adaptation and its Impact

A search for fertile and cultivable land led the farmers to the hills, which were cleared for farming. But this was done with an inherent knowledge that they were attacking the very core of their sustenance. The hills housed the forests and the forests have sustained them for ages. The truant rains are creating a vicious cycle. The space that was cleared for farming was used for three years and then left for better pastures. In due time it was noticed that these patches were rendered barren with no chances of regeneration of forest area.

## Laya and the Adaptation Process

A comprehensive vulnerability assessment[1] study was carried out to gain insight into people's perception on the nature of changes in forest and other natural resources and climate and to identify potential initiatives necessary to decrease vulnerability and improve resilience. This study draws our attention to the causes of vulnerability in this region. It points to the soil degradation on hill lands and over exploitation of forests due to unsustainable practices of extraction, lack of management, unregulated conversion of forest into agricultural land and non-forest activities due to insecurities in conventional livelihood activities. Regeneration has been adversely affected not only due to absence of land development but also because of climatic fluctuation and prolonged dry conditions. Variations in the climate appears to have been working as an overarching trigger for the local communities who are being forced to cope with the changing situation by overexploiting 'unregulated forest resources'. Subsequently there have been changes in social values and aspirations.

Based on this study and Laya's own experience with natural resource management as well as new insights gained from discourse on climate adaptation, Laya's engagement in Pathakota cluster focussed on the following:

### Low carbon and sustainable farming practices:

*Low carbon farming supports sustainable farming* by encouraging farmers to adopt practices that reduce/ minimize/remove the use of synthetic fertilizers while, at the same time, improving soil carbon content. This is done through reduced tillage, anaerobic composting, using organic fertilizers, mulching, intercropping, multi-cropping, planting fuel, fodder and fruit trees, and protecting those that are already there on the farms. Planting multiple crops on the same field supports biodiversity. Proper crop mixes, based on science and demonstrated results, promotes resilience by bringing about a balance in the farm ecology and reducing the risk of crop failures due to pest attack. Multiple cropping also reduces the risk exposure for farmers against erratic and spatial rainfall. This effort by Laya is being undertaken with insights gained from being part of a national network called Fair Climate Network[2].

In this context the following practices were promoted:

*Tuber crops* that are not water intensive and use the existing moisture in the ground such as: turmeric, ginger, ground nuts, and banana.

*SRI* (rice and *ragi)* spread across 14 villages in 70 acres. SRI has helped in optimum use of limited water resources and has guaranteed a yield per acre increase by about 40%.

*Forest regeneration* through re-plantation of NTFP and fuelwood species such as pongamia, hillbrooms, bamboo, tamarind with the intention of reducing the burden on depleting forest resources and contributing possibly to better regularity in rainfall.

*Horticulture* by facilitating the growth of fruit bearing trees such as mango, chickoo, pomegranate, lemon, orange, banana, guava across 188 households in 47 acres that not only increase the income of the family and provide food security but also provide moisture and nutrient to the soil and act as carbon sinks.

*Agroforestry* by facilitating a comprehensive and sustainable land use system, which combines agriculture and forestry. Trees and plants are grown on agricultural land along with crops while NTFP species are grown in forest settings. More specifically jatropha and bamboo were promoted for fencing.

*Organic manure* at the household level particularly compost pits of farmyard manure and vermicompost in the cluster.

*Kitchen gardens* comprising 12 varieties of home grown vegetables that are free of chemicals in all households across the cluster such as leafy vegetables, various types of gourd, beans, tomato, brinjal, and carrot. This reduces the dependency on markets, assures a regular supply of nutrition and reduces at least 20% of the expenditure on food.

*Soil and moisture conservation* such as farm ponds, terracing of gradient land, rockfill and stone bunding on 'podu' lands, percolation tanks through the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). This also enhances the governance processes in villages as a resolution in the village meeting is required to be followed up by an application to the Mandal Development Officer and Assistant Project Officer to prepare an estimate and proposal for sanction.

## Renewable and Decentralised Energy Alternatives:

A *pico-hydel* constructed on a perennial stream flowing through Pathakota, provides electricity to 2 villages with a maximum output of 6 kWh. *Solar lanterns* provides basic lighting in 13 villages (450 households) replacing kerosene lanterns. Despite




the fact that the grid connection is available the access to electricity is negligible. Hence alternative options are a boon to the village, especially women for their household chores. *Energy efficient wood stoves* that require lesser firewood and are more efficient in meeting domestic energy needs have also been extremely helpful for women both from a health perspective as well as saving them the drudgery of collecting firewood. Renewable and decentralised energy options, apart from their mitigative value help communities to adapt to the phenomenon of climate change by promoting sustainable development[3].

## Learning and education:

Given the changing realities and the exposure of youth to formal education processes, which are often alienating, much of our communication with the community is on making effective and informed choices related to their own livelihood. Hence integrating skill development and value dilemmas are crucial in a perspective building process. Real change will only happen when insights on sustainable farming and technology alternatives are valued while also meeting economic needs and aspirations. Herein lies the challenge. Apart from engaging with critical reflections with community and youth representatives Laya has also been organising *adult literacy* programmes that aim at enabling women farmers not only to cope with new circumstances where their offsprings have increased access to formal education but also to play leadership roles in their communities[4].




"We were caught in a vicious cycle – we used to till the land and wait for the rains. When the rains became scarce, we found our selves in debt. We borrowed money for livelihood and for cultivation purposes. But when the crops failed, we were unable to repay our debts and would borrow again to repay. That is when Laya trained us in cultivating crops like turmeric, ginger, banana and peanuts that not only bring in good money but also require less moisture."
- Mohan Rao, Pathakota, East Godavari District, Andhra Pradesh

"Laya trained us on SRI. With this system, the input cost in less and the output is more than double. We require to plant around 2 kg of paddy per acre and the yield is around 25 bastalu (1 basta=75 kg) compared to the normal yield of 10 bastalu." – Balaraju Reddy, Pathakota, East Godavari District, Andhra Pradesh

## Notes :-

1. Vulnerability of the forest ecosystem in context of the changing climate: a participatory assessment, Sanjay Khatua, INECC, 2012. This study was undertaken in collaboration with the communities from two Panchayats, Y.Ramavaram Mandal, East Godavari district, Andhra Pradesh The clusters are part of Laya's (a CSO based in Visakhapatnam having interventions in tribal areas of East Godavari District) renewable energy intervention where Laya has recently intervened on pico-hydel, solar and efficient woodstoves.
2. The Fair Climate Network (FCN) is a pioneer in Low Carbon Farming. Simply put, this is the incentivising or rewarding of Sustainable Agriculture practices taken up by small, marginal and drought affected farmers with Carbon Revenues. Initially, Low Carbon Farming was considered merely as a strategy to incentivise small and marginal farmers with Carbon Revenues, to abandon High External Input Destructive Agriculture (HEIDA) and adopt Sustainable Agriculture with Carbon Revenues. Later FCN recognised 3 other Economic Drivers that root for SA as Increased Yield, Decreased Input Costs and Improved Price for SA Produce. On further reflection, FCN now understands Low Carbon Farming as synonymous to a low carbon growth trajectory in all fields of farm economics, fulfilling farm and family energy needs. The farm sector offers significant opportunities for carbon sequestration and emission reductions. Emissions from farming contribute 14% of global Greenhouse Gases. In India, farming contributes to 28% of the national GHG emissions. Low Carbon Farming practices offer farmers the opportunity to capitalize on the carbon market, as they shift to agricultural methods that are more sustainable, involve lower input costs and result in emission reduction and sequestration by sinks (www.fairclimate.com)
3. Approximately half of our population does not have access to electricity. It is these low carbon consuming societies which provide us a range of choices for promotion of relevant and carbon friendly technology options.
4. Laya organises 10 day crash literacy programmes and other field based modules for semi-literates and illiterates with leadership potential to develop reading and rudimentary writing skills to cope with fast changing social realities. The methodology for learning is based on logical thinking particularly since Telugu is a phonetic language. Besides the adult learners know the spoken language which thus is a tremendous asset in the development of their literacy skills in Telugu.

# HOLY RIVER!
# Wetland Ecosystem


GEOGRAPHICAL LOCATION:

Patharpratima town, Patharpratima Tehsil, South 24 Parganas, West Bengal

PROJECT FACILITATOR:

Development Research Communication and Services Centre (DRCSC), 58A, Dharmotala Road, Bosepukur, Kasba, Kolkata, West Bengal 700042.
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in collaboration with
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ADAPTATION PROCESS:

Sustainable Agriculture & Natural Resource Management

BENEFICIARIES:

Communities in 12 Districts of West Bengal

INITIATION: 1992

## Context:

The total global area of the mangroves is estimated at only 18.1 million ha, against over 570 million ha of freshwater wetlands including peat lands globally.

The ecosystem of the mangroves is mainly threatened by global climate changes and the rising sea levels in particular.

The region is a meeting point between the freshwater of the rivers originating from the Ganges and the saline water of the Bay of Bengal.

Tidal waves caused by storms inundate the land causing heavy damage and is also the main cause for the salinity in the ground and surface water. Salinity reaches up to 50km inland and increases significantly during cyclonic storms.

The major livelihood activities are farming and fishing (except between February and May); other minor activities like collecting NTFP honey, and firewood are undertaken by communities that are closer to the forest area.

Agriculture is dependent on rainfall, and surface and ground water for irrigation.

## Major Changes in Climate

- Erratic rainfall characterised by a switch between periods of drought and heavy downpour as a result of deforestation. Increase in demand for timber and fuel wood for consumption is a major cause for deforestation of the Sundarbans. Mangroves are increasingly being cleared for agriculture and aquaculture by local communities;
- Steady increase in temperature;
- Frequent cyclones and tidal surges.

Broken river bund, Brajaballavpur, Patharpratima

## Climate Change and its Impact

Frequent floods and cyclonic storms cause inundation and consequently salinity in the soil. Saline soil is unfit for cultivation for a minimum of 3 to 4 years. Increase in salinity affects the biotic composition of the region. Increase in temperature and variability in rainfall decreases the inflow of freshwater. Frequently occurring drought forces farmers to turn helplessly towards moneylenders to support their farming and sustenance expenditure. Difficulties in farming forces farmers to take up activities that put pressure on forest land – sale of firewood collected from the forest, sale of forest honey, and cutting down of trees to make furniture. Indiscriminate destruction of mangroves for firewood and other needs is destroying the mud dykes that protect the Sundarbans from the raging sea and thus threatens human settlements during high tides.

Inundated saline soil, Brajaballavpur, Patharpratima

## Local Coping Processes for Tackling Change

Frequent cyclones and tidal surges that plague the region forced people to look at alternative sources of livelihood such as prawn culture, which in turn increased salinity of the soil. Seeds purchased commercially are not adaptable to climate change and hence either fail to yield results or give poor yields. This forces farmers to resort to the use of chemical fertilizers and pesticides in a bid to increase yield. This has not only increased the cost of cultivation, but also threatened to pollute the ground water and rob the soil of its organic nutrients. The region is also plagued by erratic and disrupted rainfall pattern. To escape dwindling income, farmers shifted to mono-cropping, which increased the cost of living and threatened food security. Mono-cropping would leave land unutilized for long periods of time and this meant that there is no comprehensive and sustainable land use system in place.

## DRCSC and the Adaptation Process

A comprehensive package of practices has been initiated from the perspective of building long term resilience to climate impacts. These initiatives relate to improved resource management and technology adoption:

**Integrated/Allied farming –** Promoting a system of agriculture where the yield per unit area is maximum and has the following benefits:

- Provides balanced nutrition to the family;
- Effective utilization of by-products makes it a more sustainable form of agriculture;
- Effective recycling of waste material;
- Profits can be reaped by maximum utilization of land through the year by growing a variety of crops; and availability of quality fodder;
- A combination of agroforestry provides firewood and prevents deforestation.

**Biofarming –** Promoting the use of biofertilizers, biomanure, biopesticides in 22 villages. This reduces the cost of farming, is more sustainable, counters soil degradation and increases soil nutrients resulting in higher yield. DRCSC also promotes the production of organic manure at the household level, which reduces the use of chemical based agricultural products that deplete the soil of its organic matter and pollutes ground water.

**SRI –** Training farmers in SRI (Rice). DRCSC distributed biofertilizers as a motivational strategy, but the resulting yield and the economy of water usage (with climate change playing havoc with the rainfall pattern) clinched the deal for farmers.

**Sack Agriculture –** Facilitating mobile plots (plants grown in gunny sacks/burlaps) that are an excellent anti-flood mechanism. It also saves plants from natural calamities and inundation during the rains. The sack is removed once the plant is big enough to withstand calamities.

**Nutrition garden –** Promoting homegrown vegetables (thus reducing carbon footprints) that are free of chemicals. This reduces the dependency on markets, assures a regular supply of nutrition, reduces cost of living and increases food security.

**Saline resistant seeds –** Promoting the use of local varieties that had lost its market to the new hybrid and modified varieties. Indigenous saline-resistant seed varieties are more sustainable and adaptable to climate change.

**Grain gola/bank[2] –** Reviving the indigenous seed banks that were in practice 30 years ago. Grain banks preserve the integrity of local seeds; reduce farmer's dependency on moneylenders in times of need; allows farmers to borrow in times of food scarcity, for a small amount of interest. Grain gola ensures food security in a region that is torn by recurring natural calamities.

**Surface water recycling system –** Installing surface water filters that make optimum use of available water resources and thus reduce the increasing pressure on groundwater for agriculture and domestic needs. These water filters are effective enough to provide potable drinking water.

**Solar energy –** Promoting the installation and use of solar lamps to reduce the consumption of kerosene oil (for lighting and domestic purposes) that is detrimental to the environment and also eats into the earth's non-renewable resources. Kerosene was also the main cause for many respiratory problems that were observed in the region.

**Biogas –** Promoting the production and use of renewable biofuels that use biodegradable materials such as biomass, manure, sewage, plant material, and waste from crops. This system converts organic waste into methane biogas and reduces climate change by decreasing the emission of harmful gases like nitrogen dioxide and methane, which are present in decomposed manure. The by-product (slurry) is used as biofertilizer.

**Ecosan toilets –** Installing ecosan (ecological sanitation[1]) toilets, which are built on a system where the collected human waste is turned into compost. This prevents pollution and returns nutrients and humus to the soil.

**Common Property Resource (CPR)[3] –** Developing huge plots of mini-forests that will provide firewood, fodder, medicinal material, wood for construction, furniture and other crafts. This reduces the pressure on mangroves and prevents deforestation. Mangroves are invaluable as they moderate the effects of coastal storms and cyclones and act as nutrient sinks and reduce excessive pollutants[4].






**Social Network –** Farmers' Groups – Facilitating the formation and maintenance of two farmers' groups – SFG (Small Farmer's Group) and SHG (Self-Help Groups) as social networks are important determinants for adaptation to climate change. These groups facilitate farmers in adopting practices like integrated farming, grain golas, community managed mini-forests, etc. Women belonging to SHGs facilitate various income generation (IGP[5]) activities in their villages and thus help women counter situations that render their families' financially dependent.

"Five years ago, my cost of farming was very high. I used chemical fertilizers and bought seeds from the market. My land would remain unused for many months and that meant irregular income, no savings, and dependency on moneylenders. But now I practice integrated farming. I grow paddy, oil seeds, vegetables, pulses, tubers, and during rains when my land gets inundated, I turn my land into a fish farm. I practice bio-farming, which protects my soil, helps me recycle waste and also save more money. I maintain my own seed bank and contribute to the grain gola managed by the farmers of our village. People consider my farming as exemplary.

- Sukumal, Bishvanathpur, Patharpratima.

## Notes :-

1. In ecological sanitation urine and faeces are separated at source and are not mixed with water. Hence this sanitation solution avoids the contamination of large volumes of water with pathogens. In addition, the separation of urine and faeces make it easier to recover and recycle nutrients such as phosphorous and nitrogen. After dilution and/or processing separated urine can be applied to the soil as a hygienic fertiliser. Faeces, on the other hand, can be safely composted and allows for the integration of organic waste treatment into food production: http://www.ecosan.nl
2. Grain gola targets poor and marginal farmers; collects a designated amount of food grains from members (200 kg per member, with an equal amount contributed by DRCSC); the borrowed grains are returned during the next harvest season; the collected interest helps increase the stock of the bank; the matching amount of grains initially given by the DRCSC is donated to the Area Resource Training Centre, which uses this to start more grain banks; more than 50% of these banks are run by women groups.
3. CPR - The varieties of trees are decided by the community based on their need; some useful shrubs too are planted alongside the trees. Members nurture and protect the plantation and share the resulting NTFP. The area used for plantation is leased out from the local self-government or panchayat for a term of 20 to 30 years. DRCSC assists them with seeds, saplings, the training required and also the cost of raising and transplanting the saplings. The last five years of this program has seen around 50 such active groups with 1055 members and a total area of 67 sq km of land being planted. This community managed woodlot has multiple utilities - women and children spend less time collecting fodder and firewood; prevents soil erosion; creates bio-diversity areas; protects by acting as a barriers against storms and cyclones.
4. Resource-dependent livelihoods in the Sundarbans, Md. Tamimul Alam Chowdhury, Center for River Basin Organizations and Management, Indonesia, 2010.
5. IGP – women belonging to these groups facilitate various activities in their villages -animal husbandry, nutrition garden and sale of vegetables, poultry, making and selling of vermicompost, managing grain banks, processing rice and pulses, circle beds for vegetables, cultivation of beetle leaves. They have been practicing these models for 4 years now.

# WAVES OF CHANGE!
# Coastal Ecosystem



GEOGRAPHICAL LOCATION:

Gorai, Uttan & Manori, Dharavi Bet,
Mumbai & Thane Districts,
Maharashtra

PROJECT FACILITATOR:

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ADAPTATION PROCESS:

Sustainable Practices of Fishing

BENEFICIARIES:

Fisher communities of Dharavi Bet

INITIATION: 2007

## Context:

Gorai, Uttan and Manori are all part of the Dharavi Bet (island), which comprises 10 villages.

Out of Dharavi's 1.5 lakh population[1], 70% depend on fishing and fishery related activities for their livelihood (majority do not have a supplementary or secondary income) and the remaining 30% engage in other activities like farming, salt making, and other trades. A very small percentage work as skilled and unskilled labour in the neighboring areas of Mumbai city.

This coastal ecosystem is threatened mainly by climate changes such as erratic rainfall, rising sea levels, and in particular, increase in temperatures.

Overfishing[2] by commercial fishing vessels (fishing trawlers) and pollution plague the fishing communities of this area.

The region also faces extensive destruction of mangroves[3] and coastal wetlands, which affect the productivity and yield of fish by disrupting the spawning and nursing grounds of the fish.

Fishers agree in unison that the number of boats and the mesh size of fishing nets have to be regulated but have not raised their voices against it yet.

Fishers with large mechanized boat have benefitted but the artisanal fishers in all villages have suffered and now work as crew members on large boats/trawlers.

Catches of commercially valuable fish[4] has declined. But the decrease in one variety of fish (pomfret) is usually off-set by an increase in availability of other varieties such as the (ribbon fish[5]), which gives a false sense of normalcy.

Manori, Dharavi Bet

## Major Changes in Climate

- Major shift in seasonal variations – change in direction of the wind and tidal pattern, short winters and long summers, and extended rains;
- Rising sea level[6] - 1.2 mm per year along the Mumbai coast;
- Steady increase in temperature - both on land and sea;
- Change in ocean currents;
- Frequent cyclones and tidal surges;
- Sea water upwelling[7] ;
- Acidification of sea water due to an increase in carbon dioxide concentration in sea water.

## Climate Change and its Impact

- Extended and erratic rainfall affects fishing activities – fishers find it increasingly challenging to go out into the sea due to sudden and untimely heavy rains that extend into the fishing season (spanning from August to May). Variability in rainfall also affects the drying of fish that bring a major portion of their income. Frequent flooding and cyclonic storms have adverse effects on their livelihood too;
- Sea level rise and temperature increase pushes the fish further into the sea and force fishers to go deep into the sea, which increases the cost of fishing as they require more fuel and sophisticated fishing nets. All this demands an increase in investments that in turn require huge loans. Artisan or traditional fishers are deeply affected when the catch is very low, even if the price is high as the input cost is very high. This often lands them in debt;
- Rising sea surface temperature also increases salinity[8] in the water and thus affects fish. Changes in ocean currents and sea upwelling affect fish breeding and the supply of nutrients for the fish,

thus affecting fish population. Increasing sea surface temperatures cause stormy winds, stronger thunder storms and lightening;

- A drastic change has been seen in the tidal pattern in the last few years. The number of days with high tide has gone up and when this is coupled with heavy rains, coastal and low lying areas are inundated. Inundation in turn causes displacement of the community and salinity in wells, surface water bodies and soil;
- Increase in land temperatures makes it difficult for women to work in the hot sun as they have to walk long distances to dry their fish. They also face a number of health risks (urinary tract infection, asthma, weak joints) as they are out in the heat and humidity, and lack proper nourishment;
- Rising temperatures also affects the freshness of the fish and this requires fishers to use tons of ice for preservation, which in turn increases their expenses;
- Pollution (waste from construction sites, human waste, and industrial effluents) is pushing fish further into the sea. There is zero catch in the Manori creek where fishers used to get a good catch and earn a living even during off season;
- Increasing in medical expenditure - less catch, increasing demand, high cost of living and the lure of profits all deter fishers from using a portion of their catch for domestic consumption. This affects food security and nutrition intake.

## Local Coping Processes for Tackling Change

The fishers of the Gorai, Uttan and Manori region are well aware of the changes that affect their livelihood directly, but most are still unaware of the impact of climate change and consider overfishing (mechanised trawlers, purse seine nets[9], more boats per village); and pollution[10] as the main reason for the decrease in fish.

Based on this understanding, the most common coping strategies found in the fishing communities of the 3 regions are:

- **Mechanization**
  - Investing in bigger and motorised boats that can be taken deep into the sea and stay there longer. Fishers are investing in fibre boats as these require less maintenance, are sturdier, and last longer than the traditional wooden boats;
  - Using an assortment of fishing nets[11] to catch all varieties of fish;
  - Communicating through wireless GPS helps fishers to locate their stakes and nets accurately, saving time and fuel.
- **Trading –** Buying fish commercially from wholesale dealers and selling it at the local market.

- **Co-operative societies –** Establishing co-operative societies[12] that help them with loans, act as a buffer between the buyer and the fishers and help them sail through the dry season between June and August when fishing is not allowed.
- **Youth groups –** Pooling resources, finance and skills to ensure livelihood security. The young fishers of Gorai and Uttan tackle dwindling income and lack of investment capital through this ingenious system where they form a group of 10 to 12 members who invest equal amount of money and buy a huge boat. The catch and the resulting profits are distributed equally among the members. It is a system of entrepreneurship where every member is the owner and the work is divided equally.
- **Alternatives –** Educating[13] their children (both boys and girls) to help them find alternative means of livelihood seems to be another way to prepare for the impending situation when fishing may not be a viable option. This increases their occupational mobility, which was non-existent earlier.

"We may be better off today than we were some years ago, but we work harder to make ends meet. The catch is very less although the prices are high and the demand is growing. When I was young I used to work as a maid in Mumbai city to supplement the family income but wherever we go we always want to come back as our hearts is in fishing. Women do all the work – cleaning, sorting, storing, drying, selling, taking care of the family, making sure the children are educated for a better tomorrow, and even taking care of the meagre savings we manage every month. We walk a kilometre to dry our fish and sometimes when there are sudden rains, a lot of it is destroyed. We work in hot sun all day and when we are at the market, we eat poorly and are usually dehydrated. We work in very unhygienic conditions as the markets are not maintained. Women are also prone to more illnesses due to the amount of hard work done." – Marion, Gorai.

"We did not want to work as mere crew members on a big boat. We wanted our own boats. As huge investment was not possible by each one of us, we formed a group, pooled in the money and bought a boat. We each invested Rs. 30,000 and raised the remaining money through a loan from the society. We do all the work ourselves and equally distribute our fish and our earnings. We want our present and future to be secure and be able to pass it on to our children." – Youth Group members, Gorai

## Notes:-

1. Gorai has a population of around 7000 with 60% involved in fishing of which 90% is artisanal and small scale fishers. Uttan has a population of around 30,000 with 65% involved in fishing of which 85% is artisanal and small scale fishers; and Manori has a population of around 8,000 with 75% involved in fishing of which 90% is artisanal and small scale fishers.
2. Overfishing results from more families owning boats, mechanized trawlers by commercial fishers, and trawlers from neighboring states.
3. The mangroves are being destroyed by the locals for fuelwood and by the growing suburbs to create real estate. The mangroves have also become dumping grounds by surrounding construction companies and industries. These mangroves have recently been declared by the Central government, as protected forest areas following a lengthy campaign by the fishers of this region.
4. Commercially valuable fish like *ghol, khoth,* lobster and threadfin are not available anymore.
5. The population of ribbon fish has increased and it is bringing in good income as they are being exported to China.
6. Gorai and Uttan are at the sea level while Manori is slightly above sea level. All three villages touch the high tide line and are hence vulnerable to sea level rise. (Vulnerabilities of Fishing Communities to Ecological and Climate Change, A pilot study in Dharavi Bet by ICOR,2012).
7. Sea upwelling is a process of vertical mixing which brings the colder nutrients-rich water from the bottom of the sea to the surface near the coast. (Vulnerabilities of Fishing Communities to Ecological and Climate Change, A pilot study in Dharavi Bet by ICOR, 2012).
8. Salinity of the sea is increased by an increase in evaporation of sea water and reduced flow of fresh water into the sea. (Vulnerabilities of Fishing Communities to Ecological and Climate Change, A pilot study in Dharavi Bet by ICOR, 2012).
9. Purse seine nets – these nets create a wall around a school of fish and purse the bottom to trap the fish in. The problem with this method is that catches all kinds of fish indiscriminately – non-edible, non-commercial, other species of marine life, fish spawn, and damage a lot of endangered species too.
10. The other serious threat perceived by the fishers is pollution of the coastal waters and the creeks from domestic and industrial waste – sewage, chemical wastes and garbage. Sewage contains bacteria, which consume oxygen in the water and make it difficult for the fish to survive. (Vulnerabilities of Fishing Communities to Ecological and Climate Change, A pilot study in Dharavi Bet by ICOR, 2012).
11. Nets that are locally made last longer (12 years) than the ones available in the market (5 years).
12. Cooperative societies locate potential buyers for fish (presently it is pomfret), take an advance in cash much before the start of the fishing season, and provide fishers with this money (as loan) to see them through the dry period. Once the fishing season starts, the society buys the fish from the fishers and sells it to the buyers. The fishers are thus able to repay their loan and even have decent savings.
13. Manori has a higher level of education among its people where at least 20% of them are graduates. Women take up jobs like teaching and nursing.

# HOW GREEN WAS MY VALLEY!

## Mountainous Ecosystem



GEOGRAPHICAL LOCATION:

Chaukutia Block, Almora District, Uttarakhand

PROJECT FACILITATOR:

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ADAPTATION PROCESS:

Sustainable Development Models

BENEFICIARIES:

Communities of the Kumaon Region, Uttarakhand

INITIATION: 1982

### Context:

About 65% of Uttarakhand is forest area. Of the 13 districts, 4 have large areas in the plains whereas the other nine districts comprise the hill region of the state[1]. Literacy rate stands at an impressive 80%-90%;

More than 75% of Uttarakhand's total population depends on agriculture for their livelihood and the economy is predominantly dependent on mountain agriculture[2]. It is the first state in India to be recognized as organic;

Majority of landholders are small and marginal with subsistence farming;

Perennial streams are the main source of irrigation while mountain springs are the main source for drinking water;

The Himalayan ecosystem is mainly threatened by global climate changes like erratic rainfall, and rising temperatures.

Collecting firewood, Basbeda, Chaukutia, Almora District

Forest Fire, Chaukutia, Almora District

## Major Changes in Climate

- Erratic rainfall characterised by a switch between periods of drought and heavy downpour as a result of deforestation and global climate changes;
- Steady increase in temperature;
- Drying up of natural water sources (mountain springs).

## Climate Change and its Impact

- There has been large scale migration owing to failure of farming and paucity in livelihood options since the 1990s;
- Erratic and disrupted rainfall pattern, threat from wild animals[4], lack of quality seeds, irrigation, and technical know-how have forced people to look away from cultivation;
- Storage of grains is another problem and farmers are forced to use pesticides and medicines, which increase the cost of cultivation;
- There has been uncontrolled deforestation as trees are cut down for firewood, fodder, and construction material. Forest fires are rampant during summer increasing atmospheric pollution (release of carbon dioxide);
- Natural springs are fast disappearing and perennial streams are turning seasonal; groundwater is being affected by low rainfall; communities at higher altitudes face acute water shortages in summer, which render their land barren and unfit for cultivation;
- There has also been a major change in the local biodiversity (pine tree plantation) with a narrow view of commercial viability. The appearance of fruit trees like mango and peach and the cultivation of vegetables like peas and okra, for example, which were not traditionally grown in the region is a testimony to the drastic changes in climate.

## Local Coping Processes for Tackling Climate Change

Abandoned House, Gharsiary, Almora District

Fallow Land, Basbeda, Almora District

Migration for better livelihood prospects has always been ailing this hill state but large scale migration as a response to climate change induced conditions like scarcity of water resources and increase in temperature and its effects on crops is the latest setback in the region's local development. Families either migrate all together or some members shift to nearby towns to supplement family income.

Dependency on rain deterred farmers from cultivation and this resulted in land being fallow for long periods of time and left them with no comprehensive and sustainable land use system in place.

To escape dwindling income, most farmers made a shift from food crops to cash crops, which in turn threatened food security.

Seeds purchased commercially are not adaptable to climate change and hence either fail to yield results or give poor yields. This forces farmers to resort to the use of chemical fertilizers and pesticides in a bid to increase yield. This has not only increased the cost of cultivation, but also threatened to pollute ground water and rob the soil of its organic content.

## INHERE and the Adaptation Process

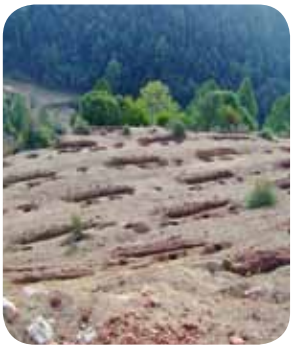
A comprehensive package of practices has been initiated from the perspective of building long term resilience. These initiatives relate to improved resource management and technology adoption:

- **Integrated/Allied farming –** Promoting a system of agriculture where the yield per unit area is maximum and has the following benefits - provides balanced nutrition to the family; effective utilization of by-products makes it a more sustainable form of agriculture; effective recycling of waste material; profits can be reaped by maximum utilization of land through the year by growing a variety of crops; availability of quality fodder; a combination of agroforestry provides firewood and prevents deforestation;
- **Diversified Agriculture[5] Development –** distributed seeds for fruit trees and plants that provide fodder; construction of low density polyethylene (LDPE) tank; formation of groups – Farmer Interest Groups (FIG), Self-Help Groups (SHG) and organising capacity building programmes for farmers; and land leveling and construction of contour bunds;
- **Biofarming** – Promoting the use of biofertilizer, biomanure, biopesticide. This reduces the cost of farming, is more sustainable, counters soil degradation and increases soil nutrients resulting in higher yield. INHERE also promotes the production of organic manure (biocompost and vermicompost pits) at the household level, which reduces the use of chemical based agricultural products that deplete the soil of its organic matter and pollute ground water;
- **SRI –** Training farmers in SRI[6] (Rice);
- **Alternate fuel and control of forest fire** – promoting the manufacture of pine needle briquettes[7] as green fuel; preventing the felling of trees for fuel and avoiding forest fire by clearing the land of pine needles. 49 families[8] have taken up briquette making as an alternate livelihood source;
- **Biogas –** Promoting the production and use of renewable biofuels that use biodegradable materials such as biomass, manure, sewage, plant material, and waste from crops. 10 biogas units of 3 cum 8 volume capacity have been constructed, benefitting families in 10 villages;
- **Smokeless wood stove** – introducing briquette stoves that use green fuel and reduce carbon emission. 1470 families[8] are currently using these stoves;
- **Agribusiness** – Promoting group farming, cash crops (turmeric, ginger, new varieties of potato, etc.) and capacity building of farmer groups; enhancing soil fertility; developing irrigation infrastructure (building canals); adopting improved farm techniques, high quality seeds, and use of biomanure*. 4225 farmers[8] from 70 villages have benefitted so far from agribusiness;
- **Forestation and soil conservation** – increasing biodiversity in forests; fencing the areas designated as forest land; plantation in Panchayat land and community pasture land; establishing nurseries; soil conservation (river bank protection walls) and soil protection through treatment of soil and construction of terraces; and increasing the availability of NTFP by planting forest species (432 ha);
- **Agroforestry and Horticulture[9]**
  - Promoting a comprehensive and sustainable land use system which combines agriculture and forestry. Trees and plants are grown on agricultural land along with crops while non-timber forest products are grown in forest settings;
  - Promoting the growth of fruit bearing trees and fruit based product manufacturing that not only increase the income of the family and provide food security but also provide moisture and nutrient to the soil and act as carbon sinks;
  - Water Catchment Area Protection – building check dams, plantation surrounding natural water sources, constructing vegetative check dams, and facilitating rooftop rainwater harvesting plants on almost every house in the region.

- **Integrated Rural Development Programme**
  - Livestock improvement and cattle rearing – Providing cattle health care information and facilities; capacity building for community health workers for animals (paravets); improving living and feeding conditions; promoting trees, crops, and grass (napier grass on terrace bunds) that can provide nutritious fodder; organising health check-up camps; providing livestock insurance; pasture development on common land. Cattle rearing provides an alternate livelihood source for the community, both landed and landless;
  - Livelihood diversification for vulnerable communities - Creating sustainable income generating livelihood sources for the poor through skill development; promoting poultry, goat rearing, carpentry, iron smithy, basket weaving, tailoring. INHERE also facilitates easy access to loans;
  - Medicinal and Aromatic Plants (MAP) – Uttarakhand has experienced depletion of its biological resources due to excessive extraction of medicinal plant species in high altitude areas. To conserve these species, the state government has introduced policies to promote the conservation of these species and encourage farmers to cultivate them and supplement their incomes[10]. Some of the medicinal species are *tejpatta, satavari, ashwagandha, brahmi, rosemary, amla, harad, sarpagandha, and baheda.*






"Along with agriculture, I also make briquettes between the months of February and September. This is my assured additional income. I also provide training to people who are taking this up as an alternate source of livelihood. The machine works excellently with pine needles, dried wood from nearby trees like oak and shrubs like lantana. Availability of bigger machines would be even better as I am unable to meet the demand right now!" – Briquette master, Ramdatt Bilwal, Gharsiari village, Chaukutia Block, Almora District.

## Notes :-

1. Demography statistics - Districts in the plains are far ahead on various development indicators. The hill region districts are less developed in terms of infrastructure, i.e., electricity, roads and irrigation; http://www.icrier.org
2. Food grains account for more than 80 percent of the total cropped area while pluses are the main commercial crops.
3. Season creep refers to change in the timing of the seasons – late or early arrival of seasons that in turn affect plant and animal species.
4. The threat from wild animals and the havoc they wreak on farm lands has increased in last 10 years. Deforestation and disappearing water sources are believed to be the main cause.
5. Crops that are used for diversification of agriculture are wheat, ragi, soyabeen, arhar, maize, ginger, turmeric, chilli, pea, potato, lentil, radish, onion, french bean, brinjal, and garlic.
6. SRI promotes optimum use of limited water resources and guarantees high yield.
7. Pine needle briquettes – INHERE has introduced household briquette making machines that use anaerobically burnt pine needles, clay, and dung as raw material. These materials and mixed and fed into the machine to make cylindrical no smoke green fuel which cost between Rs. 8 and 12 per kg.
8. Uttarakhand Decentralised Watershed Development Project GRAMYA.
9. Promotion of horticulture involves growing the following fruit trees - mango, guava, malta, lemon, and nuts (almond). INHERE also promotes fruit based product manufacturing like- pickles (mango, amla, lemon) and squashes (lemon, rhododendron, malta, peach, pear, apricot).
10. Cultivation of medicinal plants in Uttarakhand - Ghayur Alam, Lucian Peppelenbos. http://www.indiaenvironmentportal.org.in

# Conclusive Insights

## Adaptation to climate change is a location-specific issue:

The coping mechanisms vary across different ecosystems and are location-specific. While the nature of adaptation is different in a coastal ecosystem, where adaptation response is understood primarily from the perspective of maintaining fish production and value addition to meet livelihood requirements; the adaptive response in a forest ecosystem, which is a resource base for herbal medicines involves revitalisation of herbal medicinal practices. Decentralized ways of working are needed within the framework of coherent national policies. There cannot be 'one-size-fits-all' solutions at local level among ecosystems. Hence, managing anticipated risks requires developing location-specific adaptation options that consider biophysical, socio-economic and socio-cultural factors.

## Responsive coping mechanisms by community or by external facilitators:

The coping mechanisms have been responsive activities undertaken by the communities themselves or the ones which have been facilitated by external agencies. It was observed that farming communities have accumulated considerable experiences for living with climate risks over time and have developed a range of adaptation or coping strategies. External facilitators have carefully introduced and discussed the potential climate impacts on traditional practices and the relevance of existing local knowledge. Science-based climate prediction information has been tailored to farmers' perceptions and understanding. Local adaptations to climate variability practiced to some extent among farmers in the study area can be categorized as:

- Traditional, locally managed responses – e.g., millet cultivation in Karnataka, reviving grain banks in Sunderbans, maintaining kitchen gardens in Andhra Pradesh;
- State supported responses – e.g., deep tubewell irrigation;
- Alternative innovative responses – e.g., mango farming in Uttarkhand, low carbon farming in Andhra Pradesh, System of Rice Intensification (SRI) and biofarming, sack agriculture in the Sunderbans, etc.

Most of the case studies reflect "coping" and not necessarily adaptation. Adaptation is a long term process constituted by mainly the following 3 key pillars:

- Favourable socio-demographic profile;
- Diversified livelihood strategies; and
- Strong social networks.

However, coping is a temporary response to any climate perturbation and in some cases may be lethal from a long term perspective. Farmers will be bound to take action on their own if they can, irrespective of external interventions. Autonomous adaptation is taking place in an unplanned and uncoordinated manner and might prove detrimental in the near future.

There is a need to monitor ongoing adaptation practices and potential risks of mal-adaptation, and to establish links with policy making

## Prerequisites of an effective adaptation strategy:

*Institutional capacity building and organizational networking with clear definitions of roles and responsibilities are essential.* Institutional capacity building and strengthening of organizational networks across all levels and sectors are the basic preconditions to making adaptation work. Since adaptation to climate change is a new field of work, the institutional responsibilities are not yet well defined. However, as the field develops, there will be need to integrate top-down and bottom-up perspectives and capacities, and to establish mechanisms to coordinate the functions of various agency activities such as planning, communication and operations at field level. Furthermore, it will be crucial to factor adaptation into other on-going development activities, in order to make community-based adaptation effective.

*Multiple and integrated adaptation measures across sectors are essential.* Study findings indicate that climatic conditions and anthropogenic factors mutually reinforce chronic vulnerability to climate variability and natural disasters. Technology, on its own is at best a partial solution to climate change. The study points to the need for multiple but integrated pathways across sectors to improve adaptive responses of local communities, especially the poorest sections of the communities. Neither an agricultural nor any other single sectoral intervention alone can provide sufficient scope to manage the future climate change risks. Short-term and long-term adaptive measures in agriculture, linked with clear focus on possible future risks, must be integrated into cross sectoral planning.

*Applying a livelihoods perspective is helpful to understand and promote local-level adaptation to climate change.* Community and household assets are influenced by the institutions, organizations, policies and legislation that shape livelihoods. The institutions and processes operating in both public and private spheres and from household to national levels determine access to assets, livelihood strategies and vulnerability to climate change. Adding climate change adaptation through a livelihood perspective improves the adaptive capacity of farmers by increasing household access to assets and services. Increasing awareness of climate variability at grassroots level – through government and non-governmental interventions, provision of essential support such as information, technology, technical know-how, alternative sources of income and employment, credit facilities, insurance mechanisms, health facilities and information on markets, and dissemination of all awareness messages in local languages – needs to become an integral part of the livelihood adaptation process.

*Assess the value of indigenous knowledge in the context of managing future risks:* Although farmers often rely on proven local practices and indigenous knowledge for managing climate risks, it is necessary to assess the real value of these practices in the context of managing future risks. This requires viewing them not only in terms of dissemination but also adding value with knowledge, for example, from research institutions that may not be locally available. Factoring existing knowledge about climate risks into new approaches in the context of climate change adaptation is a good entry point.

*Climate adaptation should be seen as a social learning process:* Climate adaptation should be seen as a social learning process that creates the capacity to cope with climate change-related impacts. Since we are not yet able to anticipate exact future impacts of climate change, particularly at local scale, the study suggests that climate change adaptation programmes should have an intermediate goal of empowering communities to adapt to the impacts in a broader ecosystem perspective. In pursuing this goal, climate adaptation should focus on support for the decision-making and capacity-building processes that shape social learning, technology transfers, innovations and development pathways. This process of adaptation needs to address explicitly the needs of the marginalized. The social learning process needs to identify the best practices through participatory processes for community-based adaptation. A key message is that the current uncertainty regarding the precise impacts of climate change should not be used to justify inaction.

*Need to better promote sustainable natural resource management practices in the context of future risks:* The study shows that activities to address climate change adaptation will go further if they build upon what is already known about sustainable natural resource management and agricultural development. There is no need to reinvent the wheel – it is best to use exiting knowledge on sustainable natural resource management as an entry point, adapting or adopting successful, tested practices and working approaches.

## Adaptation, mitigation and sustainable development:

There is often a close link between adaptation and mitigation at the grassroots level. It is important to note that several of the adaptive processes have intrinsic mitigative characteristics and several mitigative renewable energy initiatives are adaptive in nature at the grassroots level:

- SRI (System of rice Intensification) - reduces methane emissions that are also responsible for causing climate change;
- Organic Farming - increases soil carbon (sequestration);
- LEISA (Low Energy Intensive Sustainable Agriculture) – ensures optimal use of energy;
- Pico-hydel, solar, biogas, fuel-efficient woodstoves projects promote access to energy for livelihood improvement.

*The linkage between sustainable development and adaptation:* While the concepts of sustainable development and adaptation are being contested, unlike sustainable development, adaptation is posited in the context of climate variability. From a long term perspective it is vital that a framework for adaptation based on specific ecosystems be prepared in order to safeguard coping mechanisms in the short term and sustain adaptation measures in sync with bottoms up sustainable development approach in the long term,the elements of which must ensure basic survival, environment soundness, equity and good governance.

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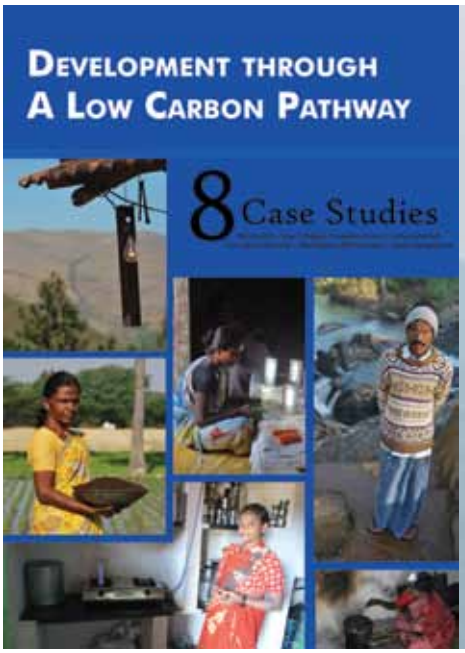


## Publications of INECC


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