INDIA – Coastal Tamil Nadu

Challenges and Prospects for Adaptation: Climate Change & Disaster Risk Reduction in Coastal Tamil Nadu

CRA Toolkit
CASE STUDY

This case study is part of a broader ProVention Consortium initiative aimed at collecting and analyzing community risk assessment cases. For more information on this project, see www.proventionconsortium.org.

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http://www.proventionconsortium.org/themes/default/pdfs/winds_of_change.pdf

Click-on reference to the **ReliefWeb country file for India**:
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Note:
A Guidance Note has been developed for this case study. It contains an abstract, analyzes the main findings of the study, provides contextual and strategic notes and highlights the main lessons learned from the case. The guidance note has been developed by Dr. Ben Wisner in close collaboration with the author(s) of the case study and the organization(s) involved.

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CHAPTER

Challenges and Prospects for Adaptation: Climate Change and Disaster Risk Reduction in Coastal Tamilnadu

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Case Study Guidance Note

Country: India
Location: Tamilnadu
Date: May 2007
Sector and Spatial focus: Coastal fishing and coastal agriculture
Title: Challenges and Prospects for Adaptation: Climate Change and Disaster Risk Reduction in Coastal Tamilnadu
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Abstract

This case study examines the challenges of climate change impacts and disaster risk reduction strategies in Tamilnadu. It outlines the existing prevalent responses by the people and by the government. Adaptation processes and strategies currently undertaken needed to better cope with future climate change impacts are discussed. These include the context of the potential rise in sea-level, accelerating sea erosion, increasing risks from cyclones and storms, the ongoing flooding and inundation due to backwater and freshwater floods, droughts, increasing salinisation of land and groundwater, etc. The Tamilnadu study is being undertaken in three ecosystems where the basic livelihoods are fishing and agriculture.

Technical Description

- **Hazard/risk type:** High wind speeds with heavy rainfall, flooding, sea water ingress, inundation, salinity of land and groundwater, excessive heat
- **Type of assessment:** Vulnerability and risk assessment, initial cost-benefit analysis and strategies for possible interventions, long-term adaptive strategies.

Contextual Notes

- Tamilnadu's 1,061 km of coast is the second longest coastline in India. The livelihoods of millions of people are supported along this coastline, based on marine fishing and fishing in numerous backwaters. 700,000 people depend on marine fishing for their livelihoods, spread over 591 coastal villages. Many hundreds of fishermen and farmers are already facing severe threats due to the pollution load dumped in the backwater rivers by industries, cyclonic storms, floods in the Cauvery River, sea water flooding agricultural land, etc. They are constrained due to lack of skills to diversify from their traditional livelihoods. The potential impacts of climate change are quite likely to aggravate the problems already confronted by the people.

Research and Analytical Process

- Methods / tools used: Initial secondary data collection from various governmental and non-governmental sources, literature collection, time-series data collected from the Indian Meteorological Department, a series of shared learning dialogues at village, mid- and state levels, ranking potential costs and benefits of strategies to reduce risks as perceived by communities, etc.

Key Insights Generated for Vulnerability Reduction and Capacity Enhancement

A. For fishermen in all ecosystems:

- Except in some places there is no bio-shield in the villages. Mangroves could benefit and save the fisher population. Many people have shown a preference for coconut trees as bio-shielding.
- People need to aquire non-fishing skills such as carpentry, masonry, electrical works, plumbing operations, heavy vehicle driving and communication.
- Access to insurance and credit.
- Training in fish processing such as manufacturing of fish pickles, prawn pickles and tinned fish, and training in exporting these goods.
- Need better schools and particularly education in the English language.
- Everyone appreciated the idea of a community FM station for information dissemination during times of disaster.
- Safe drinking water is one of the most important demands. The groundwater is saline and polluted.
- A Village Information Center (VIC) is considered a good facility but needs to be integrated with people's preferred needs. There is a case for strengthening existing VICs by providing them with reliable climate information.
- Sponsoring young boys and girls for industrial training, computer training, science courses, training in NGO activities and the English language.

B. For agriculture dependent populations in all ecosystems:

- Skill acquisition in non-farm activities such as industrial trades (fitter, welder), carpentry, masonry, plumbing, electricals and electronics servicing.
- Sheep breeding and dairy, fodder which could be grown within the village even on saline land (*subapul*, for example, is a salt resistant fodder crop). Several other crops could be grown in brackish water and used as animal fodder. Sheep breeders are less affected by these problems.
- Poultry farming as another alternative livelihood.
- Training in brackish water shrimp and fish farming.
- Sponsoring young boys and girls in employment oriented courses such as industrial training, computer training, science courses, training in NGO activities, English language courses, etc.
- VIC and FM radio services.
- Improving the local library with Tamil and English newspapers for information on education and employment opportunities.

Strategic Notes and Lessons Learned - Key Points to Emphasise

- Compared to the vulnerable groups, those who are unaffected by disasters face lesser impacts due to key behavioural or other differences. These differences, once identified, can be used as points of leverage for removing the same factors that make other groups vulnerable.
- Shared learning dialogues were found to be an extremely useful method to analyse and document risks and vulnerabilities of different groups. These methods also allow the identification of non-land based and non-fishing based livelihood strategies for reducing vulnerability and enabling adaptation.

Keywords: Coastal livelihood, Tamilnadu, climate change, disaster risk reduction.

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Introduction

Coastal cities and towns of Tamilnadu are vulnerable to the impacts of climate change.

People living in Low Elevation Coastal Zones, areas within 10 meters above sea-level, are, according to a study carried out by Gordon McGranahan from the International Institute for Environment and Development, highly vulnerable to the impacts of climate change, particularly sea-level rise.[1] In India, over 63 million people live in this low elevation zone. Gujarat and Tamilnadu, where the coasts are over 1,000 km long, will be the most affected states. Orissa and Goa are also highly vulnerable to sea-level rise.

Within Tamilnadu, the worst affected region will be the Cauvery delta, which encompasses the whole of Nagappattinam District and parts of Cuddalore District. The Cauvery delta's 1,800 year-old irrigation system is a complex network of rivers, canals and drainage systems with thousands of miles of canals and channels. Nagappattinam District, which almost entirely lies within the delta, is a narrow stretch of land 165 km long and 15-20 km wide. This district has two major disadvantages: a) most of the district falls within the low elevation coastal zone, and b) 56% of the land also lies below sea-level. A further 18% of the district which is just at sea-level is water-logged and marshy. Already the Cauvery delta, on the whole, suffers from saltwater intrusion up to five kilometres inland, as well as severe drainage problems. Due to its flat terrain, the region is prone to flooding from drainage canals and sea water, particularly during the October to December monsoon months when most of the monsoon rain falls within a few days and is often combined with cyclones and high wind storms.

In the Nagappattinam District, 90% of the population consists of small and marginal farmers with a very high concentration of landless agricultural labourers. Furthermore, the coastal region of Tamilnadu is very densely populated (528 people / km^2, almost double the state average of 372 people / km^2). Pollution and land degradation from rapid industrialisation along the coastal region, and in particular in the cities of Chennai and Cuddalore, has further aggravated the situation and made coastal cities and towns more vulnerable to the impacts of climate change. Many chemical, textile, oil refinery, thermal power and fertiliser industries are established along coastal zones for easy disposal of effluents into the sea. The predicted impacts of climate change such as sea-level rise, increasing intensity and frequency of cyclones and storms, coupled with existing anthropogenic factors, will aggravate this already vulnerable situation. Long-term, non-land based adaptive strategies are needed for the region rather than simple engineering solutions.[2]

All adaptive measures undertaken to date have been ad hoc and structural,

[1] The Hindu, March 29, 2007

[2] NCRC (2007), Mapping and Study of Coastal Water Bodies in Nagappattinam District.

with largely no effect. Non-land based, long-term disaster preparedness, risk reduction strategies and early warning systems have not been part of any policy planning framework so far. The present case study aims to look at adaptation from a much broader perspective.

Objective

This case study examines the challenges of climate change impacts and disaster risk reduction (DRR) strategies in selected districts of coastal Tamilnadu. It also outlines the responses made by the people of Tamilnadu governments. The processes of adaptation currently undertaken and strategies needed to better adapt to future climate change impacts are discussed in the context of potential rise in sea-level, accelerating sea erosion, increasing risks from cyclones and storms, the ongoing flooding and inundation due to backwater and freshwater floods, droughts, and increasing salinisation of land.[3]

Concepts and Key Issues

Certain behavioural or other attributes allow some people to remain relatively unaffected by the impacts of climate change. We need to work with communities to identify these differences in behaviour or other attributes. By doing so, we can identify points of leverage (policy, infrastructure, etc.) for removing the constraints that limit affected groups from undertaking the same changes in order to reduce their vulnerability to the same impacts. Then we can identify strategies that will be able to respond to local conditions and the incentives of the local groups. This idea is being developed as follows:

- Mainstream disaster risk reduction strategies as part of the regular planning and policy processes. This task involves a comprehensive assessment of risk and vulnerability, identification of existing coping strategies, and developing ways to strengthen the capacities of vulnerable communities to respond to these changes.
- Establish links between concepts (such as disaster risk reduction and adaptation to impacts of climate change), shared learning dialogues as a two-way learning process to understand the impacts of climate change and community-based risk reduction, and other strategies.
- Incorporate climate change information into community-based risk reduction strategies facilitated through shared learning dialogues.
- In order to develop effective mechanisms for adaptation, identify groups less vulnerable than others to the impacts of climate change and those factors that constrain or enable different groups to respond to disaster events.

An increase in sea-level implies a major risk to those whose livelihoods depend on coastal ecosystems. These communities will clearly need support to offset climate change impacts. At a

Non-land based, long-term disaster preparedness, risk reduction strategies and early warning systems need to be promoted.

[3] A backwater river is that part of a river, within a delta, that is brackish and represents the interface between freshwater flowing from inland and sea water moving inland as a result of tides, sea-level rise, and a decrease in freshwater flow.

minimum, the state must play a facilitating role to enable coastal communities to transition and adapt to changes to their ecosystems. The knowledge and awareness local communities have about climate variability and change including its impacts and how they will be affected needs to be identified.

Communities need support to offset climate change impacts.

This chapter first discusses the demographic characteristics, including livelihood occupations, of each case site. It then outlines a description of the existing hazards of each area and how climate change might impact these areas. The next section discusses the process of shared learning dialogues and vulnerability analyses and describes the key insights obtained. Then a discussion on the benefits and disadvantages of strategies identified for pilot implementation plans in each site follows. The final section discusses the project methodology and concepts summarising the key insights from the current research in Tamilnadu.

Tamilnadu: Coastal Area, Ecosystems and Vulnerability

The coastal ecology of Tamilnadu is highly degraded.

Among the coastal states of India, Tamilnadu's 1,061 km of coast is the second longest. Of the state's approximately 62 million people, about 29 million live along the thirteen coastal districts[4] whose livelihood is dependent on marine fishing and fishing in numerous backwaters. In 2003-04, 381,000 tons of fish were caught in the state, about one quarter of which was caught by small fishermen using non-mechanised boats. All along the coast, agriculture is another important livelihood. Tamilnadu's coastal wetlands have high hydrological, biological and socio-economical values.

The state's coastal area is exposed to multiple hazards: coastal floods, tsunamis, storm surges, cyclones and strong winds (Map 1). Along with the states of Orissa and Andhra Pradesh, Tamilnadu is most affected by cyclones. According to Kavikumar and Tholkappian (2006), India's eastern coastal districts (including those in Tamilnadu) are more vulnerable to coastal disasters than districts on the west coast. According to the Asian Disaster Preparedness Centre, four times more cyclones are formed in the Bay of Bengal than in the Arabian Sea. In addition to these hazards, coastal Tamilnadu faced a devastating tsunami in December 2004. The giant sea waves affected about one million people living in 376 coastal hamlets, killing an estimated 10,000 people. Most of the damage occurred in Cuddalore and Nagappattinam districts. The United Nations-Asian Development Bank-World Bank Joint Assessment Mission estimated the total direct damage at US$ 437.8 million, with an additional estimated US$ 377 million in loss of livelihoods.[5]

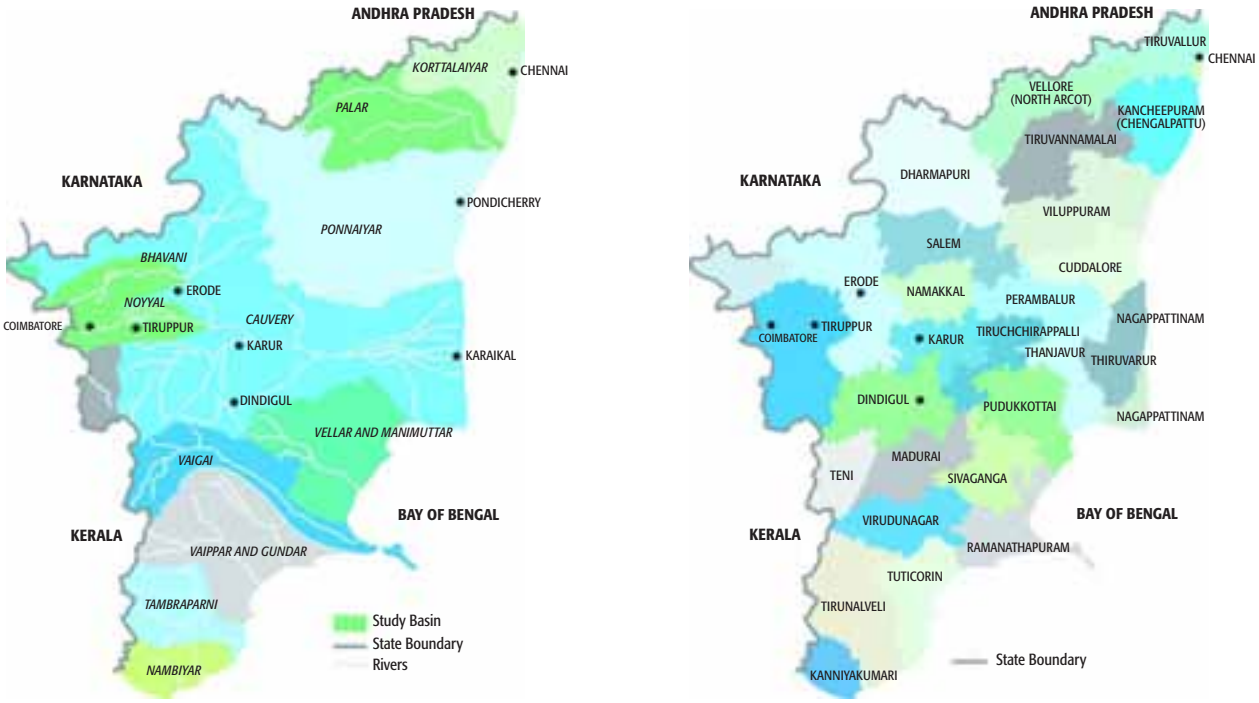
The coastal ecology of Tamilnadu, as with similar ecosystems elsewhere in India, is polluted with industrial wastes, groundwater is over-extracted, sea water ingress and sea erosion are in advanced stages, marine resources are over-exploited, coral reefs and mangroves are degraded. The threat of sea-level rise and other coastal hazards substantially aggravate the vulnerability of the coastal population. Studies indicate that there is a long-term trend in sea-level rise of about one millimetre a year, projected to rise to 2.5 mm a year. This compares to the global trend in sea-level rise of 46-59 cm[6] over the period of 2000-2090. This would amount to a 20+ cm sea-level rise along India's coastline for the same period. This is likely to represent a minimum since emerging scientific information suggests rates of sea-level rise may accelerate. Even given this low rate of rise, according to Aggarwal and Lal 0.41% of India's total coastal area and 4.6% of the coastal population (7.1 million people) could be

[4] Census data (2001)

[5] Krithika Ramalingam, India Resource Center, May 20, 2005.

[6] Diksha Aggarwal and Murari Lal: Vulnerability of Indian coastline to sea-level rise, http://www.survas.mdx.ac.uk/pdfs/3dikshas.pdf, accessed May, 2007.

MAP 1 | Tamilnadu river basins and districts



Source: S Janakrajan (1999)[10]

directly affected (TERI, 1996). The most vulnerable areas along the Indian coastline are the Kutch region of Gujarat, Mumbai and South Kerala, deltas of rivers Ganga (West Bengal), Cauvery (Tamilnadu), Krishna and Godawari (Andhra Pradesh) and Mahanadi (Orissa). The islands of Lakshadweep Archipelago would be totally lost. In terms of population, West Bengal, Maharashtra and Tamilnadu would be worst affected because of their high population density. The paper indicates that 0.07 million hectares of Tamilnadu's total coastal area of 13 million hectares are likely to be inundated by sea-level rise. The inundation will affect over 1.62 million people.

The Tamilnadu coast also sometimes experiences severe cyclonic storms in the October-December monsoon (Appendix 1). A study by Antonio Mascarenhas indicates that more than 1,000 cyclonic events have occurred in the Bay of Bengal in the last century.[7] Of the documented cyclonic storms, 55 crossed the coast of Tamilnadu, 69 hit Andhra Pradesh, 58 affected Orissa and 33 struck West Bengal . Mascarenhas quotes a study by Mani (2000) about historical cyclone events in Tamilnadu which shows that one event produced wind speeds exceeding 250 km / h and caused a 12m storm surge. Table 1 summarises the information available in Mani's study.

[7] Dona, P., Need for Setback Lines in Coastal Zone Management: A Meteorological Point of View, National Institute of Oceanography, Goa, India.

TABLE 1 | Wind Speed, Storm Surges and Inland Penetration of Saline Water Associated with Cyclones Along the Coast of Tamilnadu.

Period	Area affected	Wind speed (km/h)	Storm surge height (m)	Inland penetration (km)
November 1952	South Nagappattinam	Not recorded	3	8.0
December 1955	Thanjavur	200	3 to 5	3.0 to 8.0
October 1963	Cuddalore	139	6	Not recorded
December 1964	Rameswaram	193	3 to 5	Not recorded
December 1967	Nagappattinam	130	Not recorded	Thanjavur area
November 1978	Ramanathapuram	212	3 to 5	Not recorded
November 1991	Near Karaikal	89	Not recorded	0.25
December 1993	Near Karaikal	133	3 to 4	2.0

Source: Mani (2000)

The many types of hazards in coastal Tamilnadu debilitate the existing livelihoods of the region. Other challenges include changes in the coastal ecosystem, land use patterns that are socio-economically and environmentally degrading and sea-level rise and saltwater intrusion into coastal aquifers.

Study Sites

For the purposes of this study, three distinct ecosystems defined by access to livelihoods and availability of coastal wetlands were identified. In ecosystem I, the only livelihood is fishing; fishing and agriculture are the main livelihoods in ecosystem II, whereas ecosystem III is dominated by dry-land agriculture and backwater fishing. The particular issues facing each ecosystem and the potential impacts of climate change on each of the sites is discussed in detail further below.

Ecosystem I: Cuddalore Old Town[8]

Cuddalore Old Town (OT) (Map 2) has a population of about 30,000 whose main source of livelihood is marine fishing, supported somewhat by fishing in the Uppanar River. A small percentage of the population is small vendors, construction workers, road builders and industrial workers. Fisher folk belong to the community called *Parvatharaja kulam*, which is classified by the government as the most backward caste. Children as young as 14 stop going to school and are involved in fishing activities. Only about 10% of the population has attempted to diversify into other sources of livelihood.

Shared learning dialogues were conducted in the Sonankuppam area of Cuddalore OT. These dialogues showed that there are only three castes of people in the area. Of the 547 households in Sonankuppam, 545 belong to the *Parvatharaja kulam* caste, with only one each from the scheduled caste and the caste of washermen. Of the 545 *Parvatharaja kulam* caste households, 91% are fishermen and 7% sell fish. The remaining 2% are government workers, seamen, weavers, small vendors, NGO workers and

Many types of hazards in coastal Tamilnadu debilitate the existing livelihoods of the region.

[8] The response we received from the residents of Cuddalore Old Town was very weak and discouraging. People demanded money for every interview. This new behaviour, known as 'tsunami money', is a result of the flow of donations that came after the devastating 2004 tsunami. Nevertheless, the researchers still managed to obtain instructive information.

MAP 2 | Cuddalore old town

drivers. Table 2 below shows the educational level of the population of Sonankuppam.

Box 1 explains the kinds of problems confronted by children, especially school dropouts.

The Uppanar is a 30 km-long, backwater river along which 21 fishing hamlets are situated. This ecosystem is not only threatened by sea-level rise, coastal storms and cyclones, but also by increasing pollution. The growth of Cuddalore Old Town has made it one of the most polluted areas. Around thirty industries producing pesticides, pharmaceuticals, dyes and paints discharge their wastes into this ecosystem and their effluents have also polluted the groundwater on which the villagers depend. Ever since they began operating, in 1980, the local people have been complaining about air, water and land pollution.

The industrial effluent is discharged directly into the Uppanar River, affecting the livelihoods of small fishermen spread over 30 villages along the river's 28 km stretch. The residents feel that industrial pollution is a slowly unfolding disaster, with the fish catch having gone down by 80% since the industries opened. Some species of fish, such as *sudhumbu*, *navarai*, *sura*, *yeral*, and *kanavai*, have completely disappeared. Until two decades ago, shrimp catch in the backwaters was meant for export. Today, there are no shrimp. Whatever fish is caught cannot be sold because the fish smells of the chemicals. Instead, the fish is dried and sold to poultry feed manufacturers. Over 100,000 people who depended on river fishing, small-scale salt production and small-scale farming have lost their livelihoods due to the release of untreated industrial effluents. Those who have lost their fishing livelihood have become casual labourers. Since the labour market is not guaranteed, they face uncertain futures.

TABLE 2 | Educational Status in Sonankuppam

Sex	Population	Illiterate (%)	Students who completed primary School (%)	Secondary school dropouts (%)	Final year dropouts	Number going to college
Male	1240	40	26	23	10	1
Female	1222	41	30	20	8	1

BOX 1 **Problems faced by school dropouts in Sonankuppam**

We interviewed Madhavan, a 17 year-old boy who had to drop out of school in the 8th grade. His story is similar to hundreds of other young men of Cuddalore:

As a young boy, he was often late for school because he had to do his share of the household chores. His punishment for being late was to be beaten, which he feared. Then, three years ago, when he was in the 8th grade, his father suffered a fishing accident and became physically handicapped. Madhavan was forced to work to earn the family income, and became a coolie fisherman. But Madhavan does not like fishing. He gets up at 3 a.m. every morning and spends anywhere from seven hours to one week out at sea. The owner of the boat he operates does not allow him to return from sea empty-handed. When the sea is rough, Madhavan prays for his life, vouching never to go out again; but he has no alternative. Handling the fishing net is not easy, and yet, "I will be scolded and abused if I do a bad job" he told us. Fishing is difficult and very tiring, and yet, as soon as he returns from sea he cannot rest but must immediately lay out the net to dry, or else the next fishing trip will be delayed. On the day of our interview with him, Madhavan had gone out to sea at 3 a.m. and returned at 10 a.m. with two edachi fish weighing four kilos each. The Rs. 400 obtained from their sale was divided into three shares – one for the boat owner, one for the net owner, and the last equally divided among five labourers. Madhavan's own share was Rs. 40, which he gave to his parents. Madhavan is determined to see his 13 year-old sister, currently in grade 9, complete school.

These same chemical industries also release volatile organic compounds which have polluted the air to the point of causing chronic respiratory problems such as throat infections, constant headaches, tuberculosis, dermatological problems, gastroenteritis, early tooth decay (even in children), miscarriages and high incidences of irregular menstruation. We even came across eight young cancer patients. Many complained that even cooked food and the water they drink smells and that children sometimes vomit after eating. We observed in every village of Cuddalore OT that relatively new buckets (less than six months old) used to store groundwater were red from chemical residue. Until 1990, good quality groundwater was available below 10 feet. Today, the water table has dropped and the quality of the water is too poor to drink. Proposals for a new textile park, a PVC plant (Chemplast) and a petroleum refinery (Nagarjuna) threaten further environmental degradation.

Ecosystems II and III: combined characteristics

Ecosystems II and III are the most common on the Tamilnadu coast. Both fishing and agricultural populations exist here. As a result, unlike in the first ecosystem, villages are made up of multiple castes. Furthermore, these villages are larger and their populations distributed across many hamlets (Table 3). The population densities of 910 / km^2 in Vanagiri and 726 / km^2 in Pushpavanam villages are higher compared to the state and national averages of 528 / km^2 and 272 / km^2 respectively. The characteristics and livelihoods of the selected villages of ecosystems II and III are described in detail below. Each hamlet in each village is separated by caste and by livelihood, with fisher folk living on the coast and farmers inland. There has long been animosity between fishing and farming communities, such that the two do not mix. The main risks confronted by different social groups of Vanagiri, Pitchavaram and TS Petai villages are the same mentioned earlier for Ecosystem I.

TABLE 3 | Population, Number of Households and Hamlets, and Size of the Selected Villages in Ecosystems II and III

Ecosystem and village	Population			Number of households	Number of Hamlets	Total area (km²)	Population Density (per km²)
	Male	Female	Total				
Ecosystem II Vanagiri	3,670	3,622	7,292	1,623	9	8.01	910
Ecosystem II TS Pettai	554	569	1,124	281	2	3.17	354
Ecosystem II Pitchavaram	2,550	2,500	5,050	614	6	6.64	384
Ecosystem III Pushpavanam	3,150	3,100	6,250	1,779	11	8.60	726

The suitability of certain crops comes into question in a changing climate context.

The Kollidam, the main flood barrier of the Cauvery River is breached at least once every five years causing total loss of crops in TS Pettai and Pitchavaram villages. These villages are located at the tail end of the Cauvery delta where water drains into the sea. There are a good number of backwater rivers whose floods inundate agricultural land during dry months (March September) when the Cauvery drainage canals are dry. Furthermore, sea water floods these agricultural lands, greatly increasing land and groundwater salinity. 50 years ago, the arrangement in the Cauvery delta was to let tail end regions receive irrigation water first. This practice has enabled farmers to start cultivation in June. But, with less water available in the Cauvery River, farmers upstream violate the practice and irrigate their fields. As a result, arrival of water to the farmers in the delta is often delayed until September, which coincides with the northeast monsoon. The canals act as flood conveyers and damage the crops. The original seasons of *kuruvai* and *samba* have disappeared; paddy and groundnut (winter crops) are cultivated in the *navarai* season starting in December and ending in April-May. Even one heavy spell of rainfall inundates land and it can take months for the floodwaters to recede. This occurs more often in Pitchavaram and TS Pettai. The main crop, paddy, is now only cultivated once a year. Groundnut once yielded 25 to 30 bags of pods (one bag weighs 40 kgs) per acre but now only yields 10 to 15 bags per acre. Groundnut is sensitive to climate conditions: both excessive heat and too much water lower the groundnut yield. The suitability of this crop comes into question in a changing climate context.

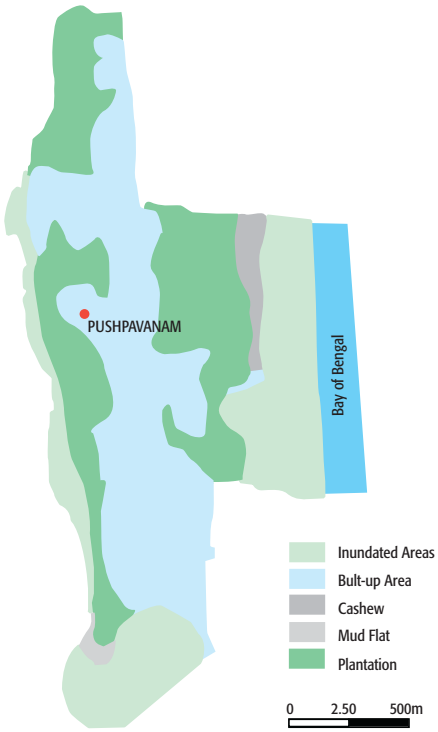
Ecosystem II: Fishing and agriculture are the two major livelihood activities for the villages of TS Pettai and Pitchavaram in Chidambaram taluk, Cuddalore District and Vanagiri village in Sirkazhi taluk, Nagappattinam District. Most of this ecosystem lies within the deltaic region of the Cauvery River. Besides coastal flooding, high flows in the Cauvery River and its numerous backwater tributaries cause inundation, the natural flooding cycle of the Cauvery River having been altered by upstream interventions. The use and allocation of the Cauvery water is an issue of heated dispute between the states of Tamilnadu and Karnataka. Since the late 1970s, the river acquired a seasonal character (it was perennial before), remaining dry for over six months of the year. This change in the river's hydrology has increased the occurrence of flooding from the sea and has aggravated salinisation of the land and groundwater, making drinking water

scarce. This salinisation and reduction in freshwater flow is also threatening the 3,500-acre Pitchavaram mangrove forest.

Ecosystem III: In this ecosystem, the main livelihood is agriculture, while marine fishing supports a small section of the local population. Pushpavanam (Map 3) is surrounded by backwater rivers on three sides. Although the village lies within the delta, gravity flow irrigation from the Cauvery River is impossible because it is at a higher elevation. In the immediate post-monsoon period, the groundwater level is about 10 feet underground. In the summer months, the level drops and the water salinity increases. As a result, drinking water is dangerously scarce and irrigation very difficult. Crops are mostly rain-fed and paddy crops are planted by directly sowing the seeds rather than transplanting seedlings. Sea water flooding is a constant threat.

Nagappatinam District: On the whole, the district of Nagappattinam (most of it lies either below sea-level or between 0-5 m above sea-level) and one taluk of Cuddalore District (where all four villages selected in Ecosystems II and III are located) are vulnerable to inland (from the Cauvery River) and sea water flooding. Sea water inundation is leading to salinisation of soil and groundwater and the situation is likely to continue because of the complete lack of drainage over a large stretch of land in the Cauvery delta. The farmers say that even though normal rainfall in Nagappattinam District is only 970 mm, lack of drainage and sea water flooding gives the impression of very heavy rainfall. Since several parts of this district are below sea-level, the flooding damage is serious

MAP 3 | Pushpavanam village

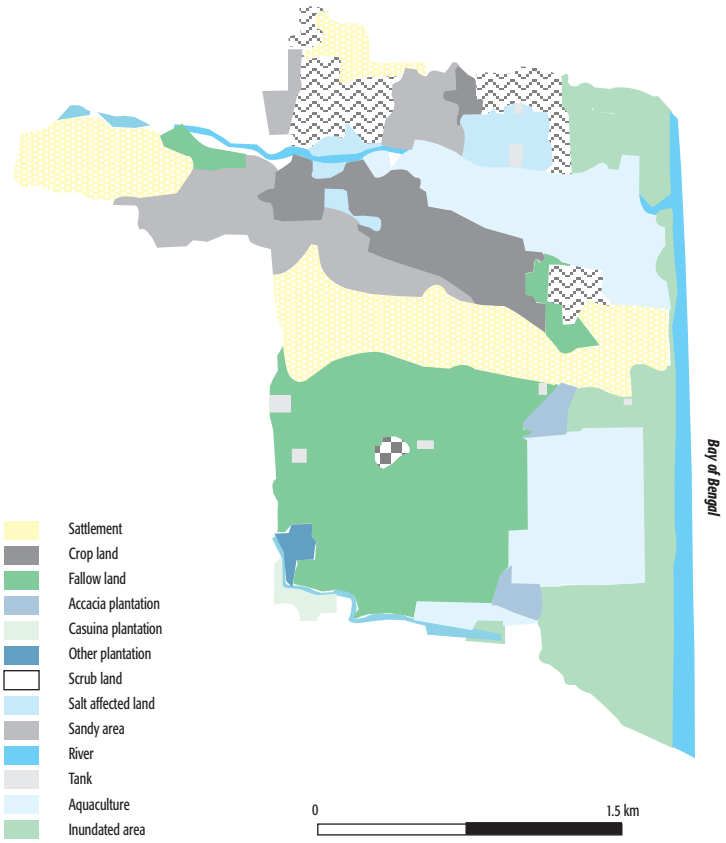


Drainage congestion and floods add to poverty and food insecurity. The absence of access to credit means that people have nothing to hedge against these debilitating factors, and this adds to their stress. People are forced to migrate and seek livelihoods in casual employment. In particular, the most affected are the landless agricultural labourers and small and marginal farmers, comprising about 85% of the total agricultural population in Nagappattinam District.[9] Because they belong to deprived castes, the situation is more serious. Money lenders charge interest rates of up to 120% per year and further exploit the situation.

Inundation by sea water is leading to salinisation of soil and groundwater.

Vanagiri (Ecosystem II): 7,292 people live in 1,623 households distributed over 9 hamlets. There is very little diversification of livelihood in Vanagiri:

MAP 4 | Vanagiri village



Money lenders charge interest rates of up to 120% per year and further exploit the situation.

over 90% of the population is engaged in the traditional livelihoods of farming, dairy or fishing, 8% are landless agricultural labourers and 0.7% are wholesale fish merchants. Fully 374 households in this village are headed by women (widows), over half of which belong to the fishing community. This attests to the fact that the mortality rate among fishermen is high. About 50% of the agricultural land has turned saline or brackish.

TS Pettai (Ecosystem II): 41% of the people of TS Pettai are farmers who also engage in non-farm activities, 16% are landless agricultural labourers who also engage in non-farm activities, and 43% are fishermen and also engage in non-fishing activities such as construction. About 20 people from this village work in Singapore, Saudi Arabia or Dubai, indicating that there is some diversification of livelihood. About 120 men also seasonally migrate to Kerala for agricultural work and fifty families have settled in Ahmedabad, working in an asbestos cement factory. In addition, many have become construction workers and traders. This diversification in livelihood has resulted in a shortage of agricultural labourers in TS Pettai.

Pitchavaram (Ecosystem II): This village is known for its mangrove forests, governed by the forest department. The village has six hamlets with a total population of just over 5,000. There is less livelihood diversification here than in TS Pettai: farmers make up over 60% of the population, landless agricultural labourers 15%, construction workers (and other non-farm livelihoods) 15%, with small businessmen, fishermen and traders making up the rest. 75% of the agricultural land has turned saline or brackish due to sea water ingress.

Pushpavanam (Ecosystem III): Unlike the three other villages, Pushpavanam is a dry village with no access to irrigation. The majority of the population is either farmers (38%) or landless agricultural labourers (42%), while 9% are fishermen and the rest small traders or construction workers. 68% of the households live below the poverty line. Paddy is the main crop which is grown using the broadcasting method. This village is surrounded by backwater

[9] Based on the study by NCRC

rivers on three sides and by the Bay of Bengal on the fourth side. Both drought and flood affect the village. Excessive heat and drought conditions create a famine-like situation. Cyclonic rainfall brings floods and destroys huts. With each cyclone, sea water ingress contributes to salinisation of the land and groundwater.

The monsoon is erratic and rainfall untimely. In the past, the Aadi (mid-June) rain was accurate and timely, helping the broadcast method of sowing. But in the last 10 years, there is either no or uncertain rainfall in the month of Aadi. In addition, the north-east monsoon brings excessive rainfall in a few days, flooding the land. This is true of all other villages selected for this study.

Shared Learning Dialogue and Vulnerability Analysis

Shared Learning Dialogue (SLD)

The emerging climate change context warrants a community-based approach for gathering information and offering risk reduction strategies both in the short and long run. Furthermore, information gathered through research from various sources should be disseminated to community members through a two-way dialogue. The unique feature of shared learning dialogues is that it is an interactive exercise involving various stakeholders / agencies such as government, private sector, non-government and community members. The process provides a platform for sharing information so that the approach to DRR can be broadened through wider participation. SLDs are an effective methodology for scoping, designing and implementing of adaptive strategies.

SLDs for this research were organised at various levels. First a series of SLDs at the village level were organised with various socio-economic groups; the number of participants varied between four and 20. With each round of SLD, as new insights emerged, new questions were added and others dropped. Second, at district level SLDs, insights gained from village level SLDs were shared.

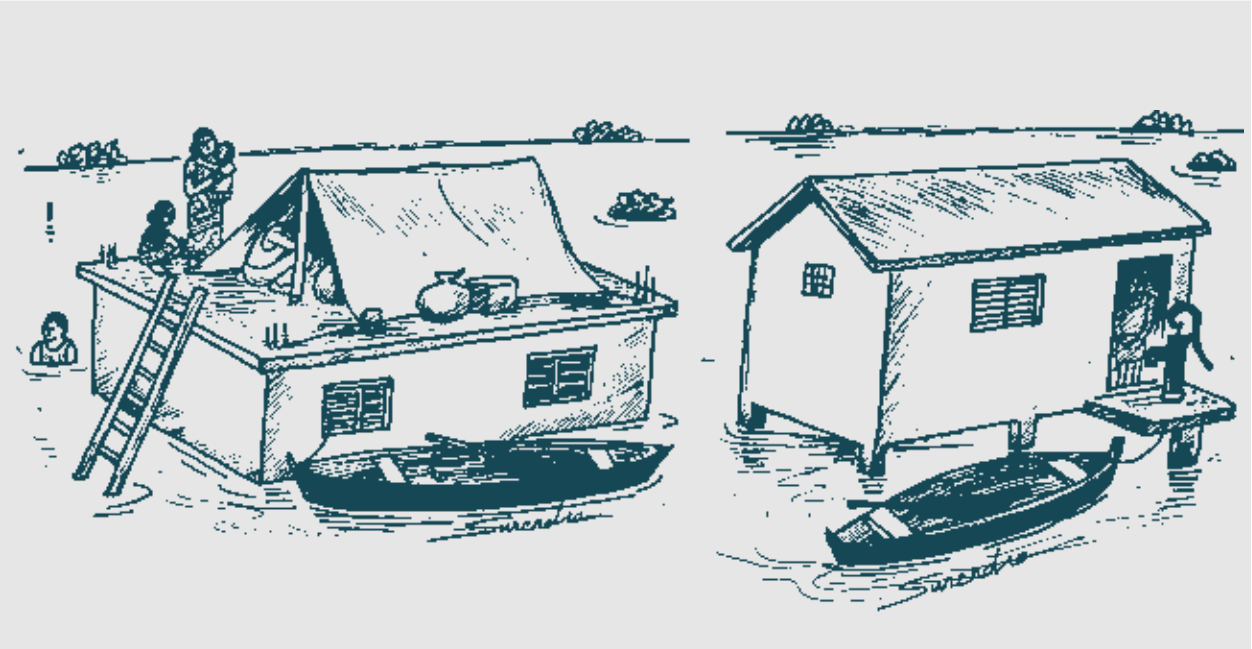
Key issues discussed and information gathered at village level SLDs are used to understand the sequence of disasters and level of vulnerability of different socio-economic groups. They are also used to better understand the behaviour of monsoons, changes in agricultural seasons, crop patterns and productivity, poverty and inequality, demographic characteristics and changes in occupational characteristics. Other insights gained include factors that constrain occupational mobility, asset ownership and losses due to disasters, the coping strategies in times of disaster and the responses of NGOs and governments, local knowledge of weather, modes of communication and necessary early warning systems. The details concerning community-based organisation, measures needed to strengthen them and factors contribute to the safety of those unaffected by disasters were also obtained. Insights gathered were used to understand the specific vulnerability and develop strategies for risk reduction.

Shared learning dialogues are an effective method for scoping, designing and implementing of adaptive strategies.

Participants at the district level SLDs included the district disaster management officer, officials from the fire service, forest department and

Insights gathered were used to understand the specific vulnerability and develop strategies for risk reduction

insurance companies, an officer from NABARD (The National Bank for Agriculture and Rural Development), a soil scientist from the agricultural research center, the director of the Coordination and Resource Center at Nagappatinam, several NGOs, a local cable television operator, mobile operators, farmers and fishermen and women from self-help groups (SHGs). Altogether, forty participants attended the day-long workshop. Insights gathered from these SLDs were taken to the state level SLDs attended by state level officers such as the Relief Commissioner, Revenue Secretary, officials from the meteorology department, officers from insurance groups and banks, NGOs, researchers, state level and district level fishermen and farmers' leaders. The number of participants varied from 2 to 30. Discussions at all SLDs at all levels were recorded and transcribed in Tamil and translated into English for information sharing.



Key Issues

This mix of ideas, in effect, represents a starting point for evolving common understanding of both emerging problems and potential response strategies.

As illustrated by the bullet points below, many issues were raised in the district and state level SLDs. These issues, as might be expected in an initial meeting on climate change and the anticipated impacts in coastal regions, touched on a very wide range of problems and local perceptions regarding potential solutions. What is most important to recognise from the points raised is the mix of conventional solutions to emerging problems (people, for example, often called for embankments to protect coastal regions) and more innovative, locally-tailored strategies. The discussions also identified many of the limitations associated with current strategies. This mix of ideas, in effect, represents a starting point for evolving common understanding of both emerging problems and potential response strategies.

District Level SLD

- Inundation has lead to chronic salinity of soil and groundwater, and lack of drainage is the major source of vulnerability in a large portion of the Cauvery delta.
- Thalaignanirru is below sea-level. The 27 rivers in this district are flood carriers.
- Agricultural yield and production has come down by at least 50% due to the impacts of cyclones, sea water and fresh water floods, and land and groundwater salinity.
- Floods and cyclones are annual phenomena but to what extent local administrative measures are capable of handling these disasters in a sustainable manner is a question without easy answers.
- To avoid inundation on agricultural land, farmers suggested that Tail End Regulators be constructed on streams where they meet the ocean.
- Farmers also suggested that bunds on both sides of the Cauvery drainage rivers should be strengthened with appropriate control structures. Other suggestions to directly control the impact of storms included: (1) desilt drainage channels, strengthen bunds, create new canals, bed dam to save water; (2) sand dunes need to be protected (at the moment they are being destroyed) and (3) tanks need to be de-silted and drainage improved.
- In response to the impact of storms and the Asian Tsunami, there was substantial discussion regarding the kinds of houses that should be constructed for people who live close to the sea. Reinforced cement concrete (RCC) construction is not good enough since the steel corrodes quickly. Many suggested tiled houses to cope with the corrosion problem; but a few also argued that from the point of view of coping with cyclones and high-speed winds, RCC houses are far better.
- In order to respond to land and groundwater salinity problems, the development of new farming systems is necessary. People should explore the possibility of cultivating salt resistant crops. Traditional

varieties of paddy are more suitable for salt water. One should explore all possible indigenous technologies to combat and remove the salinity problem in the Nagappattinam District.

- The absence of access to credit for vulnerable fishing and farming groups during times of distress (following storms or droughts) was identified as a major constraint in their recovery.
- Lack of drinking water and sanitation was identified as a major factor accentuating the impact of disasters.
- The unavailability of accurate weather predictions was expressed as a major concern particularly for fishing communities. Existing weather information is considered inaccurate. Only obvious warnings at obvious times are issued. Timely and accurate predictions are necessary to help the fishing population that depends on local knowledge for 90% of its weather forecast needs.
- The creation of a separate fishing cooperative society similar to the existing agricultural cooperative societies was demanded as a key element that would help fishing communities meet both immediate needs and respond to the impacts of climate related disasters.
- Available insurance coverage is viewed as very restrictive. A much broader insurance coverage for both fishermen and farmers was sought as a key element that would assist them in dealing with climate risks.
- Farmers and fishermen expressed concern about the viability of existing livelihoods. As a result, capacity building for better livelihoods and greater mobility in non-fishing and non-farm activites were demanded.

The unavailability of accurate weather predictions is a major concern for fishing communities.

- Where responses to the Asian tsunami are concerned, fishermen have been affected due to excessive distribution of boats in each village as part of the recovery effort. Traditional methods using catamarans produced good fish catches in comparison to current methods. Fish stocks are declining due to intensive and competitive fishing using modern boats and nets.
- In response to depleting fishing stocks, the fishermen debated increasing incubation periods from the current 45 days to sixty days. Such strategies were discussed as important both in response to current declining stocks and the sustainability of fishing livelihoods as part of responses to climate change.
- In response to the Asian tsunami, there was substantial debate regarding compensation policies. There was particular focus on the asset based compensation package that has been promoted and whether or not it solves medium-term and long-term problems. Though controversial, many still supported asset based compensation
- Partnerships between NGOs and the government has been rewarding.

State Level SLD

Key issues emerging from the SLDs conducted at lower levels were discussed at the state level SLD. The state level SLD (a one-day workshop) was attended by state level officers such as the Relief Commissioner, Revenue Secretary, officials from the meteorology department, officers from insurance groups and banks, NGOs, researchers, state level and district level fishermen and farmers' leaders.

Key issues discussed at the state level SLD were:

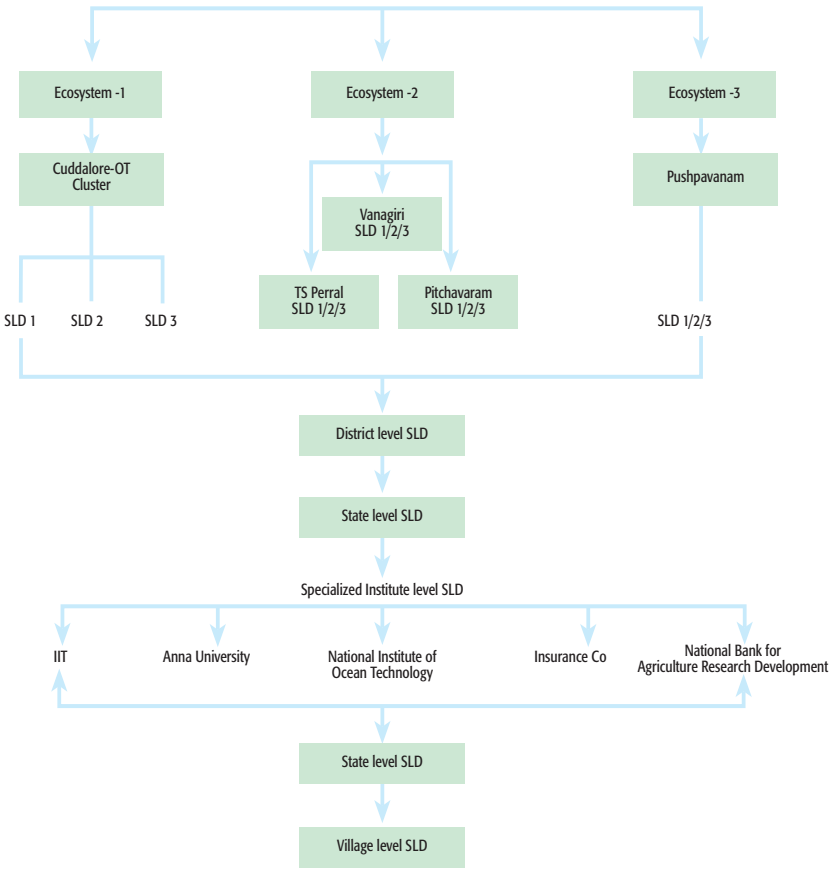
- The community's experiences in handling or responding to coastal extreme events such as storms, floods and tsunamis.
- The community's collective strengths and weaknesses, and the prevalence of community organisations and their strengths.
- The evolution of adaptation strategies undertaken by the community over a period of time.
- Local knowledge in disaster preparedness, early warnings and disaster mitigation.
- The strengths and weaknesses of the community in relation to opportunities and threats confronted.

Further, the following issues in relation to adaptation were discussed:

- What kind of adaptation policy and framework should there be for the immediate, medium and long term.
- How to integrate adaptation in key policy-making and planning process.
- How to make the adaptation policy framework proactive and ensure risk management is from the bottom up.
- How to engage all concerned stakeholders in the decision-making.

Farmers and fishermen expressed concern about the viability of their existing livelihoods.

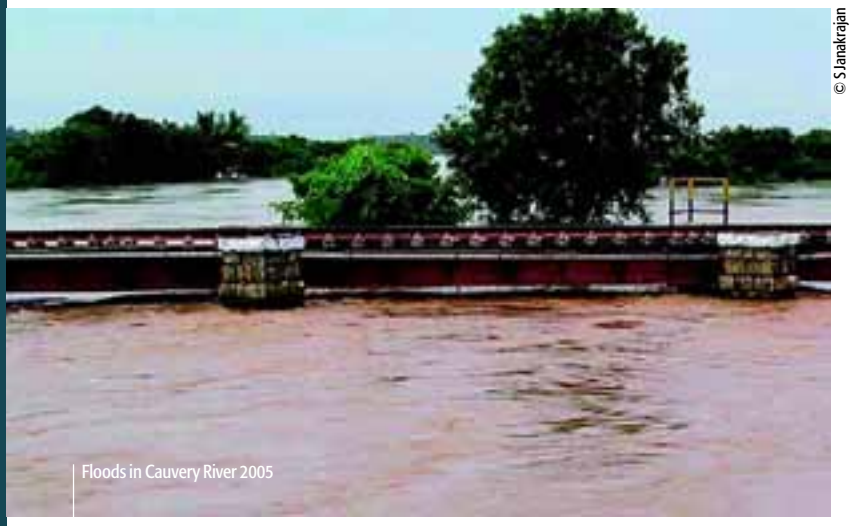
FIGURE 1 | SLDs at different levels



Analysis of SLD Results

Discussions at the district and state level SLDs identified issues and potential response strategies that in some cases reflect the standard water control measures already in practice and in other cases offer new alternatives. As might be expected, discussions on salinity and the impact of storms initially led to calls for the construction of tidal regulators. Several such regulators have been constructed in the area over recent decades. They are, as a result, already a known and accepted feature that people are well aware of. However, many of the existing regulators are in poor shape and, whether or not this would actually help control salinity, reconstruction would be a clear and tangible activity.

The formation of cooperative societies for fishermen, for example, responds primarily to a current need.



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Floods in Cauvery River 2005

As discussions progressed, a wider array of issues and response strategies were raised. From purely structural control, discussions moved onto livelihoods. Issues related to the sustainability of fisheries and the tolerance to salinity in agricultural systems, for example, are potential points of entry for adaptive changes to existing livelihoods as opposed to measures to protect existing ones. As a result, the SLDs represented a starting point for identifying very practical courses of action that could assist local communities in dealing with both existing problems and the emerging consequences of climate change. Some of the actions proposed appear at a first to be removed from issues of climate adaptation, but could ultimately prove pivotal. The formation of cooperative societies for fishermen, for example, responds primarily to an immediate need. The formation of such societies that would serve as a nodal point for managing fisheries and introducing new practices as sea-level rise inundates more land could, however, be critical in adaptating to new realities. The ability to organise has, after all, been identified as central to adaptive capacity. As illustrated in Box 2, which details debates over shrimp farming, the problems with intensive use of shallow coastal waters are complex. Organisations that can gradually build the technical and institutional capabilities to overcome such problems are central to the ability of fishing populations to adapt to climate change.

Overall, the SLDs provided a mechanism to start the process of identifying courses of action for responding to climate change and other hazards in ways that reflect the insights of both local communities and external actors. More specifically, the SLDs resulted in the identification of key

BOX2 **The shrimp farming debate**

Intensive use of shallow backwater and coastal marine resources is seen by many as a core need in responding to the sea-level rise that is likely to occur as a result of climate change. As the discussion below on shrimp farming illustrates, however, the development of sustainable systems faces major challenges.

In 1991, a company called Fencer Eral first started shrimp farming in 100 acres of wetland in Vanagiri, one of the study villages. The company bought 80 acres of *Thasil Pannai* and another 20 acres of land. After 10 years, the company incurred losses for various reasons. At present the company has leased the farm out to an individual from Dharmakulam village. There are a few other shrimp farms of between 2 and 9 acres. Many schedule caste farmers have sold their land to shrimp farms because their land and groundwater have turned saline.

Costs and Benefits of shrimp farming in all selected villages:

Stage I Fertile land yields 30 bags (60 kg each) of paddy per acre per season, and, when possible, there two harvests per year.

Stage II When land turns saline, only 15 bags of paddy/acre is produced and only once a year.

Stage III When land was converted into shrimp farming (in 1991) the yield from one acre was 1,000 kg of shrimp with a value of Rs. 400,000 from an initial investment of Rs. 200,000 per acre. However, the harvest value has gone down due to insect attack. Currently, the same initial investment only gives a profit of Rs. 25,000 per acre.

Stage IV What happened to those who sold their lands to shrimp farmers? Most of them did not buy land elsewhere and spent the money either in settling debts or on household needs. They have been forced to turn to farming or non-farm casual work.

One of the most important requirements of shrimp farming is good drainage for discharging effluent and proximity to an inlet to pump brackish water. If these facilities exist, irrespective of land quality, shrimp farmers are willing to pay a good price. Land that is saline but without drainage has very low value.

Overall, shrimp farming does produce high returns from inundated lands – at least initially. As currently practiced, however, it is far from sustainable.

points of vulnerability and a wide range of potential response strategies. Vulnerabilities identified are detailed below and lead into the final section on potential response strategies and their costs and benefits.

Key Points of Vulnerability

Weather Information: Local weather information is the same for all the villages selected for this study. If clouds are moving fast, there could be a cyclone. If there is a high tide out at sea, cyclone or heavy rains are possible. The weather information given by the Indian Meteorological Department is unreliable, untimely and inadequate. Cyclone warnings are issued only when there is a threat of a cyclone hitting the coast with in 48 hours. While cyclones do often hit the coast when a warning has been issued, many do not. Villagers need accurate and timely information regarding the start of the monsoon, daily weather information, the number of rainy days and early warning of cyclones. Currently, people use community television, *panchayat* Tom Tom, cable television or temple bell ringing as communication channels during times of disaster. Other channels on which people rely are Karaikal FM, Kodaikanal FM, other FM radio news, television, newspapers and cable television. Existing access to television and telephone are given in Table 6. However, local knowledge such as cool winds, bird movements, roughness of the sea and cloud clusters seem more reliable for many than the weather bulletins issued by the state meteorological department

Cyclone warnings are issued only when there is a threat of a cyclone hitting the coast within 48 hours.

TABLE 4 | Risks, Short-term and Long-term Coping Strategy and Potential Costs and Benefits of Remedial Measures as Perceived by Different Social Groups.

Village name; Type of the social/ economic group	The most important risks faced by each community, in order of priority	Present coping strategy for each risk factor	Long-term strategies sought	Ranking of remedial measures during SLDs (1=least expensive, 10=most expensive)		
				Cost	Short-term benefit	Long-term benefit
Vanagiri **Social Group 1** SC women , farm labourers, small and marginal farmers	1. Floods 2. Sea water inundation and salinisation of land and groundwater 3. Cyclones and storms	1. Migrating to other villages / towns either for agricultural or non-farm work. 2. Working in Shrimp farming 3. Borrowing money	1. Small shutters 2. Concrete sea wall 3. Cyclone shelter 4. Mangrove forest	6 10 7 7	8 9 7 9	8 10 5 10
Social Group 2 Fishing population	1. Cyclones 2. Floods 3. Rough seas 4. Trawlers	1. Seeking temporary shelter in schools 2. Borrowing money 3. Government hand-outs	1. Cyclone shelter 2. Concrete sea wall 3. Community radio 4. Mangrove forest 5 VIC	8 10 4 6 5	8 10 9 10 5	10 10 7 10 8
Social Group 3 Non-SC small farmers / (men and women)	1. Floods in the Cauvery and the untimely availability of water 2. Sea water flooding and salinisation of land and groundwater 3. Cyclones 4. Lack of sanitation	1. Seeking non-farm work and migration 2. Growing alternative crops 3. Borrowing from money lenders	1. Three tail-end regulators 2. Government should ensure water supply to tail-end villages first 3. Strengthen banks of backwater rivers 4. Protecting waterways and lagoons 5 Removing salinity on the land	8 8 5 6	8 10 6 10	9 10 8 10
Pushpavanam **Social group 1** SC labourers and farmers	1. Sea water inundation 2. Droughts 3. Flooding in the backwater rivers	1. Seeking non-farm work and migration 2. Working in shrimp farms 3. Borrowing money	1. Build a series of tail-end regulators 2. Training for non-farm jobs 3. Silt removal from the drainage rivers	8 6 7	6 10 10	9 10 10
Social group 2 Farmers belonging to backward castes	1. Sea water inundation 2. Droughts 3. Floods	1. Migrating to other villages / districts for agricultural or other work 2. Borrowing money from others 3. Breeding sheep	1. Small shutters 2. Try to get Cauvery River water for irrigation which can also reduce soil salinity 3. Desilt the drainage canals	7 10 8	5 7 6	8 8 10
Pushpavanam **Social group 3** Fishing population	1. Cyclones 2. Flooding in the backwater rivers 3. Rough Seas	1. Seeking temporary shelter in schools and govt. relief measures 2. Borrowing money 3. Borrowing money	1. Cyclone relief shelter 2. Mangrove forest 3. Concrete sea wall	8 8 10	10 10 10	10 10 10
TS Pettai **Social group 1** Small and marginal farmers	1. Salinisation of land and groundwater due to sea water floods 2. Droughts 3. Cyclones	Migration and seeking non-farm jobs; a few have tried shrimp farming, unsuccessfully; seeking government support.	1. Shutters in backwater rivers 2. Training for non-farm jobs	5 8	10 10	10 10
Pichavaram **Social group 1** Small and medium farmers	1. Salinisation of land and groundwater due to sea water floods 2. Droughts 3. Lack of sanitation	1. Growing alternative crops 2. Migrating to towns and cities to seek construction work	1. Shutters 2. Strengthening river bunds 3. Desilting and strengthening backwater rivers	5 10 7	10 10 10	10 10 10

After the tsunami, a Village Information Center (VIC) was started in Vanagiri with internet connection for access to daily news and weather information announced (three times a day) through a public address system. DHAN Foundation runs a community radio in Vanagiri but people have no knowledge about this station. Both farmers and fishermen report that Karaikal FM is useful and informative. DHAN Foundation has also started a VIC in Pushpavanam village also transmitting news and weather information three times a day through public address system.

Insurance: Very few people have any life insurance. Most do not pay the premiums regularly. In Pushpavanam, however, 50% of people do have life insurance policies and regularly pay their premiums. There are three life insurance agents residing in this village. Crop insurance is possible only if money is borrowed from the agricultural cooperative society for the main crop grown during the samba season. However, in all the villages, the samba season is non-existant due to changes in irrigation patterns and the late arrival of Cauvery River water. As a result, most farmers cannot get a loan from the agricultural cooperative society or buy crop insurance.

Asset Loss: In each cyclone period, the boats and nets of the fishing population are seriously damaged. Each fisherman spends a minimum of Rs. 20,000 for repairs, borrowed from money lenders and wholesale fish merchants at high interest rates. As a result, in each village close to 25% of fishermen are in perpetual indebtedness. During every cyclone period hundreds of huts are destroyed, the total loss ranging from Rs. 50,000.00 to Rs.100,000.00 per village depending on the intensity of the cyclone. Although many concrete houses were built after the tsunami, hundreds of huts are threatened by cyclones. Hundreds of nets, boats and catamarans need additional heavy investments for replacements and repairs. Total asset losses range from Rs. 2 to 10 lakhs (1 lakh = 100,000) depending on the severity of the cyclone. On average, during each cyclone year, one fisherman borrows up to Rs. 4,000 or Rs. 5,000 for repairs and

Backwater river in Cuddalore OT

Inundated land in TS Pettai

replacements. In some cases, they borrow up to Rs. 20,000.

Livestock: Cyclones cause loss of livestock and chicken. The average loss per household is around Rs.500.

Damage to crops: Most cyclones and floods result in total loss of crops. The loss per acre is in the order of Rs. 2,500 to Rs. 3,500.

Drinking water supply: Drinking water supply is disrupted during floods, cyclones and droughts. The disruption poses a constant threat to livelihoods.

Hundreds of nets, boats and catamarans need heavy investments for replacements and repairs.

Sanitation: Only a few households have toilets and a majority of people defecate in the open. The most affected are women and teenage girls who are forced to walk for miles, even at night, to find privacy. Rape and sexual abuse happens but is rarely reported. Furthermore, finding open space for defecation has become more difficult since the boom in house construction after the tsunami when the government freely distributed land to the landless. Women of Vanagiri, Pitchavaram and TS Pettai villages are demanding toilets.

Land value: Changes in land value (gain or loss) over a period of 20 years gives a reasonably good picture of the vulnerability farmers face. In almost all selected villages, the value of land has steeply declined due to salinisation and flooding. However, even saline land is sold for shrimp farmers for a good price, but only if such plots have an inlet for pumping brackish water in and an outlet for draining effluent out. The plots located close to backwater rivers are preferred for shrimp farming (see Table 5).

TABLE 5 | Changes in the Value of Land per Acre in (Rs)

Village	Land/acre			Acres of land sold to shrimp farming	
	Value 20 years ago	Current value of unaffected land	Current value of saline land	Near backwater	Far from backwater
Vanagiri	20,000	100,000	5,000	60,000	30,000
Pushpavanam	80,000	150,000	50,000	1,75,000	100,000
Pitchavaramn and TS Pettai	25,000	100,000	15,000	100,000	Demand for shrimp farming decreasing so no value here

Strategies Identified

Our analysis of potential strategies starts with the current coping mechanisms that people use to overcome vulnerabilities outlined above. These existing strategies represent key points of entry for bringing together external and internal perspectives on adaptation to hazards and climate risks in coastal areas.

Fisher Community

People are increasingly interested in getting their children educated. The level of literacy has gone up over the last two decades; school enrolment figures confirm this trend. People also express interest in changing occupation but feel constrained because they lack the skills. Still, a good number of young people have migrated to towns and cities; some even to Middle East countries and Malaysia, working in the construction industry, cleaning toilets, rearing camels, laying roads and as servants. It is said that they are heavily in debt and unable to send money to their dependents back home. Hundreds of people are cheated by recruiting agents.

Fishermen in action in anchored boats

© S Janakrajan

During lean periods almost all fisherfolk borrow money from any available source (money lenders, pawnbrokers and mortgaging of jewels). They also borrow from friends and relatives. Some depend on remittances from relatives working in cities. Worst, small fish vendors (mostly widows who turn to small fish business after they lose their husbands) borrow at interest rates up to 120 % per annum from *thandal* (specialised money lenders living in towns whose targeted customers are small and marginal fishermen, small business people etc.). Borrowing money is a standard coping mechanism.

Everybody buys rice at a subsidised price of Rs. 2 per kg which is considered a big boon. On average, each person consumes 750 grams of rice a day. Suji and wheat are also purchased at a subsidised price. During lean seasons, many people go without food for many days.

During times of heavy floods and cyclones, people move to school buildings or cyclone relief centres. After the tsunami the use of mobile phones substantially increased. However, it was reported that small scale fishermen (who use fibre boats or catamarans) cannot use mobile phones while at sea because the phones get wet. But for

those using trawlers, mobile phones are useful.

Strengthening Village Level Organisations

Informal associations among fishing villages is an integral part of social life. These local level institutions play a crucial role during times of distress. The associations are generally headed by wealthier fishermen with better access to communication. These fishermen are articulate and possess organisational skills and some political clout. These associations exist alongside formal *panchayats*. These informal mechanisms are more powerful with office bearers such as a president, secretary and treasurer to safeguard funds collected from members and to strengthen the association. This money is used during festivals and after cyclones and other disasters for feeding the local community. Fights, heated arguments and even violent actions seem to be a standard feature in fishing communities (within as well as between villages). On the other hand, unity is common too. Orders from the *panchayat* are respected. Many informal associations have savings ranging from Rs.25,000 to a few hundred thousands rupees. One of the main functions of the *panchayat* (formal or informal) is to settle local disputes. The *panchayat* also protects the members and their families from any kind of outside disturbances. The *panchayat* is empowered to exercise actions to punish those who violate rules. The fine ranges from one rupee to Rs.1,000 depending on the nature of the violation.

Local level institutions play a crucial role during times of distress.

The most important aspect of the informal *panchayat* is its organised, collective capacity to cope and bargain with outsiders, including government

SLD in progress in TS Pettai

officials, during times of cyclone relief distribution, which was well demonstrated in the post tsunami period. But they still lack the capacity to deliver relief and rehabilitation support. Their capacity needs to be strengthened through access to better information on weather and climate. Fishermen in backwater regions are considered inferior to marine fishermen. They may not become members of the informal *panchayat*, and there are no efforts to help them organise. There is, however, no animosity between these two groups.

During the post tsunami period, a separate committee was formed in many villages to coordinate the relief and rehabilitation work in the hamlets. Cases of mismanagement of relief aid have been reported. Some openly criticise this corruption during meetings, but others negotiate with the committee for personal gains. In some cases, villagers have jailed Tsunami Relief Committee Members (who are part of village *panchayats*) for mishandling tsunami relief resources.

Farming Communities in Ecosystems II and III

Schedule caste people, landless agricultural labourers and small and marginal farmers (who are most severely affected by coastal hazards, floods in the Cauvery River or erratic drought conditions) keep migrating, daily, seasonally or permanently. Many have migrated to Kerala, Bangalore and Gujarat, taking up all kinds of non-farm jobs. But most of them work as construction labourers. In TS Pettai and Pitchavaram, about 80% of small and marginal farmers seek jobs in construction. To a lesser extent migration also takes place out of Vanagiri and Pushpavanam. The state government has begun issuing social security cards to those living below the poverty line. The card is expected to help them obtain assistance for marriages, compensation in cases of accidental death, assistance to meet funeral expenses, assistance during pregnancy and abortions, education subsidies for dependent children, and old-age pensions. A large number, however, borrow from friends and relatives and mostly from money lenders. In recent years, rice has been sold at Rs.2 per kg and each family card-holder is eligible to buy 20 kg of rice per month. This arrangement helps daily wage earners and small and marginal farmers to survive during time of drought and flood. Most importantly, self-help groups provide support for these very poor people who otherwise depend on money lenders to meet their financial needs.

Local institutions lack capacity to deliver relief and rehabilitation support.

Due to inundation from sea water and the resulting salinity, many farmers have shifted to salt and flood resistant varieties of paddy such as *kar and uyyakondan*. Many others have shifted to coconut, casurina and mango plantation. Saltwater intrusion affects plots near the Uppanaru River. Shrimp farming on poramboke land (government land) has also contributed to salinity, which has forced landowners along the river to either convert to shrimp farming or sell their land to shrimp farmers. Converting to shrimp farming appears to be an alternative livelihood in salt affected areas, but small and marginal landholders cannot withstand both the initial investment and high maintenance cost involved in shrimp farming. Farmers who have sold lands to outsiders for shrimp farming have spent the money in meeting household

and health expenses. They end up being landless labourers.

Irrespective of whether the livelihood is fishing or agricultural, coping mechanisms and strategies depend on the facilities available in the villages (see Table 6).

Strategies Identified

Affected people have expressed innovative strategies which could form a part of a long-term adaptive strategy plan, although the preference is for 'structural' strategies. One example is the fishermen's demand for cold storage facilities to store fish and be able to sell them at a later date. They also demand good drinking water and sanitation facilities. Other expressed needs are prevention of pollution in backwater rivers and better housing. Similarly, most people among the farming communities mentioned that shutters in various backwater rivers would prevent mixing of sea water with freshwater. They also argued that the shutters would prevent periodic flooding of

TABLE 6 | Facilities Available

Type of infrastructural facility	Vanagiri	TS Pettai	Pitchavaram	Pushpavanam
panchayat office	1	1	1	1
Community hall	2	1	1	6
Library	2	1	1	1
Ration shop	2	1	2	2
Noon-meal center for children	2	1	2	2
Day care center: Government	2	1	3	2
NGO	0		1	3
Drinking water: Public taps	70	20	52	
Hand pumps	43	8	53	188
Private taps	46	30	60	0
Overhead tanks	7	1	4	2
Primary health center	2	1 (unused)	1	2
Wireless and public address system	1	1	1	1
Schools: Primary School	2	1	3	5
Middle School	3	0	0	1
High School	0	1	0	1
Private School	3	0	0	1
Telephones: Landline	120	0	0	963
WIL Phone	60	55	35	0
Mobile	1108	125	150	1105
Public booth	2	1	6	50
Electricity connection	90%	90%	90%	80%
Type of houses: Terrace	129	40	26	77
Tiled	265	75	121	150
Colony houses	494	100	47	226
Huts	735	10	664	1468
Toilets Public	1	1-unused	1	2 (unused)
Private	722	50	240	705
Television with cable connection or DTH	1200	100	250	500
Public television	2	1	2	6
Post office	1	0	1	1
Cyclone relief center	0	1	1	1
Bus service	Yes	Yes	Yes	Yes
Cooperative Society	1	1	2	2
Number of NGOs operating	10	3	6	12
Meeting hall for self-help groups (SHG)	2	0	1	1
Number of SHGs: Women	30	22	38	58
Men	5	0	6	12
Village Information Centre	1	0	0	2

agricultural lands from sea water. In Pushpavanam village, many people mentioned that they needed either community wells or private wells. All these measures would definitely enhance the capacity of the community to better adapt in extreme climate conditions but will not help to overcome the risks posed by long-term impacts due to climate change. These interventions appear ad hoc in nature and may not contribute to long-term adaptive strategies.

Overall perception of risks, vulnerabilities and local needs in all ecosystems are summarised as follows:

Floods in Cauvery River 2005

1. Cyclones and Storms

Populations most affected: Fishing communities and some others
Vulnerability level: Very high
Risk factors: High wind speeds with heavy rainfall; flooding; sea water ingress
Asset loss: Extensive damage to huts and semi-roof dwellings, to livestock and poultry, to boats and fishing nets; loss of land; loss of livehoods
Coping strategies: Temporary move to cyclone shelters or schools; financial loans; reliance on government support and NGOs; support from self-help groups
Existing government support: Ad hoc cash support, provision of 10 kilos of rice, 10 liters of kerosene, one dhoti (traditional Indian man's trousers) and one sari (traditional Indian woman's dress). No long-term adaptation plan whatsoever.
Potential impacts of climate change: Already serious and likely to be aggravated. Vanagiri village has lost developed land to sea water ingress. Sea water has encroached on at least 800m of land in all villages.

Sea water encroachment is increasing.

Individual debt has gone up with the increasing frequency of cyclones and droughts.
Climate change risk awareness: Some fishermen are aware of the threat of climate change, but the majority of people are not, despite seeing changes in weather and monsoon patterns, erratic rainfall, sea water ingress, etc.
Reasons why some populations are unaffected by the impacts of climate change: Concrete homes built on elevated land; better education, including in the English language leading to better jobs; at least one household member engaged in non-fishing livelihood; better drinking water and sanitation; vehicle ownership; access to government officials; greater wealth allowing ownership of trawlers, multiple boats, etc.
Demands of affected populations: Better weather forecast information; a stop to the polluting of backwaters and the sea; skills acquisition in non-

fishing activities such as carpentry, masonry, construction, electronics and electrical engineering, etc.; mangrove and coconut plantation and stonewall protection from sea surges; cheaper credit. Most women need better sanitation, drinking water and healthcare.

2. Cauvery and Sea water Floods Contributing to Land and Groundwater Salinisation

Populations most affected: Small and medium farmers (and some others)
Vulnerability level: very high
Risk factors: Inundation; land remaining fallow due to salinity; very poor crop yield; decreased land value
Asset loss: Decreased land value; total loss of groundwater due to salinisation; loss of agricultural production and employment
Coping strategies: Out-migration for non-farm jobs in towns, shrimp farming, borrowing money, sheep breeding, support from self-help groups
Existing government support: None
Potential impacts of climate change: Already serious and likely to be aggravated; hundreds of people have already lost their livelihoods
Climate change risk awareness: None
Reasons why some populations are unaffected by the impacts of climate change: Ownership of land in elevated areas or at least two kilometers inland; better education; non-farm livelihoods; remittances from abroad; credit worthiness and the capacity to take loans; self-employment (self-employed people are relatively better-off, both economically and socially).
Demands of affected populations: Among young men: skill acquisition in industrial trades (welding, electrical engineering, electronics, etc.) and computer skills. Most farmers want shutters in backwater rivers to prevent further salinisation of land and groundwater. Some farmers want support in obtaining salt resistant crop seeds and in creating a market for salt resistant crops. Here also women need better sanitation and drinking water facilities and credit for sheep breeding.

Most women need better sanitation, drinking water and healthcare.

3. Drought

Populations most affected: Farmers, landless agricultural labourers (and some others)
Vulnerability level: Medium intensity
Risk factors: Excessive heat; poor drinking water supply; poor crop yields; unemployment; lack of fodder; food shortages and hunger
Asset loss: Selling off of livestock, land, jewelry and other household items for income
Coping strategies: Borrowing from money lenders; support from self-help groups; out-migration
Existing government support: Rural employment guarantee scheme for job creation is helpful but very political
Potential impacts of climate change: Loss of livelihoods and worsening food security
Climate change risk awareness: None
Reasons why some populations are unaffected by the impacts of climate change: Assured non-farm employment; supplemental sources of income from trade and business or remittances; ability to borrow large sums of money; better education.

Government and private sector workers tend to be better-off economically and socially.

What affected populations want: Among young men: skills acquisition in industrial trades (welding, electrical engineering, electronics, etc.) and computer skills. Most farmers want shutters in backwater rivers to prevent further salinisation of land and groundwater. Women need better sanitation and drinking water facilities and need to be given official identity cards as belonging to self-help groups in order to easily obtain bank loans. There is strong demand for a drought relief package from the government.

4. Lack of Sanitation and Assured Drinking Water

Populations most affected: Women (in particular teenage girls) and the sick
Vulnerability level: High intensity
Risk factors: Sexual abuse; snake bites; for those who have no toilets, the time taken in having to walk long distances for any privacy; falling sick during drought and flood conditions.
Asset loss: Death from snake bites; poor health and associated medical expenses; loss of valuable time in seeking toilet privacy and fetching safe drinking water
Coping strategies: None
Existing government support: Houses with toilets built after the 2004 tsunami; construction of public toilets for women and children
Potential impacts of climate change: Likely to become a serious issue in the future
Climate change risk awareness: None
Reasons why some populations are unaffected by the impacts of climate change: Ownership of homes with private toilets; ownership of concrete houses
What affected populations want: Continual access to safe drinking water; health care; toilets

Implementation Schemes and Strategies Identified in the SLD Process

For Fisher populations in all Ecosystems

- Except in a few places there is no bio-shield in the villages. Growing mangroves would benefit and even save the fisher communities from extreme weather events. Many people have shown a preference for coconut trees as a bio-shield.
- People need skills training in non-fishing activities such as carpentry, masonry, electrical works, plumbing, heavy vehicle driving, and communication.
- Access to insurance and credit needs to be established
- Training in the fish processing industry such as manufacturing of fish pickles, prawn pickles and tinned fish as well as training in the expert of these products needs to be provided.
- Need better schools and particularly education in the English language
- Everyone appreciated the idea of a community FM station for communicating information during times of disaster
- Safe drinking water is one of the most important demands the groundwater is saline and polluted.
- VICs are considered a good facility but need to be integrated with

Most people need and want the same basic necessities: skills training in non-farm based livelihoods, access to safe potable water, sanitation facilities.

people's needs and wishes. VICs could be strengthened with the provision of reliable climate information.

- Sponsoring young boys and girls for technical training such as industrial training, computer training, science courses, training in NGO activities and the English language would be of great benefit.

For Agriculture Dependent Populations in all Ecosystems

- Skills training in non-farm livelihoods such as industrial trades (fitter, welder), carpentry, masonry, plumbing, electrical and electronics servicing.
- Sheep breeding, dairy production and growing fodder (which can be grown on saline land). Subapul, for example, is a salt resistant crop which is also a fodder. Several other crops could be grown in brackish water and used as animal fodder. Sheep breeders are less affected by the impacts of climate change
- Poultry farming
- Training in brackish water shrimp and fish farming
- Sponsoring young boys and girls for industrial training, computer training, science courses, training in NGO activities, English language courses, etc.

- VIC and FM radio services
- Better library with Tamil and English newspapers for information on education and employment opportunities.

Cost-Benefit Ranking of Response Strategies

In order to prioritise discussions within both the district and state level SLDs on the identification of practical strategies for responding to risks and vulnerabilities, a cost-benefit ranking exercise was carried out. Potential costs and benefits were ranked in the range of 1 and 10, in which 1 referred to the least and 10 to the highest cost. Similarly, potential benefits were also ranked between 1 to 10. For example, if the cost of a particular strategy was ranked 9 and the potential benefit was ranked 3, then the strategy would be regarded as a high cost low benefit strategy. Ideal strategies would cost rank as 4 or below with potential benefits ranking above 7. A series of such exercises were documented, giving insights into the perspective of each community regarding the costs and benefits of strategies to overcome their risks and vulnerabilities (see Table 4).

Conclusions

This case study assessed the nature of existing hazards and vulnerabilities and identified possible adaptive measures in select study villages. Shared learning dialogues were used to understand and analyse the risks and vulnerabilities experienced across different sections of the population. Discussions with government officials, private sector and NGO personnel were held. SLDs were used as a two-way process to identify and discuss the issues. Furthermore, the SLDs were useful for identifing innovative and practical measures for long-term adaptation by the affected communities. Existing adaptation measures undertaken by the communities are ad hoc and not sustainable in the long-term. More SLDs should be organised to clarify practical, long-term, comprehensive and innovative strategies. The communities have agreed that carefully planned adaptive strategies are superior to their current coping mechanisms. There needs to be a continuous exchange of information gathered through this research with government agencies, private service providers, NGOs and those engaged in climate adaptation studies and disaster risk reduction.

There needs to be continious engagement with various stakeholders to identify practical, long-term, comprehensive and innovative strategies for adaptation to climate change.

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Appendix 1

Severe Cyclones that hit the Tamilnadu Coast, in Particular the Cuddalore and Nagappattinam Coasts

1. Cyclone Rameswaram, 17th to 24th December 1964, wiped out Dhanuskodi village on Rameswaram Island. A passenger train which left Rameswaram Road station at about midnight on the 22nd was washed away by the storm surges, killing nearly all the passengers. The Pamban bridge connecting Mandapam and Rameswaram Island was also washed away by storm surges 3-5 meters high.

2. December 1st-8th, 1972: A cyclone tracked over the Tamilnadu coast just north of Cuddalore at 2330 UTC on 5th December and was within 50 km WNW of Cuddalore at 0300 UTC on December 6th. Maximum wind speed recorded at Cuddalore was 148 km / h between 2230 UTC of the 5th and 0230 UTC of the 6th of December. 80 people were killed and 30,000 people rendered homeless in Madras due to the resulting flood. Total losses amounted to Rs. 40 crores (1 crore = 10,000,000).

3. November 8th-12th, 1977: A cyclone tracked over the Tamilnadu coast within 10 km of the south of Nagapattinam early in the morning of the 12th around 2230 UTC. The system weakened into a cyclonic storm by that evening over interior parts of Tamilnadu and emerged as a deep depression onto Laccadives off the north Kerala coast on the morning of the 13th. Maximum wind speed recorded was about 120 km / h on the 12th morning at Thanjavur, Tiruchirapalli and Podukottai. 560 people died and 100,000 people lost their homes. 23,000 heads of cattle perished. The total damage to private and public property was estimated at Rs. 155 crores.

4. November 14th-24th, 1978: A cyclone tracked over between Kilakkarai and Rochemary in Ramanatharam District of Tamilnadu on the evening of the 24th as a severe storm emerged off the Arabian Sea on the Kerala coast, emerging as a deep depression on the morning of November 25th. Maximum wind speeds of 145 km / h were reported at Batticola, Sri Lanka. In India, 5,000 huts were damaged; total damage was estimated at Rs. 5 crores. In Sri Lanka, 915 people died and one million people were affected; 10,000 houses were damaged.

5. November 27th-30th, 1984: A cyclone tracked over the southern Tamilnadu coast near Nagapattinam in the afternoon of December 1st near Karaikal. About 35,000 people were affected in East Thanjavur and South Arcot districts. 50, 000 acres of land were submerged in Thanjavur district.

6. 11th-15th November 1991: A cyclone tracked over the Tamilnadu Coast north of Karaikal. 185 people died and 540 heads of cattle perished.

7. 11th-17th November 1992: A cyclone tracked near Tuticorin (Tamilnadu). 175 people died and 160 more were reported missing. The resulting floods caused extensive damage to standing crops.

8. 1st- 4th December 1993: A cyclone tracked north of Karaikal in Tamilnadu, killing 100 people.

9. 28th November-6th December 1996: A cyclone tracked near Chennai around 2100 UTC on December 6th. The cyclone persisted for 9 days, reported to be one of the longest duration stationery cyclones in the Indian Ocean. It caused extensive damage to life and property.

10. Tropical Storm 06B formed 550 nautical miles east of Chennai on December 6th, 2005, west of the Andaman Islands. It became Cyclonic Storm Fanoos on December 7th. Cyclone Fanoos later weakened into a deep depression before crossing the northern Tamilnadu coast near Vedaranyam at 0530 UTC on December 10th. The storm weakened further into a low pressure area over the southern Tamilnadu coast the following day. It caused major floods all over Tamilnadu, in particular the on coastal districts.

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