Project Completion Report

Policy Support for the Green Coast Project

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R.S.Bhalla

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Foundation for Ecological Research, Advocacy and Learning,
FERAL, No.27, 2nd Cross
Appavou Nagar, Vazhakulam
Pondicherry 605 012, India
Web page. http://www.feralindia.org

Contents

This report presents findings of a series of studies conducted to validate and support the policy advocacy component of the Green Coast project. The studies involved field based research and collation of primary and secondary data from other sources. The study was conducted by FERAL between the period of February and August 2006 and had three basic components; a field based assessment, literature review and a remote sensing based analysis of freely available satellite imagery. The mandate of the study fell in four basic areas; fisheries, coastal defences, coastal changes and post tsunami reconstruction. The study refers to and uses published and unpublished data from other studies in the area, including those supported by the Green Coast project. A review of international and Indian literature on the subject was conducted.

A large area under the Coramandel coast was covered during the study with over fifty villages surveyed using a combination of field and participatory survey techniques. The project area was selected on the basis of available data, particularly imagery. A total of eight different types of schedules and field investigations were run in the course of the study. These covered changes in fisheries both among sea and backwater fisher folk, shrimp farming, coastal zone regulations, environmental monitoring, vegetative shelter belts, coastline changes and reconstruction. Spatial locations of field sites were collected where practical.

There has been an increase in fishing pressure as a direct result of post tsunami interventions. There are more boats, motors and larger crews exploiting the same areas as earlier. The increasing popularity of a fine meshed purse sine net is a cause of alarm among fisher folk and is leading to conflict amongst fishing groups.

The study showed no positive impacts of vegetative shelter belts on the distance travelled by the tsunami. This finding questions one of the basic premise on which extensive bio-shield plantations are being undertaken along the coast, often at the expense of natural habitats such as sand dune systems.

Community based consultation for post tsunami reconstruction was minimal in the sties surveyed. The majority of these sites have insufficient sewage or solid waste management infrastructure. Temporary settlements and existing habitations show a high level of e-coli contamination in the ground water. This is probably the result of inappropriate sewage disposal techniques leading to contamination of a high water table.

A large number of violations of the coastal regulation zone exist. These include commercial, industrial and residential projects, many of which are recent in origin. Types of violations include construction type and height, extraction of ground water and disposal of wastes.

The results question the validity of interventions such as sea walls as “protection” against tsunami’s and cyclones. Evidence shows that coastal erosion, a direct result of these sea walls are playing greater havoc with lives of coastal and fishing communities. Results also show that fishing capacities have been built to levels higher than prior to the tsunami and are likely to further exacerbate the over exploitation of coastal fisheries. It highlights the need for a comprehensive coastal management programme which is based primarily on the restoration of natural goods and services and adoption of best practises for industries such as shrimp farms and housing projects.

Part I.

Executive Summary

1. Introduction

The policy assessment study was launched in the beginning of February 2006 with the primary objective of strengthening policy reccommendations within the four sectors of fisheries, reconstruction, shelterbelts and coastal zone regulations. This report present the findings of the study whose scope was defined in the terms of reference which included the following:

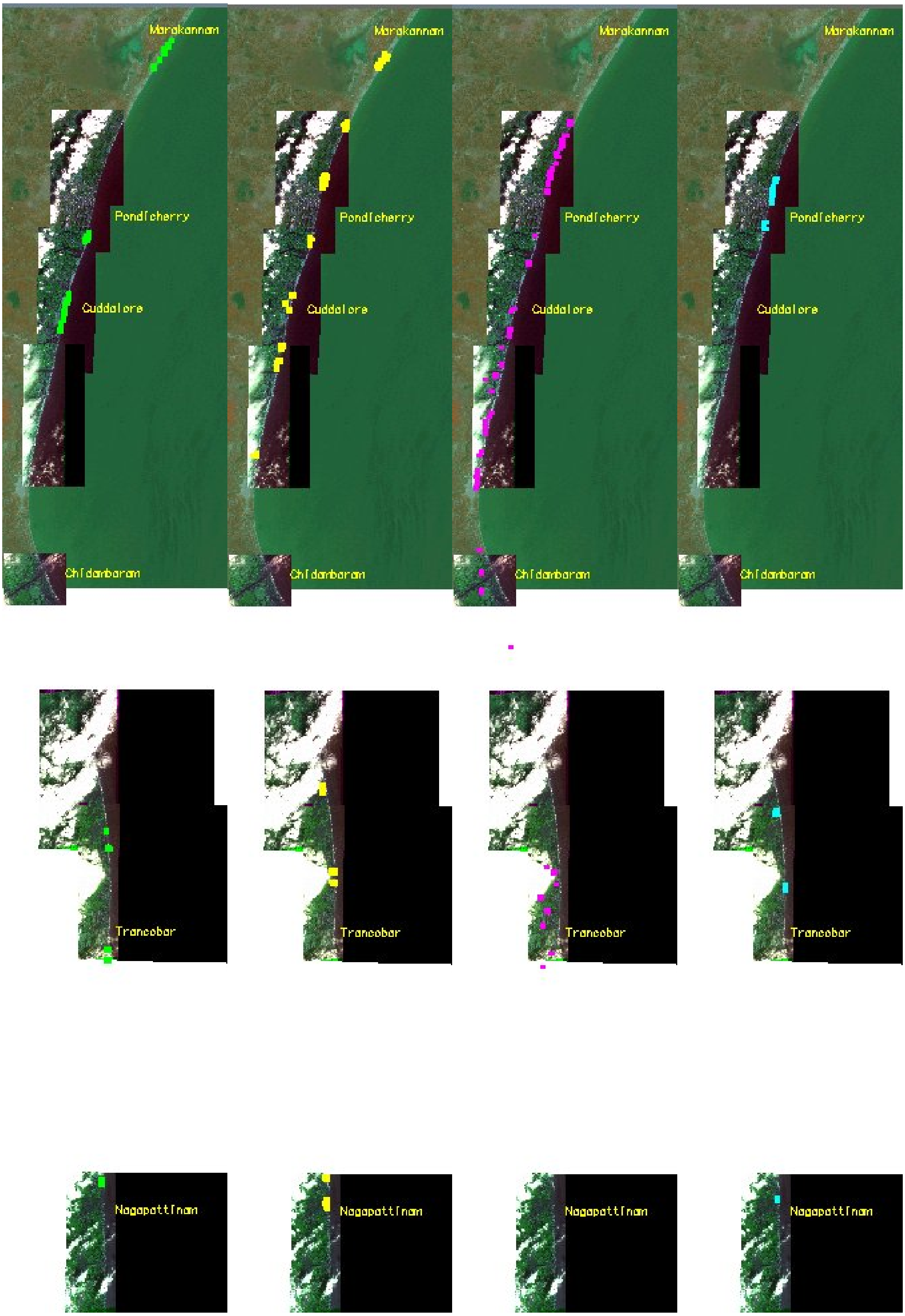
- Sustainable fisheries.
  - A review of existing policies on fisheries and ground realities along the East Coast.
  - Community perceptions of fisheries.
  - Changes in equipment used for fisheries, post tsunami.
- Ensuring that coastal defences, particularly shelter-belts do not adversely impact coastal ecology and livelihood.
  - Changes along the Coramandel coast.
  - Community perceptions on coastal defences, both vegetative and sea walls.
  - Potential impacts of existing reconstruction on coastal ecology and livelihood.
- Ensuring that post-tsunami reconstruction and rehabilitation is environmentally sensitive in terms of structure and location.
  - Community perceptions and experiences in relation to reconstruction.
  - Major environmental issues related to re-construction.
  - Pollution and sewage discharge related to reconstruction.
- An assessment of the shrimp industry and its impact on backwater and estuarine areas.

The study was field based and involved collection of data, primarily via interviews with local community groups and individuals and through direct measurements of water quality and global positioning system (GPS) based mapping. This data was complimented by other studies in the region as well as reports and publications from other groups. FERAL had been involved in various assessments related to post tsunami reconstruction and rehabilitation and experience and data collected from these was also incorporated into the findings.

2. Study Area

The project area encompasses Pondicherry and three tsunami affected districts in Tamil Nadu, namely Villupuram, Cuddalore and Nagapattinam[1]. Between two and five hamlets were chosen in each district. Figure 2.1 shows the location of some of the different studies undertaken.

[1] Kanyakumari was initially included in the project area but dropped in favour of a larger sample size within the Coramandel coast.



(a) Bio-shields. (b) CRZ. (c) Inundation points. (d) Sea walls.

Figure 2.1.: Project sites. The available imageries did not cover the entire coast and thus the gaps.

3. Organisation of this report

This report is split into parts corresponding to the various components of the study barring this introductory part and the final part which presents the Annexure, supporting documents and bibliography. Even though this was a research based study, attempts have been made to cater to both the scientific and non-scientific community in the report. Each component presents a detailed methods and analysis section, the latter with a short discussion in non-scientific terms. Photographs, maps and satellite imagery[1] have been presented where appropriate.

The introduction covers an overview of the objectives of this study, the study area, the methods and analysis employed. It presents the overall results of the study and conclusions. The section on fishing equipment compares the pre and post tsunami fishing scenario in fishing hamlets across the Coramandel coast. This is followed by the section on coastal defences broken up into status of sea-walls and vegetative shelter belts. The section on reconstruction briefly describes the status and likely impact of re-settlement colonies that are nearing completion. The section on water resources presents data of impacts of run-up on water sources across the Coramandel coast as well as that of local sewage disposal in selected areas. This is followed by the analysis of whether shelter-belts actually provided any protection against the tsunami.

[1]Note: Spatial data presented here is not to scale.

4. Overview of Methods

Selection of sites

Four to five sites were selected from each district. These were selected on the following basis:

- Existence of data from other sources, these included:
  - Earlier studies run by FERAL and/or partner agencies/individuals[1].
  - Available satellite images.
  - Other Green Coast Partners.
- Presence of fishing harbours or jetties in at least one of the sites per district.

In addition, specific surveys were conducted in:

- Areas where reconstruction was taking place.
- Areas with shrimp farms and hatcheries.
- Areas where there were mature *Casuarina equestifolia* plantations at the time of the tsunami.

Spatial data

All spatial data was geo-referenced using Garmin 76 GPS units which have accuracies between 5 and 15 metres on average. Most of the field surveys carried out, including schedule administration for shrimp farms, reconstruction sites, sampled wells and toilets were given a spatial attribute. Between 40 and 100 geo-referencing points were used to rectify each set of images[2].

Schedule administration

Structured schedules were used to determine responses of communities to the various issues. These were generated through a three step process of generating a question list based on a preliminary field visit. This was converted into a schedule and field tested. Finally incorporating changes into the final schedule based on the field tests. Schedules were administered for most components of the study and are presented in Annexure B.

[1]Please refer to the credits section for details of partner agencies and individuals

[2]Downloaded from the PDC (Pacific Disaster Centre http://www.pdc.org) and the Global Land cover Facility http://www.landcover.org site and procured from the National Remote Sensing Agency http://www.nrsa.gov.in.

Focused and group discussions

Focused group discussions were conducted on the basis of a pre-defined question list. This list was field tested on site and modified as necessary. In some cases the list was administered as a schedule to a group of discussants.

Field surveys

Field surveys were conducted for a number of investigations which incorporated many of the elements discussed above. These included GPS based mapping of structures such as shrimp farms, permanent shelters, CRZ violations, inundation points, water resources and Casuarina plantations. Water quality parameters such as pH, salinity, electrical conductivity and total dissolved solids were measured for water sources inundated by the tsunami, shrimp ponds and backwaters or water sources for the shrimp farms. These parameters were also collected for control points of un-affected water sources. Additionally, e-coli readings were taken for drinking water points for the drinking water quality study.

Analysis

All the GIS and remote sensing analysis was done on GRASS [1]. R [2] was used for all statistical analysis. Data collected from the schedules was stored on a PostgreSQL relational database and data entry was done using OpenOffice spreadsheets or through HTML forms created for the purpose. All the software used for this study was under the GNU public license or other open source licenses.

Interpreting the analysis

The basic definitions and interpretation of the various statistical tests carried out are summarised below for the non-scientific reader.

Confidence interval: This is the probability that the results show statisitical significance when there is no statistical significance. At 95% it means that there is a one in twenty chance that the results state a significant difference even though the results are not significant.

Paired t-tests: The test determines whether there is a statistically significant difference between the averages of different variables measured. In statistical terms, whether the alternative hypothesis is true (null hypothesis always states that there is no significant difference). Any p-value below 0.01 indicates very strong evidence against the null hypothesis, a value between 0.01 and 0.05 indicates strong evidence, a value between 0.05 and 0.1 indicates suggestive evidence and a value greater than 0.1 means the evidence is not sufficient.

Box-plots: These graphs provide a large amount of information at a glance:

- The median of the data is shown by the central line. If this line is not in the middle, the data is skewed.

- The body or box shows the middle two quartiles of the data i.e. from 25% to 75%.
- The ends of the vertical lines or "whiskers" indicate the minimum and maximum data values, unless outliers are present in which case the whiskers extend to a maximum of 1.5 times the inter-quartile range.
- The points outside the ends of the whiskers are outliers or suspected outliers.
- If the medians of a boxplot is higher or lower than the body of another there is a significant difference between the two parameters being compared.

5. Overall Conclusions

The tsunami of 2004 brought into focus an array of issues confronting the battered coast and its inhabitants. While relief and rehabilitation were and remain primary concerns, attention was also given to the larger issue of coastal zone management. This study provided a field based scientific backup for these policy issues and found that many of the problems were exacerbated by post-tsunami efforts.

Livelihood Reconstruction

The mad rush for "livelihood reconstruction" led to replacements of boats, nets and motors to fisher folk. While undoubtedly many individuals were left without adequate compensation, fishing capacities post tsunami stand higher than pre-tsunami. Unless immediate steps are taken to ensure compliance with net seine sizes and zones, a further depletion of fish stocks is to be expected.

Reconstruction and Contamination of Ground Water

Provision of toilets was another area wherein a large number of organisations built latrines based on the leach pit model. This has resulted in fecal contamination of ground water resources along the coast. Most post tsunami reconstruction continues to rely on the leach pit model for sewage disposal, pointing to further and continual contamination of the ground water in the near future. District govt. authorities have been aware of this danger, and in spite of the availability of other appropriate models, it has not been possible to contain the use of the leach pits. There is a clear need for policy interventions in this area. Guidelines for construction that ensure minimum safeguards against ground water contamination and pollution of ecologically sensitive areas need to be evolved or reviewed and implemented where there already exist.

Shelter Belts

Sea Walls

Sea walls are now being constructed in various areas along the coast. More are planned in the near future. While the walls undoubtedly provide protection from coastal waves, they do not serve any purpose in areas with shallow shelves such as Nagapattinam. The latter, as tragically witnessed, are more susceptible to tsunami generated waves. On the other hand sea walls and groynes pose a host of problems to coastal communities. They limit access to the beach, cause competition for parking boats, drying nets and fish and selling catch. Policy makers need to be informed that sea walls can actually exacerbate the problem of coastal erosion further downstream of prevailing currents. This can cause more serious and long term ecological degradation than sporadic cyclonic events and other natural disasters. The construction of sea walls can also seriously impact the natural process of sand dune formation which form natural barriers and wind breaks in many areas.

Bio-Shields

The other form of coastal protection has been that of vegetative shelter belts. There is no clear evidence that vegetation played a role in reducing the tsunami run-up. On the contrary, there is strong evidence that suggests this did not happen, including the present study. Thousands of hectares of coastal land are currently undergoing or are earmarked for plantations of coastal shelter-belts. Most of the trees planted will be varieties of Casuarina, an exotic timber and pulpwood species. *Casuarina equestifolia* is a fast growing pine, pest resistant, saline tolerant and not particularly favoured by cattle. On the down side, its leaves and roots are known to inhibit growth of other plants. Survival rates for native coastal plantations have been low in areas where they were not protected and watered adequately. However where communities did so, the survival is above 60%. It is argued that native species will provided a more “natural” habitat and a wider range of resources to local communities. Proponents of Casuarina state that the quick growth of the tree will provide protection from cyclones and meet local fuel wood demand. Both sides fail to see that there are large parts of coastal sand-dune systems which are being modified. Most of the fishing communities along the coast did not permit planting of coastal shelter belts in front of their villages as this would block the view of the sea from the habitations. This questions the very premise of “bio-shields” on the basis which such large scale plantations have been initiated by the government and various non-government agencies.

Inundation and Contamination of Water Sources

Inundation by the tsunami affected a large number of water sources near the coast. Many of these were the basis of coastal agriculture and precious little has been done to assist the farming community along the coast. The study measured the physical parameters of water in impacted water bodies along the coast. In spite of a good intervening monsoon and summer rains, there is a significant difference in the water quality parameters between affected and non-affected water bodies. Similar studies in Thailand have examined the introduction of heavy metals into water sources[3]. The question whether similar levels of contamination have occurred along the Coramandel coast needs to be answered at the earliest.

Comparisons of pre and post tsunami data shows that large coastal areas have been modified for shrimp farming and that there is a decrease in vegetation along the coast and backwaters. There is a clear case for restoration of mangrove communities in these backwaters, both to ameliorate the impact of shrimp farm discharge as well as to provide breeding grounds for the increasingly depleted fish stocks.

Part II.

Fisheries

6. Background

Introduction

The rush for livelihood support to groups affected by the tsunami was unprecedented. While the relief was welcomed by the fishing community at large, it appears to have further increased fishing capacity in the artisanal fishing grounds along the Coramandel coast and may have, in the long run, jeopardise the livelihood of the very community it set out to support. This component presents and discusses observations on fishing grounds, fishing equipment, crew size and composition of catch for marine fisher folk.

Figure 6.1.: Fishing gear at Nagapattinam.

Literature review

A literature review shows that the "alarm" bells for Indian fisheries have been on for over two decades [4, 5, 6, 7, 8] and even the tenth plan notes the levels of over exploitation of existing stocks and the over capacity of both the traditional and mechanised fishing fleet[9]. A need for reduction of fishing capacity is considered a necessary precondition to the rebuilding of fish stocks [10]. However the state authorities appear less aware of this danger and there have been increased outlays for the marine fishing sector [11]. Evidence from the central marine fisheries research institute (CMFRI) records on fisheries shows clear trends in overfishing [12] and that there has been a reduction in the catch and sizes of predatory species and that juveniles of many of the species are being harvested[7].

Objectives

The primary objective of the study was to determine whether post tsunami interventions for livelihood restoration of the artisanal fishing community had resulted in an increase in their fishing capacities after the tsunami.

Specific objectives of the study were to:

- Quantify the additional fishing capacities created
- Determine whether there were any community concerns regarding depletion of fish stocks
- Determine what policy measures have been suggested and taken up as a reaction to these concerns and
- Suggest specific interventions which need to be taken to address these issues.

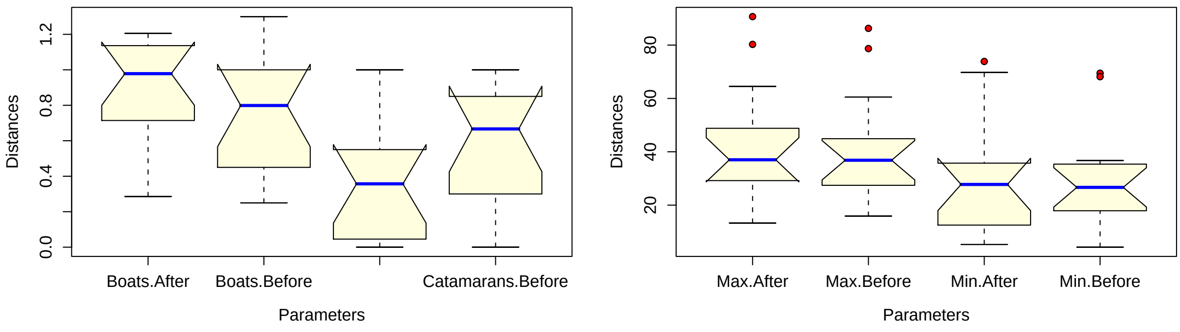
7. Methods and Analysis

The findings on local fishing practises before and after the tsunami are based on 296 schedules administered in 16 hamlets details of which are summarised in Annexure A. A sample of the schedule is presented in (see Annexure B). The data was first aggregated (mean) per village to ensure the data was continuous and only those villages were selected where there were at least five data points for each response. Thus data for Chettikuppam and Chinnamudliarchavady was excluded from the analysis. Analysis of the data was done using paired T-Tests using the R software package [2]. A 95% confidence interval was used for all tests.

8. Observations and Discussions

Fishing grounds

The data showed that there was no significant increase in the average fishing ranges before and after the tsunami (t = -1.4534, df = 13, p-value = 0.1698). Neither was there any significant differences in the average minimum distances (t = -0.1661, df = 13, p-value = 0.8706) or maximum distances travelled (t = -0.6357, df = 13, p-value = 0.536). The data (figure 8.1) however shows a non-significant decrease in the minimum and increase in the maximum distances travelled.



(a) Average ranges of craft.

(b) Average ranges.

Figure 8.1.: Fishing ranges.

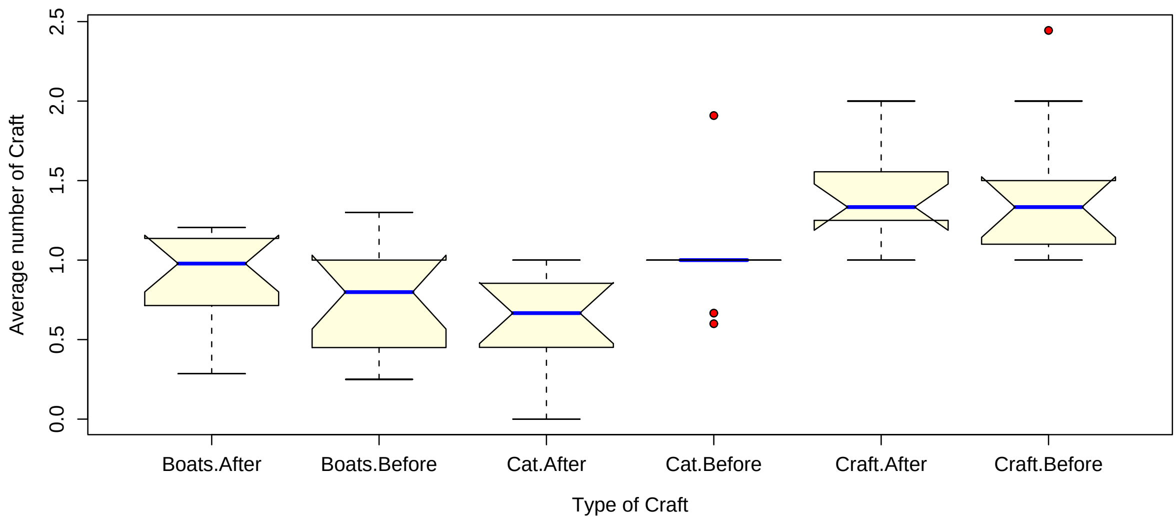
The data also show a consistent and significant increase in the average distance travelled by fibre boats as compared to catamarans both before and after the tsunami. Proponents of increasing the fishing capacity for artisanal fishers often given the argument that better motorised boats would automatically result in the fishers exploiting more distant areas. Data from the study indicates that although the fishing ranges might have increased for fishers using boats instead of catamarans the total extent fishing grounds has, not increased significantly. In fact catamaran users appear to have reduced the distances travelled for for fishing after the tsunami.

Equipment used

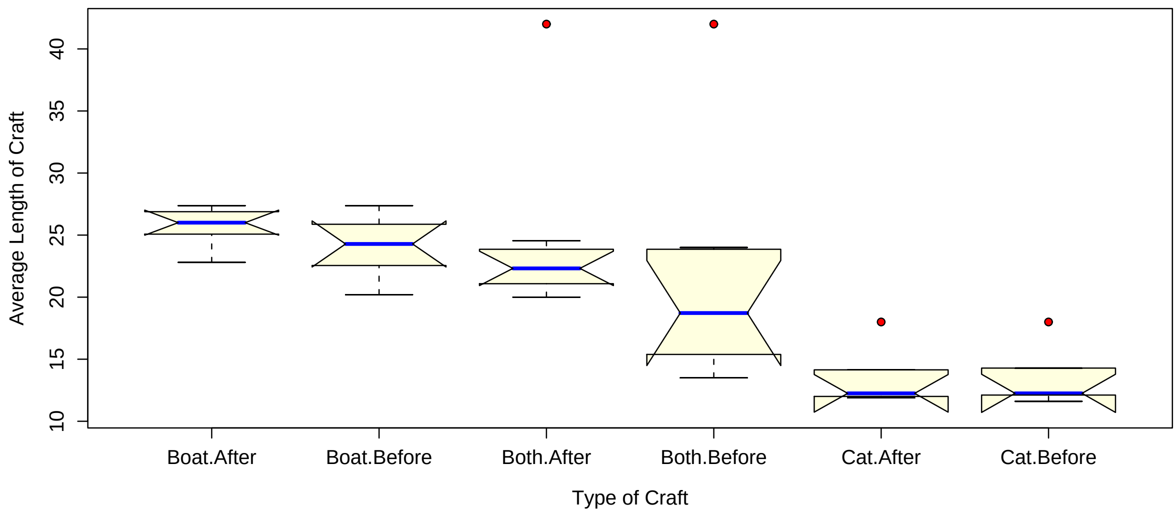
Crafts

There has been a substantial change in the types and lengths of craft being used prior to and after the tsunami. Figure 8.2 summarises the number of craft before and after the tsunami.

The total number of catamaran had reduced in favour of fibre glass boats while the number of trawlers remained the same. There was a highly significant increase in the length of craft after the tsunami (t = -3.4956, df = 9, p-value = 0.00677), figure 8.2. There was no significant increase in the lengths of fibre boats after the tsunami (t = -1.7385, df = 7, p-value = 0.1257).



(a) Average number.



(b) Average length.

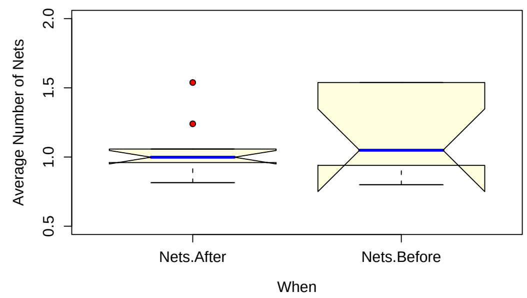
Figure 8.2.: Number and length of craft before and after the tsunami.

Neither was there a significant difference in the lengths of the catamarans before or after the tsunami either (t = -0.0652, df = 4, p-value = 0.9511). Thus the increase in average craft size was a result of fibre boats replacing catamarans.

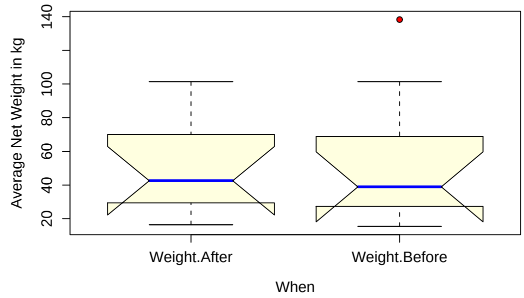
The difference between the number of craft operating before and after the tsunami was non-significant. However when the data was separated into boats and catamarans, the number of boats were significantly higher (t = -3.4302, df = 13, p-value = 0.004475) and the number of catamrans significantly lower (t = 2.6437, df = 10, p-value = 0.02458).

Nets

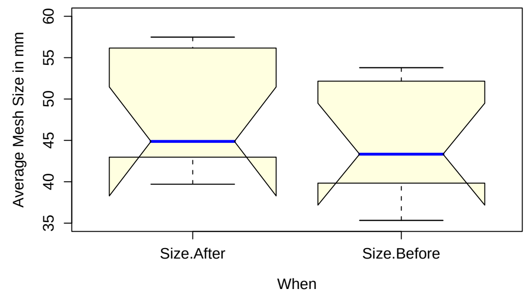
There is no significant difference in the average number of nets being used in hamlets after the tsunami (t = 1.525, df = 10, p-value = 0.1582). Neither is there a significant difference in the weight (t = 0.3105, df = 10, p-value = 0.7626) . The number of nets used before and after the tsunami have been summarised in figure 8.3. There is, however, a significant increase in the mesh size of nets being used (t = -2.6994, df = 10, p-value = 0.02234). The averaged data per hamlet has been presented in figure 8.3. The reasons for an increase in mesh sizes of nets is not known but there are no indications that this was due to compliance with policy regulations.



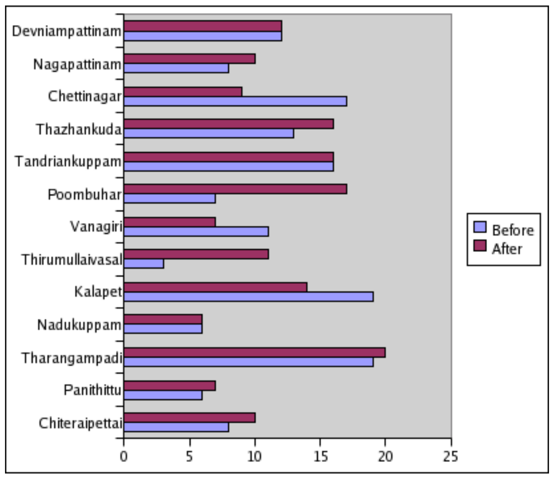
(a) Average number of nets.



(b) Average weight of nets.



(c) Avearge mesh size.



(d) Number of hooks per village.

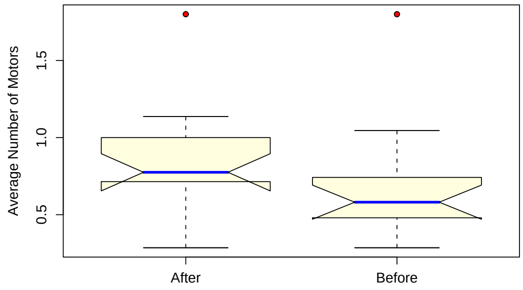
Figure 8.3.: Use of nets and hooks.

Hooks

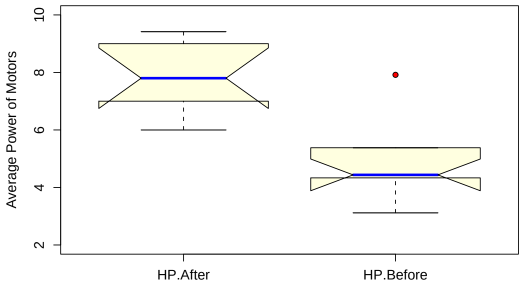
There has been a significant increase in length of line being used for hook fishing after the tsunami (t = 2.3583, df = 11, p-value = 0.03793). There was no significant change in the number of persons using hooks or sizes of hooks being used before and after the tsunami. The change in number of persons using hooks is shown in figure 8.3.

Motors

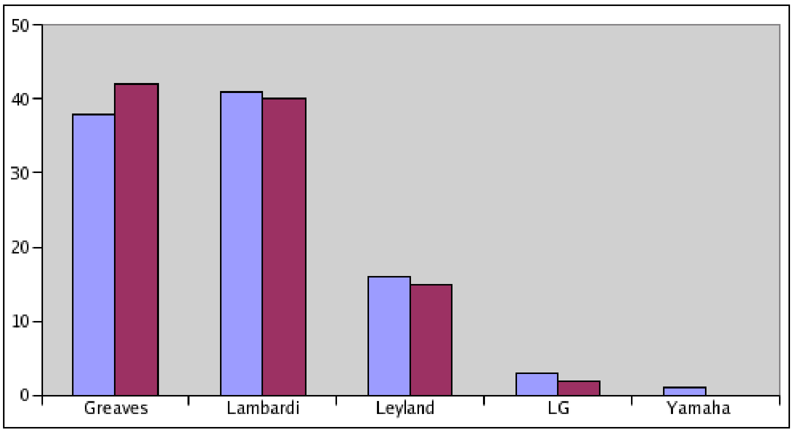
There has been a highly significant increase in the average number of motors being used in the hamlets (t = -4.2335, df = 13, p-value = 0.0009767). There is also a highly significant increase in the power of the motors (t = -5.373, df = 8, p-value = 0.0006672). The type of motors, shaft based versus "box type" did not change and remained at 16 and 83 respectively and there was a slight shift in the brands of motors being used (Figure 8.4).



(a) Averge numbers.



(b) Average power.



(c) Makes being used (blue=after, maroon=before the tsunami)

Figure 8.4.: Details of motors.

Crew size

There has been an increase in the average crew size after the tsunami (t = -2.5637, df = 13, p-value = 0.02357), figure 8.5. This figure goes against the premise that the increased number of boats would create a shortage of crew members for fishing trips. The survey did not ask about the social background or prior occupation of the existing crew members and whether there had been any recruitment of non-fishing castes or a return to fishing by fishermen in other occupations.

Resource related conflicts

There is a rising conflict among artisanal fisher folk about the introduction of a mini purse seine net called the "*surukuvalai*" about four years ago. This net was introduced in the Palayar village according to the respondents, but was burned down by a group of fisher folk from led by people from Devanampattinam. Now however, it is fisher folk from Devanampattinam itself who are using the net which has slowly spread to other villages including:

- Kotakuppam.
- Thazhanakuda.
- Pannithittu.
- Narambai.
- Chitiraipettai.
- Pazhayar.
- Sonankuppam.
- Sothikuppam.
- Rasapettai.
- Nallavadu.

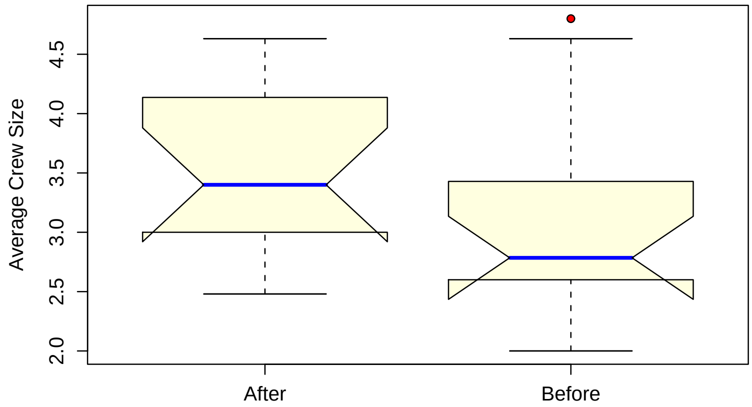


Figure 8.5.: Average crew size.

This net, which weighs about 500kg and costs up to four lakh rupees is reportedly causing a decline in fish yield as it results in the killing a large number of fingerling. The net is operated and owned in partnership with up to 20 persons. A large number of respondents said the net was causing a decline in yield and a complaint regarding this has been given to the Collector of Cuddalore but action is yet to be taken.

Yield Status

There were 107 respondents who expressed their view on the question of yield status. The majority (96) felt there had been a decrease in yield and reasons attributed to this are impacts of the tsunami and increased use of the surkuvalai. The responses have been summarised in figure 8.6.

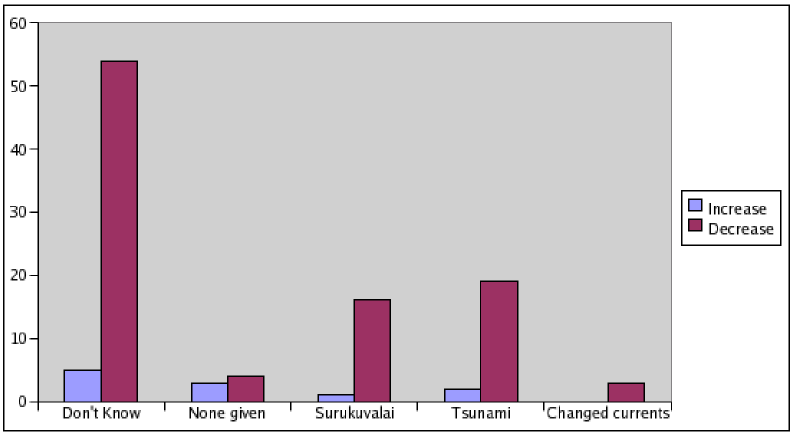


Figure 8.6.: Reasons for change in yield.

9. Conclusions

The data shows that there is a clear increase in fishing capacity due to post tsunami interventions even though the area under fishing has not increased. This evidence goes against the argument that the possible increase of fishing effort would be offset by increased areas under fishing grounds. The increased use of the purse seine nets (*surukuvalai*) further highlights the need for adoption and implementation of policies for sustainable fisheries. A combination of awareness and education with regulation on mesh size and control on fishing zones for larger craft as well as nets is required.

The data shows that the increased capacity in almost all facets of artisanal fishing. The hamlets have a more modern fishing operation with a higher number of craft, larger craft, more motorised craft and larger crew sizes when compared to before the tsunami. Data on types and number of nets used was difficult to analyse as local names for nets varied and was thus aggregated. However the data suggests that there was no significant change in the number of nets used after the tsunami, probably because of the aggregation of data. It is relevant to note that the mesh size of nets had increased significantly after the tsunami. It is not known whether this is due to closer adherence to mesh sizes by donors.

By no means do these findings imply that the fishing community should not have been compensated for their loss of livelihood. However they do ask whether there was any policy framework or application of mind on part of the relief agencies while distributing aid. There appeared to be no effort for quality control or adherence to existing rules on mesh sizes for nets. As a result many of the boats were not sea-worthy and nets distributed violated the rules for mesh sizes. Perhaps most alarming however is the increased use of the *surukuvalai* which appears to be a direct result of increased cash available to the fishing community for investing in such nets.

The fisheries sector provides a clear case for the govt. and environment agencies to intervene with a combination of enforcement and awareness programmes. The livelihood support provided post tsunami will only accelerate the depletion of fish stocks. If not dealt with this will result in a greater and more permanent loss of livelihood for these communities than the tsunami of 26th December 2004.

Part III.

Coastal Regulation Zone

10. Background

Introduction

The tsunami brought into sharp focus the coastal regulation zone notification of 1991 (see box), and the various violations and issues regarding its interpretation. This component of the study had the limited objective of illustrating the extent and type of violations along coastal areas. In particular it attempted to highlight the large scale modification of coastal habitats due to shrimp farming and salt pans.

> The Government of India, in 1991, issued a major notification under the Environment Protection Act, 1986, framing rules for regulation of various coastal zone activities. These rules are called the Coastal Regulation Zone (CRZ) rules. Under these Rules, the entire coastal stretch from the lowest low tide to highest high tide line and the coastal land within 500m from the high tide line on the landward side is termed as CRZ. The latter is classified into four categories depending on the sensitivity of the zones. Prohibited and regulated activities have been listed for each zone.[13].

The CRZ notification has been amended 19 times upto July 2003 alone [14] and the conditional approval of State Coastal Zone Management Plans by the MoEF, have made it almost totally ineffective. The various zones demarcated in the CRZ notification essentially bring the entire coastline under some form of protection (see Annexure C). The notification applies to coastal stretches of seas, bays, rivers, estuaries and backwaters, which are influenced by tidal action.

Literature review

There have been a number of recent publications and reports[14, 13] pertaining to the CRZ regulation, starting with the release of the review of the CRZ notification by the M.S.Swaminathan Committee [15]. The majority of these suggest ways to improve the CRZ by making it more participatory and de-centralised and emphasise the need for a detailed assessment and baseline of the coastal zone, existing property rights and commercial activities. The ambiguity and arbitrariness of the demarcations in the earlier act and in the more recent review by the M.S.Swaminathan committee have also raised concerns [14].

Objectives

The overall objective of this component was to build a baseline geo-spatial database for the Coramandel coast and map on it the various coastal regulation zones and activities that violated the notification. The specific objectives were:

- To map violation of the CRZ along the Coramandel coast.
- To document the type of violation in terms of space, resource use and pollution.
- To map prominent areas being utilised for aquaculture and where possible collect information about the operations.

The sheer volume of CRZ violations, particularly near towns and cities made it impossible to conduct a detailed assessment. This survey was therefore as an indicative assessment and limited its outputs to a profile prominent violations and the nature of their impacts.

11. Methods

Available high resolution satellite imageries[1] for the Coromandel coast were geo-referenced. As the are of interest of the project was limited to the coast, geo-referencing was limited to a two kilometre band inland from the coast. The coastline was mapped on a RGB-PAN hybrid of the imagery, the former at a 2.4 and the latter at a 0.6 metre resolution.[2] A five hundred metre buffer was created on the image thereby creating two lines corresponding roughly the high tide line and the zone within which the CRZ regulations are applicable. The 500 metre line was uploaded onto a GPS receiver which was taken to field and used to identify structures within the CRZ. Opportunistic sampling of structures clearly in violation of the CRZ was done along the coastal stretch between Pondicherry and Cuddalore. Structured schedules (Annexure B) were filled along constructions which were non-customary and permanent within 500 metres of the high tide line. Way points were collected for all the four corners of development work that violated the CRZ regulations and the data from the schedules was attached to polygons created from joining these way points. Shrimp farms were mapped in a similar fashion.

Schedules were administered where possible during both the CRZ and the shrimp farm surveys. The survey points were later digitised into polygons and data from the schedules was attached to them. pH and salinity levels were recorded from samples taken from the ponds and backwaters using electronic meters. A total of 50 and 51 schedules were administered regarding CRZ violation and shrimp farms respectively. The breakup of these has been provided in Annexure A.

[1] Downloaded from the PDC site http://www.pdc.org.

[2] Note that this line only approximates the high tide line, whose definitions are provided in the Annexure.

12. Observations and Discussions

Coastal regulation zone survey

The definition of the CRZ used for this study is an approximate (figure 12.1) and has been used to make up for the absence of physical markings on the ground which could have provided more accurate reference points. This study was not as detailed as is ideally required to gauge the type and extents of CRZ violations. It however clearly showed that the spatial extent and nature of violations were serious. Given the rate of growth of coastal towns and villages, this is likely to increase in the near future.

A breakup of the types of constructions has been provided in table 12.1.

Type	Numbers	Customary	Violations	Average area (m^2) of violations
Historical	1	1	0	
Religious	3	1	2	1775
Farm house	1	0	1	1600
Residential	24	22	1	25
Educational	1	0	1	Not Available
Commercial	18	0	18	16330
Habitation	3	3	0	

Table 12.1.: Type of construction.

As is evident, the maximum number of violations were are in the form of commercial activities which also occupy the largest area. The type of commercial activities included aquaculture - 6, tourism -4, small industries (including an ice factory) - 3, and one NGO and poultry unit. The aquaculture industry took up the largest area, averaging 2.82 hectares.

Aquaculture (shrimp farms) survey

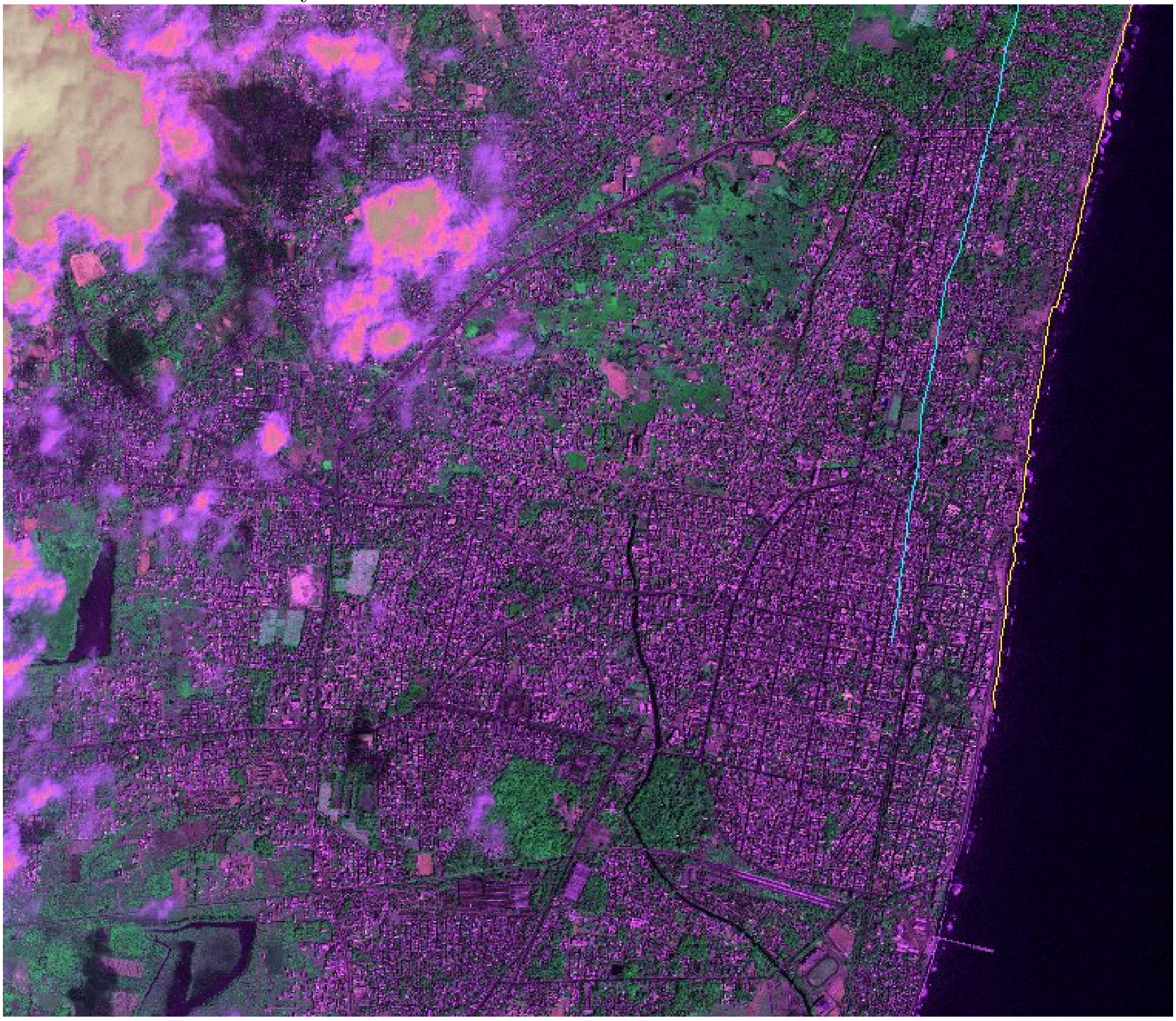
Shrimp farms along backwaters were a common violation in the more rural stretches of the Coramandel coast. Satellite imageries (figure 12.2) clearly show the extent of aquaculture ponds and salt pans.

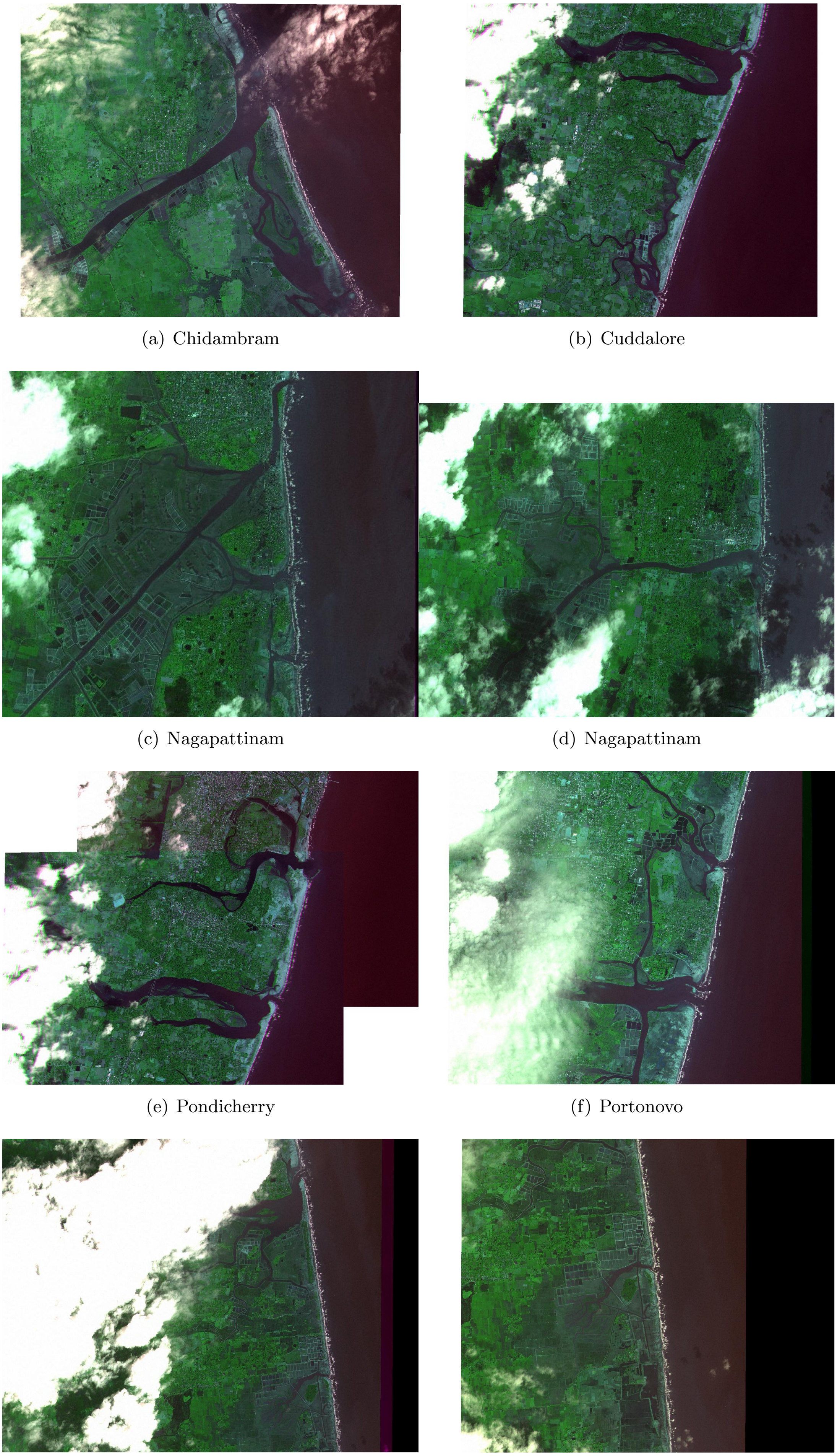
Barring Pondicherry, all the backwaters have substantial areas under shrimp farms or salt pans.

The average age and areas under the shrimp farms surveyed has been summarised in figure 12.3.

65% of the ponds depended on the backwater as their water, 27% on bore-wells and about 1% use both sources. While the number of samples did not permit a statistically valid analysis the data collected showed that backwaters had highest salinity and pH levels, the bore wells the lowest and the ponds between the two extremes (figure 12.5). Both diesel and electric pumps of varying power and pipe diameters were used as summarised in figure 12.4.

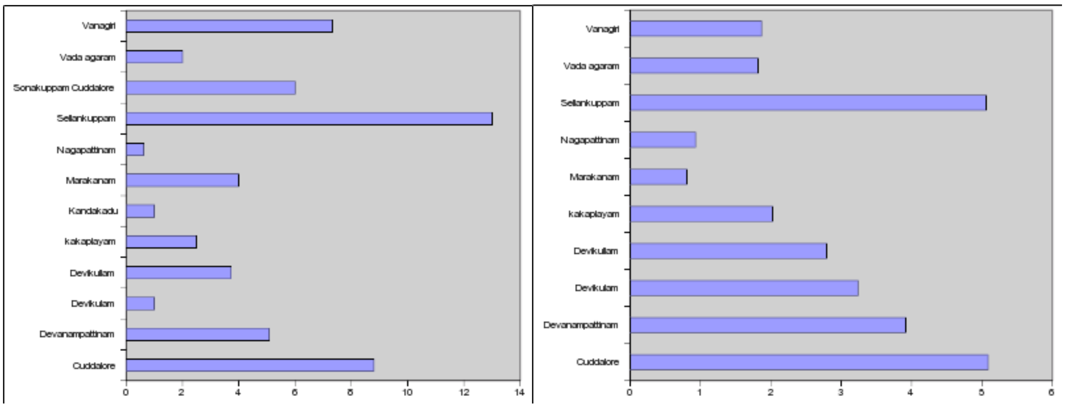
Figure 12.1.: The high tide (yellow) and 500 metre (blue) lines overlayed on an image of Pondicherry.





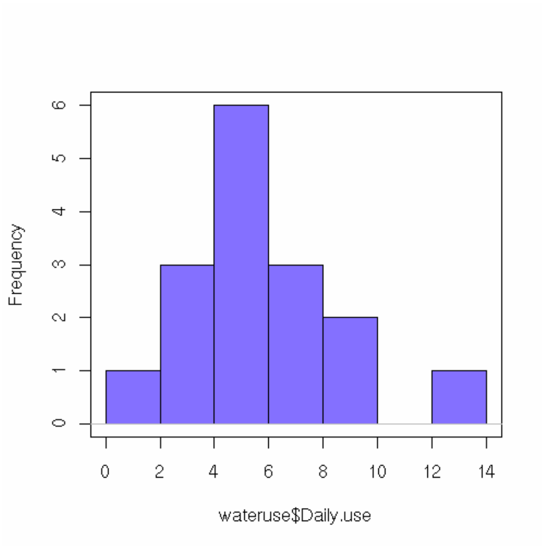
(a) Chidambram (b) Cuddalore (c) Nagapattinam (d) Nagapattinam (e) Pondicherry (f) Portonovo (g) Sirkazhi (h) Trancobar

Figure 12.2.: Shrimp farms and salt pans occupy large areas around backwaters and river mouths along the Coramandel coast.

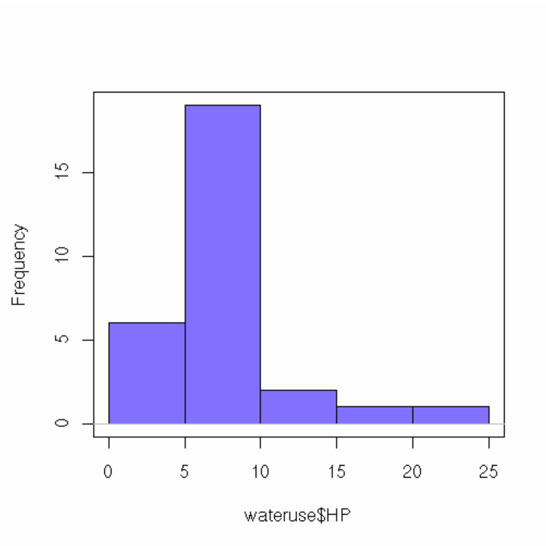


(a) Average age. (b) Averge area.

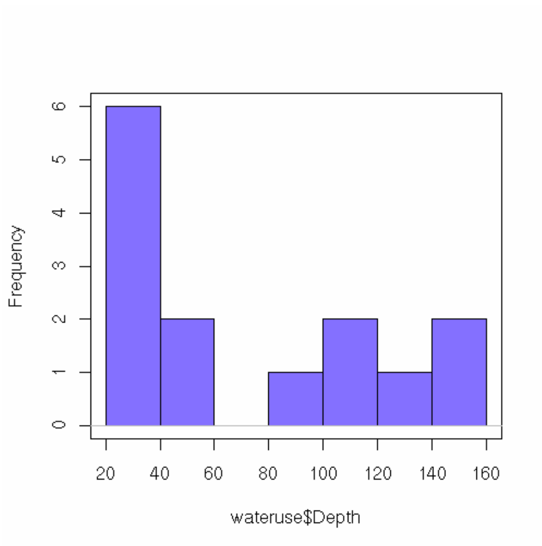
Figure 12.3.: Average age and area under shrimp farms.



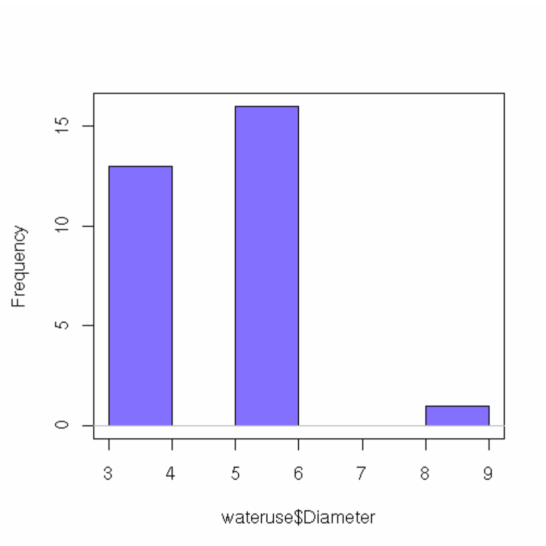
(a) Hours of pump use per day.



(b) Power of pumps being used.



(c) Depth of water source (for bore wells).



(d) Diameter of pipe.

Figure 12.4.: Details of water extraction for shrimp farming.

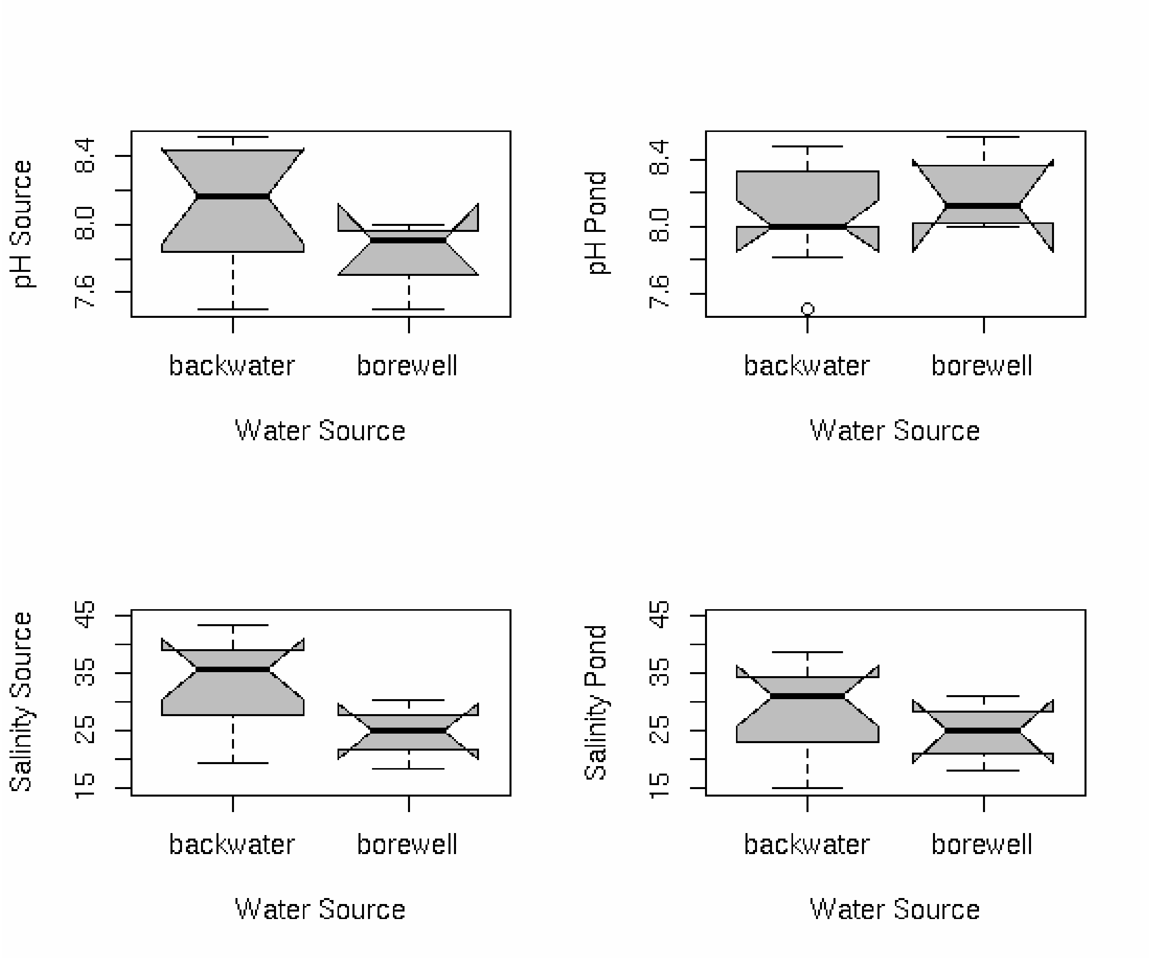
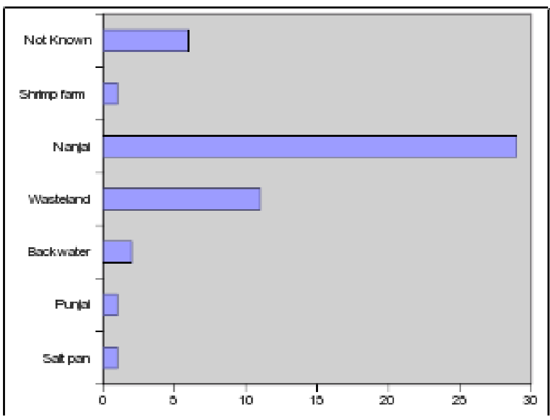
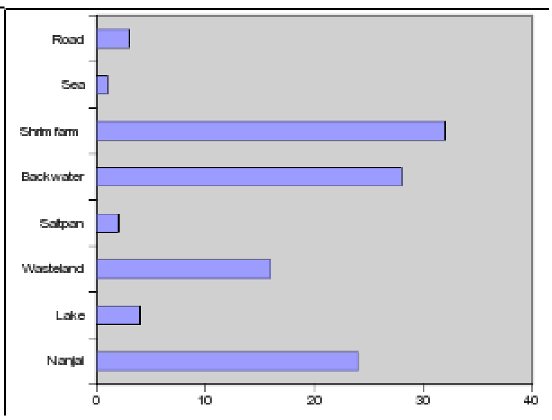


Figure 12.5.: Salinity and pH levels.

The survey found that a high proportion of the shrimp farms were either agricultural land[1] or had adjacent lands under cultivation. The landuse prior to conversion to shrimp farms and in the surroundings has been summarised in figure 12.6.



(a) Landuse prior to conversion.

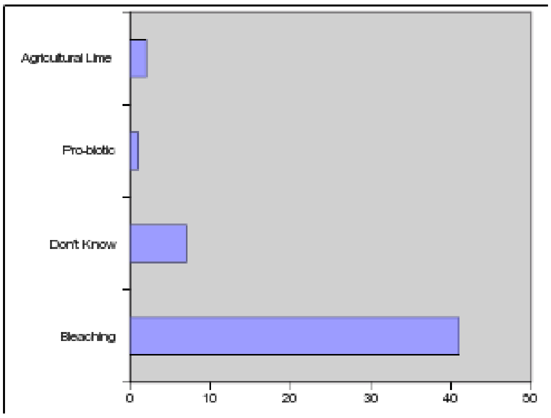


(b) Adjacent landuse.

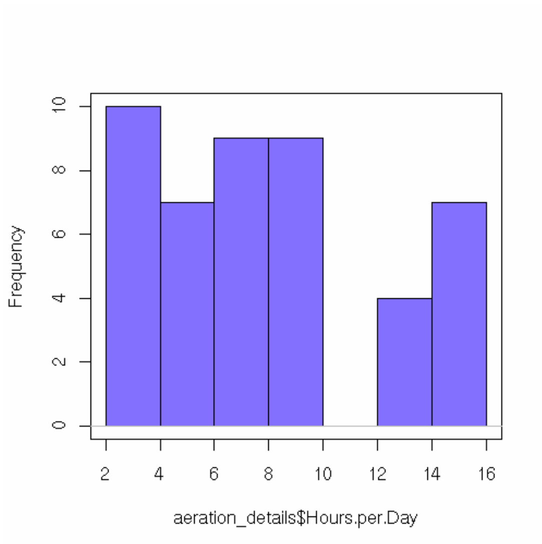
Figure 12.6.: Landuse prior and adjacent to shrimp farms.

Most of the water was treated with bleach prior to filling the pond. Dissolved oxygen levels were maintained through electrically or diesel operated paddles details of which have also been

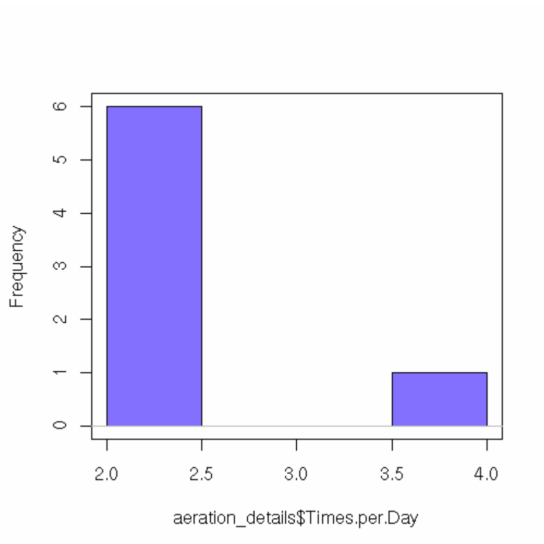
[1]Paddy land = Nanjai, non-paddy land (often irrigated) = Punjai.



(a) Wate treatement done.



(b) Number of daily hours of aeration.



(c) Number of times aeration done daily.

Figure 12.7.: Water treatment and oxygenation details.

provided in figure 12.7. Only one of the 51 shrimp farms did not use any aeration. 30 of the ponds used electric power while 20 relied on diesel engines. All the ponds used pre-manufactured feed from various companies and all but one of the ponds raised the tiger prawn (*Penaeus monodon*).

13. Conclusions

As pointed out by a number of authors, there is a need for an unambiguous identification of the various zones that fall under the coastal regulation zone notification. The vulnerability classification that was proposed by the MS Swaminathan committee further complicates the issue. Our yardstick for identifying the violations showed that a very a high proportion of these were commercial in nature. Shrimp farms formed the largest of these in terms of area covered and their preferred location, along backwaters and river mouths further highlights the need for identification of vulnerable areas and permitted activities.

The survey of shrimp farms indicates the lack of procedures for selection of sites with a high number of conversions of agricultural land and possible impacts on agricultural areas. The field survey further demonstrates the huge expanse of this industry along the Coramandel coast. While the data is insufficient to analyse the cultural practises in shrimp farming, the nearly total reliance on the tiger prawn indicates a monoculture which has implications in spread of diseases.

There is no data on the impact these farms are having on local diversity and abundance, particularly of economically important fish and wild shrimp species. Further studies need to be undertaken to determine the prevalent practises in shrimp farming to enable shrimp farmers to use best practises for these ponds and minimise their ecological footprint. Simultaneous research on the impact of shrimp cultivation on backwater fauna and flora needs to be undertaken. Restoration of backwater habitats needs to be undertaken urgently both to buffer the impact of the shrimp industry as well as to enhance local productivity.

Part IV.

Reconstruction

14. Background

Introduction

Post tsunami reconstruction has received a large amount of support, both from government and donor agencies. A huge reconstruction effort is currently underway with "quarters"[1] appearing along the entire east coast. Any large scale reconstruction project raises a number of environmental concerns, particularly if it is located in an ecologically sensitive zone. One of the objectives of the Green Coast project was to determine whether post tsunami reconstruction programmes have taken local views and environmental issues into account.

(a) Nagapattinam. (b) Anumandai.

Figure 14.1.: Some reconstruction sites.

There were two major phases of reconstruction after the tsunami, the first concentrated on temporary shelters, some of which continue to be used. The second round of permanent settlements is nearing completion. Sanitation and drinking water supply were a priority in the first phase which continue to be reflected in the second phase of construction. A number of "community toilets" were constructed near each temporary shelter to cater to the requirements of those affected. Typically one community toilet was constructed for men and another for women and children. Most permanent settlements also have individual toilets built in.

Literature review

Sanitation, particularly the disposal of "black water" or raw sewage, is one of the primary concerns in all relief situations. Lack of sanitation in relief camps can create "epidemic time bombs", a term used to describe the conditions of temporary shelters in Nagapattinam [16]. The WHO guidelines specifically state "The greatest waterborne risk to health in most emergencies is the transmission of fecal pathogens-gens, due to inadequate sanitation, hygiene and protection

[1] How permanent reconstructions are referred to by local communities.

of water sources." [17]. According to the EcoDesign and NeTPEM rapid environmental impact assessment, there were high levels of e-coli as well as nitrates in samples taken from shallow hand pumps. The study also found that levels of bacterial contamination seemed to be associated with use of toilets by adults and open defecation by children, distance of water sources from toilets. The levels of contamination of water sources increased during the monsoons and was ascribed to mixing of various organic wastes including fecal matter[16].

The inundation of coastal regions by the tsunami has led to the contamination of water resources. The nature of contamination included marine sediment and has raised concerns about migration of the contaminants into ground water and food [3]. In addition the run-up transported fecal and organic matter rendering many drinking water sources unfit [18]. The extent of tsunami run up and inundation was recorded on the east coast by [19], by whose estimates the the maximum run up was between 10-12 metres and inundation of up to 3 k.m.

> The combination of a shallow water table, highly permeable soil, open defecation and soak or leach pits for newly constructed toilets is responsible for the majority of drinking water quality problems in coastal villages.

Objectives

The purpose of this component was to determine whether post-tsunami reconstruction and rehabilitation is environmentally sensitive in terms of structure and location. Its specific objectives were to:

- Determine community perceptions and experiences in relation to reconstruction.
- Identify major environmental issues related to re-construction.
- Identify risks of pollution and sewage discharge related to reconstruction.
- To map the extent of inundation and its impact on water resources along the Coramandel coast.

15. Methods

Three independent surveys were undertaken for this component of the study. This included a survey on drinking water quality targeting e-coli contamination in particular, a survey of reconstruction sites and a survey of water sources which had been inundated by the tsunami. The location of the two project sites are provided in Annexure A.

Drinking water quality (fecal contamination)

A study on water quality of the various drinking water sources was conducted which covered hamlets in Cuddalore, Karaikal and Nagapattinam. An OXFAM Delagua Kit was used to take e-coli counts in various habitations and a GPS location was taken at each location. The OXFAM Delagua Kit is designed to test for coliform bacteria using membrane filter technique, residual chlorine, pH and turbidity.

Status of reconstruction

Three kinds of data were collected for this survey. A schedule (Annexure B) was administered which pertained to the sourcing of materials and participation of communities in the reconstruction processes[1]. GPS locations of the area earmarked for reconstruction were taken to get the spatial location and area of the reconstruction sties.

Impact of tsunami inundation on water resources

Water sources before and after the run-up line were tested for physical water parameters using electronic testing kits. This study covered the entire Coramandel coast. Each testing point was located using a GPS and a schedule/question list administered (Annexure B) to document the owner, use and type of water source. A total of 71 samples were taken along the coast. Measurements for pH, EC, Salinity and total dissolved solids were taken using electric metres and a refracto meter. An analysis of variance was done on the data using the R statistical package [2].

[1] Most of the sites were still under construction and the schedule could only be administered at one site. Only locational and publicity information was collected from the remaining sites.

16. Observations and Discussions

Drinking water quality[1]

Most coastal habitations obtain domestic water from hand pumps which tap shallow aquifers ranging between 5 and 15 feet (depending on the season). Most hand pumps are installed with piping to the depth of 20 feet which serves their annual domestic water requirements. After the tsunami, a number of additional hand pumps were installed by the government and various relief agencies. These were initially used only for bathing but as tanked and chlorinated water supplies to villages reduced, the hand pumps became the principal source of water.

Figure 16.1 provides a summary of the status of water quality in the samples from the three

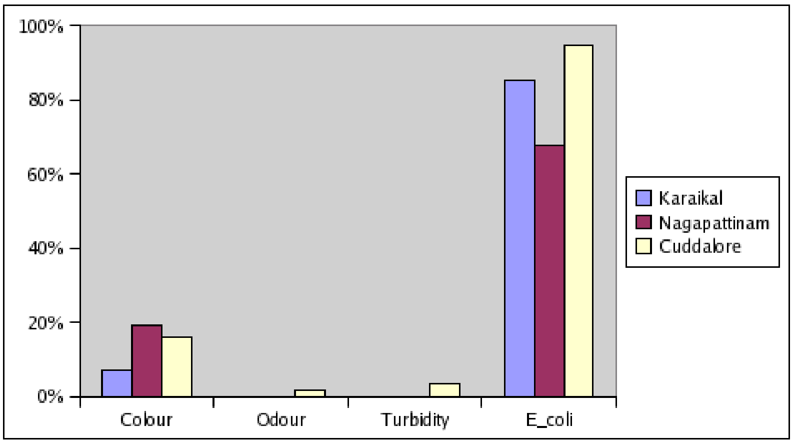


Figure 16.1.: Drinking water quality.

districts. Acceptable values for potable water under the Indian Standards Institute are presented in table 16.1. . The bulk of the samples had higher than permissible levels of e-coli. The average values for e-coli were 82.4, 72.3 and 231.5 for Karaikal, Nagapattinam and Cuddalore. Cuddalore had significantly higher levels of e-coli than either Nagapattinam or Karaikal as shown in figure 16.2.

The large number of samples violating e-coli standards indicates the seriousness of ground water contamination from untreated sewage. The largest number of toilets in coastal areas, including those built as part of post-tsunami reconstruction, rely on leach pits. This is recipe for fecal contamination of ground water in coastal areas which have sandy soils and shallow water tables. The data suggests that the problem of fecal contamination is likely to increase both in terms of higher loads as well as spatially as more and more households adopt these inappropriate sewage disposal techniques. Agencies involved in re-construction have largely ignored technologies such as ECOSAN toilets or small treatment units based on baffled reactors. A substantial number of the reconstruction sites did not specify the mode of sewage disposal,

[1]Data for this study was collected by Benjamin Larroquette, ACTED, No.56, Muttumariamman Koil Street. Pondicherry - 1.

Parameters	Drinking water	irrigation water	Fresh water	Marine water
pH	6.5-8.5	4.5-9.0	6.5-9.0	6.5-8.5
Temp	10 C			
DO			5mg/l	
RC(Residual chlorine)	0.2 mg/l		0.01 mg/l	0.01mg/l
TU(turbidity)	Less than 5 - 10			
Cl(Chlorides)	250-1000 mg/l			
NO3(Nitrate)	45 mg/l			
F(Fluoride)	1.0 mg/l (max)			
P(Phosphorous)	0.1 mg/l			
Fe(iron)	0.3 mg/l		1.0 mg/l	
HRD(Hardness)	300-600 mg/l			
NH3(Ammonia)	1.5 mg/l		0.02 mg/l	
Coli	should be nil			

Table 16.1.: ISI standards for water.

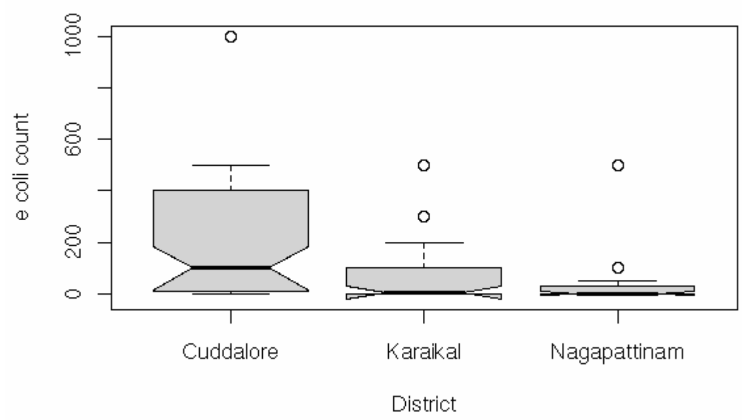


Figure 16.2.: E-coli levels in districts.

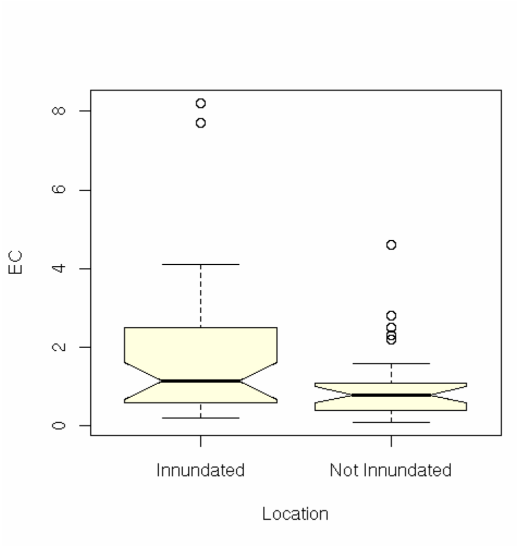
saying that it would be provided “by the government”. There is a clear case for policy guidelines for disposal and treatment of sewage waste for coastal dwellings. There is an equally strong case for conversion of existing leech pits to other forms of disposal.

Status of reconstruction

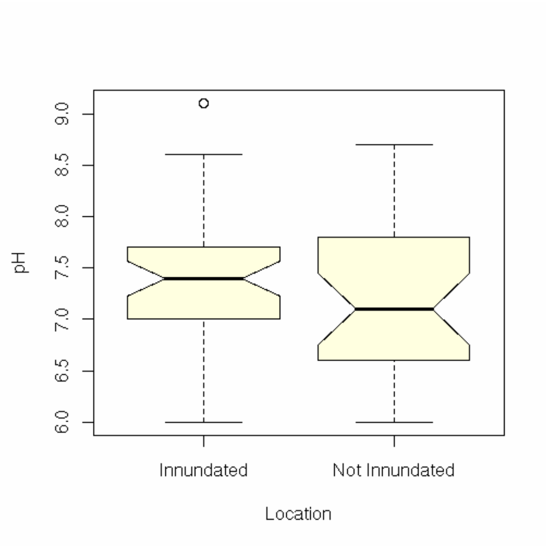
The involvement of communities in the reconstruction activities was minimal in the sites surveyed. The hand over of the houses has not yet happened and involvement of local groups has been limited to the Panchayat and administrative functionaries. Only one of the sites (Surya Nagar at Nagapattinam) had completed construction and the houses had been occupied. Thus data collected only pertained to one site and were not amenable to analysis. All of the sites where details of toilet types were available, sewage disposal was through individual soak pits (7 sites). In the case of one of these (Surya Nagar at Nagapattinam) the sewage disposal was in a common leach pit to which the toilets were connected.

Impact of inundation on water resources

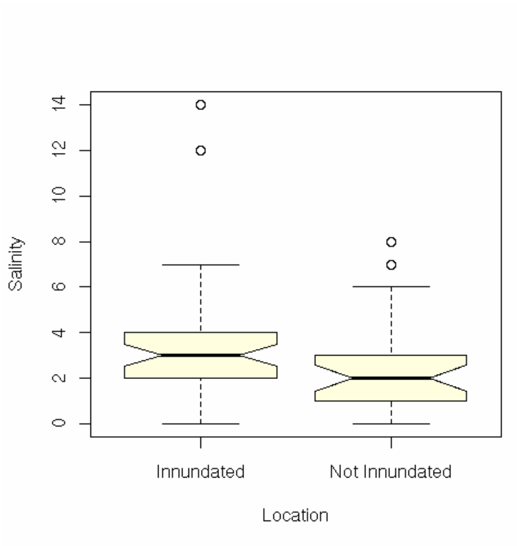
The differences in quality of water sources surveyed is shown in figure 16.3.



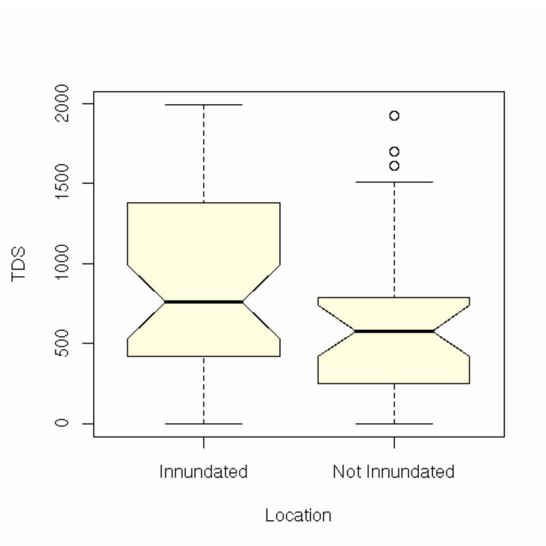
(a) Electrical Conductivity



(b) pH.



(c) Salinity.



(d) Total Dissolved Solids.

Figure 16.3.: Status of water sources.

There was a significant difference in the EC (F value= 4.1298, Pr(>F)= 0.04599) at a 95% confidence and salinity (F value=3.1836 and Pr(>F)=0.07878) at a 90% confidence. The pH values were not significantly different (Sum Sq.=0.307, Mean Sq.=0.307, F Value=0.6596, Pr(>F)=0.4195), nor the total dissolved solids (F Value = 2.5409, Pr (>F)= 0.1155).

Data from a similar exercise undertaken a year ago at Nagapattinam however showed significant increase in these parameters [20]. There appears to be a gradual decline in initial salinity levels due to the intervening monsoons.

17. Conclusions

Coastal ground water resources are highly prone to contamination. They lie close to the ground and usually below a sandy and highly porous surface. Most water in coastal areas is drawn through hand pumps with bore wells normally within 20 feet, the ground water itself rising up to four feet below the surface during the monsoon.

Post tsunami reconstruction as well as various rural development and sanitation programmes in the recent past have resulted in the construction of a number of toilets in coastal areas. The vast majority of these toilets are based on leach pit designs, which have been shown to cause significant levels of fecal contamination of drinking water. Other sources of contamination include washing and cleaning of fish around public hand pumps. The need for a policy dealing specifically with disposal of domestic sewage in coastal constructions is evident from this study. There are a number of designs of toilets and sewage disposal which specifically deal with this problem. It is crucial that these designs be incorporated into government guidelines and enforced at the earliest. It is also necessary that existing toilets are switched to more environmentally sound systems. On the social side, there is a real need for building awareness among communities about the nature of this problem and providing them practical options to deal with it.

Inundation by the tsunami has affected a number of water resources along the coast. This study demonstrated that some of the physical parameters remain significantly different in-spite of a heavy intervening monsoon. If reports from other areas are to be taken seriously, a rapid assessment of heavy metal contamination of these water sources needs to be conducted. It is quite possible that water from some of these wells is no longer safe for human consumption.

Part V.

Coastal Defences

18. Background

The differences in run-up and inundation by the tsunami along the Coromandel coast [19], generated a large amount of interest in coastal defences, both natural and man made. Various studies highlighted the efficacy of bio-shields resulting in a rush to plant hectares of coastal dunes over by Casuarina. Public demand for sea walls resulted in their construction and extension of existing structure. Little attention, however, was paid to sand dunes themselves, even though they probably provided the most effective defence. Two studies were conducted to highlight these issues as part of the GreenCoast project. The first was a case study of Pondicherry and villages to its North which have had severe coastal erosion. The second was a remote sensing based study on the role played by vegetation on tsunami inundation.

Coastal Erosion - A case study of Pondicherry[1]

Coastal erosion is a worldwide issue which has gained all the more importance in the discourse about global warming. The "protective role" of sea walls gained importance on the Coramandel coast after the tsunami [21, 22]. As a result sea walls made of concrete, stone and soil have been constructed at various places along the Coramandel coast. It is not known whether any formal process or assessment of potential environmental impacts was done prior to taking up these projects [23]. It is also not known whether there were any studies done which would be able to predict how the currents would be altered and the impacts thereof further downstream.

The case study presented here tries to highlight some of the dangers and repercussions of sea walls and groynes using Pondicherry and neighbouring villages of Kotakuppam and Chinnamudliyarchavadi. Much of the material presented here is based on work done by Mr.Aurofilio who has been campaigning to restore the beach at Pondicherry and neighbouring villages.

Group discussions were held in Tandriankuppam, Solainagar (North and South), Kurchikuppam, Vaithikuppam, Vambakirapalayam, Nadukuppam and Kotakuppam. Group discussions were held (see AnnexureB) with respondents affected/alongside the sea walls. Locations of sea walls were mapped along various stretches of the coast, as summarised in Annexure A. Responses from the group interviews suggests that the sea walls, where they existed, did prevent the inundation of houses behind then during the tsunami. However respondents mentioned two specific problems that are associated with these structures:

- Lack of beach space making it difficult to park boats and dry nets/motors. Thus fisher folk are forced to keep boats and equipment fairly distant from their houses and some end up anchoring their boats in open water. The latter had associated problems of anchors dragging or ropes breaking resulting in drifting of the boats.

[1]Parts of this note were adapted from a study cum presentation by Aurofilio, Craft and Associates with his permission.

(a) Before (b) After

Figure 18.1.: Loss of dwellings at Kotakuppam (photographs Aurofilio).

- Conflicts with neighbouring villages regarding parking space resulted from the lack of beach near the habitations. There is a fear that these conflicts will intensify over time.

In addition to these issues there are larger ecological issues.

In the case of Pondicherry there is clear evidence that the primary cause for erosion was the construction of the harbour at the mouth of Tengathittu estuary. With a net movement of sand towards the North (to the tune of 500,000 cubic metres), there has been a deposition of sand towards the South of the breakwater and a removal of sand to its North. This has resulted in the loss of the Pondicherry beach in a span of a decade since the breakwater was built. The erosion has moved further North into neighbouring Tamil Nadu. This resulted in the loss of dwellings on the coast (photographs 18.1) in a reaction to which Groynes and walls were constructed (photographs 18.2).

The process of groyne construction has now moved further north of Kotakuppam, and it is not known till which point this will continue. The solution to the problem is to either re-design the breakwater so that it allows the natural sand movement patterns to re-establish, or to take up dredging and sand nourishment programmes for the coast which will cost between 2.5 and 5 crores annually.

(a) Groynes at Kotakuppam.

(b) Stumps of palm trees, preparing for erosion at Chinnamudliyarchavadi.

Figure 18.2.: Groynes at Kotakuppam and erosion further North.

19. Bio-Shields

Introduction

Natural shelter belts have received a high degree of attention post tsunami. There have been a range of claims made about the efficacy of natural barriers or “bio-shields” in arresting the inundation caused by the tsunami. Particular attention has been given to vegetative shelter belts, particularly mangroves and more recently Casuarina. Various organisations, including the Forest Department of Tamil Nadu and Pondicherry have taken up plantations of Casuarina, coconut and mangroves. The preferred species for shelter belt plantations has been Casuarina due to its easy availability, low cost and low demands for after-care. A few organisations have attempted to plan tropical dry evergreen species - a mix of coastal plants native to the Coramandel coast.

The width of the continental shelf provides the primary explanation for the height of the inundation with local structures such as breakwaters arresting the wave backwaters and mouths of rivers explaining local peaks. Shallow coastal zones cause the long high speed waves to bunch up and rise up to great heights [24]. Thus it is the bathymetry that governs the size of the wave and shallow coasts such as Nagapattinam are far more susceptible to a tsunami than deep shelves such as the areas around Pondicherry. Coastal erosion, however, is more active in steeper leading-edge coasts where there is a narrow continental shelf. The deeper near shore waters are subject to higher wave energy and result in smaller beaches with coarser sand. A common misconception about the inundation and size of the tsunami induced wave is that the closer the waves break to the shore normally, the larger would be the impact of the tsunami. This misconception has found its way into many reports pertaining to the tsunami, including some reviewed publications [25] (page 1302).

(a) A failed TDEF plantation. (b) Coconuts planted on dunes in Pannithittu.

Figure 19.1.: Some “bio-shield” plantations.

Literature review

A few recent publications [26], [27] suggested that vegetative shelter belts were effective defences against the tsunami. Of these the analysis in the second paper [27] was questioned by [28] and later defended by [29]. The Green Coast sponsored assessment [30] also supports the belief that mangroves provided protection against the tsunami. There are conflicting views about the role vegetation plays as a coastal defence against tsunami generated waves. Much of the analytical confusion lies in there being a relationship between elevation, distance from coast and presence of tracts of protective vegetation (in this case mangroves). The report titled "Beneath the Waves" Sankaran [31], showed that the largest mangrove patches in the Andaman and Nicobar islands were unable to withstand the tsunami. There are a number of publications that explain and simulate the propagation of tsunami like waves and inundation along the coast [32, 25, 33] including the Green Coast study [34].

The role of coastal vegetation as protection against high winds is better acknowledged however and there appears comparatively less debate on the issue. Some concerns are being raised about large scale plantations of Casuarina monoculture along the coast and the need for restoration of native coastal species. Replanting and restoration of damaged mangrove systems has been highlighted as a priority [35, 36] as well. While Casuarina does figure as an important shelter belt species [37], the literature review did not find any reports on its efficacy in reducing the impact of the tsunami.

Objectives

This component attempted to test the basic premise that has been used to justify the plantation of thousands of hectares of "bio-shields" along the coast. More specifically it asked whether there was any statistically significant relationship between the distance travelled by the tsunami (inundation) and vegetation on the coast.

20. Methods

Relationship between tsunami inundation and coastal vegetation

Defining the coastline

The inundation of the tsunami was measured using a baseline corresponding to the coastline digitised from a high resolution image comprising of the red, green and blue band at 8 feet or 2.44 metres hybridised with a panchromatic band at 0.6 metres.This was done because water and moisture show up as negative values in an NDVI. This baseline thus provided the more conservative measurement of distance from the coast as wet areas affected by tidal action and soil moisture were treated as the coastline. River mouths and backwaters were digitised such that the coastline looped into them. Figure 20.1 illustrates this more clearly.

Measuring inundation

Points up to which the tsunami had inundation were identified with the help of local people and mapped. Perpendicular distances were calculated from the inundation points to the coastline for the analysis[1]. In cases where backwater areas extended landward, they were taken as the coastline for the sake of analysis. The sum of NDVI of pixels along this line was calculated and regressed with the distance the tsunami travelled or inundation. [2]

Measuring vegetation

The accumulated NDVI along the pixels falling beneath the perpendicular described above was measured. The NDVI or normalised difference vegetation index is based on the equation $NDVI = \frac{(NIR-R)}{(NIR+R)}$ which calculates the amount of chlorophyll present in a given pixel on a scale from 0 to 1.

Analysis

A regression of the distance versus accumulated NDVI was performed for 43 such points measured which fell along the stretch between Kalapet, Pondicherry and OT, Cuddalore. The data was normalised prior to running a regression. The results are presented in section 21.

[1] This is borne out by observations that backwaters conducted the tsunami far inland.
[2] Only positive values were considered as a negative NDVI only indicates absence of vegetation.

(a) RGB line (b) The innundation line.

Figure 20.1.: The two baselines used.

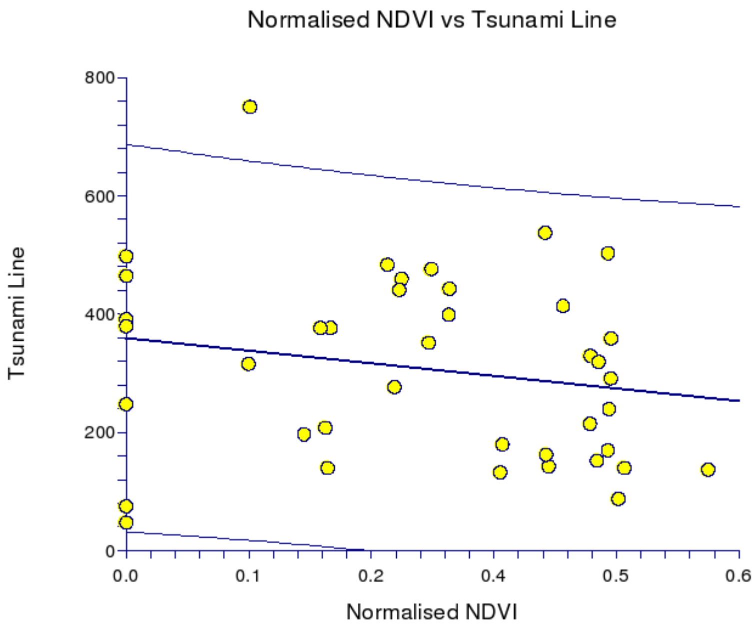


Figure 20.2.: The relationship between inundation and vegetation.

21. Observations and Discussions

The regression results showed a non significant relationship between tsunami inundation distance and vegetation. This has been graphically presented in figure 20.2. Evidently vegetative shelter belts did not make any significant impact on the distance travelled by the tsunami. Even though there is a statistically non-significant relationship, this would probably be better explained by the increase in height as one moves inland[1]. The premise that vegetation can hold back a tsunami induced wave is tenuous at best.

[1] Height measurements were not conducted during the survey.

22. Conclusions

Protection against natural disasters in coastal areas is an important and necessary requirement of their communities. The tsunami showed how succeptable coastal communities are to such disasters, and the far more regular cyclones and squalls. However the solutions proposed to deal with this situation lack adequate scientific basis. Sea walls and groynes are known to cause substantial changes in local coastal currents and often create or exacerbate coastal erosion. The evidence in support of bio-shields as defence against tsunamis is not conclusive either. What is alarming is that both these proposed solutions threaten the one known natural coastal defence - sand dunes. The case study of Pondicherry clearly shows that Groynes and sea-walls are not a long term solution, but in-fact create long term problems for local communities as well as those downstream of them. Vegetation does not appear to have any relationship with inundation. In fact even if it did, the reluctance of communities to allow plantations in front of hamlets makes them effectively useless as "bio-shields".

Policy makers need to take a closer look at some of the successful natural barriers and wind breaks. Coastal sand dunes deserve protection as an important native ecosystems. Their value as tourism sites also must be recognised. Perhaps most importantly, solid scientific research and evidence must be used to plan interventions that can change the very nature of the coastline. Unfortunately, this has not been the trend thus far.

Part VI.

Annexure

A. Location of different studies

Sustainable Fisheries

District	Revenue Village	Hamlet	Schedules
Cuddalore	Chiteraipettai	Chiteraipettai	20
Cuddalore	Devinampattinam	Devniampattinam	20
Cuddalore	Panithittu	Panithittu	23
Cuddalore	Thazhankuda	Thazhankuda	22
Nagapattinam	Poombuhar	Poombuhar	14
Nagapattinam	Thirumullaivasal	Thirumullaivasal	7
Nagapattinam	Vanagiri	Vanagiri	21
Pondicherry	Chiteraipettai	Chinnamudaliyarchavady	1
Pondicherry	Kalapet	Chettikuppam	1
Pondicherry	Kalapet	Kalapet	39
Pondicherry	Narambai	Narambai	20
Villupuram	Koonimedu	Chettinagar	31
Villupuram	Kotakuppam	Nadukuppam	7
Villupuram	Kotakuppam	Tandriankuppam	25
			251

Coastal Regulation Zone and Shrimp Farm Surveys

CRZ survey		Shrimp survey	
Hamlets	Samples	Hamlet	Samples
Veerampattinam	2	Vada agaram	2
Narambai	1	Marakanam	4
Thanthiriyankuppam	6	Cuddalore	8
Panithittu	1	Kandakadu	1
Poompuhar	2	Devikulam	1
Chettinagar	6	Vanagiri	11
Devanampattinam	3	kakaplayam	3
Tharangampadi	7	Nagapattinam	7
Thirumullaivasal	2	Kakaplayam	4
Nadukuppam	4	Devikullam	6
Thazhanguda	1	Devanampattinam	2
Vanagiri	2	Sellankuppam	1
Periakalapet	5	Sonakuppam Cuddalore	1
Kirumampakkam	2		
Sothanaikuppam	4		
Chittaraipattai	2		
Total	50	Total	51

Drinking water and Reconstruction

District	Drinking Water	Reconstruction
Cuddalore	56	17
Nagapattinam	31	11
Karaikal (Pondicherry)	41	
Villupuram	0	4
Total	128	32

Coastal Defence

District	Village	Material
Villupuram	• Nadukuppam • Sothanaikuppam • Solainagar • Vaithikuppam • Kuruchikuppam • Vambai keerapalayam	Stone
Nagapattinam	• Vanagiri • Kizhamoovarkarai • Manikkapangu	Soil
Nagapattinam	• Nagapattinam	Concrete
Nagapattinam	• Tharangampadi	Stone

B. Schedules and Survey Forms

CRZ survey

Sl.No.	Waypoint	Date	Name of building	Hamlet name	Building type			Construction	
					Commercial	Residential		Roof	
					Age in yrs	New	Customary	Thatch	Tile

Construction				Water source			Waste type and disposal	
	Walls		Size in sq m	Type and depth			Sewage	Solid waste
Concrete	Mud/Brick	Cement		Bore	Open	Hand pump		

Table B.1.: CRZ survey form.

Questionnaire for Sea fishing

Hamlet Name: Date:

Village Name: Boat owner Name:

1.Type of boat:

What type of boat do you have?

After Tsunami

Type of boat	Length

Before Tsunami:

Type of boat	Length

2. How many kilometers will you go for fishing?

A. After Tsunami____________________________________

B. Before Tsunami_________________________________

3.How many nets do you have?_____________________

After Tsunami

Type of net	Nos.	Target species	Weight	Seine size

Before Tsunami:

Type of net	Nos.	Target species	Weight	Seine size

4. Do you use hook and line. If so describe

After Tsunami:

Where it is used	
Length of line	
Type of hook	
Species targeted	
Area where used	
When used (season)	

Before Tsunami:

Where it is used	
Length of line	
Type of hook	
Species targeted	
Area where used	
When used (season)	

5. Has the fish yield increased/decreased or remained the same after Tsunami?

6. Give reasons if increased or decreased?

7.Type of Motor:

After Tsunami			Before Tsunami		
Make	HP	Type	Make	HP	Type

1. Do you take Ice box in the boat? If so what is the size? (B*L*H)

2. How many members are there in your CREW?

a. After Tsunami:___________________________

b. Before Tsunami:___________________________

Questionnaire for Back water fishing

Hamlet Name: Date:

Village Name: Boat owner Name:

1. How many boat do you have?

After Tsunami

Type of boat	NO of logs	Length

Before Tsunami:

Type of boat	NO of logs	Length

2. How many kilometers will you go for fishing?

A. After Tsunami______________________________

B. Before Tsunami____________________________

3.How many members are there in your CREW?

a. After Tsunami ____________________

b. Before Tsunami __________________

4. What equipment is used for Fishing?

After Tsunami

Type of equipment	Target species	Where used

Before Tsunami:

Type of equipment	Target species	Where used

5. Is there any change in catch or species in the past years (tick)?

10 years ago	Decreased	Increased
5 years ago	Decreased	Increased
Present	Decreased	Increased

5.1. Give reasons:

6. Has the fish catch diseased?

Species	Disease Name	Describe symptoms

7.Is there any impact of Shrimp farm an yield? Y/N

7.1. If yes describe

8. What is your secondary occupation?

Name of the occupation	Nos. of day/week	Amt/day

Question List for Coastal Defences

1. Names of respondents:
2. Name of surveyor:
3. Date:
4. Name of village:
5. How many houses are there in the village.
6. How many boats/catamarans are owned?
7. Where are they parked?
8. When was the sea wall built?
9. What are the major issues concerning the sea wall?

Plantation survey

Hamlet name:

Village name:

Survey date:

Facilitating NGO name and address:

Name of surveyor:

Name of respondent:

Position of respondent:

Planted area(in acres): Waypoints:

Track name:

Species of plants:

Sl.No.	Species	Numbers

Planting density:

Date of Plantation:

1. Where did you get the saplings from

    a) Nursery name:

    b) Address:

2. What was the cost paid per sapling

Sl.	Species	Cost

3. Did you used compost during plantation time? Yes/ No

    a) if yes, how much?

4. Was there any local participation during the planting and aftercare: If yes give details.

Group name	Community	Activity	Men hired	Women hired	Male Labor charge	Female labor charge

5. Is watchman being appointed? Yes/ No

    a) if Yes,

        i. how much are you paying?

        ii. For how long is the watchman hired (specify months/years)

    b) if No, who will ensure:

        i. watering,

        ii. protection,

6. Type of maintenance following planting

a) Frequency of watering to the plants.(once in a day/ alternative day/ once in a week/ once in a month/ twice a month
b) How many times did you weed after plantation?
c) Did you Mulching to the plants?
d) Did you provide additional compost?

7. How many plants are alive? (in percentage)
8. Did you have problems in watering the saplings? Give details
9. How do you protect the saplings from the cattle?
10. Did the community is receiving any bonus for surviving saplings?If yes means, How much they are getting per saplings?
11. What are the general problems you are facing in maintenance o f the saplings(both in terms of social and technical)?
12. What are the helps or inputs you need from the implementing agency for maintaining the saplings?

Reconstruction survey

Village Name: Name of Surveyor:

Hamlet Name: Date:

Name of Respondent: Caste:

Administrative details:

1. Name of the Implementing agency:
2. Foreign agency.
3. Indian agency.
4. Foreign govt.
5. Indian govt.
6. Name of the Funding agency:
7. Foreign agency.
8. Indian agency. Foreign govt. Indian govt.
9. When did the construction start? When was the construction completed or is likely to be completed?

Logistics:

Who has provided the materials which required for the construction?
a. NGO
b. Panchayat
c. Contractor
Type of material used and source (L for local E for external):
Sand:
Brick:
Concrete:
Tiles:
Steel:
Wood (scaffolding)
Wood (doors/windows etc.):
What was your contribution to the construction?
Labour (describe):
Materials (describe):
Cash (details)
None
How many persons were employed for the construction?
Who selected these persons?
NGO
Panchayat
Contractor

How many of these were from your village?

Type of work	Numbers	Wages

Land details:

How much of area required for construction? ———— Ha/acre

For what purpose the land was used before construction?

Construction details:

Type of construction:

a. Permanent

b. Semi-permanent

c. Temporary

Layout of house:

a. Number of rooms

b. Size of rooms in sq.ft.

Type of roof:

Titles

Concrete

Sheet

Thatch

Type of toilet:

Soak pit (single) (double)

Eco-san.

Size of toilet in sq. ft.:

Use of toilet:

Defecation

Bath

Other

Do you know, the cost of construction of building and toilet? Yes/No

If yes :

Building construction cost:

Toilet construction cost:

Total construction cost:

Is the kitchen part of the house? (y/n)

Did you own any animals, if so how many:

Cows

Goats

Chickens

Dogs

Cats

Are there facilities to keep these in the new construction? Y/N

If Yes, where.

If No, where will you keep them?
Do you own any fishing equipment?
Are their facilities to keep your fishing equipment? Y/N
If Yes, what are the facilities.
If No, how do you store them safely.
Are there facilities to keep your vehicles? Y/N
If Yes, what are the facilities.
If No, where do you keep them.

Sanitation

Where are the clothes washed
Toilet
Outside
In the house
Where does the clothes washing waste go?
Drained to street.
Drained to trees.
Soak pit.
Other (describe)

Where are the utensils washed:
Kitchen
Toilet
Outside
Other

Where does the waste water of utensils go?
Drained to street.
Drained to trees.
Soak pit.
Other (describe)
Where does the waste from animals go?
Compost heap (dung)
Thrown on street.
Drained to street (urine).
Drained to trees (urine).
Soak pit.
Other (describe)

Where does the excessive feed and food waste of animals go?
Compost heap/pit

Thrown on street.

Thrown on trees.

Other

Access to the sea

How far are you from the beach?

Is this a problem, if so give details: (get these details so we can further streamline the schedule).

How do you access the beach?

Are there any concerns regarding future access to the beach?

What was the participation of beneficiaries in planning

Participation of beneficiaries:

Were you involved in the selection of the location? Y/N

If Yes, how (details)

Who has chosen the location?

a. NGO

b. Elected Panchayat

c. Village Panchayat

d. Govt.

Were you involved in the design of the house Y/N

If so how?

Were there any specific concerns you had w.r.t. house design? Y/N

If yes, give details:

Who decided the house design?

a. NGO

b. Contractor

c. Elected Panchayat

d. Village Panchayat

Is there any complaint in construction? Yes/No

a. If yes give details:

Is there any social/communal issues are existing in regard to the location of the new building? Yes/No

a. If yes means give details:

Quality of construction

House quality:

Toilet quality:

Are you satisfied with the quality of the house? Y/N
What are the good points?
What are the deficiencies?

Water resources checklist

Sl.	Date	Wpt	Village	Owner	Inundated	Source	Depth	Usage	p.h	Ec	Tds	Salinity
					Y/N							

C. Definition of the High Tide Line

High Tide Line means the line on the land up to which the highest water line reaches during the spring tide and shall be demarcated uniformly in all parts of the country by the demarcating authority so authorised by the Central Government in consultation with the Surveyor General of India.

The distance from the High Tide Line shall apply to both sides in the case of rivers, creeks and backwaters and may be modified on a case to case basis for reasons to be recorded in writing while preparing the Coastal Zone Management Plans provided that this distance shall not be less than 100 meters or the width of the creek, river or backwaters, which ever is less. The distance up to which development along rivers, creeks and backwaters is to be regulated shall be governed by the distance up to which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt). For the purpose of this notification ,the salinity measurements shall be made during the driest period of the year and the distance up to which tidal effects are experienced shall be clearly identified and demarcated accordingly in the Coastal Zone Management Plans.

CRZ-I(i) areas are those that are ecologically sensitive areas (including marine parks, national parks, sanctuaries, mangrove areas, wildlife habitats, heritage areas, historically important areas, areas likely to be inundated by global warming etc.

CRZ-I(ii) areas refers to the intertidal zone lying between the LTL and the HTL.

CRZ-II areas are those that are already developed close to or up to the shoreline (this is with reference to the geological features as of 1991). These "developed areas" are only those within municipal limits or in other legally designated urban areas which are already substantially built up and which have been provided with drainage, approach roads and other infrastructural facilities, such as water supply and sewerage mains.

CRZ-III areas are those which are relatively undisturbed and which do not belong to either CategoryI or II. These include the coastal zone in rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up. By definition then, all rural areas are classified as CRZ-III and some urban areas could also be included in this category.

CRZ-IV are those coastal stretches in the Andaman & Nicobar Islands, the Lakshadweep Islands and small islands, except those designated as CRZ-I, CRZ-II or CRZ-III. [14]

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