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Introduction

Understanding the impacts of climate change on agriculture, associated landscapes and natural resources is crucial if local development efforts are to be successful. The climate smart village concept is developed based on this where the villages, scientific personnel and local governance join hands to introduce climate smart technologies in the village. The location of a Climate-Smart Village (CSV) is selected based on its climate risk profile and the willingness of farmers/fishermen and local governments to participate in the project.

Researchers conduct a baseline survey to capture the current socio-economic conditions and analyse resource availability, average production and income among other indicators. This enables an impact assessment after a period of time to gauge the benefits of the interventions. Stakeholders convene to prioritize which interventions they will take up, that are best suited to their local conditions. This is done through a choice experiment that analyses their preference and willingness to pay for technologies. Disseminating information on climate-smart fisheries and agriculture practices and outcomes is an important part of the capacity building process. Farmers are encouraged to record their testimonials and feedback at regular intervals and share it with researchers and the community.

Villages are also locations where partners have already established vital links with local communities. After potential sites are selected, a steering group of community representatives and researchers together identify appropriate climate-smart options for that village. These might include climate-smart technologies, climate information services, local development and adaptation

plans and supportive institutions and policies, all tailored to that community's needs. The community chooses its preferred options in a process that aims to be as participatory and inclusive as possible, encouraging women and more vulnerable groups to participate.

How can a village become climate-smart?

The process of implementing the CSV approach is simple.

First is a "baseline assessment", which is understanding the problem. This is done in a participatory manner, taking in the concerns and local knowledge of all the stake holders in the cycle. Historical climate data is analyzed to assess the risks and long-term suitability of the main cropping and livestock/fishery systems.

The next step is all about constructing the right basket of solutions—a portfolio of practices and technologies that will address food security, adaptation, and mitigation that need to be tested in the CSVs. "Typically this includes interventions which are water-smart, weather-smart, seed/breed-smart, carbon/nutrient-smart and/or market/institution-smart. All of these interventions are site-specific and are chosen after extensive discussion with women and men farmers/fishermen, local governments and researchers.

Once the plan is in place, the ground is set for creating evidence for other areas with similar conditions, problems and constraints. This is the real test of theory and on-the-field realities, and bringing all farmers/fishermen on board is critical.

And finally, the scaling up of useful technologies. Once intervention portfolios are successfully tried and tested, the evidence is used to contribute to scaling promising innovations.

This is done in two ways:

1. Farmer-to-farmer (or fishermen-to-fishermen) learning through self-help groups or associations. Messaging from a trusted source is the most effective way to spur farmers/fishermen to adopt new technologies and practices.
2. Sharing CSV research and lessons to influence large-scale CSA investment plans, promote mainstreaming of institutional changes, and inform policy instruments.

Case study from Karnataka

As per the concept of CSV, selection of most suitable villages for the study is most important. Historical database and surveys to understand the severity of problem is the most important phase.

According to the studies conducted by National Institute of Oceanography, mean sea-level-rise trends along the Indian coasts are about 1.30 mm/yr and future projections (global) indicate about 0.48 m (A1B) by the turn of the century. Saltwater/freshwater interface moves further inland which is causing the reduction and extinction of estuarine associated habitats and ecosystems. The estuaries are becoming more saline due to sea level rise and the low influx of fresh water from catchment due to various anthropological and climatic factors. This poses a very serious livelihood issue for the coastal population, depending on the estuarine fishery

The Energy Research Institute (TERI), India projected a map of coastal areas of vulnerability with 1 m rise in Sea level (by constructing weighted index). According to the study the coastal areas of Karnataka have highly vulnerable and moderately vulnerable regions.

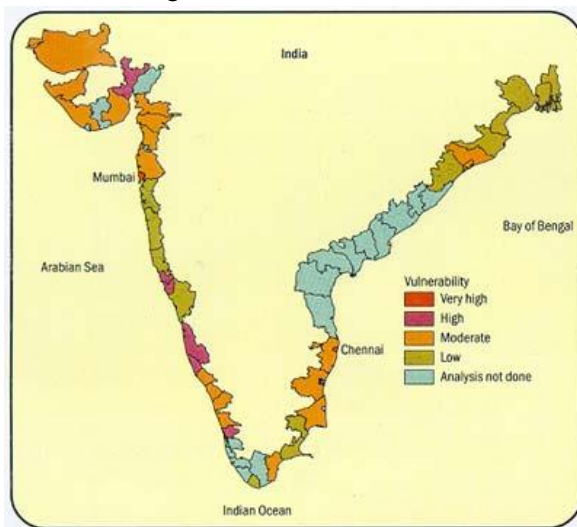


Figure 1. Vulnerability of coastal districts of India to sea level rise

To understand the holistic impact of climate change in Karnataka exhaustive surveys were carried out in coastal Karnataka. Karnataka's coastline stretches for 320 kilometres and consists of the three coastal districts namely, Uttara Kannada, Udupi and Dakshina Kannada. Of these, Uttara Kannada has 160 kilometre long

coastline, Udupi district has 98 kilometres coastline and the rest 62 kilometre length of coastline falls in Dakshinakannada district.

The vulnerability index of the three coastal districts of Karnataka were analysed by the method described by Dwarakish *et.al*, (2009). The five most important climate parameters such as demography, infrastructure, occupation, climate and fishery were used for the construction of the vulnerability index. It could be observed that, Udupi district has the highest vulnerability index of 0.460, followed by Dakshina Kannada with an index of 0.418 and Uttara Kannada with the lowest index of 0.362 (fig.2). Udupi district is vulnerable to accelerated sea level rise (SLR) due to its low topography and due to its high ecological significance.

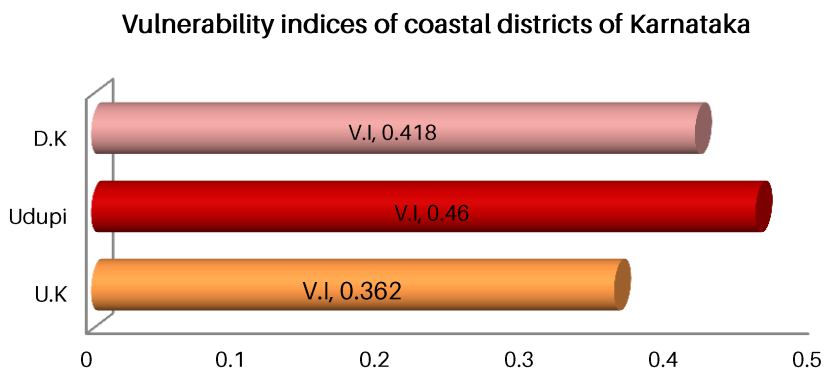


Figure 2. Figure showing the vulnerability Indices of three coastal districts of Karnataka

Selection of district

Based on the results of Integrated District Level Adaptation and Mitigation (IDLAM) studies, Udupi district was selected for developing CSV. IDLAM studies were carried out based on secondary data such as historical data on extreme weather events, sea erosions, loss in fishing days. Forty six kilometres of the total 95 km stretch of Udupi's coastline is under critical coastal erosion and sea water intrusion. Besides this, studies have revealed that, 59 per cent of the 95 km of shoreline of Udupi district is at a very high risk due to future sea level rise. (SLR) Besides, secondary data collection, Participatory Rural Appraisal methods (PRA) and Rapid Rural Appraisal (RRA) methods were used for the selection of the district.

Selection of the Village

For successful demonstration of climate smart technologies, willingness of both farmers/fishermen and local government to participate in the project is the major criteria. CMFRI have demonstrated various technology and Tharapati village in Byndoor was found to be most progressive village, highly receptive to all the technologies extended to them.

Tharapati Village in Byndoor is a progressive fishing village with fishing coastal hamlets Karkikali and Alvekodi. Hamlets are having scenic beauty a combination of clean water body in the sea and also with estuary of Suvarna River. Alvekodi, one of the northern hamlets at the mouth of Suvarna River is a hamlet with active fishing and fish landing areas, long and clean beach extending to river mouth. Greenery is mainly formed by coconut plantations and rich assemblage of mangroves. Most of the coastal fishermen thrive on coastal fishing and estuarine fishing. In earlier years the fishing was highly profitable venture and by year 2000, Alvekodi rose to a status of one of the most progressive village with organized fishing sector adopting self-regulation to ensure overall development.



Problem identification

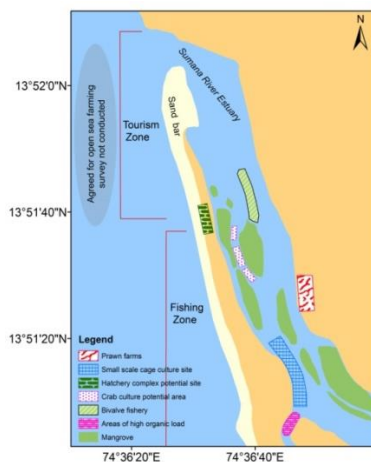
Fishery related issues

From year 2000 onwards low returns from the fisheries was felt as a major problem for the fishermen from the year 2000 onwards and it was found that estuarine fishery is totally collapsed. CMFRI has taken up scientific analysis of the issue of low catch from the sea and estuaries and found that heavy competition for limited resources in the sea is a major reason for reduction of catch per fishing units. Increasing number of fishing boats lead to low profitability. For understanding the reasons for the collapse of estuarine fishery, environmental studies were carried out and one possible reason observed was increased salinization of estuary, a reason for the fishery collapse of true estuarine species

like lady fish. Apart from the rainy time the salinity in the statutory remains more than 30ppt.

Measures for fishery resource enhancement:

CMFRI wanted overall development of the village, with peaceful co-existence for which GIS based Marine Spatial Planning concept was introduced for the first time in India with making spatial zonation for different activities in coastal and marine area of the village in which the areas were marked for fishing, marine cage farming, estuarine aquaculture zones, tourism activities and also are designated for aquaculture compile for envisaging future multi species seed production/ rearing area.



Economic use of mangroves as a supporting activity to give awareness of mangrove protection also included in the MSP in the MSP.

To increase the fish production from the fishing village, alternate fishery enhancement techniques were introduced in 2007. During 2008-2009, marine cages were experimented sea of Tharapathi Village involving most of the fishermen families from this area. Rearing fishes in open waters was the first exposure of such knowledge to the fishermen which revolutionaries the thinking of fishermen population in fish production. The experiments with seabass farming in sea and their hands on experience in the daily cage maintenance activities gave them the confidence to take up the fish culture as an alternative vocation.



Looking at the invest capacities of fisherfolk of the village. CMFRI have taken up the responsibility of providing demonstration and popularization of customized cages which can be further fabricated and operated by fishermen as a family occupation. Along with production increase, utilization of the sea water dominated estuarine arise which showed very low productivity due to climate change induced sea level rise was important motive with this customized cage introduction in estuaries.

First demonstration of the customized cages with CMFRI design was demonstrated in northern part of Tharapathi village in which all fishermen of the village were given hands on training in cage fabrication, cage maintenance in all procedures till harvesting and marketing.



The fishermen of the village showed extra ordinary skills in improving feasibility and production and the fish production per cage have risen to 1 ton/cage (6mX2mX2M) for one year 3.2t per cage in 20 months. This is the highest production reported from seabass farming in India and the fishermen of the village deserve appreciation and they should be made to feel the importance of their achievement.

Encouraged and empowered by the CMFRI customized cage demonstration, first cage made of Netlon was introduced in Alvekodi estuary by a group of fishermen and at present we can see more than 100 cages of different dimensions managed by fishermen of the estuaries.

The success story of the village has attracted media attention and all important print media and visual media including Doordarshan telecasted the success story with great importance. Production from first demonstration cage was 400kg of Seabass and 200 Kg of red snapper which fetched a total revenue of Rs. 1.8 lakhs. In 2017 the fish production from the estuary was 20 t (from about 80 cages @ 250kg).



Improving the self-esteem of the fishermen was found to be a major catalyzing factor for the technology transfer and acceptance and for boosting the self-esteem of the fishermen harvest meals felicitating the fishermen were conducted time to time by inviting very reputed personalities from various walks of life. The boosting of their self-esteem at different phases led to revolution in fish production from small scale cages.



Low productivity per cage was due to non-availability of sufficient seeds to stock in full capacity of cages and the value realized for the production in 2017 was 80 lakhs. Fish cutting waste from fish cutting centres, Fishing harbours and hotels

were routed to the village for feeding fishes. Insufficient seed availability is the major limitation for higher production.



To increase the production from the limited water body the concept of “multi trophic aquaculture” was introduced in the Village in which green mussels were grown along with fish culture cages and further to improve production seaweeds also introduces in the finfish cages as a future avenue to be looked up on to produce more income from a limited water body. To sustain the production from these customised cages without environmental and disease problems, the carrying capacity of the estuary was estimated with scientific methodology.



The carrying capacity for the estuary was estimated to be 50 cages of 6mX2mX2m dimension with a stocking density of 12,000 seeds. Anticipated production from these cages will be 1 t. If well managed the production from the estuary per year is estimated to be 50t, 20 t more than present production with substantial reduction of existing number of cages. As per the studies conducted any increase in number of cages (above 50numbers) will lead to lower production and lead to environmental and disease problems.

Sea weed farming was introduced as an alternate vocation to improve seaweed production from village and also to improve the livelihood avenues. In

carbon sequestration context also the seaweed farming was proposed as a possible technology for immediate future.

Problem identification of issues apart from fisheries

Scarcity of drinking water

Scarcity of drinking water was the major problem pointed out and rain harvest methodologies were introduced in a limited manner. Low returns from the fishery are projected as major outfall of climate change and awareness regarding alternate vocation was an immediate requirement.

The fisher women who were involved in daily routines of fish collection, fish carrying and also in fish sales were turned jobless and the income generated through the fishing related activity is totally stopped during last few years. Rain harvest system was introduced and Officials from NABARD and Ministry of Environment and Forest were brought to the Village for further plans for improving water scarcity issues in futuristic perspective.



Project formulation with NABARD support is under preparation.

Lack of awareness about alternate Vocation for coastal families

Looking at the present status and future pressure CMFRI conducted a workshop introducing alternate vocation in which all members from the house can be participated. Officials from agriculture/ horticulture/ livestock/ fisheries departments and KVK resource persons explained the possible activities to be taken up for increasing the income from alternate sources so as to keep the fishermen diverting for unskilled sectors in urban areas by empowering them in alternate income generation possibilities.

During the discussion in the workshop, the coastal people were given an opportunity to express their interested in different activities explained in the workshop and a farming groups were created. As an immediate follow up of the workshop the coastal fishermen households having coconut plantations were made into Society and the society was registered in the agriculture department and free fertilizers were provided to these cooperative under State government schemes.



The workshop created lot of interest in coastal population especially women folk in the village. They showed their interest in making for alternate livelihood and the immediate action planned was horticulture development and poultry. Since the land area is limited, grow bag based vegetable farming was planned and the seeds of Tomoto, Chilly, and Brinjal were grown to sapling stage form at nurseries and farms of Department of Horticulture Brahmavar and it was transported to Alvekodi. 20 grow bags each were distributed with saplings of these plants and also seeds planted of r different gourd varieties.

Since the poultry farming also can be done in limited area chicks of two fast growing varieties "Giriraja" and "Suvarna Dhara" grown by Department of Poultry Department of Karnataka with 10 chicks each were distributed to coastal fishermen. Vegetable production from the village increased substantially. Poultry also helped in improving income level.



Achievements so far

The biggest achievement so far is the empowerment of fishermen to alternate livelihood vocations, making them self-confident in taking up alternate vocations. The fish production through cages improved financial status of the fishermen and many of the fishermen who were about to leave villages due to lack of regular income could be used for the development of the village with alternate vocations. Due to low catch per boat operation the fishing intensity and engine capacity also were increased leading to high fishing pressure and high CO₂ emissions from fishing sector, the knowledge about the alternate vocations made some of them divert their fishing pressure for low carbon technologies like agriculture and horticulture farming and fish culture.

The villagers were introduced to the various authorities in government and non-government sector so that they can address their problems and get the possible solutions for their livelihood issues. They were exposed to various development schemes being organised by government and non-government sectors to make use of maximum use of the schemes. The major organizations introduced to the CSV were Department of agriculture/ horticulture/ livestock/ fisheries of Government of Karnataka, KVKs, non-governmental organizations like ATMA, NFDB, Officials from different commercial and cooperative banks, Officials from CRZ and ministries of environment and forest and Ministry of agriculture, policy makers like members of legislative assembly, suppliers of fish seed and fish feed, media like Doordarshan, various TV Channels, National and local print media etc. Alvekody hamlet of Tharapathi village is a well-known village in coastal Karnataka and the village is fighting hard to combat the vagaries being felt from climate change and low fish catch with adequate support from CMFRI and other organisations.