Vulnerability and Adaptation Assessment of Coastal Hazards: Study of Marine Fishing Communities in Southern Kerala

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Economics

by

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CERTIFICATE

This is to certify that the thesis entitled **"Vulnerability and Adaptation Assessment of Coastal Hazards: Study of Marine Fishing Communities in Southern Kerala"** submitted by **Feba David** bearing registration number **15SEPH04** in partial fulfillment of the requirements for the award of Doctor of Philosophy in the School of **Economics** is a bonafide work carried out by her under my supervision and guidance.

The thesis is free from plagiarism and has not been submitted previously in part or full to this or any other university or institution for award of any degree or diploma.

Further, the student has the following publication before submission of the thesis.

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Further, the student was exempted from doing coursework with reference to the Office Note No: UH/DRAE/2020, dated 16.06.2020.

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DECLARATION

I, **Feba David**, hereby declare that this thesis entitled, "**Vulnerability and Adaptation Assessment of Coastal Hazards: Study of Marine Fishing Communities in Southern Kerala"**, submitted by me under the guidance and supervision of **Dr. Prajna Paramita Mishra** is a bonafide research work. I also declare that it has not been submitted Previously in part or in full to this University or any other University or Institution for the award of any degree or diploma.

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ABBREVIATIONS

APL	Above Poverty Line
BPL	Below Poverty Line
CBA	Community Based Adaptation
CCZM	Centre for Coastal Zone Management
CED	Centre for Environment and Development
CMFRI	Central Marine Fisheries Research Institute
CRZ	Coastal Regulation Zone
CV	Coefficient of Variation
CVI	Coastal Vulnerability Index
EM-DAT	Emergency Events Database
FCDP	Fishermen Community Development Programme
GDP	Gross domestic product
GIS	Geographical Information Systems
GPS	Global Positioning System
GSDP	Gross State Domestic Product
GST	Goods and Service Tax
HH	Household
ICZM	Integrated Coastal Zone Management
IPCC	International Panel on Climate Change
KFDRCA	Kerala Fishermen Debt Relief Commission Act
KMFRA	Kerala Marine Fisheries Regulation Act
KMML	Kerala Minerals and Metals Limited
KSDMA	Kerala State Disaster Management Authority
KSMTF	Kerala Swathantra Matsya Thozilali Federation
Matsyafed	Kerala State Co-operative Federation for Fisheries Development Ltd
MNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MPEDA	Marine Products Export Development Authority
NCESS	National Centre for Earth Science Studies
NCRMP	National Cyclone Risk Mitigation Project
NFDB	National Fisheries Development Board
NDZ	No Development Zone

NGO	Non-Governmental Organisation
NSSO	National Sample Survey Office
OBC	Other Backward Class
OEC	Other Eligible Communities
PDS	Public distribution system
RGCA	Rajiv Gandhi Centre for Aquaculture
SAF	Society for Assistance to Fisherwomen
SC	Scheduled Castes
SHG	Self Help Group
SIFFS	South Indian Federation of Fishermen Societies
SSB	Social Security Benefits
ST	Scheduled Tribes
SWOT	Strengths, Weaknesses, Opportunities, and Threats
T-S	Tranvancore–Shornoor
TEAP	Tsunami Emergency Assistance Programme
TRP	Tsunami Rehabilitation Programme
UNDRR	United Nations office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNSDR	United Nations International Strategy for Disaster Reduction

CHAPTER 1

INTRODUCTION

1.1 Background

The oceans cover two-thirds of the earth's surface while the coastline connects the land to these vast oceans. Sea intrusion at any level signifies closer proximity to the ocean or loss of more inhabitable land for the terrestrial animals and plants. Therefore, any loss of coastline is not just a loss for the coastal community alone, but it is so for the entire humanity.

The amenities offered by the coastal landscape vary from scenic to economic: when the natural beauty paves way for tourism and other recreational activities, oceanic transport, fisheries, and mineral deposits provide economic benefits. The major industries aligned to the coastal terrain are shipping and logistics, fisheries, mining, tourism and real estate. For agriculture, coastal deltas offer alluvium rich fertile land. The abundance of natural resources, scenic beauty, feasibility of trade and proximity to the sea have attracted the human population towards coastal zones from historical times (Neumann, Vafeidis, Zimmermann, & Nicholls, 2015).

The density of population in coastal regions is much higher than other climatic zones (Ferro-Azcona et al., 2019)—when the average global population density is 44 people/km^2, the same in a near coastal zone[1] is 112 people/km^2, that is, 23 per cent of the world population (Small & Nicholls, 2003). All around the world, there are 14 megacities in near coastal zones and the majority of them are situated in developing countries with lower per capita income and inadequate infrastructure and coastal protection measures (Sekovski, Newton, & Dennison, 2012). The population pressure and concentrated urban cities in coastal zones gives warning on the potential risk, severity and magnitude of exposure to coastal hazards.

Coastal hazards are those phenomena which exposes coastal zones to the effects of a hazard. According to the United Nations International Strategy for Disaster Reduction (UNSDR), a 'hazard' is defined as "a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods

[1]Near coastal zone: Region within 100 km horizontal to the coastline and 100m vertical of sea level.

and services, social and economic disruption, or environmental damage" (UNSDR, 2009). Shoreline erosion, floods, storm surges, hurricanes, tsunami, harmful algal blooms are different forms of coastal hazards.

According to the Emergency Events Database (EMDAT), the factors which cause coastal hazards can be climatological, technological, geophysical, meteorological and hydrological. This implies that coastal hazards emerge from natural as well as anthropogenic elements. For example, an anthropogenic activity such as dredging for mineral mining without sand replacement in the coastline can cause diminution in water quality, alterations to water currents and wave climates, and bring about changes to coastal morphology and siltation patterns which can affect marine and coastal species (Bray, Csiti, Dolmans, & Raalte, 2008). A hazard originating from solid earth, from movements and distribution of surface water, from toxic substances and living organisms, and micro- to meso- to macro-scale climate variability are the natural factors causing hazards (EMDAT, 2020).

1.2 Impacts of Coastal Hazards in Asia

A hazard can devastate the marine and coastal ecology: mass extinction of marine species, death, injuries and ailment to human population, destruction of property, infrastructure and environmental degradation are the potential impacts of a hazard. Most importantly, a hazard can undo the development accomplishments of a region.

Among all coastal hazards, coastal inundation has caused the most significant damage around the world (Wilby & Keenan, 2012). The potential severity and frequency of inundation events is projected to worsen the coastal cities as they grow populous (Guofang, Fukuzono, & Ikeda, 2003) (Hallegatte and Corfee-Morlot, 2011) and sea levels rise further (Hallegatte, et al., 2011). This is alarming, given the intensity of potential losses and extent of vulnerability in urbanised coastal regions, where resource exploitation and population density are high (e.g. Mumbai). In the 1970–2000 period, the highest urban conversion of coastal land occurred in China and Southwest Asia (Seto, Fragkias, Güneralp, & Reilly, 2011). Out of 16 mega cities in Asia in 2015, six (Mumbai, Jakarta, Shanghai, Tokyo, Manila and Bangkok) are situated on the coastline (Biswas, 2016).

According to the United Nations Office for Disaster Risk Reduction (UNDRR), between 2000 to 2019 period, Asia witnessed the highest number of disasters[2] (3068 events) in the world. Most frequent and devastating events were floods and storms. Flooding events contributed to 41 per cent of all disasters. About 93 per cent of the world population affected by floods and 79 per cent of the total population affected by storms were Asians. In case of storms, the Asian continent accounted for 90 per cent of all deaths. Economic loss of disasters between these periods is USD 1.26 trillion, with the larger share of economic loss being borne by China (USD 482 billion or 38 per cent) and Japan (USD 439 billion or 35 per cent) (UNDRR, 2020).

According to the Intergovernmental Panel on Climate Change (IPCC), the effects of coastal hazards in various regions differ according to their ability to cope with it. Inequalities in socioeconomic status, income level, political participation and representation and other factors differentiate the magnitude of impact of climatic changes on the masses. Economically, socially, politically and culturally deprived and marginalised populations are more susceptible to the effects of climate change. In the same manner, the less developed countries are more vulnerable than the developed countries as the later are better equipped to safeguard their land and lives (IPCC, 2014).

Human cost of hazards is high in India and China, given the population size of these countries—in absolute numbers, between 2000 and 2019, 70 per cent of the globally affected population were from these two countries (UNDRR, 2020). Within Asia, in 2002, 24 per cent of the deaths due to disasters occurred in India, on account of its size, population and vulnerability (Planning Commission, 2002), and, by 2019, 48 per cent of all deaths due to disasters occurred in India (Centre for Science and Environment, 2019).

1.3 Impacts of Coastal Hazards in India

India has a total coastline of 7500 kilometres, among which 5400 km is the mainland or peninsular India and the rest is accounted by Andaman, Nicobar and Lakshadweep islands. The Indian coastline is just 0.25 per cent of the global coastline but it accommodates 11 per cent of the total world population in its low elevation coastal zones (McGranahan, 2007). The height of population density is that 17 per cent of India's population lives within 73 coastal districts out of the total 640 districts (Census Organisation of India, 2011). The total

[2] Disasters are extreme hazard events.

population of coastal districts is 171 million and the population of island territories is 0.44 million (Centre for Coastal Zone Management and Coastal Shelter Belt, 2017)

In India, the major coastal activities are fishing, harbour based trade, tourism, metals and minerals extraction and coastal agriculture. There are 197 major or minor ports, 308 large scale industrial units and 77 cities including the dense urban agglomerations of Mumbai, Kolkata, Chennai, Kochi and Visakhapatnam in the coastal zones (Centre for Environment and Development, 2009). Ninety-five per cent of India's trade is through maritime transport while shipping contributes to 7 per cent of the domestic water transport (Ministry of Shipping, 2016).

Indian fisheries stand third in world ranking by contributing 6.3 per cent of world fish production; the share of fisheries to the GDP is 1.1 per cent and 5.15 per cent of agricultural Gross Domestic Product (National Fisheries Development Board, 2016). It employs 1 million fisher folks permanently and another 1.2 million during harvesting and post harvesting periods (Centre for Environment and Development, 2009). Fisheries hold the largest share of agricultural exports; fish and fish allied products supplies 10.51 lakh tonnes in quantity and 33,442 crore in value and India exports more than 50 varieties of fish to 75 other countries (National Fisheries Development Board, 2016).

Although the coastal activities and coastal cities contribute a decent share to the growth of the nation, over the years, they have become highly vulnerable to coastal hazards. A tsunami or super cyclone hitting Indian coasts can affect 171 million of the coastal population and the livelihood of 6 million people of the fishing community (Centre for Coastal Zone Management and Coastal Shelter Belt, 2017). On an average, nine cyclones per annum hits Indian coasts and their prime periods are November and May (National Cyclone Risk Mitigation Project, 2016). India has experienced the destruction of 34 per cent of its mangroves and 66 per cent of coral areas over the last 40 years (NCRMP, 2016). The country loses 2 per cent of its GDP and around 12 per cent of central government revenue per annum due to natural disasters (World Bank, 2003). Concentration of the country's population in urban agglomerates in the hazard prone coastal areas not just risks lives but being the centres of service and industrial production, it risks the sustenance of the nation itself.

Cyclones are the most frequent coastal hazard with high impact in India. Cyclones developed in one region of the ocean can affect multiple states and can cross from west coast to the east and vice versa. In total, there are 13 coastal states which are affected by cyclones. The three key elements which trigger destruction during cyclone occurrence are strong winds, torrential rains and storm surges (NCRMP, 2016)**.** The squall or strong winds damages the installations, dwellings, communication systems and transportation facilities. Torrential rains and inland flooding cause large-scale soil erosion and weakening of embankments. Storm surges or the abnormal rise in sea level due to tropical cyclones inundates the low lying coastal regions, destroys vegetation and thereby soil fertility and erodes the beaches, embankments and human settlements. These three elements together causes loss of life and massive property destruction.

The resilience of rural coastal communities to the extreme climatic events is low due to the existing socio-economic impoverishments. The 2004 tsunami itself had led to the death of 10,749 people, loss of livelihood opportunities of over 3 lakh fishermen, and crop damage in 11,827 hectares of land (NCRMP, 2016). Studies have already acknowledged significant acceleration in sea level and it is predicted that a 1 m sea level rise would flood nearly 6000 km^2 in India, potentially displacing 63 million people living in low elevation coastal zones (IPCC, 2014). Regular occurrence of coastal hazards not only causes deaths, livelihood loss, infrastructure and property destruction, it also reverses the development gains at regular intervals.

1.4 Coastal Hazards in Kerala

Kerala is a multi-hazard prone region with high population pressure. East Kerala is bound by the highlands of Western Ghats while West Kerala is bound by lowlands to the Arabian Sea. The population growth of Kerala is the lowest among other states of India but the population density is much higher than the country's average. According to the 2011 census, Kerala's population density was 860 persons per km^2 whereas, for the country, it was 382 persons per km^2. In coastal Kerala, the density of population is 2168 persons per km^2 which is five times more population than the national average. The share of the aging population to the total population is also rising at the rate of 2.3 per cent in Kerala (Subaiya & Bansod, 2011).

Kerala has a 580 km long coastline, covering about 15 per cent of the state's total area. These regions are prone to erosion, monsoon storm surges, tsunami and sea level rise (Kerala State Disaster Management Authority, 2010). More than 50 per cent of its coast is artificial or of constantly eroding nature (Kankara, Ramana Murthy, and Rajeevan, 2018). Coastal Kerala experiences a net shoreline erosion of 2 to 5 ms per year as the rate of erosion is higher than accretion (Mallik, Samsuddin, Prakash, Vasudevan, & Machado, 1987). Monsoon, storm tides, heavy rainfall, sandy sea shore, heavy discharge of water devoid of alluvium, destruction of mud banks are the natural factors that causes erosion (Mohan & Jairaj, 2014). Construction of harbours, jetties and groynes, sand mining on the shores, destruction of mangroves, coastal regulation zone violations, unscientific coastal protection measures are the observed anthropogenic factors which causes coastal erosion (Pavithran, Menon, & Sankaranarayanan, 2014).

The monsoon predominant climatic phenomenon in the state occurs twice in a year: North-West monsoon from June to September and the North-East monsoon from October to December. It is during the South-West monsoon that Kerala receives the highest rainfall and experiences erosion due to storm surges and floods. The coastal belt of Kerala is one of the most populated regions in India and this factor aggravates the vulnerability of the monsoon fury. The height of storm surges goes from 2.3 m to 3.5 m and during high tide, this increases to 3 m to 4.3 m in the monsoon (Kerala State Disaster Management Authority, 2010). Though the government has constructed extensive sea wall along with groynes and gabion boxes, this has failed to arrest the erosion.

On 26 December 2004, coastal Kerala encountered the tsunami for the first time. Wave heights were 3 m to 5 m long and it inundated the coastal areas multiple times; 176 people lost life, 6280 dwelling units were completely destroyed, 11,175 were partially damaged and nearly 84,773 persons were evacuated from the coastal areas and accommodated in 142 relief camps (Kurian, Abhilash, Rajith, Murali Krishnan, & Kalairasan, 2006). The maximum devastation was reported in low lying coasts of Kollam and Alapuzha, where the majority of the population depends on maritime fishing for livelihood. In November 2017, the state witnessed cyclone Ockhi and in 2018, level 3 flooding which inundated most parts of the state.

1.5 Vulnerability among Marine Fishing Community of Kerala

Overall share of the fisheries sector to the GSDP of Kerala was 1.29 in 2010. Still, 79 per cent of fishermen families have an annual income less than INR 6000 (Department of Fisheries, 2016). This indicates the general socio-economic conditions of marine fishing communities. For decades, the marine fishing communities in Kerala remained as 'outliers' of social development and livelihood opportunities. They had been left out from the domain of 'public action' for capacity building, a major trait of the Kerala model of development (Kurien, 1995). They could not benefit from the increased value of fisheries output or state's efforts to improve quality of life. Within the fishing industry, mechanisation led capital inflow into the fisheries sector, making the sea, an open access regime to the outsiders. This further led to over fishing and job loss among traditional fishermen in most regions (Dhanuraj, 2004). Being socially excluded with comparatively poor quality of life and marginal land holding, the marine fishing communities which solely depended on natural resources (marine species) for livelihood, became more susceptible to coastal hazards.

1.6 Coastal Hazards and Vulnerability: A Review

For coastal communities, vulnerability aggravates with recurring hazards. Frequency and magnitude of coastal erosion depends on the disposition of human interactions with the ecology, as hazards are the outcome of both natural and anthropogenic factors. In his study on historical, seasonal, natural and manmade erosions to the coasts of Kerala, Moni (1972) analysed how monsoon, geological factors, level and steepness of the shore and mud banks are causing coastal erosion. Griggs (1994) emphasised on developmental activities as the main reason of coastal erosion. He addresses the heavy influence of local economies and politics. Pavithran, Menon, and Sankaranarayanan (2014) discussed issues of population density, untreated sewage discharge, exploitation of land space, sand mining, destruction of mangroves, coastal regulation zone violations, overfishing led terrestrial conflicts as the main reasons of erosion. Balasuriya (2018) points out the human activities in coastal zones of Sri Lanka to explain coastal erosion. Sand mining, conversion of wetlands, thoughtless infrastructural constructions are few of the reasons given for the extended erosion in the case of Philippines (Licuanan, Cabreira and Aliño, 2019). Human activities at the global scale such as carbon emission, deforestation as well as the construction of groynes, breakwater, jetties etc. at the regional scale contributing to sea level rise is identified as the cause of coastal erosion by Naga Kumar et al. (2019). Overall, other than natural hazards, the

everyday functioning of society, which includes the geographical and socio-economic marginalisation of coastal communities, has the power to worsen coastal erosion and vulnerability to hazards (Gaillard et al., 2019).

Vulnerability reduction and resilience building has become a priority with climate change (Maskrey, 1984; Chambers, 1989; Pelling, 1997; Adger, 2006; Birkmann, 2013; Chaib et al., 2020). Different disciplines being interlinked in the assessment, vulnerability to coastal hazards were perceived in different manners (Kienberger et al., 2009; Phillips and Fordham 2009; Cutter and Finch, 2008). Initially, the scholarship on vulnerability focused purely on the ecological and geophysical perspective. Coastal slope, shoreline change rate, wave height, tidal range, coastal geomorphology were used as variables for analysis. Studies of the same nature were continued to record the alternations in coastal morphology. Though the research on disasters were given a political economic perspective from the 1970s onwards (O'Keefe et al. 1976; Wisner et al. 1977), the inclusion of economic factors in vulnerability assessment came much later in the 1990s, as additional risk factors to characterise vulnerability (Gornitz, White, & Cushman, 1991; Cannon, 1994). That led to the inclusion of economic data such as the value of residential and commercial buildings, value of infrastructure such as schools, hospitals, industries, power plants, bridges and roads to highlight the areas where major economic and structural losses occurred due to coastal hazards.

The inclusion of social and cultural factors in vulnerability analysis was more challenging with the problem of quantification. For the sake of quantification, vulnerability indexes were introduced. However, before establishing the vulnerability indexes, there were several studies which incorporated socio-economic factors in the analysis of coastal vulnerability. For example, in a study on coastal vulnerability, the researchers used socio-economic variables such as population, cultural heritage, roads, railways, land use and conservation status along with other physical characteristics of vulnerability derived from GIS (Geographical Information Systems) data (McLaughlin, McKenna, & Cooper, 2002). Wu, Yarnal, and Fisher incorporated the population factor into it by assessing and identifying the patterns of differential losses among people affected, focusing on the perceived coping ability of individuals or communities which are affected (Wu, Yarnal, & Fisher, 2002). To analyse the effect on humans, Godfrey St. Bernard tried to develop a social vulnerability index for Caribbean societies. He took variables within the context of five social systems such as education, health, security, social order and governance, resources allocation and

communications technologies for Strength, Weakness, Opportunities, and Threats (SWOT) analysis (Bernard, 2004). In the study of Boruff, Emrich and Cutter (2005), the overall place vulnerability has been analysed by combining both physical vulnerability and socio-economic vulnerability. They have used GIS based spatial models for physical vulnerability and principal component analysis for the 42 socio-economic variables. The study also checks whether the principal driver of vulnerability is physical or socio-economic, in order to help the policy formation.

For the quantification of vulnerability associated with coastal hazards, a Coastal Vulnerability Index (CVI) specifically for coastal areas was developed by Pendieton, Thieler, and Jeffress (2005), using both geological and physical process variables. They explained vulnerability as the potential exposure to a physical hazard and later modified the index by including economic factors (Penndleton, Thieler and Williams, 2010) (Pendleton, Barras, Williams, & Twichell, 2010). The goal of all these indexes, both geophysical and the one with socio-economic factors (Maclaughlin and Cooper, 2010; Boruff, Emrich and Cutter, 2005), is to provide an indication of the physical, ecological and economic impacts of frequent coastal hazards on a community or any region of study.

The magnitude of vulnerability is determined by the adaptive capacity of the coastal community. Traditional adaptation measures emphasised only the physical geography and not the human aspect, so traditional adaptation measures were hard engineered structures. Hard measures such as sea wall, groynes, dykes, breakwaters of coastal protection are considered as non-viable in the long term due to high engineering and maintenance cost (Jonkman, Hillen, Nicholls, Kanning, & Ledden, 2013). Construction of these structures can be traced to the 13th century and currently, around 40 alternative measures are available (Charlier, Chaineux, & Morcos, 2005). But since the vulnerability matrices have improved over time to accommodate qualitative variables, studies have found that socio-economic factors can also be the prime drivers of vulnerability (Boruff et al. 2005) because factors which determine the adaptive capacity to hazards are access and distribution of resources, technology, wealth and information, social and human capital, institutional framework and risk perception (Dolan & Walker, 2006). As vulnerability studies transformed, adaptation strategies too changed. An analysis of the nature of coping strategies would give us the indication of adaption priorities or vulnerability triggering factors.

Paul and Routray (2010) explored various coping strategies adopted by two villages in Bangladesh. Their strategies were related to human life, household items, shelter, crops, poultry, livestock, fisheries and strategies related to food, fuel, drinking water and medical facilities. The study observed that these coping strategies depended on income, education, occupation, external assistance and flood characteristics. Guleria and Edward (2012) examined resilience of coastal community based on eight elements identified with respect to vulnerability and capacity assessment. These are governance, coastal resource management, land use and structural design, society and economy, risk knowledge, warning and evacuation, emergency responses, and disaster recovery. The nature of coping and resilience strategies suggests the idea that socio-economic factors draw more attention in adaptation and vulnerability reduction. Therefore, human capital enhancement can aid vulnerability reduction. However, it is conditional upon intensity and frequency of hazard events.

1.7 Research Gap

Studies on the vulnerability and adaptation assessment of coastal regions in India are few in number (Hegde and Reju, 2007; Kumar, et al. 2010; Mohan and Jairaj, 2014). The available literature on Indian coasts are based on remote sensing and GIS mapping which prioritise physical vulnerabilities of the coast more than socio-economic vulnerabilities (Sudha Rani, Satyanarayana, and Bhaskaran, 2015), besides being predominantly secondary data based. The dearth of studies which incorporate social, economic, physical factors and the impact of historical social structures (which is important when analysing a marginalised community), calls for an extended assessment of developmental issues along with physical vulnerabilities among the marginalised marine fishing communities. This should help to understand how this 'outliered' community along the coast of Southern Kerala is coping with the frequent and intensified coastal hazards. Also, it would help in predicting what adaptation policies a community should focus on based on the principal determinants of vulnerability. With this background, this study tries to answer the following research questions.

1.8 Research Questions

1. Does the transition from traditional fishery to mechanisation reduce the vulnerability of marine fishing communities?
2. What are the determinant factors of vulnerability among marine fishermen? And why does income based vulnerability assistance fail?

3. How does a marginalised community adapt to coastal hazards and what are the factors influencing their adaptation decisions?

1.9 Study Area, Data and Methodology

Data Sources

This study is based on both primary and secondary level data. Secondary data on various issues related to coastal hazards have been collected from state and central government reports, panchayat level development reports, relevant journal articles, working papers, and various climate change and disaster impact studies from UNDRR, UNSDR, UNEP, IPCC, and UNFCCC. Data related to coastal protection measures and various other regional adaptation policies have been collected from the Kerala Irrigation Department and local panchayats. The list of marine fishing households required for field survey were collected from the respective panchayat offices. Data regarding physical vulnerabilities and data on eroding coasts were collected from the National Centre for Earth Science Studies, Thiruvananthapuram (Table 1.1).

Table 1.1: Eroding Coasts in Coastal Districts

District	Length		Length		Length	
	km	%	km	%	km	%
	High (without sea wall)		High (with sea wall)		Low	
Thiruvananthapuram	11.9	15.86	15.66	20.88	30.84	41.11
Kollam	1.14	2.34	37.77	77.58	0.91	1.86
Alappuzha			29.98	37.84	3.7	4.67
Ernakulam			33.39	69.02		
Thrissur	2.58	3.43	17.37	23.16	0.98	1.3
Malappuram			15.4	31.63	6.44	13.23
Kozhikode			35.4	44.68	8.47	10.69
Kannur			9.33	14.27	17.38	26.58
Kasargod	1.3	1.47	4.34	4.93	28.31	32.15
Total	16.91	3.02	198.63	35.47	97.02	17.33

Source: CESS, 2010

It is clear from the above table that Thiruvananthapuram district has the highest erosion without coastal protection (15.86 per cent) and Kollam district experiences the highest erosion even with coastal protection (77.58 per cent). In the coastal belt of Thiruvananthapuram, the majority of the population belongs to the Other Backward Class (OBC) Christian fishermen while, in Kollam, most of the marine fishing communities come under the Other Eligible Communities (OEC-SC) category of the state's scheduled caste list. Along with their socio-economic and educational backwardness, they face livelihood

difficulties. Depletion of fish stock due to mechanisation and over-fishing and rising temperature-led habitat-shifting of fishes makes them vulnerable due to their dependence on a single sector for livelihood.

Almost 80 per cent of the Kollam coast and 36 per cent of the Thiruvananthapuram coast is officially classified as an artificial or constantly eroding coast (Warrier, 2016). Though these coastlines are protected with sea walls and groynes, they fail to stop erosion during the monsoon and at the time of other coastal hazards. Marine fishing communities of Kollam face sand mining in their highly eroding coast. Amidst the continuous protests by the coastal community, decadal long mining is still an on-going process in this coastal district. Therefore, for primary level analysis, the study has chosen the districts of Thiruvananthapuram and Kollam.

Once the districts were identified, after consulting with the then Head of State Disaster Management Authority, the Anchuthengu panchayat of Thiruvananthapuram district and the Alappad panchayat of Kollam district were identified based on the rate of beach loss. Anchuthengu (or Anjuthengu) is a traditional fishing community with a partially protected coast. Alappad is prominently a mechanised fishing community, protected with sea walls and groynes but it nevertheless experiences extreme erosion at one end where mineral mining is practised.

Study Area

Figure 1.1: Anchuthengu Panchayat Map

Source: Central Survey Office (year)

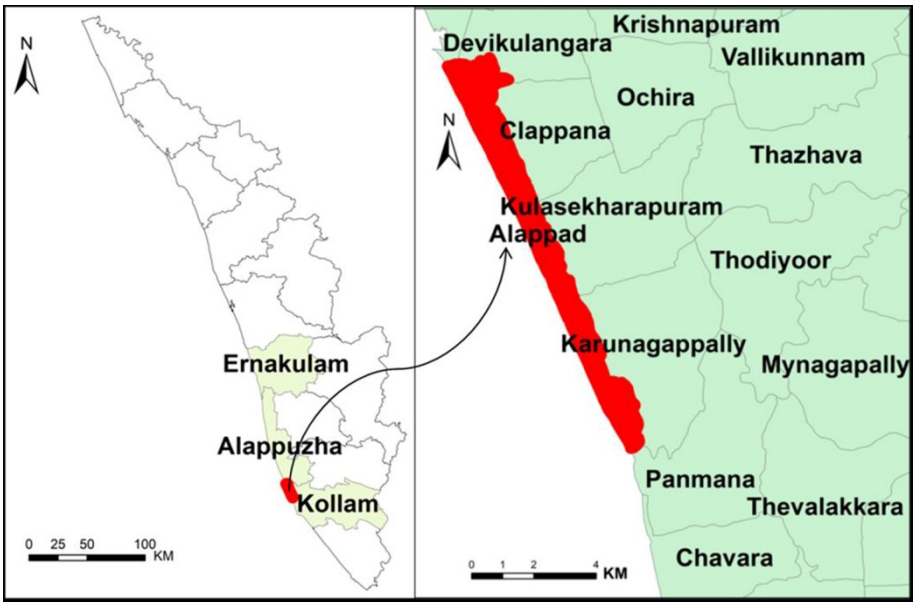
Anchuthengu was a land of trade even before the colonial period. The Portuguese and the Dutch used Anchuthengu for the collection and export of pepper to Europe. In spite of the glorious past, Anchuthengu now struggles with socio-economic backwardness. This 3.36 sq. km panchayat under the Chirayinkeezhu zilla panchayat and Chirayinkeezhu taluka has a population density of 7028 per sq. km, which is one of the highest in the Asian sub-continent. The literacy rate of the panchayat is 72.49 per cent, which is much lower than the state average of 93.91 per cent (Government of India, 2011). The state had achieved an average literacy rate of 72 per cent between the year 1971 (69.75 per cent) and 1981 (78.85 per cent), i.e. four decades before Anchuthengu could achieve the same.

Being geographically placed between the Arabian Sea and the Anchuthengu lake, most of the wards of the Anchuthengu panchayat are narrow strips of land sandwiched between two water bodies. The implications of this geo placement are manifold and the greater part of the land area in these wards falls in the 'No Development Zone (NDZ)' category of Coastal Regulation Zone (CRZ) notification, 2018. Though the CRZ notification 2018 relaxed the NDZ Zone from 200 m to 50 m from the High Tide Line for rural areas with a population density of 2161 per sq.km as per the 2011 census (Government of India, 2018), one can still see congested settlements and petty shops within 10 or 15 m distance from the coast in Anchuthengu. NDZ limits developmental and tourism activities in the region and also restricts reconstruction and modification of the existing buildings.

Being an area without much width, the Anchuthengu lacks sufficient land for any cultivation or any developmental activities and this limits its potential for employment generation. It is also in need of fields suitable for paddy cultivation. Coconut is the only remaining crop which is cost effective. Along with landlessness, intrusion of salt water and unavailability of regular water restricts the farming of other crops. Even the once famous coir industry of Anchuthengu is struggling to operate due to the unavailability of raw materials. Due to the reduction in coconut husk production, coir cooperatives, already running in losses, are forced to buy fibre and yarn from Tamil Nadu. Constraints on land and ever increasing beach erosion remain the major stumbling blocks in alternate employment generation.

Alappad is one among the major fishing villages in Kollam, with the Arabian Sea on one side and the TS Canal on the other. The panchayat is connected to the mainland through bridges.

Figure 1.2: Alappad Panchayat Map



Source: (Anilkumar & Banerji, 2020)

Alappad was once a traditional fishing community, actively engaged in paddy cultivation, coir making and marine fishing. But due to coastal erosion, except fishing, the other two occupations have disappeared from the region. The coir industry, once known for its quality across the world, died out owing to the lack of availability of raw materials, as a result of which there was an increase in labour pressure on the fishing industry. Alappad was among the first to adopt mechanised fishing when Kerala introduced it through an Indo-Norwegian project, and thereafter, the economy has prospered economically.

Alappad village is a sand-filled coast of 17 km with a width of less than 500 m and lies between the Arabian Sea (Lakshadweep Sea) and the Travancore–Shornoor (TS) Canal. The total area under the panchayat is 7.38 sq.km. The panchayat is merely 7 ms above sea-level and is generally considered a '*teerasamatlam*'.[3]

Being placed in close proximity to the sea and the canal, the region is prone to coastal hazards. Cartographic views of the region portray it to be a narrow tail-like landform. At certain locations, the distance between the sea and the lake is not more than 50 ms. The 2011 notification of the CRZ declared an area of 0–200 m as a No Development Zone under this category, but the coastal community were unwilling to accept this condition, as most of the village falls under the less than 200 m width.

[3] Teerasamatlam: flat area without any highlands

In the opinion and estimation of the elders and senior citizens of the panchayat, it could be roughly tabulated that areas of not less than 7200 hectares have been lost to sea erosion in the past. The entire panchayat is protected with hard structures as the coast continues to face extreme erosion and beach loss every year. Before construction, the location which houses the present harbour had also undergone several monsoon floods. Mineral mining in its coast drive the region more vulnerable to coastal hazards. The magnitude of the impact is high as the region has high population density (2934.28 persons per sq.km).

1.9.1 Survey Design

After selecting the coastal districts, panchayats were chosen based on purposive sampling considering the rate of erosion. From both panchayats, 151 households each were selected randomly, covering each and every ward of those panchayats. The survey also incorporated 50 fishermen working in traditional, motorised, and mechanised fishing. In total, we have 302 household samples and 50 fishermen specific samples. The survey had two sets of questionnaires: one household questionnaire and one fisherman specific questionnaire

The household questionnaire consists of information on basic household characteristics, asset holding, earnings, consumption, savings, debt and insurance patterns, infrastructural facilities, social security benefits availed, community life, general health and special needs population, skill development programmes, potential employment loss with a hazard event, and political participation and representation. The questionnaire also collected particulars on adaptation plans, effectiveness of structural and non-structural adaptation measures and erosion perceptions of community members.

The fishermen specific questionnaire is precisely on the impact of climate variations on fisheries from the standpoint of marine fishermen working in catamarans, motorised and mechanised boats. The questionnaire collected details on changes in their nature of employment, targeted species, technology used, employment mobility, resource depletion, cost of operation over the past 10 years, as also their future outlook on fisheries industry.

1.9.2 Method of Study

The impact of changes in fisheries from the time of Independence especially mechanisation of fisheries (a policy decision to reduce rural poverty) on the sustainability and vulnerability reduction is studied through oral history, literature review, and decadal data analysis.

Anecdotes from the field regarding changes in fish catch composition over the past 10–30 years, gives a clear view of changes in the availability and size of targeted species, by-catch, and total fish production. By connecting various studies and reports, the decadal data analysis reaffirms the anecdotes.

The susceptibility of marine fishing community to coastal hazards is examined by studying structural vulnerability, occupational vulnerability and socio-economic vulnerability. Structural vulnerability is studied through a spatio-temporal analysis using oral history and available academic literature. Occupational vulnerability is analysed from data collected through primary survey. For identifying the lead factors driving socio-economic vulnerability, a coastal vulnerability index has been constructed. The index has four dimensions—social and demographic structure, access to resources, built environment, and spatial proximity to hazards—which incorporates both physical as well as socio-economic vulnerabilities that contribute to the overall vulnerability of that particular region.

To determine the adaptation gap, the existing adaptation strategies followed by the state government, panchayats, and households (as individuals and together as a community) were identified. Then each strategy is critically analysed and efficacy of these policies are tested by examining the socio-economic and physical changes these strategies have had on the panchayat. By understanding the differences between existing adaptation efforts and adaptation needs, the gap is documented and factors influencing the adaptation decisions are identified.

1.10 Chapter Scheme

The study comprises of five chapters. The first chapter provides the introduction and research framework. It discusses the background of the study, impact of coastal hazards on the coastal communities of Asia, India and Kerala. It discusses the vulnerability of the marine fishing community in Kerala. The chapter reviews the existing literature on coastal hazards, key vulnerabilities, and various coping and adaptation measures. It also reviews the transition of the vulnerability assessment models over time. From the review of literature, the research gap is identified and research questions are developed. The chapter also introduces the study area and the methodology.

The second chapter begins with a detailed description of traditional fishery and then charts out how the introduction of mechanised fishing practices, a 1953 government policy for poverty eradication in rural areas, eventually led to the transformation of fisheries from labour intensive subsistence occupation to a capital intensive machine oriented process. Through a decadal analysis of marine fishing history, the chapter points out the impacts of mechanisation on marine ecology and total fish production by traditional fishermen. The analysis helps us to understand why more than 50 per cent of marine fishermen in Kerala still fall below the poverty line.

The focus of the third chapter is to find out the determinant factors of vulnerability among marine fishing communities for which the study analyses the structural, occupational, socio-economic and physical vulnerability of the marine fishing communities in Kerala. Structural vulnerability considers historical spatio-temporal factors and sees how it affects the current vulnerability of the community. Occupational vulnerability decodes how climate variations and mechanisation induced their vulnerability. Finally, the coastal vulnerability index is constructed to identify various socio-economic-political and geographical factors contributing most to the vulnerability of the community. This chapter also looks at how a relief package based purely on income vulnerability analysis can re-establish pre-disaster inequalities.

The fourth chapter lists out the various adaptation strategies practised in the surveyed panchayats by the government and households (individuals and together as a community). The chapter critically analyses all the strategies to determine the policy gaps. So, the study discusses in-built problems of engineered coastal protection structures, impact of formal adaptation policies on traditional fishermen and other problems such as long-term implications of short-term adaptation solutions.

The fifth chapter concludes the study with a brief summary, findings, policy suggestions and limitations of the work.

CHAPTER 2

OCCUPATIONAL HISTORY OF MARINE FISHING COMMUNITY SINCE INDEPENDENCE

2.1 Introduction

Post-independence fishing economy in Kerala witnessed a transition from being a sustenance occupation to profit generating commercial occupation. In this due process fishery in Kerala shifted from the sustainability goals of traditional fishing. With the use of mass harvesting gears by the mechanised[4] and motorised boats[5], the sector witnessed resource depletion. Livelihood dependency on fishing has always been high in the state; currently about 1,21,637 fishermen households depend solely on marine ecology for livelihood among which 72,507 families still live below the poverty line (Government of India, 2019). Intensified fishing not only transformed nature of fishing but also socio-economic situations among the fishermen. By 2018 fisheries transformed from 100 per cent traditional fishing at the time of independence to, 75 per cent mechanised fishing (CMFRI, 2019).

The chapter tries to answer the research question: does the transition from traditional fishery to mechanised fishing reduce the vulnerability of marine fishing communities? This chapter is divided into three main sections. The section after the introduction gives a detailed description on the nature of traditional fishery in Kerala; a caste based, community based subsistence occupation which used species specific fishing nets to ensure the sustainability of marine resources. The next section discusses the transition of the Kerala's marine fishery from traditional to mechanised fishing (1950 to 2020). It tries to comprehend how the differences in style of fishing created the income gap between traditional and mechanised fishermen and how fishery witnessed resource depletion within few decades after independence. Understanding the changes in the nature of fishery would throw light into the existing pattern of vulnerability among fishermen. The last section discusses the responses of various stakeholders to capitalisation of fishery.

[4] Mechanised boats: line boats, trap boats, dolnetter, gillnetter, and trawlers with high powered engines
[5] Motor boats: are the country boats fitted with in/out board engines below 10HP

2.2 Traditional Fishery: Sustainable Production

Traditional fishery in Kerala was a subsistence occupation of a certain caste based community. They considered sea as common property resource and had set up mechanisms for dispute settlement and income distribution among community members. The methods used for fishing inculcated from terrain specificities; they modulated the technology in accordance with regional requirements. As the caste system regulated the entry of 'others' and scope of expansion of trade, fishing continued to focus on sustainability than profitability. Even after mechanisation, majority of fishermen population in Kerala carry on practicing traditional fishing, but its share of production to the total fish produced has drastically declined. This section discusses the major features of traditional fishery.

2.2.1 Caste Based, Community Nature of Fishery

Medieval India practiced Vedic style of caste (Varna) system and the hierarchical order attached to it. Over time social regrouping on the basis of profession and birth-based caste system came into force (Sonawani, 2017). Until the advent of British, caste and related customs remained relatively fluid. British census used 'caste' as a variable for easy classification thus forcing people to slot into caste customs (Appadurai, 1993).

In the caste order, marine fishermen are assigned into the lowest segment. As the system is hierarchical less dignity and social status was given to fishing as an occupation. Fishing continued as a caste-based, community-based hereditary occupation. Elders of the community transferred the accumulated knowledge about marine environment and nuances of fishing to the younger generations. They considered sea as their community resource and preserved it. Caste system prevented the entry of 'others' or outsiders into the fishing occupation. Being from the lowest segment of caste system, their interaction with other castes was limited. They were treated as untouchables; this induced many in Kerala's fishing community to convert to Roman Catholicism and Islam.

Christianity spread in Kerala with the landing of 'St. Thomas' in A.D 52 (a popular claim). Initial cases of conversions are claimed to be from families in the upper strata of the caste hierarchy, so they remained socially well off. Only from 1498, with the arrival of Portuguese Vasco De Gama, fishermen in present Kerala got converted into Roman Catholicism. Islam was introduced in the Malabar Coast of Kerala in the 8th century (Halfdanardottir, 1993). Many fishermen converted into Islam for social and economic reason. The converted

fishermen were called '*puislam* / *puthiyaislam*' which means newly converted (Mumtas Begum, 2006). Social status of fishermen did not find much difference as both Catholicism and Islam differentiated them under the title of 'newly converted'. Thus, fishing community continued to face same social stigmatisation and remained as 'untouchables' (Halfdanardottir, 1993).

Though the caste system as well as the skill requirements prevented the entry of 'outsiders' to fishery, with mechanisation in 1950's those outside the community started participating in fishery as investors and crew members. From community occupation and sea as a common property resource, fishery became an open access resource.

2.2.2 Passive Fishing Practices

Kerala's aquatic zone is unique as it is home for ample variety of fish species, widely dispersed at smaller quantities. Traditional fishery practices multitude of techniques and equipments which are based on species specific and geo-specific designs. Fishing of various species depends on the growth stages of the fish as well as the seasonal changes and it catered mainly the consumption needs of the local community as well as to pay for the services hired from the non-fishing communities. In a way traditional techniques are in accordance with the nature, growth and availability of species rather than that with the needs of people. Conservation was an essential part of traditional fishery; they considered sea as goddess and took only what is essential for survival. Profit making was never their endeavour.

Most of the fishing equipments used were the modified versions of technology from various countries. The most commonly used *Kattaumaram* / Catamaran (forest wood) is of Egyptian and Polynesian origin, *kettuvallam* / plank canoe of Arab, *kambavala* / shore seine of Portugese, *cheenavala* / dip nets of Chinese are used by the traditional fishermen of Kerala (Iyengar, 1985). Multitudes of fishes attaining maturity at different seasons prepared traditional fishermen to use diverse fishing nets and gear according to the fish size and availability. These fishing practices were ecologically sound. Traditional fishery was maintaining the sustainability of marine resources.

2.2.3 'Karanila': The System of Traditional Income Sharing

"*Karanila*: means shore status- a privilege granted to anyone who expresses a demonstrable interest in associating with a fishing unit by being present on shore when the unit is ready to set out to sea"(Kurien and Vijayan, 1995). Their ability to fish out in the sea is tested at the initial instance they approach as a '*Karanila*' worker. Thereafter they need not have to go for fishing in the sea. In a way they act as 'workers in reserve' or as a labour bank. However, as the system follows, '*karanila*' workers, who have not productively contributed to a particular fishing trip, are privileged to get a share of profit from that fishing trip. *Karanila* system is practiced in *thanguvallam* or large wooden plank canoe along the coasts of Alappuzha and Ernakulam districts.

According to Kurien, (2000) about 70 to 90 years ago, it was the landlord class who owned the *thanguvallam* in Alappuzha, they controlled fishermen as bonded labourers. It is after the working class uprising of 1940 through Punapra-Vayalar Struggle, fishermen started forming own groups mostly based on kinship and controlled production(Kurien, 2000). As traditional fishery is emphasised on community welfare and fishing for consumption needs, first *thanguvallam* boat which lands with fish of any *thanguvallam* unit is to satisfy the consumption needs of the crew and *karanila* workers (Kurien and Vijayan, 1995). Widows, handicapped members of the community, and those non-fishermen who render service to fishermen also have claims over fish. Only after settling the consumption claims of the community, fish would be put on sale. This ensured the nutrition needs of the entire community as well as basic income generation among elderly and teenagers who are otherwise economically dependent.

2.2.4 'Kadakkodi': The Community Court for Regulation & Settlements

Fishermen in Kerala have various indigenous institutional arrangements to regulate their actions on resources. *Kadakkodi* or sea court is one such found in northern part of Kerala among the Hindu fishing communities (Kurien, 2004). *Kadakkodi* is conducted by the elders of the community to take decisions regarding conflicts, access and conservation of fishery. They listen to fishermen and take decisions for them and their decisions are final and must be implemented. The community altogether ensure that the decisions are implemented. Offenders get punished by the same court and punishments can vary from warnings to social ostracism depending on the situation. Such court helps to make easy and effective decisions

at low cost. Now *kadakkodi* is limited to few northern regions as fisheries have undergone changes due to mechanisation further changing the social structures.

2.3 Modern Fishery: Resource Depletion (1950's to 2020)

It was the economic planning by the planning commission of India in 1950's, which envisioned potentials in the 7517 kilometre long coast and the attached continental shelf of the country. As fishery remained as subsistence occupation for centuries, fishing communities were among the poorest of rural population. Their lifestyle differentiated them from other communities and their caste from moving to better socio-economic strata. As the economists found potential in the development of rural areas through modernisation of fisheries, soon they aimed at acceleration in fish production, export, generation of employment and thereby improving the socio-economic conditions of the community. Planners promoted the involvement of both the state and private parties in achieving their goals (Kurien, 1991).

Looking at the rate of harvest by then existing technologies, the planning agency understood that they are not sufficient enough for the expected growth in fishery. Thus, the planners decided to import technology from those countries which produce surplus from fisheries. Unfortunately, this led to the superimposition of technology used in better developed countries with temperate water. Thus automatically, existing traditional fishing practices which were labour intensive and of wide variety were substituted with modern capital-intensive specialized technology (Kurien, 2004).

2.3.1 1950's to early 1960's

In 1953 Government of India with the support of United Nations got to an agreement with the Government of Norway to share their fishing technology. The aim of the project was to improve fishing methods and thereby improving socio economic and health status of the fishing communities. For initial implementation, this project has chosen an area of 10 square mile in the current Kollam district of erstwhile Travancore Kochi State (Gerhardsen, 1958). This project introduced trawlers named M.O. Christenson 77, Cochin 65 and Travancore 56 (Xavier, 2013) and boats of 22 feet and smaller.

As part of this Indo Norwegian project a refrigeration plant consisting both ice and cold storage, a health centre, and a pipe factory for the proposed water supply scheme were

constructed. To ensure healthy sanitary condition, sanitary inspectors were appointed; they were in-charge of the construction of latrines offered at a nominal price (Gerhardsen, 1958). But after the formation of Kerala state in 1956, approach of the state government was radically different. They preferred to enhance the existing fishing technology than importing new technology. It prioritised the traditionally gained knowledge and skills of the fishermen and tried to boost the productivity over a certain time period (Kurien, 1985). Therefore, in the first decade of planned development, Kerala witnessed artisanal fishermen putting more effort to increase the fish catch using various nets, gears in their non-mechanised crafts and changes from cotton to stronger nylon nets.

Kerala is home to variety of prawns species. In general, the term prawns and shrimps are used interchangeably but technically prawn represents species of the freshwater family and shrimp represents species of marine family. Peculiarity of Kerala water is that it is home for wide variety of species in lesser quantity. Before finding international market for prawns, fishermen in Kerala used prawns as manure for coconut tree, the most commonly found tree in coastal belt. During the cold war period as supply of prawns from China got blocked, India got the opportunity to cater for the high demands from United States and Japan for the frozen prawns. This boosted the morale of Kerala fishery to produce more and export prawns to these countries. This rush in production due to the increased international demand is known as Pink Gold Rush.

As prawns were never tapped before the pink gold rush, it was a great opportunity for the fishermen. It also had the biggest international market and widely available in inshore areas. Therefore, increase in the harvest of prawns was their prime objective and they were successful in it. It worked as a major source of foreign exchange for the government. So, the changing state governments' continually promoted fishermen to harvest more prawns. Thus, the initial decade of planned development witnessed rapid increase in the harvest of prawns.

Though mechanisation was gaining momentum, the rapid change left its marks on sustainability goals of traditional fishery. Fishing trawlers have the history of being used as mine sweepers during World War II as it has the power to scrape the sea bottom. When the same is used in fishing on everyday basis, especially in inshore water which is the breeding ground of many species, destruction of marine ecology is inevitable. Foliages, corals, rocky and sand formations in the sea bottom is where the fish lay eggs and hide the juveniles

from the predators and bottom trawling has the capacity to destroy them all together (Iyengar, 1985).

Trawlers in Kerala water were indulged in inshore fishing where their main target (prawns) was available. The indiscriminate trawling during the monsoon season, the breeding period of many fish species had led to the catch of fishes before attaining their full size, which indeed led to over fishing to attain the targeted weight. Eventually this led to the destruction and depletion in the stock of various species. The change in the size of fish catch was clearly observable. Indiscriminate catch has also led to extinction of many species especially prawns (Iyengar, 1985). After introducing trawlers in India by the Indo- Norwegian plan, Norway itself put ban on trawling. Later Philippines and Indonesia banned trawling on the understanding that it destroys juvenile fishes and the organisms which fish feed on and trawling ban as the best option in tropical waters to recover the already overexploited fishery (Iyengar, 1985).

Introduction of mechanised fishing also led to the disappearance of *Karanila* and *Kadakkodi* system. Kinship-based group formation in *karanila* changed with motorisation (Kurien and Vijayan, 1995). Introduction of ring seine attached *thanguvala* raised the catch rate. Subsidies and credit from the government promoted more fishermen to acquire *thanguvallam*. Groups formed to take benefits from government provisions were not based on kinship but on criteria. Increased number of *thanguvallam* created sudden surge in demand for labour and it was met by the combination of traditional fishermen as well as non-fishermen residing nearer to fishing community. As soon as the initial spurt in production subsided, *karanila* system became burdensome. Motorisation had increased the cost of production and fish catch had reduced with increased number of vessels fishing in the same area. Diminution in production forced many *thanguvallam* units to withdraw and this made many fishermen unemployed. Thus, a greater number of people started taking advantage of *karanila* system, by joining as 'reserve force' thereafter new rules were given for *karanila*, and initial privileges were taken back. Thus, motorisation has threatened the *karanila* system of income sharing.

In case of *kadakkodi*, the elders of *kadakkodi* decided to ban bottom trawling fishing gears and nets to prevent the depletion of fish stock. But the involvement of more educated youth in fishery who benefit from the short run spur in profit made it difficult for the elders to finalise and implement their decision. Youngsters questioned the need to preserve old model fishing practices. Mechanisation era had also witnessed the involvement of various political

parties into fishermen's problems. Thus, these factors questioned and restricted the power of elders in decision making. Thereafter the age old *kadakkodi* system of community decision making court became less effective but still active in certain coastal villages of Northern Kerala (Paul, 2005).

2.3.2 1960's to early 1970's

In the 1960's government initiated the growth-oriented modernisation process. Government started offering mechanised boats at subsidised rates to the fishermen cooperatives. But at the same period Kerala witnessed a new trend in fishery; entry of non-fishermen into the fishing industry in the role of investors. Demand pull increase in the price of prawns had attracted non-fishermen to invest in fishing. Witnessing the trawlers harvesting huge amounts of fish made them to invest in new technology.

Non-fishermen mainly the mercantile group, who previously were investors in coir and cashew sector diversified their investment to mechanised fishing. Subsidies provided by the government to the cooperatives were used by these mercantile groups by keeping *benamis*[6] (under false name) (Kurien & Vijayan,1995). These rich and influential investors controlled and ruled such cooperatives formed in the name of fishermen. According to the government statistics return of investment for the trawlers in 1968-69 period was 14 per cent (Government of India, 1971). Since no licence or registration was required to operate trawlers in the Kerala water and no restrictions or regulation on the purchase or accumulation of fishing assets, these non-fishermen started investing greatly in the trawler fishing. Thus, mid 60's witnessed considerable influx of 'outsiders' in the trawling section.

The ingress of mechanised fishing and those outside the fishing community in fishery changed the fishing practices. When traditional fishery used species specific nets with varying mesh sizes, the nets used in trawlers caught all kinds of fishes of varying sizes in single catch, this generated more 'waste' or unwanted fishes (either by size or market demand). As return on investment sounded promising, fishing attracted more men to invest in trawlers. This increased influx of trawlers without regulations resulted in ecological crisis in Kerala water. This was obvious in the 1970's (Table 2.1).

[6] Benami: *benami* transaction means any transaction in which property is transferred to one person for a consideration paid or provided by another person.

2.3.3 1970's to early 1980's

The trend of steadily increasing production continued only till mid 1970's.Thereafter even the mechanised fishermen started seeing dwindling production.

Table 2.1: **Productivity and Income of Fishermen in Kerala (Per Annum)**

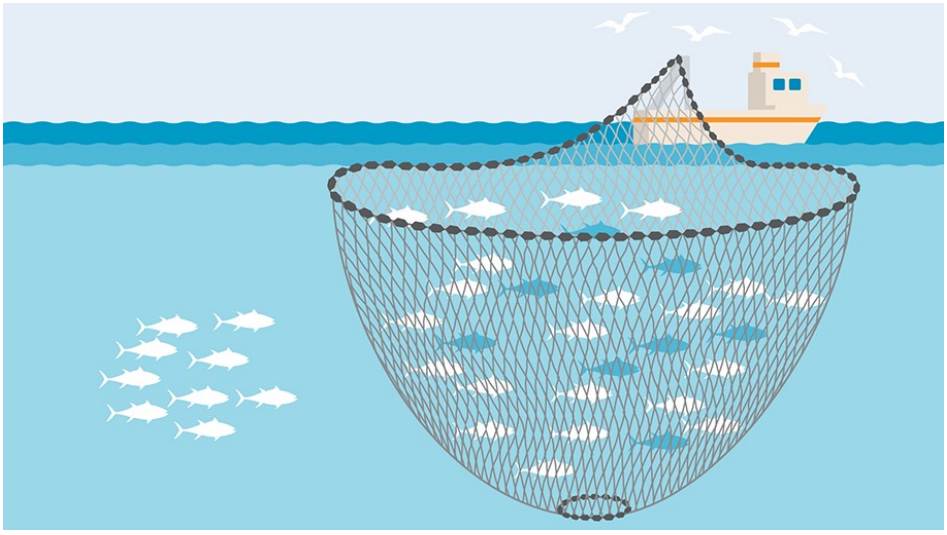
	Fishermen of Trawlers		Artisanal Fishermen	
Year	**Productivity (tons/year)**	**Income* (rupees)**	**Productivity (tons/year)**	**Income* (rupees)**
1961	NA	NA	3.54	330
1965	NA	NA	3.82	380
1969-1970	5.15	790	3.34	630
1974	10.04	2700	3.20	850
1979-1980	7.54	2630	1.78	540
1982	7.70	1560	1.62	420

Source: *In per capita terms in 1960-1961 (Kurien and Achari, 1988; Kurien, 1991)

Two major things can be traced from Table 2.1, (i) income inequality and (ii) diminishing returns to the capital invested. In case of trawler fishery initial years have shown spur in economic production but thereafter stagnation in productivity at a reduced level of production can be observed. In case of artisanal fishermen except the initial jump in production, from late 1960's onwards it is constantly showing reduction in its productivity, but the increased foreign demand led increased prices for the fishes have helped them earn better even when their productivity constantly declined. That scenario also started changing from the mid 1970's, increased competition and resource depletion has affected artisanal fishermen more than the trawler based fishery in terms of per capita income. Earnings in terms of per capita income also show growing inequality among the fishermen, which was a new phenomenon to the community oriented fishing tradition.

State of Kerala stood 3rd in the production of fishes at all India level till the mid 70's (Agarwal, 1990). As early 1970's started showing the indication of resource depletion, government of Kerala stopped providing subsidies on mechanised boats by 1973 (Kurien and Achari, 1990). Government had issued around 1200 mechanised boats during the period 1961-62 to 1977-78 to the fishermen cooperatives (Krishnakumar, 1981). When fish production started declining in 1976 purse-seiners were introduced in Kerala. However, there was no control on the size of the mesh used.

Image 2.1: Purse-seine fishing



Source: Marine Stewardship Council (2019)

Purse seine fishing in the open sea can sweep any variety of fishes into it (Korakandy, 1984). When there is no control over the mesh size, it can affect the breeding and multiplication. Compared to the traditional nets, purse seines can generate greater level of by catch[7]. Only if the mesh size is large, the fish spawns and other younger fishes can swim out of the net, but in case of Kerala the targeted fish was prawns which are considerably small in size compared to other fishes. Owners of trawlers and purse seines were mostly non-fishermen; they considered it as a source to produce more return on their investment (Korakandy, 1984). Unlike traditional fishermen, the non-fishermen trawler owners do not depend on fishery alone for their survival, thus conservation or preservation of vivid species is secondary to them. Therefore, the indiscriminate catch using purse seines added more to the resource depletion in the Kerala waters.

In 1978 net return on investment from trawler fishery reduced to mere 8.6 percentages and by 1980-81 rate of return was shockingly negative (Government of Kerala, 1979) (Kurien and Willmann, 1982). Thus mid 1970's to mid 80's were the period of stagnating or declining fish production. In case of prawns both the catch per unit as well as size of the species declined, indicating biological overfishing (Kurien and Achari, 1990).

[7] Bycatch means accidental catch of unwanted species.

2.3.4 1980's to early 1990's

Increased number of trawlers along with traditional vessels added stress to inshore marine ecology. In 1980-81 there were over 30,000 traditional boats and more than 3000 trawlers in the Kerala water (Kurien and Vijayan, 1995). As we have seen from mid 1970's itself Kerala waters were facing ecological crisis, further population pressure on inshore aggravated the matter. Constant increase in production and profit had attracted many investors into fishery but negative return forced them to remain on the expectation of bumper fish catch someday. It is in this period over populated fishery industry witnessed physical conflicts among fishermen.

The Kerala Marine Fisheries Regulation Act (KMFRA) came into existence in the year 1980. KMFRA took a landmark decision to divide the sea into two zones and trawlers were restricted to enter into the inshore water specified for traditional and motorised boats. Thus, the Act protected the interest of traditional fishermen.

By 1980's both trawlers and traditional fishery had experienced decline in production. In 1974-1982 period, productivity declined 50 per cent; due to overfishing, and over population. Real per capita income also reduced from INR 850 to 420 (Kurien and Achari, 1990). In 1981 government of Kerala had appointed an expert committee to study on resource depletion and overfishing. This committee found that the investment in Kerala marine waters has reached beyond the optimal level. Overcapitalisation in the fishery was estimated to 530 million rupees; an amount equivalent to the three decades' development assistance to the fishery by the state government (Achari, 1987).

Table 2.2: Estimates of Excess Fishing Crafts in Kerala

Craft Type	Existing Number	Committee Recommendation	Excess	
			Number	Per Cent
Trawlers	2807	1145	1662	59
Purse Seiners	54	Nil	54	100
Motorised Crafts	6934	2690	4244	61
Non Motorised Crafts	20170	20000	170	negligible

Source: (Kalawar, 1985; Kurien and Achari, 1990)

It can be understood that except in case of non- motorised artisanal fishing, active fishing vessels are much higher than the recommended number by the expert panel (Table 2.2). Considering the ecological sensitivity purse seine nets are not recommended at all. It is the population pressure and excess investment which led to the surplus of fishing crafts in the

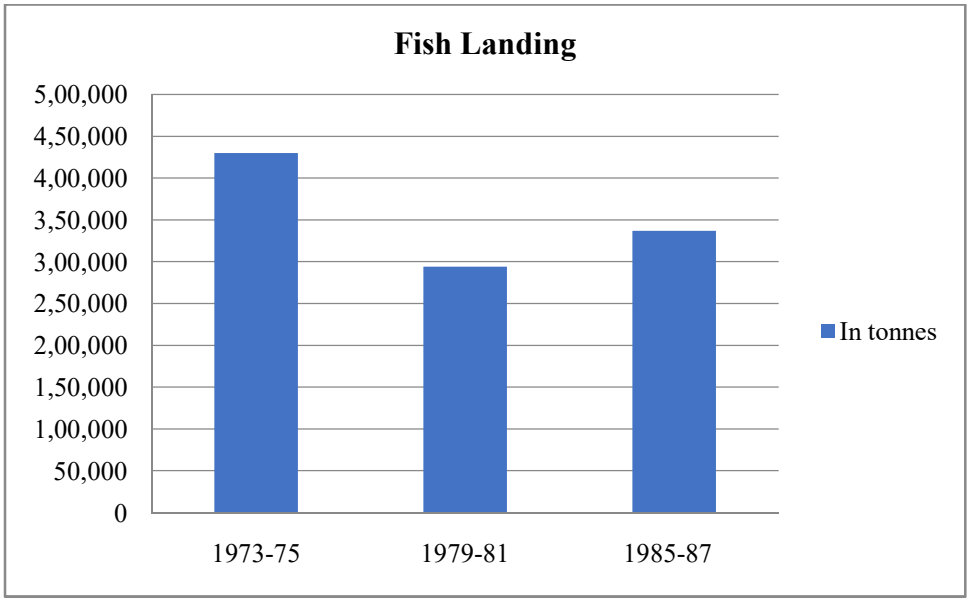
marine resources of Kerala. In 1961, number of active fishermen in the inshore water was 80,700 with the density rate of 6.4 fishermen per sq.km. But by 1985, there were 65 per cent increase in the fishermen population; from 6.4 it increased to 10.6 fishermen per sq.km (Kurien and Achari, 1990). Mounting pressure on coastal commons exacerbate the extent of overfishing.

Overfishing of species with higher market demand had led to the depletion in their stock, by mid 1980's fishermen were getting more of those species with lower market demand in their catch composition. Reduction in the harvest also had larger socio-political impacts. With resource depletion and competition, considering the proportional changes in cost and profit, traditional fishermen were worst hit as they experience constant increase in cost and fall in profit

It is also to be noted that with the increase in the price of prawns in the 1960's and 1970's the rate of raw materials and equipments of traditional fishery had increased (Iyengar, 1985). So in 1980's along with depletion of fishery, the increased cost of production and indiscriminate sweeping off nature of trawling gave intense pressure to the artisanal fishermen. This eventually led to open war at the sea with trawlers, coast guards etc. Along with open confrontation, traditional fishermen also formed unions and protested and set out demands to the government mainly to restrict trawling activity.

Another response to the mechanisation led overfishing was technological upgradation. Artisanal fishermen rushed to purchase outboard motor engines. Seeing this situation government offered INR 3000 per engine and INR 2600 per craft and gear as subsidy (Kurien and Achari, 1990). Earlier the subsidy and loan on mechanised boats went in the hands of undeserving people, this time subsidy reached to deserving artisanal fishermen. Motorisation wave spread through the coastal Kerala; fishermen in central and northern Kerala started using ring seines (adopted from purse seine) to produce more. This initiated conflicts among traditional fishermen as it added more pressure to the commons.

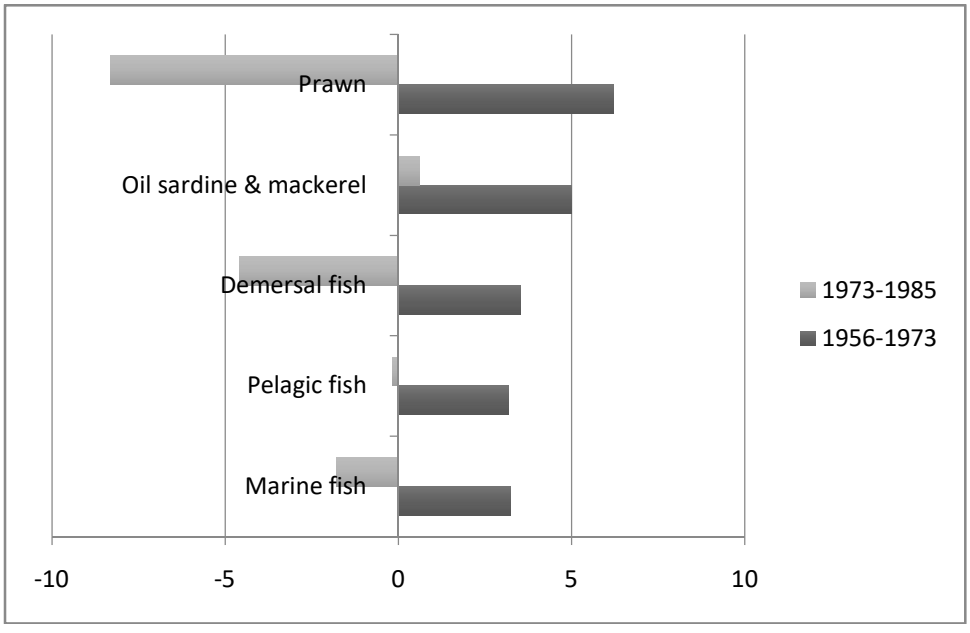
Figure 2.1: Total Fish Landing



Source: (Kurien and Vijayan, 1995)

The initial spur in production did not last long (Figure 2.1). By the end of 1970's itself Kerala water started facing ecological crisis. Restrictions on trawler fishery, and use of outboard engines and ring seine by the traditional fishermen couldn't help them to reach the initial production level. By 1980's damage was irredeemable. Clear sign of ecosystem overfishing is evident from the figure 2.1. The data for 1985-87 shows revival in total production but this need to be understood with the catch composition.

Figure 2.2: Compound Growth Rate of Fish Harvest of Kerala State



Source: (Kurien, 1991)

Except oil sardine and mackerel (mainly consumed by local population) all other species faced reduction in harvest rate (Figure 2.2). Situation was miserable for those who focused on prawn's production as it was a major source of foreign exchange earnings. Unlike demersal fishes, pelagic fishes neither lives near the coast nor sea bottom, so they are comparatively less affected by the Kerala fishermen whose target was prawns, an inshore species. But the negative compound growth rate in the total marine fish harvest was alarming given the fishermen density, level of investment, livelihood and nutritional security and replenishment of marine ecosystem.

The Kerala State Co-operative Federation for Fisheries Development Limited came into existence on 19th march 1984 to facilitate direct control on production, procurement and marketing of the fish produced by active fishermen. This is intended to save fishermen from the clutches of money lenders and middlemen who controls the sales and marketing of what produced. It provided affordable institutional credit, training in new technologies in harvesting and processing, fuel to fishermen directly to avoid middlemen, interest free loan to fisherwomen working in the marketing section, quality fishing equipments at reasonable rates and also promotes sustainable fishery by enhancing the production of fish and prawns seeds to replenish the fish stock. By 1988 Kerala government introduced seasonal fishing ban during the breeding season to let the fish seed to replenish.

2.3.5 1990's to early 2000's

As market oriented Neo Liberal policies were initiated in India by Narasimha Rao government in 1990's, Indian sea was also opened to the foreign market forces. Foreign motor boats, trawlers and factory trawlers started operating in the Kerala water which was already facing economic and biological overfishing. This increased competition has forced the fishermen to increase their investment in fishery, but fish production did not increase at par with the increased investment.

Table 2.3: Marine Fish Produce and Investment

Year	1992-93	1993-94	1994-95	1995-96	1996-97
Marine Fish Produce (Lakh Tonnes)	5.75	5.68	5.32	5.72	5.70
Total Investment in the Fishing Sector (Crores)	1202.83	1320.16	1804.74	2297.75	1960.22

Source: (Government of Kerala, 1998)

Regardless of the increase in investment, marine fish production remained almost the same (Table 2.3). Increase in operational cost due to increased competition, fish stock reduction, increase in the price of diesel and kerosene, reduction in kerosene permit limit from 1000 to 350 litres for motorised boats are the causes that forced the marine fishermen to invest more to remain in the trade. It is observed that till mid 1990's production showed consecutively a declining trend, yet total investment in the fishing sector kept rising. And even when the overall production was declining, export companies had 18.3 per cent growth in their exports and 6.93 per cent growth was recorded for processing companies in 1994 (Kerala State Legislative Assembly, 1994).

By 1996 with the introduction of new trawlers of 15-17m overall length, multiday trawler fishing of 6 to 8 days started in Kerala (Nair, 2000). It facilitated demersal trawling at a depth of 350-400 ms; this could be a reason for slight progress in the production from the mid 1990s. With the invent of multiday fishery, fishermen started staying over in sea for days and as multiday trawlers could fetch more deep sea prawns, more investors started investing in bigger multiday trawlers.

This period also witnessed opening of more export oriented enterprises and processing units. Boom in the export continued until European Economic Union imposed sanctions on fish exports from India as it failed to meet the hygiene standards. Along with this United States started levying anti-dumping duty on Indian shrimps, a major item in our export earnings. Together these hit the profit of sea food exporting companies.

2.3.6 2000's to early to 2010

Though there was mechanisation, rising export, and increased price for fishes, more than 55 per cent of fishermen families remained in BPL section; surprisingly the district which was first to adapt to mechanisation i.e. Kollam had 68 per cent of fishermen in poverty (Government of India, 2010). Dwindling profit due to high investment and low returns over

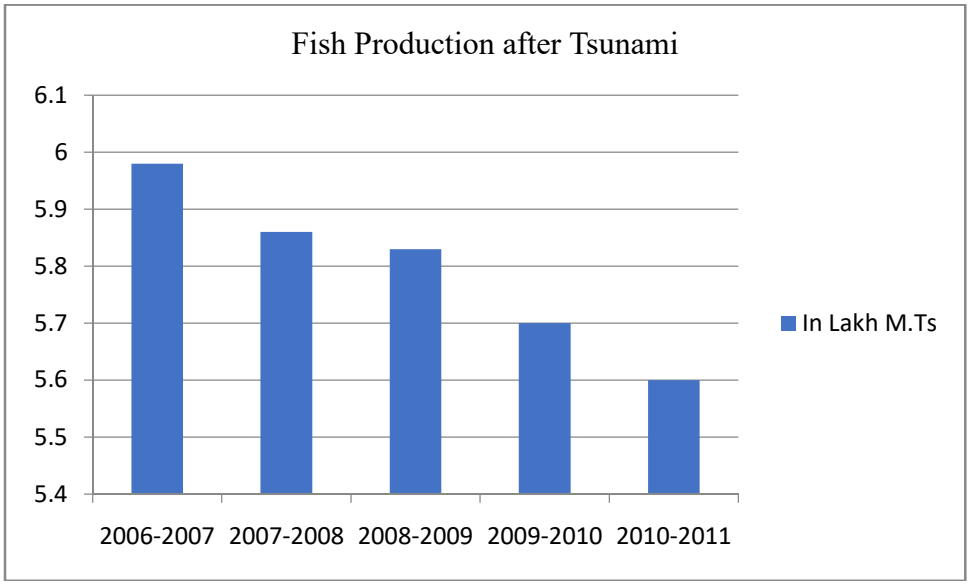
the past decade spread economic pressure to the fishermen. Unexpectedly fishermen also had to undergo tsunami disaster, something they were unheard of.

The devastating tsunami hit coastal Kerala on 26th December 2004, took the lives of 176 people mainly from fishing communities in Kollam and Alappuzha districts and particularly Alappad panchayat of Kollam district. In total 187 villages were affected and 6280 dwelling units nearer to sea were completely destroyed and 11,175 were partially damaged (Government of Kerala, 2007). In the districts of Kollam, Alleppey, Ernakulam, and Kannur together 14 shrimp hatcheries were affected which implies livelihood loss (FAO, 2005). Fishing boats, houses, personal assets, coastal infrastructure and business units were destroyed widely in 9 coastal villages. Major loss in the coastal region was for fishing sector. This tsunami disaster was a setback to the economic progress of the fishing community.

In the aftermath of tsunami, Government of Kerala initiated Tsunami Emergency Assistance Programme (TEAP) to ensure livelihood security and Tsunami Rehabilitation Programme (TRP) to support those who have lost houses and those residing in potential risk regions. Fish processing, food processing, seafood kitchens, tailoring and hygiene product units were the various categories to which livelihood option was dispersed. Later on, "*Theeramythri*" and Society for Assistance to Fisherwomen (SAF) were created to execute various tsunami relief programmes. SAF which came into existence in June 2005 provides skill based trainings, financial assistance to start micro enterprises, branding and marketing support for the empowerment of fisherwomen by enhancing them to be self employed.

According to the Kerala Fishermen Debt Relief Commission Act, (2008) high rate of investment, lower returns, fall in price, underemployment, and having no direct control over sales have put fishermen in long term debt. Sea erosion, flooding, natural calamities like tsunami, yearly monsoon fury etc. are mounting greater liabilities on fishermen as they loss fishing equipments as well as work days. Therefore, the state government decided to provide relief to them and help them through conciliation, negotiation and adjudication (Government of Kerala, 2008). The Act came into effect from 2010 and amended in 2013 and in 2018 to extent the years of debt relief due to cyclone Ockhi and flooding. Though government provided debt relief to some fishermen, overall economic condition had no progress as fish production was declining.

Figure 2.3: Fish Production after Tsunami



Source: Directorate of Fisheries, (2011)

The figure above clearly indicates the declining trend in production of fish (Table 2.3) Prawns had stagnation in the rate of production at 0.68 lakh M.Ts and slight reduction was showing from 2009 (Directorate of Fisheries, 2011). Resource depletion and increased competition changed the nature of fishing practices in various maritime districts of Kerala. District like Thiruvananthapuram vehemently opposed mechanised fishing; traditional fishermen seized border crossing trawlers from the mid-sea. But its neighbouring Kollam district had second highest number of trawlers. The difference in the attitude of fishermen in various districts is a major factor influencing their socio-economic conditions and income inequality within. The differences can be drawn out from the table given below.

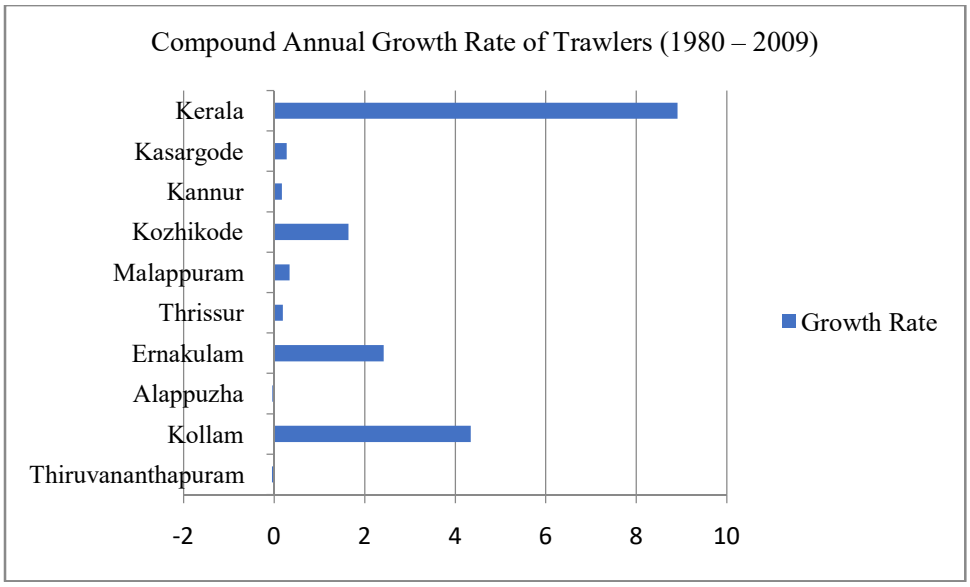
Table 2.4: Ownership of Fishing Crafts

District	Trawlers	Gillnetters	Ring seiners	Liners	Purse seiners	Total Mechanized	Motorized	Non motorized
Thiruvananthapuram	0	0	0	0	0	0	2,880	2,304
Kollam	950	5	35	3	0	993	546	299
Alappuzha	30	0	8	0	0	38	1503	1980
Ernakulam	1020	403	90	15	60	1588	531	146
Thrissur	130	0	65	0	0	195	670	217
Malappuram	200	2	150	1	0	353	1571	186
Kozhikode	950	0	110	5	0	1065	1831	260
Kannur	237	50	33	5	0	325	542	97
Kasaragod	161	0	4	0	0	165	1101	395
Total	3,678	460	495	29	60	4,722	11,175	5,884

Source: (Government of India, 2010)

The northern districts of Kerala are the major users of mechanized ring-seiners; Malappuram and Kozhikode together constitute more than 50 per cent share (Table 2.4). Ernakulam district uses 88 per cent of mechanized gillnets. Districts of Ernakulam, Kollam and Kozhikode together constituted 80 per cent of trawlers in Kerala. Motorised crafts are operated widely in the state but it is to be noted that non - motorised crafts were more in Thiruvananthapuram and Alappuzha districts. Even those who owned mechanised crafts from Thiruvananthapuram, operated them from other districts. The conflicts between non - motorised traditional fishermen and mechanised fishermen were intense in Thiruvananthapuram district. Fisher men and women actively participated in marketing, net repairing and fish processing in the district. Difference in the attitude of fishermen in Thiruvananthapuram towards trawler based fishery can be understood at length from the figure below.

Figure 2.4: Compound Annual Growth Rate of Trawlers (1980 – 2009)



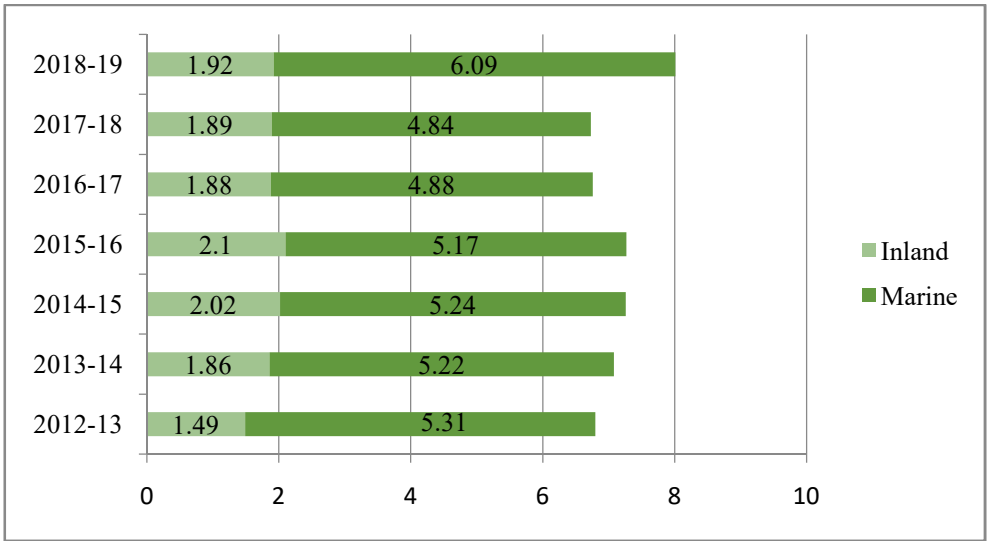
Source: (Xavier, 2013)

Among all the coastal districts, Kollam has highest annual compound growth rate in accumulating trawlers, they were the first recipients of mechanised boats and more adaptive to changing technology (Figure 2.4). They also had functioning harbours and landing centres which facilitates trawler based fishing. Whereas Thiruvananthapuram has negative compound annual growth rate in trawler usage. It is one district which witnessed immense resistance from traditional fishermen against destructive trawler fishing. Difference in the approach of these two districts to modernisation of fishing practices is very important in this study to understand the vulnerability of fishing communities in both districts.

2.3.7 2010's to early to2020

Constantly declining production and increasing cost in the marine fishery paved way for investment in inland fishery. To ensure nutritional requirements, food security, economic growth, and sustainable growth of the sector in the 12th five year plan of the Kerala state (2012 to 2017) attention was given to the expansion of inland fishery.

Figure 2.5: Fish Production in Kerala (2012-13 to 2018-19) (in Lakh Tones)



Source: Government of Kerala (2019)

The increase in the total fish production was the outcome of progress in inland fish production (Figure 2.5). Marine fish production is continuing its declining trend from 2006 (Figure 2.2) to 2017(Figure 2.5) with an exception of marginal increase in the year 2014-15. In the economic review, government of Kerala states that its marine fishery has attained 'almost the optimum level of production' (Government of Kerala, 2017). Even when we consider the total marine fish catch, those species having high market rate is less in availability, thus even if the production meet the target, fish composition may not fetch them a good income.

Unlike the national trend of prioritising inland fishery, Kerala had prioritised marine fishing. Kerala water is rich in terms of biodiversity; it has 13,000 km^2 continental shelf within 50 meter depth zone. It was the habitat of many high value species until the fish production reached the optimum level.

Table 2.5: Share of Total Fish Production in India

Fish Production	Marine (%)	Inland (%)
India	34	66
Kerala	72	28

Source: Government of Kerala (2017)

At national level marine sector only contributes to 34 percentage of total fish production whereas in case of Kerala 72 percentage of its produce is coming from marine fishing (Table 2.5). So, the state government is expecting to tap the possibility of higher earnings from culturing high value species through inland fishery. Agency for Development of Aquaculture Kerala (ADAK) has been working on to solve the fish production crisis in the state from 1989. In 2012 'Matsya Samrudhi' project was launched to increase the inland fish production from 1.5 lakh M.Ts to 2.5 lakh M.Ts in three years; though it worked for 3 years and production increased from 1.49 to 2.1 lakh M.Ts by 2015-16, in the year 2016-17 production declined.

However, the changed government continued the '*Matsya Samrudhi'* project and focus of the present government is to strengthen the existing hatcheries, nurseries, and fish farms. It is also providing subsidies to establish new hatcheries and giving training to public on aquaculture. Many traditional fishermen who found immense competition in marine fishing have become inland fishermen using their same traditional fishing crafts. This trend of prioritising inland fishery is able to be seen not just in Kerala, but all over India.

Observed stagnation in the production of maritime fishing in the country due to overfishing and resource depletion can be 'treated' with sustainability oriented fishery. Quality of aquaculture fish produced has been questioned with the overuse of antibiotics in hatcheries and aquaculture farms. At the same time marine fishermen are investing more in new technology to tap the existing resources. By 2017, in Kerala there are 51 registered deep sea fishing vessels along with 4248 trawlers (Government of Kerala, 2017). Conservation of Kerala's marine fishery at this level is more crucial as growth in total production is entirely due to the growth in inland fishery.

Table 2.6: GDP of Kerala Fishery Sector (at current price, base year 2011-12) in Lakh

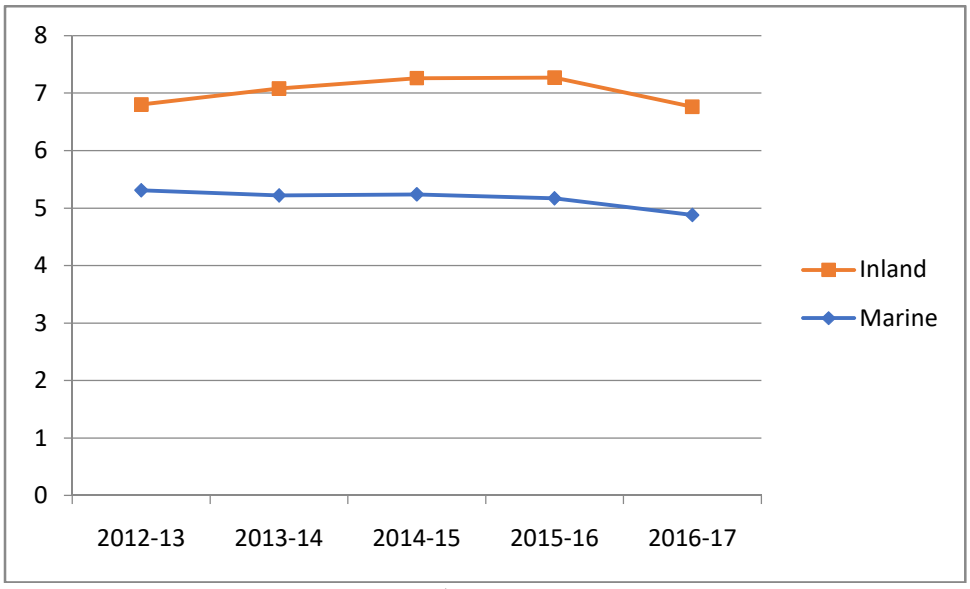
	2013-14	2014-15	2015-16	2016-17
Fisheries Sector GVA (in Rs)	622837	704319	834276	973132
Growth rate from previous year	20.90	13.08	18.45	16.64
Contribution to primary sector	10.55	10.45	12.90	13.29
Contribution to total GSDP	1.34	1.37	1.49	1.58
Per capita income of Kerala	137515	150824	163369	199778
Per capita income of Fishermen	61473	69183	71908	73802

Source: Government of Kerala (2017)

When we consider the fisheries sector growth rate over years (Table 2.6), it is fluctuating without any constant trend. Growth rate is highest in 2013-14 compared to the continuing years. But contribution of fisheries sector to the primary sector is rising; this can be due to increased production in the inland fishery sector. As the gross value added is showing progress over years, fisheries contribution to the state gross domestic product is also improving.

Upsetting factor from table 2.6 is that even in 21st century, per capita income of the fishermen are half that of average per capita income of the state. And their per capita income is directly proportional to the yearly earnings as fishermen seems to have low savings habits. In the table we can see that as Gross Value Added in the fisheries sector is increasing, per capita income of fishermen is also increasing. But difference in the per capita income of the fishermen and rest of Kerala are widening. This can be due to reduction of high value species in the catch composition or due to reduction in earnings from fish export.

Figure 2.6: Export of Marine Products from Kerala



Source: Government of Kerala (2017)

Kerala has its own share to the global phenomena of loss of marine biodiversity. Fluctuation in the ever increasing graph of marine product export value is an indication of this. Sea food export these days are aquaculture shrimp centric. In 2016 Rajiv Gandhi Centre for Aquaculture (RGCA), the research wing under the Marine Products Export Development Authority (MPEDA) initiated a large scale offshore fish farm project in Kerala, seeding cobia species. Kerala water is best suited for sea cage farming due to its calm nature. But flood and diseases are a threat to it.

Considering all the developments in the inland fishery and stagnation of marine fishery, it is understandable that conditions of marine fishermen in Kerala are not getting better off. In order to address the relative backwardness of marine fishermen in 2015-16 state government initiated a new scheme 'Basic infrastructural facilities and human development of fisher folk'. For ensuring social security there are pension for retired fishermen, pension for wives of deceased fish workers, Group Accident Insurance Scheme, Saving cum Relief Scheme etc. In the year 2017-18 around INR 150 crores was provided exclusively for the rehabilitation of fishermen families staying within 50m to the coast from the coastal erosion prone areas. In 2018 the Chief Minister handed over keys of apartments to 192 landless fishermen families from Thiruvananthapuram.

But whether such rehabilitation programmes are adding to any kind of human development is questionable. Because traditional knowledge acquired by the fishermen are based on observing the nature and marine ecology. So, moving away from the sight of sea can only handicap them. Also, it increases the cost of fishing as they need to travel to the coast. Increases tension as they have to dock their boats in places far from where they stay. In many coastal villages, they oppose rehabilitation to other places saying, they wish to die in the land where they were born. In a way it also means they are hesitant of mixing with people of other communities expecting social alienation.

Marine fishing community in Kerala had travelled a long way through poverty and social stigmatisation to economic upliftment. Over the years nature of fishery has changed from subsistence work to profit making occupation. But the 'commodity' approach to the fishery by the state government was a gaffe. When outside capital entered into the community-based fishery and opened it for market forces, for a long time government failed to regulate the industry on expectations of greater foreign exchange earnings. Thus, real beneficiaries were these outside investors who never ventured into sea for fishing. They plundered the untapped

fish stock with the new capital-intensive techniques before the traditional fishermen could keep up to them. They benefited government subsidies and interest free loans as *benamis*. They controlled the sales and exported to foreign markets at higher values. Total production and total export of the state multiplied but how much the fishermen have benefited needs a real enquiry.

The excess inflow of capital and new technology helped the traditional fishermen to upgrade themselves to better catch. They acquired new nets which can catch more; they started working in the bigger boats and trawlers as crew. Increased demand and value of prawns and other species widely available in Kerala water gave them a spree to increase production. But in the rush to catch more, many traditional institutions which ensured community welfare collapsed. Capitalisation and mechanisation of fishery was not accepted in the same manner in various districts. Some coastal belts refused trawler and deep sea fishing vessels all together; some districts eagerly accepted all the changing technologies. But as the sea and marine species does not understand these anthropogenic borders, depletion of marine biodiversity affected everyone equally. Thus, Kerala water started witnessing disputes between traditional and mechanised fishermen in the sea.

2.4 Response of various Stake Holders to Capitalisation of Fishery

The impact of changes in fishing style affected various stake holders differently, so the response to the changes and its impacts varied and in certain cases it conflicted. Some fishing communities accommodated the changes and some rebelled, together it distorted the traditional fishing practices.

2.4.1 Response of Traditional Fishermen

Fishermen response to the mechanisation of fishery was in two kinds. Initially it took the form of dissent. They understood the decline in fish stock as an effect of destructive fishing by the mechanised boats. Though the reduction in fish catch was felt from mid 1970's and various protests were happened in different places, first organised dissent happened only in 1979. Major reason for the organised dissent was the continuing physical conflicts at sea between trawlers, purse-seiners and traditional fishers. Demands put forth by them were,

(i) End night trawling and purse-seiners
(ii) Zoning of coastal waters
(iii) Total ban on trawling during breeding monsoon months of June to August.
(Kurien & Vijayan, 1995)

From 1981 onwards protest continued annually during monsoon season seeking to implement the same demands. Peculiarity of this protest was that unlike in other sectors fishermen protest was not affiliated to any political party or religious organization; it was organized by an independent trade union. Eyeing at the votes of huge coastal population, political parties started interfering. By 1984 all major political parties had their own unions for the fishermen. But being the need of the hour to stop destructive fishing, they got support from many environmentalists and ecologists. These protests gave them a space in the development programs of the state government.

Realizing that the situation of fish stock depletion is expanding and government interventions are not sufficient enough to counter the existing vulnerability, fishermen started seeking technological help. From 1981-82 a group of fishermen started to use outboard engines to their traditional crafts. Further they started trying various miniature versions of trawler nets. This helped them to improve the production and earn better. But more catch by the motorization also meant further exploitation of fishery, which in turn increased the effort of fishermen to attain the same level of catch. Thus, it increased the operational cost of fishing for these fishermen. The political upheaval observed from the 1984 was basically a response to their occupational vulnerability when their traditional rights over coastal commons were questioned.

2.4.2 Response of Trawler Owners and Export Lobby

When the demand for ban on trawling came in court, capital investors argued that fishing in the commons are their fundamental right as sea is open to all. Ban or any kind of regulation on trawling is violation of their basic rights. They also argued that ban on trawling during the main season can cause unemployment to the crew members and reduction in foreign exchange earnings to the state. High court ruled in favor of the big investors, saying state government should prove the need for regulations on scientific basis before imposing ban in coastal commons. Being politically influential, they continued trawling during monsoon for a while.

2.4.3 Response of the State Government

The state government promoted mechanization initially, it considered fishery as a source of foreign exchange and a way to improve rural economy. Government recognized the problem

of overfishing only when the traditional fishermen protested. It appointed various committees to study the fish wealth in Kerala waters.

After implementing Kerala Marine Fishing Regulation Act, 1980, the government appointed Babu Paul Committee to study on trawling ban, regulation of mechanised fishing, introduction of intermediate technology etc. This committee could not arrive at any consensus on banning bottom trawling during monsoon but decided to limit mesh size to minimum of 35mm for trawl nets and recommended strict enforcement of Marine regulation Act of 1980. Fishermen continued their protest as there was no decision on trawling ban during the breeding season.

Thereafter Kalawar committee formed in 1984 suggested reduction in the fleet size of the trawlers to half and complete ban on purse seine (Kurien & Achari, 1990). It warned the government about motorisation drive among the traditional fishermen and the need for regulating fishing practises. Committee did not recommend trawling ban during monsoon but restricted night trawling (Prabhu, 2011). Indecision of both committees on trawling ban during monsoon made traditional fishermen more vulnerable.

Prof. Balakrishnan Nair commission formed in 1987 recommended trawling ban for 90 days during monsoon on an experimental basis for the next 3 years with a suggestion to conduct study on the impact of ban consecutively. Government accepted this recommendation partially by diluting the number of days to 45 and this continued. But despite the trawling ban recommendation in 1988, conflicts between traditional fishermen and trawlers as well as fight within traditional fishermen groups continued.

Later two more committees were constituted under his chairmanship in 1990 and 1999 to study the impact of ban on marine fisheries scientifically. Both the committees recommended continuing the ban of trawling during monsoon as it is found to be an effective measure in enhancing marine resources of Kerala (Kurup, 2006). But in 1993 high court verdict, judgement was in favour of trawler boat owners. They got permission for deep sea fishing.

The 1994, Silas committee recommended demarcation of separate zones for traditional and mechanised fishery. Thus, artisanal exclusive fishing zone was created for non-motorised crafts and for motorised crafts of less than 15HP.

In 2006 D.K Singh committee was formed to study on uniform fishing ban along the Kerala coast and to analyse the extent of biodiversity loss in Kerala waters. In 2007 committee submitted its report and recommended to continue the existing fishing ban for a period of 47 days. Till today trawling ban continues during monsoon to revamp the fishery and to ensure sustainability. Though the state government initially was into commoditisation of fishery, understanding the need for livelihood protection for the marine fishing community government is continuing to ensure sustainability of fishery for the traditional fishermen.

2.4.4 Response of Financiers and Market Intermediaries

Fish being a perishable commodity and the absence of cold storage facilities make fishermen vulnerably depend on the trade intermediaries. Most commission agents or intermediaries in the marketing of the fish also perform the role of financiers; they neither buy nor sell fish. They provide loans in advance on an agreement to dispose the fish catch through them. A portion of sales would be taken by the intermediaries as interest to the loan. Thus, the intermediaries decided the price of fish catch and what to be the income of fishermen.

As fishermen's hardly had any assets, banks were never approachable to them. High operating cost of fishing left them indebted to moneylenders for longer terms. After the formation of the cooperatives and trade unions with mechanisation and government intervention in fishery, fishermen were able to have control over the sales of fish and determine the price of what they catch.

2.4.5 Response of Trade Unions

In 1980s after fisher folks demonstrated their organising capacity, political parties started taking interest in fishing communities. By 1984, larger political parties had their own trade unions for fishermen, this was something which they neglected earlier (Kurien & Achari, 1990).

In 1980 various associations came forward to form Kerala Swathantra Matsya Thozilali Federation (KSMTF, Kerala Independent Fishermen's Federation). Most of these associations were backed by the church authorities; this image hindered to keep the federation non-communal and apolitical (Halfdanardottir, 1993). Soon there were conflicts between church supporting groups and others and by 1983, the organisation was divided. The

conservative section with the backing of church hierarchy and allied political party separated and formed Akhila Kerala Swathantra Matsya Thozilali Federation.

KSMTF was officially registered as trade union. The 1980-81 protest and 1984 protest organised by the KSMTF during monsoon were large scale and it was difficult for government to neglect. Those protests captured media attention and gave strength to fishermen to organise themselves and ask for protecting their rights over sea. Major demands put forth were protection to the livelihood of artisanal fishermen threatened by the destructive fishing practices by mechanised fishing and expresses concern over depletion of fish resources. Though KSMTF were active and got support from activists and certain clergies, it always took the ire of church hierarchy. Hostility from the church was a hindrance to their activities in Thiruvananthapuram district, where majority of fisher folks are Catholics. Fishermen being highly religious, Church controlled and interfered in their religious, political, and socio-economic life. In the Catholic belt of Thiruvananthapuram, unionism was reinforced through local cooperative societies.

As earlier demands of artisanal fishermen were not accepted initially Government had constituted expert committees to study on this issue. Only the 3rd expert committee in 1988 recommended ban on trawling during monsoon, for 3 years on an experimental basis. Even after that the powerful boat owners, merchants and export lobby gained judgement in favour over trawling ban. Violent confrontations between traditional fishermen and trawlers continued along with public protests and later government decided to continue with 45 days trawling ban during monsoon.

2.4.6 Response of Co-operative Societies

The first cooperative society was registered in erstwhile Travancore state in the year 1917, but those cooperatives where restricted for certain castes (Prabhu, 2011). It was after the formation of Kerala state and by the second five year plan state government constituted fishing cooperatives for better management. From 1961-62 to 1977-78 period, government distributed 1200 modern crafts through cooperatives at 25 per cent subsidy on hull and 50 per cent subsidy on engine and remaining amount was given as loan at 7 per cent interest to be repaid in 8 years (Kurien and Achari, 1990). But in the policy analysis it was found that most beneficiaries were *benamis* (under false name) as these cooperatives were controlled by the

influential rich in the fishing filed (Krishnakumar, 1981). Thus, these cooperatives failed to stand for the traditional fishermen.

In the meanwhile, there were many local cooperatives or organisations formed to protect artisanal fishermen rights. In Marianad, most of the land was owned by a land lord. In return for the permission to live in the land, fishermen had to sell their fish catch through him. In order to save from his clutches, they established Marianad Fishermen's Cooperative Society in 1968. Once the cooperative society was established, it took control of the sales and credit facility. Later it started a savings scheme and provided loan for buying fishing requirements. Many villages followed the path of Marianad. By 1980 many village cooperatives together formed South Indian Federation of Fishermen Societies (Halfdanardottir, 1993).

The major objective of cooperatives was to support each other and to protect from middlemen and money lenders. They helped to arrange bank loans for procuring fishing equipments, promoted savings schemes for auctions, helped in marketing of fish catch. Eventually they started controlling sales to various markets and even to exporters; this saved the fishermen from middlemen. SIFFS extended its activities to boat building and disbursing new technologies. Thereby it set an example and gave hope for betterment through cooperative societies.

Involvements of radical priests were there behind the establishment of cooperatives in Kollam initially. One such example is that of poverty-stricken fishing village of Pallithottam in Kollam or then Quilon district. This fishing village was infamous for violence due to growing economic difficulties. Salesians of Don Bosco initiated social upliftment activities by teaching to read to this community where 90 per cent were illiterate (Halfdanardottir, 1993). This brought people together and they extended providing education to four neighbouring villagers too. By 1977, the Latin Catholic Matsya Thozilali Union (Latin Catholic Fisher Workers Union) was formed in this area. And by 1979 Fishermen Community Development Programme (FCDP) was established and registered formally on condition that Chairman would be a Don Bosco priest but total control of the organisation would be by the fishermen itself.

FCDP challenged the power of money lenders. They established a market fully controlled by fishermen itself, so intermediaries can no longer decide the price for what they catch. It mediated with the bank to provide loans for the purchase of fishing equipments; thereby

banks became approachable to the poor fishing community. Though they had union activities within FCDP, it got separated in 1985 and formed Fishermen Welfare Society to deal with economic activities. The successful fishermen's movements in Kollam are major initiators in the formation of National Fishermen Forum.

2.5 Conclusion

The transition of fishery from traditional fishing to motorised and mechanised fishing with advanced equipments saw increase in production and earnings. But eventually fishermen could not cover the cost of mechanisation with bigger catch as escalated completion and over fishing caused resource depletion. Responses to these changes varied among different stake holders as shortage of fish and disappearance of certain species in the in-shore region had created violent clashes between traditional and trawler boats. Reduction in marine fish production also induced inland fishing in the last decade. Given the high density of traditional fisher population, reduction in their share of production and increased cost of production pushed them to greater borrowings and economic struggle. Thus, initial boom in economic growth of fishery due to modernisation could not sustain to overcome the level of poverty among fishermen population in Kerala. This livelihood struggle has not only induced their vulnerability to external shocks like coastal hazards but also influenced their adaptation decisions upon external shocks.

CHAPTER 3

VULNERABILITY ASSESSMENT OF MARINE FISHING COMMUNITY

3.1 Introduction

The previous chapter examined the changing nature of fishery in Kerala from independence and the socio economic and political impact of such a change on the fishermen engaged in diverse fishing methods. The present chapter introduces the concept of 'vulnerability' and analyses its various forms among marine fishing communities in Kerala such as, structural vulnerability, occupational vulnerability and socio-economic vulnerability identified through a case study among the marine fishermen of southern Kerala. This chapter tries to answer the research questions: What are the determining factors of vulnerability among marine fishermen? And why does income-based vulnerability assistance fails? To aid the first research questions, 'vulnerability' is contextualised and a coastal vulnerability index is constructed using a hierarchical design[8]. The second research question examines the effectiveness of hazard relief packages in vulnerability reduction in the face of 2017 cyclone Ockhi.

Vulnerability is a multi dimensional concept analysing the state of susceptibility of an entity. In literature there is no commonly accepted definition for 'vulnerability'. The same terminology is used in various disciplines of applied research (Birkmann & Wisner, 2006), to explain multiple approaches in the understanding of vulnerability. Intergovernmental Panel on Climate Change (IPCC) has defined vulnerability as, *"The degree to which a system is susceptible to or unable to cope with adverse effects of climate change"* (IPCC, 2007) taking into account potential climate change impacts.

As the study focus on coastal hazards, vulnerability is defined as the potential degree of exposure and sensitivity of a system including physical geography, and humans to the hydro-metrological hazards. The hazard impact and magnitude of loss to the people are assumed as directly proportional to the hazard magnitude and socio-economic vulnerability of the

[8]Separates the indicators into groups which share the same dimension of vulnerability

population. Therefore, the study conducts overall vulnerability (structural, occupational and socio-economic) assessment of the panchayats selected.

The initial transition of vulnerability assessment models from vulnerability of any particular geographical location without anthropocentric indicators to the one with human welfare approach was initiated in 1970's (Adger, 1998). According to researchers like O'Keefe, Westgate, and Wisner (1976), 'without people, there is no disaster'. From then on researchers started adding insights to those human factors exhilarating hazard impacts. Later, in his study Hewitt (1983) suggested that origin of vulnerability need not be physical events; poverty and marginalisation can translate into vulnerability; i.e., vulnerability factors in the society can transform a hazard into disaster (Cannon, 1994). This was a radical change from impact assessment of 'geo-physics' to 'humans'; with these researchers began to consider historic time space factors. Studies on hazard vulnerability still follow all the three approaches; one purely on physical factors, social structures and those incorporate both. Recent examples of such scientific coastal engineering studies which integrate socio-economic aspects of vulnerability into the geographical analysis are McLaughlin, McKenna, and Cooper, 2002; Paul & Routray, 2010; Yuan, Guo, and Zhao, 2016.

Vulnerability assessment is developed into an important tool in identifying the factors determining effective adaptive capacity or mitigation priorities (Downing, et al., 2001). In this study both geographical and social factors are explored. However, social structural factors are prioritised in analysing vulnerability as the study is on a marginalised community. The present chapter elaborates how the social structure followed in pre-colonial, colonial and post colonial era have contributed to the vulnerability of marine fishing communities in Kerala. A glimpse of it is narrated in the previous chapter as features of traditional fishery; henceforth only the impacts of such practices upon the fishing community are discussed.

3.2 Structural Vulnerability

'Social world is accumulated History' (Bourdieu, 1986). Our past contributes to our present. Certain historic social structures which elevated the vulnerability of marine fishing community continue to influence their present vulnerability, one such factor is 'caste'. Other factors perceived by the study are cultural identity, power enthralled by the religious institutions and developmental negligence by the state. Structural vulnerability analysis considers the time space affairs and unravel the impact of past on the present (Adger, 1996).

It identifies the historic and currently existing factors that contributed to their vulnerability to hazards. This would help to determine the strategies that need to be addressed or prioritised while planning adaptation mechanisms.

3.2.1 Fishery as 'caste' based occupation

> *"they (the Katal-arayans[9]) were in former times considered an inferior race, and, as such, precluded from travelling along the public roads, and consequently obliged to keep to the sea-coast"*(Iyer, 1981)

The caste based social stratification forced fishermen to follow the occupations, customs, rules, and believes assigned to each caste based on their hereditary roots. As the quote mentions, social stigma and 'untouchability' limited their interactions with members of other castes for centuries, they were even excluded from the usage of public roads. As caste system prevailed, without much prospects for growth in trade, fishing continued largely as a subsistence occupation.However, being in the margins and segregated, they developed an independent cultural identity (Ram, 1992). The male members of fishing community ventured into the sea and a strong sense of independence grew among them. Women engaged in fish processing and marketing work as their entry to sea is customarily restricted. The unequal treatment by the society had enticed the fisher-folks in Kerala to convert into Catholicism and Islam. However, even after conversion fishing remained as caste based occupation as their caste status indirectly continued within these religions. Thus, caste restrained the economic progress of the community by limiting their mobility and social interactions.

3.2.2 Masculinity as Cultural Identity

Given the nature of occupation, *mukkuvars*[10] live in the geographical margins. The experience of social alienation due to 'untouchability' and practice of subsistence occupation forced by the tradition, marine fishermen put together an independent cultural identity from their individual relations with the mighty sea (Ram, 1992). In the absence of any mechanical advancement, fishery at that point relied on skills, bravery and virility of individuals. Women being restricted from fishing with community customs, masculinity became the heart of fishermen identity. Talented performances in hook loop fishing, the

[9] Katal- arayan is one of the colloquial usages referring to a marine fisherman
[10]Mukkuvar is a fishermen caste in Kerala, Tamil Nadu and Sri Lanka

toughest style of artisanal fishing gained men respect in the community as well as female attraction. Expertise in labour intensive fishing techniques gained goodwill for the '*mukkuvar*' fishermen of the south and they were accepted as 'real' fishermen by other fishermen from various coasts. When mechanisation introduced in Kerala, in the cultural conflict of 'real' fishing versus techno centric fishing, they kept themselves distanced from mechanised fishing for decades.

3.2.3 Supremacy of Church and 'Outlier' of Kerala Model of Development

Neglected by the caste system, conversion to Christianity for better social status and progress by the fishermen of south forced their dependency on church and its leaders. Church began to interfere in everyday affair of the community and started making decisions for them on economic, social and political matters. Church acted as 'quasi-state' (Ram, 1992) and some priests as 'the ex-officio leader of the village' (Halfdanardottir, 1993).

Loyalty to the church labelled them as vote bank of a particular party, so until the fishermen trade unions were formed in 1980's they were neglected by other political parties in power (Nieuwenhuys, 1990). Unlike cashew or coir labourers fishermen could not benefit from the government's policies on education, land reforms, public health etc (Kurien, 1995). Another reason for developmental marginalisation was their placement in geographical margins with unique cultural identity. Therefore, they remained as an outlier in the Kerala's famous developmental model (Kurien, 1995).

3.3 Occupational Vulnerability

Occupational vulnerability among the marine fishermen of Kerala is partially the outcome of government intervention in the community commons and partly contributed by climate change. So, climate variability and changing fishing technology are the variables considered for the analysis. Climate variability is deciphered through fishermen perceptions on changing atmospheric conditions observed over the past years. The information is collected through personal interviews based on a scheduled questionnaire. Given the differences in the fishing methods practiced in both panchayats, the interview schedule incorporated traditional catamaran fishermen, those going in outboard motorised boats, those in inboard motorised boats and those working in trawlers as crew. Some among them are owner cum worker and others are just employees.

3.3.1 Fishermen understanding of their occupational vulnerability

Among the interviewees average age of entry to fishing was 18 years; some of them had joined fishery as young as ten years of age. Fishing being a skill acquired through learning by doing and not through formal education, younger generations are asked to join as early as possible. Most young fishermen in the group had joined fishing during the 'pink gold rush' period (mentioned in previous chapter). Till today only 14 per cent among them have searched for an alternate job, rest of them had no hope to find a better substitute as they recognize themselves as less educated or unskilled for other jobs. Possible alternative employment options suggested by them are painting, plumbing, auto taxi, and casual wage work in and around the village or in Middle Eastern countries.

Given the expertise and gratification of being skilled in fishery along with the in securities on educational qualifications, the traditional fishermen of Thiruvanathapuram prefer to continue in fishing over other stable income jobs. On the contrary 98 per cent of fishermen from Kollam district (mainly workers in trawler boats) prefer stable income jobs over fishing as constantly increasing diesel price is making fishery less affordable (at present in India diesel price is at par with petrol price). Still 84 per cent agree that mechanised boats offer better return than traditional fishing. Interestingly few workers in mechanised boats claim that after the implementation of GST and hike in diesel price, traditional fishery is more cost-effective.

When asked about the prospects of fishery as an occupation, only one person approve of having a better future, 88 per cent believe that condition will be worse in future due to increasing cost of production, high competition and slow rate of replenishment of fish. The person who has hope for the future of fishery, said newer technology would take care of existing problems. It is worthy of note that 94 per cent of fishermen do not wish their children to take up fishing as a livelihood choice. They say fishing is hardship, risky, unstable and less profitable. And as children are better educated through formal mediums, as parents they want them to do jobs which offers better 'dignity', social acceptance and which could provide economic upliftment. Office jobs are preferred over those out in the sun. Thus, the younger generation aspire and old generation prefer economically stable jobs for their future heir.

3.3.2 Fishermen understanding of climatic variations

Fishermen are at different comprehension levels in their understanding of climate change. One fisherman from Alappad panchayat was educated on IPCC predictions on sea level rise; at the same time in Anchuthengu panchayat some fishermen were not even aware of climate change or global warming. As the study anticipated these differences, questions were prepared in such a way that a person uninformed about changing global climate can also respond with their observations on changes in surrounding environment.

Table 3.1: Fishermen Observation on Changes in Climatic Factors

Climatic Factors	5 Year Period			10 Year Period		
	No change (%)	Increased (%)	Don't know (%)	No change (%)	Increased (%)	Don't know (%)
Ocean Temperature	30	70	0	2	98	0
Wind Power	54	30	16	30	58	12
Water Level	64	34	2	64	34	2

Source: Primary Study (2017-18)

Active fishermen observed the changing nature of given climatic factors at present to what it was at five and ten years earlier (Table 3.1). In case of ocean temperature whole population unanimously encountered increased heat while fishing in deep sea. In the ten year time period 98 per cent of fishermen notices increase in oceanic temperature, however when asked if the temperature change is rapid over the previous few years 30 per cent were doubtful as they could not decipher the rate of change in temperature accurately. They just know that sea is becoming hotter and hotter and fishing more difficult. Also, they are ignorant about ocean acidification process associated with ocean warming.

In case of wind power, those sail in Catamaran fishing boats do not know whether wind power has changed or not. But fishermen in mechanised and motorised boats observe that wind power has intensified over the past ten years. And in case of water level, fishermen in motor boats especially from Thiruvananthapuram district hardly noticed any difference, while Catamaran fishermen as well as mechanised fishermen of Kollam observe arise in water level compared to previous years.

When asked about their understanding on the concept of 'Climate Change', half of interviewees from Thiruvananthapuram district said 'not much'. Others described it with the changes they detected in their life and locality. Some of the annotations recorded are increasing ocean temperature, stronger winds, coastal erosion, shortage of rain causing

increase in ocean temperature, unavailability of certain fishes in expected seasons, increasing heat waves towards deep sea, more cyclone storms etc. Fishermen unilaterally agree that changes in climate related factors have induced their vulnerability by making fishing more challenging.

Directorate of Environment and Climate Change, Government of Kerala has conducted an awareness programmes related to climate change resilience in both panchayats. When asked whether anyone conducted awareness programmes on climate change or on various adaptive measures to be taken with erosion, thirty per cent of fishermen (both the districts combined) recollect that programme and 66 per cent among them have attended the classes. Rest of them are unaware of any such programme.

3.3.3 Earning patterns of fishermen with the changing climate

The variations in climate, marine ecology, fishing equipments and regulations determine the earning patterns of marine fishermen.

Table 3.2: Average No. of days & Monthly Earnings Pattern from 2010 to 2017

	Catamaran		Motorised boats		Mechanised boats	
	Days	**Earnings**	**Days**	**Earnings**	**Days**	**Earnings**
March-May (Pre-Monsoon)	25-28	Normal	25-28	Normal	25-30	Normal
June-August (Monsoon)	20-25	High	20-30	High	7-14	Less
Sep-Nov (Post Monsoon)	25-28	High	25-30	Normal	25-30	High
Dec-Feb (Calm season)	25-28	Very less	20-25	Normal	20-25	Normal

Source: Primary Study (2017-18)

There is no concrete or hard and fast convention on the average number of days a fisherman venture into the sea. It depends on seasons, cash in hand, health, availability of workers etc. It varies according to the type of fishing style they are engaged in (Table 3.2). Traditional catamaran fishermen have the lowest operating cost, they generally venture within the inshore water, catching enough for subsistence and for petite sale; so, unless the sea is rough, they go for fishing. Therefore, in all seasons except in monsoon they venture into sea almost every day. During monsoon as sea goes rough fishing in their single wooden plank craft becomes difficult, skilled labourers benefit from it as rough sea offer more chances for a good catch.

Motorised boats with in-board and out board engines earn maximum during monsoon and in post monsoon season (period after trawling ban). It is the traditional knowledge that when

seabed is turbulent, it is easy to locate and capture fishes. So, during monsoon motorised boats are more active. It is also because they face less competition during that period due to monsoon trawling ban practice in Kerala.

In case of trawler boats as prawns are obtainable from deep sea fishing during October to May months, both the calm season and pre monsoon season fetch decent amount unlike traditional and motorised boats. However, as trawling ban begins at early days of June every year for almost two months in Kerala, they get to go only few trips during monsoon season. A single fishing trip of a high powered trawler boat is of 6 to 8 days. They earn the highest during the post monsoon season. During trawling ban period unemployed crew of trawlers work in motorised boats.

3.3.4 Changes in cost of production

With ocean acidification and resource depletion, scarcity of fish has enforced fishermen to travel further into the sea. Along with this, rising fuel prices and growing competition has increased the cost of production. For traditional catamaran fishermen, in monetary terms cost remains almost the same in all seasons as capital expenditure on a daily basis is negligible. On a regular day they earn between zero to one thousand rupees or so. But with resource depletion they are also forced to travel further and spend more time in sea to achieve the same catch as earlier. Therefore, non-monetary cost of production has increased among traditional fishermen. Factors contributing to the cost of production of motorised fishing boats are engine fuel, equipment maintenance and minimum allowance to the work force in days of zero catch or loss.

Table 3.3: Cost of Fishing Operations (Motorised and Mechanised boats)

Fishing operations	**Pre monsoon**		**Monsoon**		**Post Monsoon**		**Calm season**	
Type of fishing	Motorised	Mechanised	Motorised	Mechanised	Motorised	Mechanised	Motorised	Mechanised
Diesel oil consumption (litres)	Usual	Usual	Highest	Low	Usual	Usual	Usual	Usual
Distance travel(Km)	Usual	Usual	Highest	Usual	Usual	Usual	Usual	Usual
Income per trip (Rs)	Normal	Normal	High	Less	Normal	High	Normal	Normal

Source: Primary Study (2017-18)

As operational costs are proportional to the number of operational hours, motorised boats shell out highest cost during monsoon, when trawlers are banned and catamaran fishermen stay away due to rough sea (Table 3.3). With the use of high powered in-board and out-board engines, cost of production of motorised fishing skyrocketed; some fishermen use multiple outboard engines to travel farther in sea. In their calculations daily cost of a motor boat varies from INR 10, 000 to 15,000. Whether they cover the expenditure with production or not owner of motor boat is liable to pay a daily allowance of INR 150 to the workers on the days of operation. With overfishing led species depletion and rising diesel price, they complain that income from fishing at times is insufficient to meet even the operational cost of motorised boats.

Unlike motorised boats during post monsoon period by covering usual distance and regular amount of diesel, trawlers earn very high returns. With trawling ban in effect, diesel consumption is lowest during monsoon season but in every other season fishing trips extent until they catch the targeted quantity of fish. Since trawlers use high powered engines and their period of stay in the sea is higher than other vessels, their diesel consumption is equally higher compared to others. Thus, those working in trawler boats blame on diesel price hike more than other factor in the reduction of profit.

Fishermen working in both motorised and mechanised boats agreed that consumption of diesel and petrol has increased drastically over the past 15 years. Same is the case with distance travelled to capture the same quantity of fish. This clearly indicates resource depletion and hike in operational costs.

3.3.5 Resource Depletion

Mechanisation and variations in ocean temperature have equally contributed to the resource depletion experienced in the Kerala water. Ninety nine per cent of interviewed fishermen observe changes in the fishing patterns. Pink Perch and Mackerel are two commonly available fish in Kerala waters; fishermen express drastic depletion in the stock of Pink Perch, Sardine and Mackerel after the 2004 tsunami. Some fishermen state that not just stock depletion but even the taste of fish has changed after tsunami. Species like Butter fish, Indian Halibut, *'Kilivaranda'*, and *Ted* have disappeared from regional coasts. Depletion of stock enforces them to spend more hours or days in sea to fill the required quantity.

Reasons pointed out for depletion varied widely. The traditional fishermen believe that reduction in fish stock is mainly due to motorisation and increase in ocean temperature. Active fishermen engage in motor boats believe that reduction in availability is due to unsustainable fishing practices by the mechanised fishery, especially bottom trawling. Other views expressed are migration of fishes with changing climate and migration with disturbances from bright light and sound of motor boats. Fishermen working in mechanised boats mainly had two opinions; increased sea temperature or any other unfavourable climate for fish breeding and diesel waste destroying the fish seeds. Few are also of the conviction that growing plastic waste deposits in the seabed is the chief factor affecting the replenishment of fishery.

Except few mechanised fishermen rest of them documented that depletion is more prominent in inshore water compared to territorial water. The fishermen who solely depend on inshore water are traditional fishermen. And all of them agreed that it is affecting their day to day life as they are forced to travel further in sea to catch the required quantity. More travel also means more time sacrificed into fishing and increase in cost of production. In Thiruvananthapuram district, to deal with fish stock depletion in inshore water even the single engine motorised boats are taking risk and set out to deep sea fishing.

3.3.6 Species Availability and Trends

Kerala fishery has been experiencing changes in its catch composition. What determines the fish catch composition is the availability of fish and the gear in use. For motorised boats it entirely depends on the net they use, which also means they target fish by using specific nets. For trawlers availability of species, fishing gear in use as well as market demand and price of the species matters.

Table 3.4: Species Availability

Commonly found	Falling stock	Disappeared
Pink Perch	Cuttlefish	Butter fish
Mackerel	Sardine	Indian Halibut
Short mackerel		*Kilivarantha*
Anchovy		*Tead/ted*
Squid		
Ribbon fish		
Prawns		
Sawfish		
Bluefin fish		
Finned Bull eye		

Source: Primary Study (2017-18)

Catch composition of traditional fishermen predominantly include Anchovy and Sardine which are in high demand for local consumption (Table 3.4). Motorised fishermen net mostly Mackerel, and Sardine and the Cuttlefish upon the availability. As natural reefs are affected by the growing plastic deposits in the sea beds, traditional and motor boat fishermen in Thiruvananthapuram and Kollam regions are required to construct artificial reefs to attract certain fish species like Cuttlefish, which was once widely available in the inshore waters of these districts. After the construction of artificial reef, they mark the location in GPS and give the reef ample time for the fishes to migrate and breed there; later with the help of GPS finding devices they come for catch at right season.

Catch composition also changes from season to season. Fishermen have observed that lately the customary catch composition in various seasons also has changed. In general, species like Butter fish, Indian Halibut, *Kilivarantha*, *Tead/ted* have almost disappeared from the inshore waters. Trawler fishery generally nets Pink perch, Mackerel, Small mackerel, Squid, Ribbon fish, Cuttlefish, Shrimp etc. Both traditional as well as mechanised fishermen experience changes in catch composition with rising ocean temperature. In their understanding as temperature goes up fish species migrate to cooler water.

3.3.7 Change in the composition of the catch

Climate and resource depletion induced manifold alterations in Kerala fisheries. Many species have disappeared from its waters and availability of certain fishes drastically reduced. Even with a full catch, at times fishermen struggle as high valued species may not be in the catch composition. To a great extent, increased competition and over fishing have caused this distress.

Table 3.5: Changes in Catch Composition

Changes	Yes (%)	No (%)
Total fish catch	84	16
Catch composition	70	30
Fish Migration	90	10
Average fish size	34	66

Source: Primary Study (2017-18)

Changes in the fishing patterns are clearly visible (Table 3.5). Most prominent are the changes to the migratory pattern of fishes. Almost 90 per cent of interviewees were of the opinion that certain species have migrated out of Kerala waters and remained untraceable over a certain period of time. More the 80 per cent opinionated that total fish catch is

deteriorating and with migration of species the catch composition also has been changed. One aspect in which there was indistinctness among them was on the change in the size of species. Mostly those working in trawler boats and high power motor boats observed reduction in the size of species; they say Sardine and Mackerel have become half the size.

Overfishing from 1960's and climatic variations are pointed as reasons for the changing composition of the fish catch. With increasing ocean temperature, fishes move along with sea currents to north. Adding to this, plastic and diesel waste pollutes the sea bed and perturbs breeding of the species. In response to these challenges 94 per cent of fishermen modified their fishing techniques over years. They changed fishing nets, shifted to high powered engines, installed GPS and echo sounding equipments in their boats and started using led instead of stones for weighing down their nets.

All these changes in fishery have made fishermen more vulnerable. As their source of livelihood is under distress it demands their attention. Therefore, various adaptation measures to coastal hazards that are unrelated to livelihood, especially protective strategies are neglected by the community. To improve the returns from fishery and to meet the rising cost of production they borrow more and invest in fishery. This is another reason why fishermen do not want younger generations to choose fishery for livelihood. They say fishing as an occupation has come to a tough situation, return is not increasing with the challenges it generates.

3.4 Socio-Economic Vulnerability

Socio-economic vulnerability expresses the vulnerability a society is undergoing at present. Literature on socio-economic vulnerability recognizes that impact of hazards and response differs among communities even when they share a common source for livelihood (IPCC, 2014; Paton, Johnston and Johal, 2013). Therefore, within the community individuals can suffer disproportionately from hazards. To understand the reasons why it is so, one must look into the socio-economic, political and infrastructural background of that particular community at the region they live in. However, as vulnerability at individual level is a relative concept; it does not measure absolute exposure or their exact fragility to hazards. Therefore, while contextualizing vulnerability for a region or community, qualitative characterization of the study area is indispensable.

3.4.1 Contextualizing Vulnerability

The study has two panchayats selected for the field survey Anchuthengu of Thiruvananthapuram district and Alappad of Kollam district. As detailed description of study area is given in the first chapter, this section discusses the characteristics of study area in the context of vulnerability. Anchuthengu panchayat has a magnificent past as a centre of exports. In the present times there is a short fall in export of spices and coir unlike in colonial period. Alternate employment opportunities are also inadequate. With their limited skill set and educational backwardness, currently majority of the population absolutely depend on marine fishing and related activities for their livelihood.

The fishermen of Thiruvananthapuram district had mutually decided to ban mechanised fishing in its waters, so the panchayat is occupied entirely in traditional fishing. However, as traditional fishing practices fetch lesser returns compared to mechanised boats, surplus labour force of the panchayat are compelled to seek alternate employment opportunities. Other occupational activities observed in the panchayat are running petite shops and auto rickshaw driving. Poor condition of roads and limited services of public transport generates heavy demand for auto rickshaw based transportation. Since the returns from all these occupations are nominal, the community remains economically weak.

Density of population in Anchuthengu is one among the highest in the Asian continent. The Panchayat has a very high population density of 7028 per sq.km, while at the district level it is 1509 per sq.km, state level 560per sq.km and only 382 per sq.km at the all India level (Census of India, 2011). The population stress and land constrain has given rise to congested settlements on the coastlines. Most houses in the colonies of this panchayat are constructed within one to three cents of land and the spaces between two houses are only a few feet. Such colonies turn into the epicentre of contagious diseases during monsoon season. During every monsoon Dengue, Chikungunya, Tomato fever, Diarrhoea etc. are reported from these colonies. Panchayat lacks proper hospital facility; it only has one community health centre. It also faces severe water crisis. Closeness to Arabian Sea makes the water saline, most households depends on water provided by the Panchayat.

Due to insufficiency of land all developmental activities in the panchayat are restrained up on available land. Maximum utilisation of given land is declared as the motto by the panchayat. In the arena of agriculture, focus is on roof top (terrace) farming for which grow-bags,

vegetable seeds and organic manure are distributed. Barren land in the locality is prepared for banana farming. Panchayat also distributes coconut seeds the only crop which flourish in saline soil. The panchayat has also prepared biodiversity register of the locality. In the field of animal husbandry, more attention has been paid to poultry farming. Cows, goats and egg laying hens have been distributed. Activities related to nurturing of calves, cow shed construction, cattle feed for pregnant cows are implemented. Funds have also been used to purchase equipments and medicines for the veterinary hospital.

In order to cater to the needs of fishing economy panchayat has prioritised funds for the purchase of fishing nets, safety nets, and other fishing equipments and insulated fish boxes. Action has initiated to secure better access to fish for the fisherwomen engaged in marketing. Panchayat has allotted revolving fund for fisher folks who are employed in fish auction and distributed 'study' furniture to the children of fisher-folks.

Alappad Panchayat also depends entirely on marine fishery for livelihood. The history of the panchayat mentions that once the region had produced rice in plenty enabling self-sufficiency. In 2004 tsunami the top soil of the panchayat was washed away and currently the only profitable crop available for cultivation is Coconut. In 2010-2011 the panchayat had experimented upland paddy cultivation (*karanellu krishi*), but it was not a success story to carry on.

The tsunami has devastated the panchayat, 132 members lost lives and 800 families were rehabilitated to other panchayats (Alappad Grama Panchayat, 2020). Houses and other assets were washed off in the flood. As part of rehabilitation project government and many non-governmental organisations contributed to rebuild the housing and infrastructural facilities. More than 80 per cent of community members received houses with concrete roof and two new bridges were constructed for better connectivity and easy access to the nearest panchayat in case of emergency (Alappad Grama Panchayat, 2012). A drinking water project was established to reduce the drinking water scarcity and transportation facilities were improved to ensure better connectivity within the panchayat and to the city. Large sum of fund allocated in tsunami package also has been used for the construction of coastal protection measures.

The Panchayat has a population density of 3663 per sq.km. The population pressure challenges employment generation, food security and self-sufficiency of the region. Prioritizing self-sufficiency, given the land constraint, panchayat is focused on roof top farming, and animal husbandry related projects. They are also funding into infrastructural developmental activities like renovation of schools, hospitals, and construction of roads and coastal protection structures.

Vast majority of the fish-workers in the panchayat are engaged in motorised and mechanised fishing, traditional fishermen are marginal in number. Inland and lake based fisheries are also active in this panchayat. Traditional fishery in general have been disappeared from its coast with the construction of engineered coastal protection structures as it left only one fish landing centre in the panchayat. Being educationally forward alternate employment options available are salaried jobs, small scale businesses and daily wage works such as sales, plumbing, electrical, painting etc.In the previous 5 year plan of the panchayat, they have invested in fishing nets, micro enterprises for fisherwomen, and dry fish processing.

Population density in Anchuthengu is double of Alappad as total area of Anchuthengu (3.36 sq.km) is only half of Alappad (7.38 sq.km). Both the panchayats have a healthy sex ratio where the proportion of male and female are almost equal.

Table 3.6: Demographic features of the panchayats

Panchayat	Population			Sample Households (No.)								
	Male	Female	Total	General	SC	ST	OBC	OEC-SC	Total	Christian	Hindu	Muslim
Anchuthengu	8267	8475	16732	0	0	0	151	0	151	150	1	0
Alappad	12468	12463	24931	0	1	0	0	150	151	0	150	1

Source: Primary Survey (2017-18)

Average household size in Anchuthengu (4.89) is higher than that of Alappad (4.03) and the state average of 4.3. Due to shortage of land, size of the houses being extremely small some members of the family are forced to sleep in relatives' home or on the shore as they can also guard the fishing equipments simultaneously.

Anchuthengu is a Latin Christian majority area where population belongs to Other Backward Caste category of government, representation from other religious groups are insignificant (Table 3.6). Similarly, in Alappad majority belongs to Hindu religion and come under Other Eligible communities to be included in the State's SC/ST category, fishermen of Alappad come under OEC- SC category. All the active fishermen interviewed for the study are from

backward community list of the government. But when Alappad fishermen get the aids of government for the SC households, conversion to Christianity restricted these benefits offered by the government for the fishermen of Anchuthengu.

Due to high risk attached with fishery, a greater number of widows can be observed in coastal communities. Risks attached with fishery are accidental deaths during fishing trips, heart attack due to the rough nature of fishery and liver failure due to excess consumption of intoxicants. Traditional income sharing mechanisms catered to this section of population with priority, but with modernisation they are forced to find jobs within or outside fishery if no other members of the family is earning.

In general, participation of women in fishery are nominal in Alappad, only one single parent has sought employment in fishery and majority depend on widow pension from the government. But in Anchuthengu as there is active participation of women in economic activities, single parenting women also join the workforce without any customs or social norms affecting their work participation. As far as food security is concerned, whenever there is a flood, government provides additional quantity of food grains through the Public Distribution Systems (PDS).

3.4.2 Identifying the drivers of vulnerability: The Methodology

In order to understand the factors driving into vulnerability, a vulnerability assessment is performed with the help of a Coastal Vulnerability Index. Any vulnerability index is a measure of degree of exposure a community or group of population face towards any hazards. This study assesses socio-economic as well as geographic vulnerabilities. The index is measured on a scale of 0-1, with 1 indicating 'highest vulnerability' and 0 indicating 'lowest vulnerability'. The unit of analysis is the household, as individual level vulnerability is a very relative term.

In total four dimensions are analysed with 36 indicators. The four dimensions are Social and demographic structure, Access to resources, Built environment, and Spatial proximity to hazards. The first three dimensions are adapted from Quinlan et.al, (2015) and Park et.al, (2016) while the last one is partially adapted from Andreucci and Aktas (2017) to understand the vulnerability of population from the geographical placement.

The indicators representing social and demographic structures are Urban/Rural, Larger households, Dependent population, Special needs population, Single parenting households, Average age of head of the households and Infant mortality rate. The indicators under access to resources are Poverty level, Borrowings, Savings, Diversity of income sources, Dependency on money lenders, Insurance, Social security benefits, Non-earning members, Participation of women in labour force, High school passed population above 15years, Land holding , Local community support and Political representation. The indicators under built environment are Drinking water establishments in 1 sq.km, Educational establishments, Medical institutions, Banking and cooperative institutions in 1 sq.km, Communication establishments in 1 sq.km, Public distribution system establishments in1 sq.km, Social and cultural institutions, Ownership of settlement and Quality of dwelling. The indicators under spatial proximity to hazards are Dwelling in Non- Development Zone, and Coastal length.

Various indicators are measured in different units. For example, average household size is measured in actual number, average age of head of the household is measured in years, distance from high tide line in meters etc. Therefore, in order to make indicators 'unit – free' or to bring them into a common unit the indicators are normalised. Normalisation process of indicators varies according to their relation with vulnerability. For example, we have savings and borrowings as indicators; borrowings hold a positive relation with vulnerability whereas savings possess a negative relation. So, to get normalised values for indicators we have 2 sets of equations. These equations are adopted from the Climate Vulnerability Index of India (Government of India, 2018).

• Case I: Positive relationship with vulnerability

$$\text{Normalized Value} = \frac{\text{Actual Indicator Value} - \text{Minimum Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

• Case II: Negative relationship with vulnerability

$$\text{Normalized Value} = \frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

Weight is assigned to each indicator is based on their degree of impact on vulnerability. This is region specific, in various regional situations impact of indicators to the community vulnerability varies. In this study equal weight to each dimension are assigned and fulfilled the condition that summation of proportionate weight assigned should add up to 100. Thus,

maximum vulnerability score in each dimension is 25 per cent or ¼. All the indicators within each dimension carry weights accordingly.

3.4.3 The Coastal Vulnerability Index

3.4.3.1 Dimension 1: Social & Demographic Structure

Hazard vulnerability is different in different countries, states, and for individuals within a community or a household, considering the age, gender and other demographic characteristics (Muttarak, 2017). Risk perception and coping capacity is relative to the affected population's socio-economic status. Who should the vulnerability reduction policies address is determined by the susceptibility of their demographic differentials to coastal hazards. Therefore, incorporation of social and demographic indicators in index construction help to comprehend whether both panchayats are equally vulnerable to hazards and if not what makes one more vulnerable than the other.

Table 3.7: Social & Demographic Structure Indicators Value

	Social & Demographic Structure Indicators (1/4) (1/32)		**Indicator Value**			
			Anchuthengu		**Alappad**	
			Value	**Weight (1/32)**	**Value**	**Weight (1/32)**
1	Social Category	% of population in backward caste category	1	0.0313	1	0.0313
2	Urban/Rural	% of population in Rural area	1	0.0313	1	0.0313
3	Larger Households	% of HH size> mean HH size	0.53	0.0166	0.25	0.0078
4	Dependent population	% of Population below 15+ ≥60	0.21	0.0066	0.15	0.0047
5	Special Needs Population	% of terminally ill+ disabled	0.03	0.0009	0.05	0.0016
6	Single parenting households	% of male+female headed single parenting HHs	0.11	0.0034	0.04	0.0013
7	Average age of head of the households	Mean age	0.45	0.0141	0.53	0.0166
8	Infant mortality rate	Percentage	0.50	0.0156	0.28	0.0088
	Weighted Indicator value			0.1198		0.1022

Source: Primary Survey (2017-18)

All the indicators in the Social & Demographic Structure dimension have given equal weights. Since there are 8 indicators, weight given to each indicator is 1/32.Equal weight to the indicators conveys that vulnerability to the community from each indicator is proportional to their percentage of exposure to that indicator. And the percentage of exposure is represented by the indicator value given in the table. In the social and demographic dimension, factors which caused extreme vulnerability to the entire community in both panchayats are their backward caste status and placement in rural area. Third highest vulnerability contributing factor in Anchuthengu is infant mortality rate and in Alappad it is average age of the head of the households. How these indicators contribute to vulnerability is explained below.

Social Category (+)

Being a caste prominent social system, Government of India has categorized castes into Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Class (OBC) and General Categories. Those belong to SC, ST categories are historically discriminated groups and OBC consist of socially or educationally disadvantaged group. OEC is Other Eligible Communities who are recommended to include in Kerala state SC/ST listby the Kerala government. The fishermen caste is included in OEC-SC category. Hence this indicator is represented by percentage of population in backward social category.

Functional relationship of this indicator with vulnerability is that, larger the population belonging to deprived category higher the sensitivity and lower the adaptive capacity to hazards; i.e. the indicator is positively related to vulnerability. In Alappad panchayat majority of the population belong to *Dheevara* community hence come under OEC-SC social group and in Anchuthengu panchayat as majority are Latin catholic fishermen they come under OBC social group. In our sample collection all the 151 households from Anchuthengu are OBC and in Alappad 150 households are OEC and one household is SC. In both the panchayat's 100 per cent of population are in backward social category, so the indicator value is 1, indicating that panchayats experience 100 per cent vulnerability to the given indicator.

Rural / Urban (+)

In the census data Urban is defined as constituents of Statutory Towns, Census Towns and Outgrowths and non urban areas are considered as rural areas (Census of India, 2011). Both panchayats selected for study are categorized as rural areas in the 2011 census data. Urban rural dichotomy is used to distinguish the components of employment opportunities and infrastructural facilities. The study assumes that being in rural area means they have lesser opportunities for economic growth. Rural population in the absence of industries mainly depends on natural resources and agriculture for livelihood so volatility in the climate has more impact on their income generation.

Differences in education (quality as well as years of schooling), wages, employment opportunities etc. widens the gap in human development between urban and rural population thus compromises the scope for quick enhancement in adaptive capacity among rural population. Thus, this indicator has a positive relation with vulnerability, i.e. higher the population in rural settlements, greater the vulnerability. The variable is represented by 'percentage of population in rural area'; it is the share of rural population to the total population. Since all the wards in both panchayats belong to rural category, both panchayats experience 100 per cent vulnerability to the indicator, thus the indicator value is 1 for both.

Larger Households (+)

In association with expected mortality rate and high fertility rate it is a general notion that poor people have larger households (Krishnaji, 1980). In both the panchayats average family size is not vastly different from state average though there were sample households with more than 10 members. Gravity of the issue can be understood when we consider the landlessness of the panchayat and the average space available for individual house construction. In Anchuthengu panchayat many families reported that given the lack of space inside houses, they send the elder boys in the house to sleep at relatives places, which are less crowded.

It is observed in the field that, many large households are undivided families, i.e. married male siblings living together with parents along with their children. So, in this context larger family also means more potential earning members but larger families definitely means less per capita income or consumption expenditure and more chances of dependent members. Thus, large families reduce the human welfare and development unlike smaller families,

resource constrains of the large families reduces adaptive capacity. Thus, larger the household size greater the vulnerability. In this study those families with household size greater than the average household size (of the samples) is defined as a large family. And the variable is represented by percentage of larger households. So, the share of number of families with household size more than five to the total number of households is taken for calculation. Indicator value of 0.53 for Anchuthengu and 0.25 for Alappad reveal that 53 per cent of households in Anchuthengu and 25per cent of households in Alappad have larger family size.

Dependent population (+)

Dependent population is that part of population who depend on others for consumption needs and not participating in labour force. In this study population below the age of 15 years and above the age of 60 years are taken as dependent population. Children below 15are considered because in India from 15 years child labour is legal and population above the age of 60are categorized as senior citizens. Dependency of such population is not just monetary; given their age and health conditions they may also demand physical and emotional dependency.

Age associated illness makes them more vulnerable during any hazard occurrence. Thus, higher the proportion of dependent population in the community greater would be the vulnerability. In case of marine fishermen, elders above 60 and youngsters above 10 are usually active in traditional fishing and related activities. But with the disappearance of traditional fishery both these sections are economically more disadvantaged. Thus, this variable keeps a positive relation with vulnerability. The indicator is represented by the percentage of dependent population. In Anchuthengu panchayat 21.2 per cent of total population and in Alappad panchayat 15 per cent of population are dependent. Majority of the elderly population solely depend on old age pension (INR 1400 per month) from the government for survival.

Special Needs Population (+)

Those who face bodily ailments and disabilities are considered as population which requires special care. Their ill health makes them more vulnerable to hazards. Special need population not just affect their own helplessness but also the quality of life of caregivers. The ‘care’ demanded by the dependent population greatly affect the employment options and economic

independence of women as they are more demanded into care related activities at household level.

This indicator is represented by percentage of terminally ill population and differently-able population. Terminally ill population includes those who are bedridden or unable to perform physical activities due to cancer, heart or liver diseases, chronic asthma, etc. In Anchuthengu panchayat 2.98 per cent of sample population and in Alappad panchayat 5.06 per cent of population are special need population. It is observed that even with better education, health and socio economic status; people in Alappad face more terminal illness and disability. Community leaders associate this trend with the mineral mining in that region.

Single parent headed households (+)

In this study, single parent is a person without a spouse taking care of unmarried children. Those widowed or divorced single parents are also considered as head of the households. Thus, both single female and male headed households are considered as single parenting households. And the indicator is represented by percentage of single parenting households. Head of the household is usually the person who bears greater responsibility in home affairs and decision making for the house. In the census definition, if a female bears that responsibility, those households are recognized as female headed household. Age does not usually is a criterion for this classification.

Single headed households are more vulnerable as they have economic, emotional and time constraints. Every society does not consider them with equal dignity; if she is a widow their community participation can also be limited with the customs and community norms. Having to manage the house single handedly, single parents have more livelihood struggles. Thus, this variable has a positive relation with vulnerability. Fishing being a high risk job performed by men, death caused by occupational hazards like accidents, and heart attack while in deep sea leave more women widowed as traditional catamaran boats are susceptible to high tides. Anchuthengu experiences more fishing boat accidents than Alappad. Anchuthengu panchayat has 10.60 per cent and Alappad has 3.97 per cent of single parenting households.

Average age of head of the households (+)

Age of head of the household matters as younger ones being in good health and technologically advanced, they have better adaptive capacity. Thus, value of average age heading towards maximum age is considered as factor boosting the vulnerability of the household. In most families interviewed head of the households are middle aged men. In order to find the average age of head of the household, we first identified the head of the households, then added their ages and divided by total number of households. In Anchuthengu average age of head of the household is 49.61 years and in Alappad it is 50.31 years.

The Infant Mortality Rate (+)

The Infant Mortality Rate (IMR) is the number of deaths of children within 1 year old per 1000 live births during a certain period of time (Government of Kerala, 2017). IMR is a metadata indicator points towards the unmet human health needs in sanitation, medical care, nutrition, and education (Reidpath & Allotey, 2003).Thus, it helps to understand the deficiency in healthcare. Higher the IMR rate, higher would be the vulnerability of the community, thus the variable has a positive relation with vulnerability.

$$\text{Infant mortality rate} = \frac{\text{Number of infant deaths during the year}}{\text{Number of live births during the year}} \text{X } 1000$$

The IMR statistics available is of district level data, with urban – rural segregated. Since both our panchayats come under rural section, we take that particular statistic for calculation of index. IMR in urban and rural Thiruvananthapuram is 5.21 and 2.8 respectively and IMR in urban and rural Kollam is 4.46 and 1.6 respectively (Government of Kerala, 2017). Compared to the IMR performance of the state (5.59) and the country (34) rural Kollam and Thiruvananthapuram performs much better.

3.4.3.2 Dimension 2: Access to Resources

Reduced accessibility to resources can push people into poverty. Education, land holding, easy access to credits, insurance, social security benefits etc. can make people's life better. This dimension measures how accessible are resources to the marginalised fishermen community. It is important because resourcefulness of a society determines their resilience capacity to hazards. All indicators in the access to resources dimension have given equal weights, since there are 13 indicators weight given to each indicator is 1/52.

Table 3.8: Access to Resources Indicators Value

	Access to Resources Indicators (1/4) (1/52)		Indicator Value			
			Anchuthengu		Alappad	
			Value	Weight (1/52)	Value	Weight (1/52)
1	Poverty Level	%of population in BPL category	0.91	0.0175	0.58	0.0112
2	Borrowings	% of households in debt	0.93	0.0179	0.90	0.0173
3	Savings	% of population with savings	0.98	0.0189	0.91	0.0175
4	Diversity of income sources	% of households with multiple income sources	0.70	0.0135	0.87	0.0167
5	Dependency on Money Lenders	% of Households borrowed from money lenders	0.5	0.0096	0.1	0.0019
6	Insurance	% of people who have any form of life or property insurance	0.15	0.0029	0.07	0.0013
7	Social Security Benefits	Percentage of households availed any SSB	0.02	0.0004	0.007	0.00013
8	Non-Earning members	Percentage of non earning members	0.58	0.0111	0.68	0.0131
9	Participation of women in labour force	% of women in the overall workforce	0.73	0.0138	0.94	0.0181
10	High school passed population above 15years	% of population above 15 passed high school	0.62	0.0119	0.20	0.0038
11	land holding	Percentage of land holding population	0.86	0.0165	0.95	0.0183
12	Local community support	Percentage of community cooperation	0.19	0.0037	0.04	0.0007
13	Political representation		1	0.0192	1	0.0192
	Weighted Indicator value			0.16		0.14

Source: Primary Survey (2017-18)

Poverty Level (+)

Poverty level is the minimum required level of income to survive. According to the C. Rangarajan committee report, 2014, in India it is INR 32 a day for rural population and INR 47 a day for urban population. Those who do not make it to this defined level of income are categorized as Below Poverty Line group and those who earn above the specified amount as Above Poverty Line group.

'Poverty level' as an indicator holds a positive relation with vulnerability as higher the incidence of poverty greater the vulnerability to hazards. And the indicator is represented by the 'percentage of population in BPL category'. The data is obtained from the ration cards, which is allotted to the general public on the basis of this classification. Those families without a ration card are counted along with BPL households in the study as they are not even benefiting from public distribution system. Among the surveyed households in Anchuthengu there were three households and in Alappad two households without ration card.

As marine fishing communities experience high level of poverty and impoverishment, both panchayats witness larger share of community members falling into the BPL category. More than 90 per cent of surveyed households in Anchuthengu and 58 per cent of families in Alappad owns a BPL ration card i.e. they are unable to make INR 32 a day. This clearly shows the extent of vulnerability and susceptibility during hazards.

Borrowings (+)

Borrowings are the external financial borrowings sourced from various formal and informal credit institutions. Money lenders, banks, self help groups and relatives are the most common sources of credit observed in the field. Borrowings indicate financial liabilities of a person or a household. It augments the vulnerability of that household.

Mortgaging is the most prevalent style of credit observed in Alappad but in Anchuthengu being an economically backward panchayat people tend to depend on money lenders who provide loan without collaterals but they end up paying hefty rate of interest. This is a classic example of vicious circle of poverty. Borrowing in general is for reinvestment in fishery or for occasions like marriage or construction of house; women borrow during the lean seasons when return from fishery is not sufficient to meet the expenses. In this study the indicator is

represented by percentage of households in debt. Incidence of borrowing is high among the fishermen communities. Ninety three per cent of households in Anchuthengu and 90 per cent of households Alappad had borrowings at the time of interview. This also points out that irrespective of the fishing style they practice (mechanised or traditional) they are economically vulnerable.

Savings (-)

Savings is the money put aside from earnings for the future needs. This reserved amount is a direct adaptive measure to tackle the unforeseen events. Thus, savings has a negative relation with vulnerability as it helps to reduce the vulnerability. The indicator is represented by percentage of households who have savings in the bank.

Percentage of population with savings is minimal in both Anchuthengu (2 per cent) and Alappad (9.3 per cent).The nature of livelihood, demands them to reinvest a greater share of their return from fishery. Women were alleging that it is not just that, the high consumption of alcohol and other intoxicants among men just leave them without much to save.

Diversity of income sources (-)

This is to see whether a family solely depends on a single stream of income or their earnings are diversified so that even if one source is affected they can rely on another for survival. It also depends on how many members are working from a household as well as freedom the women have in their community to work after marriage.

A household with multiple stream of income are less vulnerable during catastrophe; even if one person's income is affected they can depend on another person. This is more crucial among marine fishing community as majority depends on natural resources for livelihood which is very much exposed to climatic variations. The indicator holds a negative relation with vulnerability and is represented by percentage of households with multiple income sources. In this study we have taken the NSSO's classification for identifying principal occupation i.e., division of employment into regular wage/ salary earning, casual labour and self employed (NSSO, 2011). Percentage of households with multiple income sources are 30 per cent in Anchuthengu and 13.25 per cent in Alappad. The search for alternative employment due to lower production in traditional fishery and active participation of women

in labor force are the reason why more than double the families have multiple source of income in Anchuthengu panchayat.

Dependency on Money Lenders (+)

Heavy investment requirements to meet daily expenses and maintenance charges force fishermen to borrow from various sources. Money lenders are usually either boat owner or bidders in fish auction, so they lent money without any collateral as they can easily deduct it from their salary or force them to sell fish for free or at marginal price. With the establishment of Self Help Group, dependency on money lenders has drastically reduced in Alappad but it is still common to borrow from money lenders in Anchuthengu.

This indicator has a positive relation with vulnerability and the variable is measured by calculating the percentage of households indebted to money lenders at the time of the survey. When 50.33 per cent of households in Anchuthengu are relaying on money lenders only ten per cent of Alappad population had borrowed from this informal credit source. As majority in Anchuthengu lives in slum like conditions banks refuse to provide them loans. With educational backwardness, long procedures for issue of bank loans, ill-treatment from the side of bank officials, they find money lenders as easy source to access loan.

Insurance (-)

Insurance is a financial protection against unexpected catastrophes in life. Those community members who have insured against any kind of catastrophe reduce their hazard vulnerability, so the study take account of the percentage of people protected with any form of insurance. In both panchayats fishermen holds Matsyafed sponsored health insurance which insures them from occupational accidents. Since the insurance guard them against unprecedented events, it has a negative relation with vulnerability and the indicator is measured by the percentage of insurance holders. Percentage of people with insurance is 85.4 per cent in Anchuthengu and 93.4 per cent in Alappad

Social Security Benefits (-)

Social Security Benefits (SSB) are financial support from the government to guarantee the minimum requirements for a decent living. Thus, as SSBs reduce the vulnerability of the population, the indicator is negatively co-related to vulnerability. This indicator takes percentage of population availing any form of SSBs offered by the government. Social

security benefits include financial aid on housing, toilet, well, fishing equipments, kerosene subsidy, free ration, old age pension, widow Pension, disabled pensionand participation in Savings Cum Relief Program, and *thanal*[11] scheme.

In the context of Kerala, from the first elected government onwards, public policies were welfare oriented and implemented up on public actions. So even when marine fishing communities are marginalized or once neglected by the governments, essential social security benefits are provided. In these panchayats only those households without a ration card are left out from SSBs as ration card as a document is requisite for availing SSBs. 98 per cent of Anchuthengu households and 99.3 per cent of Alappad households enjoy at the minimum one SSB scheme mentioned above.

Non-Earning members (+)

Non earning members are those family members who depend financially on the earning members. In general, this category includes children, elderly without pension and unemployed members. It also includes those above the age of 15 and below the age of 60, who are physically capable of employment, but not participating in labour force due to various reasons and are financially dependent on earning members. The ratio of earning members to non earning members determines the per capita income available for consumption. So, higher the number of non-earning member, greater would be the vulnerability. Percentage of non-earning members is as high as 57.80 per cent in Anchuthengu and in Alappad it is 67.70 per cent.

Participation of women in labour force (-)

Women, children and aged population in general are known to be vulnerable to hazards. More women participating in gainful employment can strengthen their purchasing power, economic independence and thus adaptive capacity (Government of India, 2018). It is also said that income generation by women have more effect on poverty reduction at household level thus this indicator is crucial in understanding vulnerability. Across the country women participation in fishing-allied activities are high but in Kerala it is diminishing. More women participation is observed in Anchuthengu where the community is economically backward and community still practices traditional fishing. In Alappad elderly women remembers their

[11]Thanal is a central government aided income support scheme for fishermen and allied workers in Kerala, introduced in 2011-12 period.

days working in fishing related activities, they currently participate in Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) scheme based activities.

The general sentiment is that with economic betterment they try to get job in non-fishery activities as elderly thinks that youngsters deserve a job which is less risky and gives them better respect in the society. In the survey more than 95 per cent of the households said that, they don't want the younger generations to take up fishing as their job. So very less women participate in fishing allied economic activities, elderly women also pointed that the job opportunities also have shrunken to fish peeling for exports. It is also noted that young married women who are educated prefer to stay at home than participating in fishing related activities as they find it belittling.

This indicator is adopted from the climate change index of India (Government of India, 2018) and represented by percentage of women in the overall workforce. In Anchuthengu 26.05 per cent of women are actively participating in labour force but in Alappad it is as low as 5.55 per cent. Scale of male members' income and community's' attitude towards working women are the two observed factors which influenced this number.

High school passed population above 15years (-)

This indicator is to understand the educational status of each household or to see as a community whether they are educated at least till 10^{th} to make better decisions regarding hazard preparedness and resilience. The age of 15 years is considered as the bottom line as that is the age at which a person is supposed to pass high school in formal education system. Thus, the indicator is represented by percentage of population above 15 who passed high school.

During analysis we found 80 members from Anchuthengu and a single member in Alappad as illiterates. The census considers a person above the age of seven, who cannot read and write as illiterates (Census of India 2011, 2011). The indicator has a negative relation with vulnerability as better education reduces vulnerability. Anchuthengu lag behinds in overall educational performances, only 38 per cent of population has completed high school education. Unlike Anchuthengu, Alappad has 80 per cent of its population above 15 holding Secondary School Leaving Certificate (SSLC/10th). This can clearly enhance the quality of decisions while formulating community based adaptation strategies.

Ownership of land (+)

Ownership of land provides more chances to reduce economic vulnerability but in a coastal hazard context, nearer the land to the water body greater would be the potential to loss. Since vulnerability is understood as potential to loss, (Cutter, 1996) the indicator has a positive relation to vulnerability. It is represented by percentage of land holding population in the coastal zone. Being socio-economically vulnerable marine fishing community members possess only marginal amount of land. Average land holding is less than 2 cents in Anchuthengu panchayat which means land they hold is not even sufficient to have a decent house, let alone agriculture and in case of Alappad it is 6-10 cents. Those stay in '*porampoke*[12]' land is also included in the landless category. Percentage of land holding population in Anchuthengu is 86.1 per cent and in Alappad it is95.4 per cent. Indirectly it portrays the percentage of landless population in the community.

Local community support (-)

Community participation and community based actions provide a sense of belongingness to the surroundings you live in and also a sense of social responsibility. In case of hazard rehabilitation, adaptation and resilience, community support is crucial in overcoming the impacts. In this study the indicator measures participation and cooperation of fishermen families in community activities and represented by percentage of households cooperate in community activities. Community bonding being a strong factor in reducing vulnerability this variable keeps a negative relation with vulnerability. Eighty two per cent of families in Anchuthengu and 96 per cent of families in Alappad said that they are actively participating in the community.

Political representation from the community in past 30-50 years (-)

Political representation is vital in deciding the political outcomes in allotting funds and diverting the attention to the developmental activities and other needs of the panchayat. Persistent inequality and social stigmas reduce the chances of people from marginalized communities to become political leaders and representatives. The indicator has a negative relation with vulnerability as it has strong potential to improve the socioeconomic situations of a community. Unfortunately, in both the panchayats, from fishermen community, there is

[12] Poramboke is the unassessed land comes under government ownership.

no political representation to the legislative assembly or to the parliament in the past 50 years. So, the percentage of political representation is zero in both the panchayats.

3.4.3.3 Dimension 3: Built Environment

Availability and quality of physical infrastructure reduces the vulnerability. For example transportation infrastructure can reduce the casualty during a disaster. In the same manner denial of services of critical infrastructure can induce vulnerability. Communities better equipped with physical infrastructure are more resilient to hazards. The variables selected for the analysis are drinking water establishments, educational establishments, medical institutions, banking and cooperative institutions, communication establishments, public distribution system establishments and social and cultural institutions. These were the variables given under infrastructural facilities in the panchayat level census statistics. Other variables are Ownership of settlement and quality of dwelling units.

The data on infrastructure or the selected indicators for the index construction is from Panchayat level statistics (2011) of both the districts. Presence of the given infrastructure within one kilometer proximity is marked as 1 and instead of marking absence as zero, a common practice; present study has followed the methodology of (Mishra, 2012). In his study the author has taken distance at which nearest facility available as denominator and normalized the data. Thus, in this study we follow the same pattern to normalize the data. All indicators in the built environment dimension have given equal weights, since there are 8indicators weight given to each indicator is 1/32.

Table 3.9: Built Environment Indicators Value

	Built Environment Indicators (1/4) (1/32)		**Indicator Value**			
			Anchuthengu		**Alappad**	
			Value	**Weight (1/32)**	**Value**	**Weight (1/32)**
1	Drinking water establishments in a sq.km		0	0	0	0
2	Educational establishments		0.80	0.025	0	0
3	Medical institutions		0.1	0.003	0	0
4	Banking and Cooperative institutions in a sq.km		0.1	0.003	0.3	0.009
5	Communication establishments in a sq.km		0.4	0.013	0.3	0.009
6	Public distribution system establishments in a sq.km		0	0	0	0
7	Social and cultural institutions		0	0	0	0
8	Quality of dwelling	% of houses without concrete roof	0.76	0.024	0.04	0.001
	Weighted Indicator value			0.068		0.019

Source: Primary Survey (2017-18)

Drinking water establishments in a square kilometer (-)

Coastal communities experience acute shortage of drinking water due to saline intrusion in its soil and ground water. Generally, in Kerala almost every house has a private well attached to their house, but in coastal villages hardly there are any wells let alone private ones. They depend on municipal drinking water supplied through public taps or they buy water from private agencies. During field visit, people often complained about quality of water they get through pipeline.

In Anchuthengut here are three tube wells, three public wells and 61 public taps and Alappad has nine tube wells, six tanks/ ponds, and 505 public taps. In this study not having at least one unit of drinking water source in a kilometer is considered as vulnerability increasing factor. Both the study areas fulfill this condition and they are less vulnerable to drinking water infrastructure.

Educational establishments in a square kilometer

Kerala is indebted to Christian missionaries for the establishments of educational institutions. Even though the vast majority of coastal population converted to Christianity, except primary schools, they have not benefited much from missionary education. Among both panchayats, Alappad performs at par with state average in literacy as they have various educational institutions at reach. But in Anchuthengu we could not find more than one high school or higher secondary schools. And nearest educational institution of any kind is only within five kilometer reach. Alappad has five lower primary schools, one upper primary school, high school, higher secondary and one vocational higher secondary. There is one educational establishment in every sq.km.

Medical institutions in a square kilometer

Accident care services are quintessential in coastal villages as traditional fishing vessels are prone to accidents. Though there are dispensaries, proper hospital with beds is not available in both the panchayats. Accidents are frequent especially near the Muthalapozhi fishing harbor in Anchuthengu, where the smaller boats like catamarans collide into the fallen rock boulders from engineered coastal protection structures.

Anchuthengu has one community health centre, ayurvedic dispensary and homeopathic dispensary each. Alappad has two public health centers, seven family welfare centers, one community health centre, one ayurvedic dispensary and three homeopathic dispensaries. Unlike Anchuthengu, Alappad has more than one medical care establishment in every one km radius.

Banking and cooperative institutions in a square kilometer

Establishment of more banking and cooperative institutions means, the community has the capacity to circulate money in the economy. They can generate income and either save or lend the money. It has been observed that the savings habit among fishing communities are weak, but they borrow large amount of money. Formal credit sources are usually more reasonable than informal credit sources, as informal credit sources demand high interest rate and interest on interest, if they fail to return the dues. In the scale of 0 to 1, presence of banking and Cooperative institutions in 1 sq.km lies at 0.9 in Anchuthengu as it got three institutions within four km and 0.7 in Alappad with five institutions in its 7.38 km long panchayat.

Communication establishments in a square kilometer

Communication establishments are essential in providing adequate warning before the hazard occurrence. Panchayats disseminate the warning information through mike announcements in both panchayats and also through church warning bells in Anchuthengu. Most fruitful communication source during tsunami was telephones and during cyclone Ockhi it was televisions and telephones. Tsunami had no prior warnings, so who ever observed the sea shout out physically and communicated over phones, in case of Ockhi few hours before the cyclone warning alert was broadcasted in television. Then those who were already into fishing in the sea were alerted through mobile phones using calls and social media forwards. But those fishermen who had no range in the sea/ those who were really far became victims of cyclone Ockhi.

Two sub- post offices are the only communication facility available to the panchayat members in Anchuthengu and there are four post offices and one telephone exchange in Alappad panchayat. In both panchayats people demand better communication facilities.

Public distribution system establishments in a sq. km

Through public distribution system like ration shops and 'maveli' shops government ensures that public meets the required nutritional needs at subsidized affordable rates. PDS offers same quality products at different rate depending on poverty level of the households. Certain food items at limited quantity are provided at free of cost to the BPL households. Given the level of poverty and population density ration system of the government is very efficient in reducing nutritional deficiencies among poor fishermen households.

All the interviewed families use their ration cards regularly, apart from those families who still have not received a ration card. Anchuthengu Panchayathas 15 ration shops and one *Maveli* store in total and Alappad Panchayat has 22 ration shops and one *maveli* store. In both the panchayats there is at least one public distribution establishment in every sq.km.

Social and cultural institutions in a square kilometer

Given the community nature of fishing, in both coastal panchayats there are plenty of social and cultural institutions. These institutions ensure to maintain community bonding, wellness, peace and harmony; this would be of greater help when the community has to deal with external threats like coastal hazards.

Anchuthengu Panchayat has two public libraries, two reading rooms, 24 Anganwadis, a common hall, three sports clubs, two arts clubs and a common television set. Alappad Panchayat has four public libraries, four reading rooms, 28 Anganwadis, a common hall, and 20 sports and arts clubs.

Quality of dwelling (+)

Given the nature of storms, cyclone, tsunami and other coastal hazards, types of roofing is a safety feature. Those living in tiled and thatched houses are extremely vulnerable to coastal hazards. Thus, this indicator is very crucial in assessing hazard vulnerability and it is positively related to vulnerability. The variable is represented by Percentage of people living without a concreted roof. It is shocking that in Anchuthengu 72.8 per cent of the families are not having concrete roofs, even when the majority stays within 100m from high tide line. But in Alappad only 4 per cent families are still not having concrete houses. In Alappad more than 80 per cent of the houses constructed after the 2004 tsunami using tsunami funding were

concrete houses. This reduced the hazard vulnerability of coastal population in that panchayat.

3.4.3.4 Dimension 4: Spatial proximity to hazards

For a coastal community threatened with coastal hazards, measurement of spatial proximity to water bodies and the area of coverage of water body are crucial in evaluating their vulnerability. Economic value of inundated coasts can be measured with property value of the assets and land lost. The study adopted this variable from the work of Andreucci and Aktas (2017) which uses proximity to water body, land use pattern and residential property values to measure the vulnerability. All indicators in the spatial proximity to hazard dimension have given equal weights, since there are only 2indicators weight given to each indicator is 1/8.

Table 3.10: Spatial proximity to hazards Indicators Value

	Spatial proximity to hazards Indicators (1/4)		**Indicator Value**			
			Anchuthengu		**Alappad**	
			Value	**Weight (1/8)**	**Value**	**Weight (1/8)**
1	Dwelling in Non-Development Zone	Within 50m from HTL	0.99	0.1238	0.95	0.1188
2	Coastal length	Length of the coastline	1	0.125	1	0.125
	Weighted Indicator Value			0.2488		0.2438

Source: Primary Survey (2017-18)

Dwelling in No Development Zone (+)

After the amendment to the coastal regulation zone notification, 2018, dwelling within 200ms from the High Tide Line is defined as No Development Zone (NDZ), which can be extremely prone to hazards. So, the population living in NDZ is extremely vulnerable to coastal hazards. This indicator is represented by percentage of population living in NDZ and it has a positive relation with vulnerability. The extent of geographical vulnerability is that 98.7 per cent of Anchuthengu population and 95.4 per cent of Alappad population are living within the relaxed NDZ criteria. If we consider the pre 2018 notification, 100 per cent of population in both panchayats falls into the NDZ zone of 500 ms from high tide line.

Coastal length (+)

Coastal length of the panchayat helps us to understand the extent of geography vulnerable to coastal hazards. In our study as both the panchayats are coastal panchayats, total length of the panchayat and coastal length of the panchayat are same. Which means one side of both panchayats is entirely surrounded by Sea. This variable is measured by percentage of coastal length and the variable clearly has a positive relation to vulnerability.

3.4.4 Vulnerability Index Value

Obtained values of each equally weighted indicator are aggregated to find the composite index value. To find the same we have multiplied the assigned weight to the normalized indicator values and aggregated them for each dimension and the summation of dimension values is the index value.

CVI = Weighted value of (Social and Demographic Structure +
Access to Resources +Built Environment +Spatial proximity to hazards)

Anchuthengu = 0.1198 +0.16+0.068+ 0.2488
CVI = 0.5966 = 0.60

Alappad = 0.1022 +0.14+ 0.019+ 0.2438
CVI = 0.505 = 0.51

Given the indicators each panchayat is assigned with a vulnerability score, in order to understand the magnitude of vulnerability index value in the range of 0 -1 is divided into 3 groups, not vulnerable, vulnerable, and highly vulnerable

Value < 33% or 0.33 = moderately vulnerable
Value > 33% <66% = vulnerable
Value > 66% <100% = highly vulnerable

In this scale both the panchayat falls under vulnerable category and Anchuthengu panchayat is moving closer to the highly vulnerable category. Within the marginalized community, factors which made one panchayat relatively better off than other can be found once we identify the factors which driven them to the current status of vulnerability.

3.4.5 Identification of Drivers of Vulnerability

Identifying the factors driving to vulnerability is crucial in adaptation planning. In the index scaled between 0 and 1, indicators with value more than 0.5 is taken as factors to be addressed to reduce the vulnerability or to build the resilience capacity. Some factors are common to both fishing villages but some are specific to Anchuthengu panchayat which experiences greater vulnerability than Alappad.

Common drivers of vulnerability in marine fishing villages are high population density, nearness to the sea, zero political representation from the community in past 50 years, Below Poverty Line category, high borrowings, low savings, livelihood dependency on single sector, higher proportion of non earning/ dependent population to the earning population and the absence of women in work force.

From the understanding that Anchuthengu is more vulnerable than Alappad, the drivers of vulnerability specific to Anchuthengu panchayat are the indicators of lack of educational establishments in the panchayat, educational backwardness, dwelling in Non- Development Zone, continued dependency on money lenders, landlessness and less houses with concreted roofs, more of tiled and thatched houses.

3.5 Income based vulnerability assessments for hazard adaptation

The study has divided the households in a panchayat into two sections; highly vulnerable and less vulnerable based on coefficient of variation (CV) of income, to understand the dynamics of vulnerability within one panchayat. Even within a panchayat effect of hazard would be different based on various factors. Disaggregation of social vulnerability from collective to more individual level would help to address issues pertaining to scale and unit of analysis (Adger, Indicators of Social and Economic Vulnerability to Climate Change in Vietnam, 1998). We have taken CV of income because, fishery is seasonal and each coastal hazard directly affects the current and future income earning capacity of a fishermen.

3.5.1 Income as a Variable for the Division of Households

Lack of income or consumption can capture the lack of resources and entitlements. In Amartya Sen's definition entitlements are 'the set of commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces' (Sen, 1981). In marine fishermen's case income also captures the temporal and seasonal

dimensions. Thus, in this study income is taken as proxy to poverty which again is a proxy to access to resources.

Fishing is a seasonal occupation, fishermen's earnings varies upon the season as well as the efficiency and capacity of fishing equipments. Traditional fishermen engaged in small scale production earn from 100 to 1000 in a fishing trip on a positive catch day, whereas trawlers can spend weeks to a month in sea and their revenue can be in lakhs.

A fisherman in general goes to sea on a regular basis except on religiously auspicious days and when they are sick. But during monsoon a section of traditional fishermen as well as trawler fishermen goes unemployed. This unemployment is directly related to their health, availability of alternative jobs, possibility to borrow money, hazard warnings from the government etc.

To study the impact of coastal hazards on the income of fishermen, the coefficient of variation in income is calculated during normal period and hazard or turbulent sea period. CV can be negative, zero or positive. CV negative or positive means there is variation in income earned during hazard and normal period and CV being zero means there is no difference in earnings.

3.5.2 Calculation of Coefficient of Variation of Income

Primary data is available for average monthly income, number of days voyaging to the sea during a normal month and a monsoon month. Data on days employed in a week is converted into days employed in a month, so one working day in a week becomes five working days in a month, two working days in a week becomes ten working days in a month. Once the monthly working days during normal and monsoon period is calculated, it got multiplied with average monthly income to get the earnings in both periods. Income during monsoon month is considered as income during hazard period because severe monsoon led coastal erosion and associated destruction is a yearly phenomenon and, loss of working days and economic distress during monsoon months is a well anticipated fact for fishermen in Kerala.

$$\text{CV Income} = \frac{\text{Income in normal month} - \text{Income in monsoon month}}{\text{Income in normal month}} * 100$$

Positive CV = variation is reflected by the income reduction during monsoon

Zero CV = no variation in income, thus earning remains the same

Negative CV = variation is reflected by income increased during monsoon

Based on the outcome values, those with more than 50 per cent positive variation in income is classified as highly vulnerable households (HH) and those with less than 50per cent positive variation as less vulnerable households.

Table 3.11: Income Based Vulnerability Assessment- I

Panchayat	Vulnerability	Sample HH (%)	Mean family size	Mean head HH Age	Earning Females (%)	Active earners (%)	Mean Land (in cent)	Education Mean head HH	Mean Income
Anchuthengu	Less Vulnerable	30.5	4.78	49.13	26	39	1.87	5.46 years	5000
	More Vulnerable	69.5	4.98	49.82	21	44	1.71	5.71 years	6560
Alappad	Less Vulnerable	64.9	4.03	48.70	2.56	30.9	6-10	9.19 years	11,998
	More Vulnerable	35.1	4.04	53.26	5.6	35	6-10	9.32 years	12,486

Source: Primary Survey (2017-18)

During monsoon months their vulnerability is proportional to their dependency on natural resources (Table 3.11). Higher the participation rate or higher the earnings from fishing, the risk of loss of working days and earnings with coastal hazards are also high. In income based vulnerability assessment age, education, family size does not affect the outcome of hazards on the population. Landholding variable has a positive relation with income vulnerability but since the land holding size is marginal and almost the same among all the households surveyed with high density of population in both panchayats, in Table 3.11, the variable does not convey the exact correlation with vulnerability.

Table 3.12: Income Based Vulnerability Assessment- II

Panchayat	Vulnerability	HH sample	Fishing field	No of landless HHs	HH Dependency on single sector (%)
Anchuthengu	Less Vulnerable	46	Crew in inboard motorized boats (70.4%)	4	29.1
	More Vulnerable	105	Crew in motorized boats (68.9%)	10	36.8
Alappad	Less Vulnerable	98	Crew in motor boats	7	27.3
	More Vulnerable	53	Crew in trawlers	0	30.9

Source: Primary Survey (2017-18)

This table indicates how the type of fishing they are engaged in determines their vulnerability. Those works in larger boats and trawlers are more affected than those who practice traditional fishing and those using motorized boats. Because in income based vulnerability assessment greater the investment greater would be the risk of loss. We can also see that higher the household dependency on a single sector for livelihood, they are more vulnerable to coastal hazards, especially if their livelihood depends on natural resources.

3.5.3 Problems of Income based hazard impact assessment

An analysis of this nature is futile if it is not read along with structural vulnerability because it just depicts the absolute economic vulnerability to hazards, not relative vulnerability. In this case majority of larger boats and trawlers are owned by non-fishing community members. So, the direct impact of coastal hazards without considering their social vulnerability and indirect factors of vulnerability, the result just depicts that one with higher investment in fishing industry loses out the most, irrespective of social capital and geographical location, which are crucial factors driving to vulnerability in the CVI the study constructed.

With this understanding one need to see how the governance bodies calculate the loss and decide the compensation packages to the victims after every hazard. The study also needs to question the nature of assistance given by the various government agencies as they do not find to be making the affected community resilient to future possible hazard events. From the literature on vulnerability to natural hazards it can be understood that redistribution of assets after a disaster in accordance with preexisting pattern of asset holding is a conventional practice (Cannon, 1994). This also was the major argument put forth for using income and asset holding as an indicator of vulnerability measurement (Adger, 1998). To comprehend the trend the example of relief assistance declared by government of Kerala after cyclone Ockhi is taken for study.

3.5.4 An Analysis on cyclone Ockhi relief assistance

Instantly after the cyclone government declared ‘immediate relief assistance’ of INR 2000 and 2 weeks free ration for all the active fishermen families. But when the decision on further assistance was decided it was based on pre-existing asset holding. The problem here is when the community is already socio-economically backward, compensation based on their pre disaster condition can only make them continue in the disadvantaged position or even worse

with the trauma of the hazard and the losses it cost. This further questions the intention of the government on whether they want the community to be more resilient to future hazard events or they temporarily want to compensate for what they lost and neglect that community to continue in that vulnerable position. Income based compensation also maintains the pre-existing inequalities.

In district wise house damage estimates for Ockhi, pucca house and hut were differentiated, and compensation given to both varied. When the government had given five lakh to the owners of pucca houses those with huts were given only one fifth of money allocated to the pucca house owners, with the prior knowledge that huts are extremely vulnerable even to the periodic monsoon waves let alone the cyclones. So those compensated with money just sufficient to build huts remain vulnerable to future hazards. Same can be observed when compensation for lost agriculture, land or input subsidy on fishery and agriculture is decided. So this criterion of compensation in place the government fails to supplement the vulnerable population with a quality of life they had pursued before the natural hazard also not allowing them to be insulated from future vulnerabilities.

In Alappad panchayat after the 2004 tsunami, with government and NGO support 80 per cent of the panchayat received concrete housing. From personal interview it is evident that this adaptation action not only made them more resilient to hydro meteorological hazards but also reduced their fear of being vulnerable to coastal erosion. Same time through anecdotes from Anchuthengu panchayat it is quite evident that the slab based compensation has deteriorated their coping capacity.

Thus, the question arise is on the philosophy of compensation itself. Should the government be compensating what the affected families have lost or should the compensation be empowering enough to build resilience against a natural disaster at least of the same scale which they have recovered from. This study suggests that the former one is beneficial especially when the affected population is from socio economically vulnerable communities. If compensation action can also be an adaptation action, their vulnerability to hazards would be plummeting.

3.6 Conclusion

Valuation of vulnerability based on current income or current asset holding is problematic as it ignores the historic inequality the population had to experience or the social and cultural factors which obstructed their development. Hence hazard vulnerability reduction projects or policies must run structural vulnerability analysis and include the social dimensions of vulnerability in order to be truly effective on the affected population. When government actions just end with generic compensation packages, vulnerability reduction is not happening. When quantitative mechanisms to identify the implicit drivers of vulnerability are available, government should address those factors as they can be location specific or community specific as reflected in this study.

The socio-economic vulnerability assessment performed by the study through coastal vulnerability index helped to identify the major drivers of vulnerability in both panchayats. The assessment found that more than income based compensation packages, both panchayats requires structural changes. Basic health, education, transportation infrastructure and warning mechanisms should be developed in these regions. This method of vulnerability identification and reduction will also strengthen the adaptation measures of government as well as the community.

CHAPTER 4

ADAPTATION ASSESSMENT OF MARINE FISHING COMMUNITY

4.1 Introduction

The previous chapter analyses how the social structures of the past, natural resource depletion and socio-economic backwardness contribute to hazard-vulnerability of marine fishing community. The current chapter critically analyses various adaptation strategies practiced to tackle those vulnerabilities in the selected coastal regions. Every coastal hazard or even monsoon brings changes to the coastal ecology and to the livelihood options of dependent coastal community. Adaptation is accommodating and adjusting to these changes. Responses to the changes can be technological, infrastructural, lifestyle, institutional and sometimes occupational. While adapting, the experiences of previous hazards and anticipated future threats must be taken into consideration.

This chapter tries to answer the research questions: How does a marginalized community adapt to coastal hazards and what are the factors influencing their adaptation decisions? Following a brief discussion of IPCC classification of adaptation, the study introduces technical nuances of adaptation. Next section provides listing of various adaptation strategies practiced in the selected coastal regions by government, individuals, and community. Once the adaptation strategies are identified, the study critically analyses the nature and efficacy of each adaptation strategies. Finally the study points out the setbacks of various adaptation methods and identifies the factors that influence those decisions.

4.2 Classification of Adaptation

By definition Adaptation is “the process of adjustment to actual or expected climate and its effects” (IPCC, 2014). It calls for consideration of hazard driving factor, process, outcome, and the existing adaptation policies in the study area. As adaptation actions are location specific they influence the community’s day-to-day affairs; changes in habits to diversification of livelihood are part of such actions. Thus, such direct adjustment in the existing system is preferred over mitigation policies to resolve regional issues. As adaptation decisions are choices with in a response space (Osbahr, et al., 2010), the effectiveness of adaptation actions depends on the inclusivity of these choices. Participation of various stake

holders from the affected region in the decision making and planning process of adaptation strategy is thereby vital. Along with the participation, capacity building among such communities to cope with the changes expected in the future is equally essential. IPCC (2014) has classified adaptation strategy into 3 broad sects i.e. (i) Autonomous (ii) Planned and (iii) Natural.

4.2.1 Autonomous Adaptations

Autonomous adaptations are those actions by the ecosystem without any external intervention to the changes. These are the natural or innate responses of the ecosystem including that by the humans to the changes in the environment. Therefore, it is also known as 'spontaneous adaptation' (Smith, J.B., & Lenhart S.S., 2006). These actions are the outcome of the coping capacity of that population. Some of the autonomous strategies adopted by various communities are diversification of livelihood (Smit, et al., 2000), migration (Tacconi, 2012), storage of food (Smit, B., & Skinner, M.W., 2002), communal pooling (Linnerooth-Bayer, et al., 2007), savings, and system of mutual support (Andersson, E., & Gabrielsson, S., 2012; IPCC, 2014).

Being able to practise effective adaptation depends on their agencies as a person, family and as a community. As these strategies are taken by private actors, strategies of one person or of a family can have impact on others. This also means when a person with poor agency makes a decision to adapt to the changes, that decision could be at the cost of another individual and there by such decisions could raise the overall vulnerability. Thus autonomous adaptation strategies need not be a vulnerability reduction strategy; in the absence of guidance it could also accelerate the community vulnerability.

4.2.2 Planned adaptation

Planned adaptation measures are human assisted actions, undertaken privately or with the help of public, including government. These actions focus on prevention, protection, restoration and conservation expecting long term impacts. Planned adaptation measures can be policy decisions based on the awareness of changed climatic situations. Some examples are Europe's environmental policies (Westerhoff, et al., 2010), India's water policy (Patra, 2016), green infrastructure in U.SA (Bierbaum, et al., 2013) and construction of sea wall, groin fields and break waters for the protection of coastal regions in case of Kerala. Changes in farming system or breeding different crop variety are also planned adaptation measures.

4.2.3 Natural adaptation

Natural adaptation strategies are those actions occurring within the ecosystem to the changes in the climate or the ecology, which can be intervened by the humans. Expanding the land reserved for conservation (Adams, Segan, & Presse, 2011), establishing air, soil or water regulations (Smith, J. B., & Lenhart, S. S. 2006) restoring the degraded habitats using evolutionary theory and genome biology (Hellmann & Pfrender, 2011)etc are some possible human interventions.

As the study is on coastal hazards which vary from regular monsoon floods to massive cyclones, adaptation takes place at multiple levels; planned adaptation at the state level, community based adaptation at the community level and spontaneous responses at the individual level. Natural adaptations are ecological changes, which is outside the purview of this study and human intervention to the natural adaptation process are macro scale. Since the study is looking at vulnerability and adaptation among a particular community natural adaptation is omitted. However, the study includes community based adaptation strategies as the study is on marine fishing communities, whose life and occupation are community centered.

4.3 Adaptation strategies to Adaptation actions

When planned adaptation strategies are put forth into action, they take the form of either hard or soft measures or the combination of both. Hard measures are techno centric or infrastructural. Underground bunker construction, sea wall or groin field construction are examples of hard structural measures. Soft measures are institutional measures. Risk insurance mechanisms, Integrated Coastal Zone Management (ICZM) plan, integrating climate change into education, community participation in local government decision making are examples of soft, institutional adaptation measures (IPCC, 2014).

Both hard and soft measures have advantages and disadvantages. Hard measures physically protect the coast from inundation. For individuals heavy tangible structures which are unaffordable at personal level psychologically strengthen their sense of protection. But hard structures found to be damaging the adjacent unprotected coasts (Brown, et al., 2013) also coastal squeezes as they can harm the wetlands (IPCC, 2014).

Soft adaptation measures are flexible and revocable in action. Such institutional measures can fill up the development gaps and strengthen the resilience capacity of the community. However some of the soft measures are expensive in implementation than hard structures. And for soft measure like ecosystem based adaptation both cost and benefits are largely unknown (IPCC, 2014). Hard structures are preferred for coastal protection (IPCC, 2014) as it provides short term solutions (Baills, Garcina, & Bulteau, 2020) but not sustainable in long term (Cooper & Mckenna, 2008).To strengthen the community's adaptive capacity, integration of both hard and soft measures is essential.

The factor which determines the effective implementation of adaptation strategies to actions for individuals as well as communities is their adaptive capacity. In an anthropocentric analysis adaptive capacity is the human ability to accommodate and to be accustomed to the changed environment. Various factors influencing adaptive capacity are economic constraints, class and caste inequalities, gender inequalities, livelihood struggles, institutional shocks, poverty. A community's adaptive capacity can be strengthened by minimising the socio-economic vulnerability and by strengthening the institutional structures. Some examples are access to better information, land use management, infrastructural development, and better governance mechanisms. Therefore, overall development of a community is the key to enhance the adaptive capacity of that community.

Once an adaptation strategy is implemented, it can succeed or fail. Adaptation actions may end up augmenting the vulnerability of targeted group immediately or in long term. Those location or sector specific actions which could increase the vulnerability of another location or sector are called as mal adaptation. For example, an engineered infrastructure like groin field implemented in one coastal region can generate adverse impacts on adjacent coasts (Adger et al, 2003; Eriksen and Kelly, 2007). Mal adaptation generally occurs from inadequate information, poor planning, overrated technology, or when short term impacts are overemphasised over long term possible impacts. Keeping standards, work based on scientific research analysis, inclusivity in participation of stakeholders while assessing vulnerability and following mixed adaptation strategies are crucial steps to avoid mal adaptation actions. Researchers also believe that grass-root innovations have the power to overcome government policy led mal-adaptations (Rahman & Hickey, 2019).

4.4 Coastal hazards in Study Area

Facing inequalities from the socio political structures of the past, with every new hazard event, adaptive capacity of the marine fishing community in Kerala is further compromised. Tsunami of 2004 has washed away the economic wellbeing of Alappad community; in the same manner cyclone Ockhi has shattered the asset holdings of Anchuthengu community. Community's response to a hazard is directly proportional to their standard of living, so after every hazard they become more vulnerable. This is the reason why community adaptations are preferred over individual actions in marginalised communities.

4.4.1 Coastal Hazards in Anchuthengu Panchayat

In Anchuthengu, the coast is only partially protected with sea walls and break waters. Therefore, the fishermen can directly enter sea from the shore without depending on a harbour. The open coast enables smooth sailing of smaller vessels like Catamarans and Fibre boats from the coast. Small scale fishing allows fishermen to remain as owner cum worker unlike in mechanised boats where the fishermen are mere labourers. The traditional fishing style practiced widely in Anchuthengu shore ensures the sustainability of marine ecosystem. Fishermen in these regions were the first to construct artificial reefs in the state of Kerala as a measure to compensate the depletion of fish stock.

During the field work of the study, cyclone Ockhi havocked the panchayat. In the absence of prior cyclone warning from the authority, fishermen who had already departed to the sea were the victims to that cyclone. State could only recover 52 dead bodies, more than 200 fishermen were declared as missing (Ministry of Earth Science, 2018). The community also had to deal with widespread damage to the fishing vessels, nets, communication devices, houses, and other assets. Panchayat experienced extreme beach loss. After the cyclone Ockhi fishermen expressed fear in fishing during rough sea. In the absence of precise warning mechanism and updated technology to contact with those back at shore, unexpected climatic change accelerate this fear and reduce the number of working days.

It is not just extreme hazards, during every monsoon, high tide waves lash out at the coast. The panchayat is not entirely protected with structural adaptation measures. On top of it breakwater in the neighbouring locality elevates erosion in Anchuthengu coast. Anchuthengu community argue that after the construction of groin field in Vizhinjam, as part of port development by the Adani group, the land taken by the sea is never returned i.e.,

Anchuthengu is experiencing extreme sea erosion in its coasts. This was witnessed on recent visit to the field in July, 2019; many houses were submerged in the sea and beach has disappeared. Community members claim that this has become a routine phenomenon over the past few years.

Wards in Anchuthengu towards the fort side are narrow and shares border with Anchuthengu Lake in the east and Arabian Sea in the west. In many parts of the panchayat people depend on auto rickshaws, country boats and other private mode of transportation as public transportation has stopped operating. Not having transportation facilities to connect to the mainland adds to their vulnerable condition during hazards. Disaster preparedness of the panchayat is negligible even after yearly erosion and cyclone attacks. The state has recently (2019) proposed a bridge across T-S canal in the Vakkom-Kayikara section of Anchuthengu. Connectivity through a bridge would be utmost help at the occurrence of natural coastal hazards. Bridges make the escape easier with better connectivity to outside world, especially when the panchayat is sandwiched between two water bodies.

4.4.2 Coastal Hazards in Alappad Panchayat

Alappad is just 7 ms above sea level. So far, the panchayat has faced coastal erosion, flooding, tidal surge, Tsunami, and cyclone. The Tsunami on 26th December 2004 had devastated the panchayat with maximum number of deaths and beach loss in Kerala state. After Tsunami, minimum width of the panchayat reduced to meagre 33 ms. From the year 2000 to 2018 Alappad has witnessed tsunami, cyclone Ockhi, Level-3 flooding and tidal surge and coastal erosion during every monsoon. Elders in the community recall that they have never witnessed or heard of these many hazards occurring in such short span.

Until tsunami, this 16 km long panchayat had only 1 bridge for connectivity. The Panikarkadavu Bridge built in 1977 was the sole roadway to travel to the mainland. Infrastructural deficiency elevated vulnerability during tsunami as people were forced to take ferry for emergency escape to the mainland. Many lives could have been saved in Alappad if they had bridges to cross the T-S canal. Understanding this failure, right after tsunami Aayiramthengu Bridge and Kallumootilkadavu Bridge were constructed.

Continuous erosion of the coast and flooding has caused salt water intrusion to the ground. The panchayat website claims that till 1950s fresh water was available throughout the panchayat and they had many water bodies and wells. In 1969 panchayat availed Rural Water Supply Scheme and depending on pipeline water thereafter. During interview they said that after every hazard quality and taste of the water further deteriorates. Talking of the infrastructure panchayat lacks good roads and transportation facilities. The distance between the panchayat road and the sea is of few meters in most wards. Though KSRTC service had initiated in 2010 to connect the region to the mainland but from 2014 it is partially halted.
Both panchayats have socio-economic and infrastructural vulnerabilities which limits individual as well as community adaptation capacity.

4.5 Existing Hazard Adaptation measures

4.5.1 Planned Adaptation

State of Kerala has been using engineered structures for coastal protection from its formation. A study on long term (1972-2010) shoreline change shows that more than 60 per cent of Kerala's coast is of eroding trend (Government of India, 2011). In the 580km long coastline already 350 km is protected with seawalls, riprap revetments, and groynes (Sundar and Murali, 2007).

Anchuthengu is partially protected with sea walls but those sea walls were found to be wrecked and not maintained at the time of field visit. In Alappad panchayat for arresting coastal erosion and to protect the coast and agricultural land, irrigation department has constructed sea wall and groynes on the coastline. Sea walls throughout the panchayat has been constructed almost 50 years ago and repaired and maintained thereafter. Groin field was constructed only after the tsunami based on the recommendations of scientists from IIT-Madras.

4.5.2 Autonomous Adaptation

Autonomous adaptive measures are those actions taken privately by the community members to protect themselves from the expected hazards in future. Most actions are spontaneous decisions on their everyday life. These measures among fishermen community in general are livelihood centric (Cinner, et al., 2012), (Badjeck, Allison, Ashley, & Nicholas, 2009).

Table 4.1: Spontaneous Adaptation Actions

Adaptive Measures	Anchuthengu		Alappad	
	Yes (%)	No (%)	Yes (%)	No (%)
Savings	2	98	9	91
Borrowings	93	7	89	11
Insurance	85	15	94	6

Source: Primary Survey (2017-18)

Though the percentage of saving is very less and the percentage of borrowing is very high in the study areas, Panchayat of Alappad has better savings and insurance protection and they hold less borrowing rate compared to the panchayat of Anchuthengu (Table 4.1). Previous chapter pointed that Anchuthengu is more vulnerable than Alappad with socio-economic and political backwardness and weak governance body. Alappad holds a strong local governance body. People are better educated and politically mobilised than people in Anchuthengu. Church holds upper hand on fishermen in Anchuthengu, they are less educated and experience poor governance. Awareness on government schemes including insurance scheme of Matsyafed is less known to them. Since they follow traditional methods of fishing, they have lesser earnings than mechanised fishermen. They depend more on borrowings and hardly save from their earnings as consumption of intoxicants are high in the region. They face social alienation from other communities and regions. During field work random people in bus waiting sheds advised not to go alone to Anchuthengu as ‘area not safe for 'cultured' people’ is an example of social alienation they face.

Fishermen community in general lacks savings culture; they attribute this to the nature of monetary investment and returns in their occupation. Their investment is largely funded by borrowings from money lenders, acquaintances and banks. Prejudicial attitude of banks towards fishermen is to be blamed for their dependence on money lenders. Since Matsyafed provides insurance to all active fishermen majority of the fishermen are having medical insurance, private insurances are very rare. Other than these basic financial actions, in large scale there are no autonomous adaptive actions. It is not because they are not willing to, but they claim that lack of economic agency is holding them back.

Table 4.2: Other Private Adaptation Strategies

Family protection strategies (%)	House Protection Measures (%)	Tree/Agricultural protection (%)	Household Equipment Protection Strategies (%)	Document Protection Strategies (%)
Stay away from coast during hazard (T-30) (K-28)	Construct them on pillars (T-1) (K-10)	No strategies (T- 100) (K-82)	No Action (T-88) (K-78)	Bank Locker (T- 1) (K-1)
Pray (T-43) (K-8)	Build higher private walls towards sea (T- 33) (K-3)	Tie them to bigger trees/to the house (T-0) (K-18)	Keep far from flood height (T- 8) (K-18)	With relatives or friends (T- 32) (K-2)
Construct better house (T- 4) (K-5)	Planting big trees towards sea (T- 3) (K-5)		Keep in other houses (T- 4) (K-4)	At home itself (T- 67) (K-97)
Run during hazard (T- 23) (K-59)	Ask for larger sea wall (T- 2) (K-50)			
	No protection (T-61) (K-32)			

Source: Primary Survey (2017-18)

Innate adaptive options of a marginalised community are restricted to their socio economic wellness. This explains why marine fishermen act more passive towards hazard protection strategies. During hazard for an individual loss comes in the form of human life, house one stay, trees, household equipments, documents and other assets. While collecting the adaptation responses most people were not having productive solutions in hand. Towards self or family protection, most people just prefer to pray or run when a hazard occurs (Table 4.2). They are of the opinion that hazards come out of the blue and individuals remain helpless given the scale and intensity of the incident.

In Anchuthengu panchayat to protect oneself and family majority (66.7 per cent) said they pray to god for protection and run to safe places during hazards. Only 33.3 per cent preferred to stay away from the coast once the hazard warning is issued. They emphasised that matter is ultimately not just about preference but also about affordability. For those without relatives or friends at non-coastal regions found it expensive to stay outside.

For the protection of the house, whatever little they can do, they were keen on it. Owner of a new house who is economically better off and said he constructed the house on pillars to prevent flooding and erosion. More than 32 per cent constructed mud or sand bag walls towards the sea for flood protection. But majority from the slum like areas had no adaptation strategies in hand to protect their houses (upon which most of their savings are invested) due to scarcity of land and monetary resources. Land scarcity is also the reason why community members in Anchuthengu do not have any trees or agriculture.

In case of household equipment protection, their houses being small, most of them cook outside the house and leave the cookware in the corners beside the walls, so they are prone to be lost while flooding. During the field work it is observed that when a house is submerged to the sea that family would be left with no documents to prove their ownership. Valuable documents like ration card, voter's ID, educational certificates, land tax receipts would be lost. Most families continue to pay the land tax to the government even after it is eroded as a proof of previous land holding expecting compensation from government at some point. It is a very optimistic move that 32 per cent are keeping their documents with relatives/friends who are not closer to the coast.

The study notice that compared to Anchuthengu panchayat, the strategies adopted by the Alappad community members are more practical to cope with sea erosion. To ensure the protection of family members only 8.1per cent resolved to prayer; rest of them takes pro-active strategies like construction of better house with concrete roofing, and staying away from the coast during the high tide period. Almost 60 per cent resort to running away during hazards. In other adaptation strategies like demanding for sea walls, constructing houses on pillars one can see more participation at Alappad. This indicates that people of Alappad have better economic and political resources.

Looking at the household protection strategies, majority (50.3 per cent) resort to demand for government sponsored sea wall protection. Even when people of Alappad are educationally and economically well off compared to other marine fishing communities', only 10.2 per cent of surveyed population are capable of constructing houses on pillars. With the notion that individual actions are ineffective to mass scale hazards, 31.8 per cent population refrained from adopting any protection measures. Other than these responses some members are planting large trees including casuarinas towards the sea side, also they construct concrete and sand walls towards sea side for protection.

Though the land holding in both panchayats are marginal, compared to Anchuthengu, Alappad has space for trees. Thus, those with sufficient land for planting trees plant them in Alappad and protect them by tying them to bigger trees or to the pillars/ windows of the houses. But in both the villages vegetable cultivation is not possible due to salinity; trees that grow in the coasts are also limited to coconut and casuarina.

In Anchuthengu one can observe more members trying to protect the house, household equipments and documents than the scenario in Alappad. Very less number of families ventures into individual actions to protect their assets (4.5 per cent in case of household equipment protection and 3per cent in document protection), majority demand structural protection from the side of government and optimistic on the implementation of same on time. Thus, with efficient local governance body people concentrate more on to livelihood issues than asset protection, so individual efforts are comparatively low.

Another reason for their passiveness is that 99 per cent of families in Alappad have been evacuated from their place at least once in their lifetime. So, they are more concerned about their daily life than potential future hazards. This is another reason why they emphasis on strengthening the hazard warning system, so at least they can save lives by staying far from the coast.

4.5.3 Community Based Adaptation

In this study community based adaptation is categorized into mobility, storage, diversification, communal pooling and market exchange (Agrawal, 2008; IPCC, 2014; Santha, 2014).

Table 4.3: Community based Adaptation Strategies (Anchuthengu (T) & Alappad (K))

Mobility (%)	Storage (%)	Diversification (%)	Communal Pooling (%)	Market Exchange (%)
Migration (58-T) (33-K)	Drying fish (59-T) (44-K)	Season based fishery (74-T) (21-K)	Micro credit groups (74-T) (82-K)	Borrowing (93-T) (95-K)
Shifting from usual fishing ground and travel further- (11-T) (60-K)		Change in occupation during extreme climatic events (17-T) (18-K)	Sharing of wedding expenditure (4-T) (94-K)	Mortgaging assets (44-T) (93-K)
		Parallel occupation (1.3-T) (0.7-K)		

Source: Primary Survey (2017-18)

Even among community based activities, those actions emphasising on individual efforts are less preferred. Sharing of wedding expenditure by voluntarily contributing to the family by every community member, boats travelling further to capture targeted quantity, participating in self help groups and micro credit organisations and even borrowing from the community members or from a common money lender are what is being preferred over migration or drying of fish (Table 4.3). When adaptive capacity is weak people prefer to be supported by the community while dealing with uncontrolled events. When agency to adapt as an individual is scanty community based adaptation measures are preferred.

While comparing both panchayats we can see that people from Anchuthengu are more involved in those activities where individual decisions have more space. For example, they move out from the locality during high tide, they dry fish for personal use and for sale and as traditional fishermen they practice season based fishery and borrow from various sources. On the other hand in Alappad panchayat more community oriented activities can be observed. They practise motor and mechanised fishery so as a group of 25-40 members they travel further to catch the required amount during rough season. Their primary source of borrowings is self help groups formed among them. As a community they contribute to any wedding in a household to rescue them from the financial burden. Since they hold assets they mortgage them in financial institutions. From the table we can also observe that in both panchayats fishermen do not prefer to change their occupation in any season or chose a parallel occupation. This is mainly because their skills are limited to fishery.

4.6 Effectiveness of Planned Adaptation Measures

Planned adaptation measures implemented in the coastal regions of Kerala are engineered structures. In both Anchuthengu and Alapad panchayats these structures have been constructed. These manmade structures can affect the shore stability of adjacent areas for a certain distance (Paravat, Jayadee, & Sheik Pareet, 2009). Anchuthengu panchayat experiences the negative externality from the brake water in neighbouring panchayat.

4.6.1 Benefits of Structural Adaptation Measures on the Coast

Major hard structures adopted in Kerala are seawalls, groin fields, break water and geotubes. Sea wall is a massive horizontal structure which separates sea from the coast. It functions to resist the force of high energy waves and storm surges and thereby protecting the land from high tides. Groynes are vertical structures constructed from the coastline to the sea to a

distance suggested by the scientists. They cut the waves and trap sand from the littoral drift. Rate of accretion erosion associated to the structure depends on the coastal type. Breakwaters are usually constructed to prevent tides entering the harbour or harbour mouth by intercepting the long-shore currents. They dissipate wave energy back to sea (Burcharth & Hughes, 2003). Though all these structures are for arresting coastline erosion they change the coastal morphology and thereby affect the coastal ecology.

4.6.2 Problems associated with structural adaptation measures

Engineered structures exhibit in-built problems. Such built-in problems can permanently handicap the coast in the absence of effective implementation. Be it sea wall, groynes or breakwater, they are not free from these flows.

4.6.2.1 In-built problems of engineered structures

i. Sea wall

As noticed earlier, construction of shore connected structures alter the shoreline. Sea wall made of rocks raises the wave run up heights and speed up erosion. Overtopping of water leads to bottom scours by digging out the sand beneath and causes direct destruction of the seawall (Burcharth & Hughes, 2003). When visiting Alappad and neighbouring Chirainkeezhu panchayat of Anchuthengu, it was visible that sand beneath the sea walls were getting washed off uprooting nearby trees and eventually the structure collapsing to the sea. Being less aware of the technicalities of engineered structures villagers are doubtful whether bottom scour is a natural process or backlash of unscientific construction. They are doubtful of possible mismanagement of funds and other malfunctions possible with construction and maintenance of these structures. Anyhow they are affirmative that if sea wall extends erosion, sea wall alone is not a viable coastal protection solution. They propose groin fields along with sea wall from their experience.

Image 4.1: Overtopping in Alappad Panchayat

Source: Primary Survey (2017-18)

Since the design of the sea wall itself can cause erosion of seabed to the sea side, it can advance the steepness of the area in-front, attract larger waves and increase the vulnerability of sea wall to bottom scour. Scientific studies also propose construction of groin fields or beach nourishment along with sea walls (Burcharth & Hughes, 2003).

ii. Groynes

Groynes have net drift towards north. That means to the north or down-drift side of groin there is erosion and to the south or up-drift side of groin there is accretion. This imbalance in beach level with erosion accretion process can extends to certain distance from the structure. Thai is the major reason why groin fields are recommended over individual groin and asked to construct simultaneously. Construction of individual groin can extend erosion in areas north to the structure, then people living adjacent to the eroding area protest and this trend continues. In the down drift side beach nourishment or artificial filling of sand should be done to prevent erosion of adjoining area.

iii. Breakwater- Anchuthengu Panchayat

Construction of breakwater for the fishing harbour in neighbouring Muthalapozhi village altered the coastal geomorphology of Anchuthengu panchayat. It is observed that about 2km to the south of breakwater there is accretion and to the north shoreline erosion (Noujas, Badarees, & Thomas, 2014). Anchuthengu panchayat lies to the north of Muthalapozhi harbour, so it experiences extreme erosion during monsoon season.

4.6.2.2 Implementation Problem

The establishment of groin fields in Alappad panchayat are based on a government sponsored study by the scientists from Department of Ocean Engineering, IIT Madras. The study has suggested 5 short groynes with length of 30m, 40m, 40m, 35m and 25m (Sundar & Sannasiraj, 2012). When the study report was approved and implemented only 4 groynes were constructed in Aazheekal and the remaining one for the 2 km stretch of Srayikkad region was left out. It is to be noted, in the report submitted it was strongly recommended by the scientists that all 5 groynes should be constructed simultaneously. However, in reality the recommendations were not followed leading to further coastal erosion.

The engineered coastal protection structures are expensive in construction and maintenance. The fund crunch limits the implementation of recommendations as prescribed. This alters the predicted or modelled changes to the shoreline by the engineered structures. The study of IIT-M modelled an advancement of shore for about 35-40m maximum, but the shoreline has experienced extensive erosion in most parts. When fund crunch and other compromising factors hurdles scientific implementation, the end result is intensified coastal erosion. During every monsoon, when flooding and inundation heightens, protest runs strong and panchayat comes up with a promise of a new groin at areas of high erosion. At present in the 17km coast of Alappad there are 8 groynes.

4.6.2.3 Uncertainty Problem

The structural measures of adaptation generate knowledge uncertainties among the coastal community. Even after many decades of experience with sea walls, people in Alappad are still sceptical of the impacts of walls on the coastline. Murali, a senior citizen as well as poet believes that hard measures alone cannot control erosion, if such structures could, they would not have lost kilometres of land towards sea. As per newspaper reports total area of this region has shrunk to 8.7sq.km from 87.5sq.km in past 50 years (Times of India, 2019). Aalappad panchayat performs better than state average in educational attainments. Literacy rate of Alappad panchayat is 95.52 per cent as per the 2011 census data. But the basic education or even traditional knowledge on the geography is not helping them to have a composite understanding on the impact of structures on the coast. The uncertainties attached to these constructions are multifaceted.

Coastal community admits that they are unaware of various scientific measures of adaptation practiced across the world; still they understand that sea wall alone is not sufficient. In recent protests for coastal protection, coastal communities were demanding groin field and break water. When asked about land reclamation, only activist members of the community were aware of this treatment technique. They express that whenever they demand engineered structures local bodies dump more boulders to the shore without any scientific study as the process of construction helps the corrupted officials to make money. Thus throughout the coastal belt of Kerala you can witness communities seeking scientific studies before constructing any new structure.

4.6.2.4 Ecological Problems

Shorelines are the breeding ground of many species. Sea turtles, Mussels, Sea snakes, Shore crabs are commonly found in shorelines. And there are many fish species which comes near the coast to lay eggs and reproduce. Coastal hazards not only cause shoreline erosion but also disturb the seabed. When the seabed is disturbed some of these species move towards the beach, movement of such species are indeed observed by the fishermen to predict disturbances in the sea. Construction of hard structures like sea wall not only limits the entry of these species to the shore, it also limits direct access to the sea by humans. Thus, breeding of certain species as well as traditional ways of observing the changes in the sea are restrained by sea wall construction.

4.6.2.5 Occupational Hazards

Displaced boulders from groynes and sand-wall from sediment deposits near groin and breakwater are the lead cause of accidents during boat landing. Such accidents have resulted in wreckage of boats, death and physical impairment of many fishermen. Human and economic loss from such incidents can be avoided if such structures are constructed scientifically and maintained on time. Fishermen says that construction of these structures have made landing of the vessels risky especially for the smaller boats.

4.6.2.6 Livelihood Problems

Sea wall is a long horizontal structure along the shoreline using huge boulders or rocks, which cut off direct entry to the sea. Therefore, it restricts all shore connected livelihood practices.

Image 4.2: Catamaran fishing at Alappad

Source: Author's own (2019)

Traditional catamaran boats sail and return to the shore and not harbours. So, when the wall is constructed between the sea and the shore such type of fishing becomes unfeasible. Next available option would be to carry their fishing vessels to nearest fish landing centre, wherever that facility is provided. Distance to the new destination raise their expenditure and taxes their physical capacity and sleep time. Many catamaran fishermen in Alappad region has quit traditional fishing and started working in mechanised boats as employees or crew. This change in status from self employed workers to an employee has multifaceted impacts on job flexibility and economic independence.

Image 4.3: Shore seine fishing

Source: The Hindu, 2018

Shore seine employs minimum 10 fishermen on the shore to pull the net from the sea, deposited by a fishing boat in the inland water. For inshore activities associated with shore-seine elderly fishermen who are physically incapable of going to the sea and teenagers who are in need of pocket money participate actively. Construction of sea wall has wiped out this community fishing practice from Alappad and augmented the economic vulnerability of

elderly population and weakened their adaptive capacity. This also has indirect impact on traditional community culture.

Image 4.4: Sun Drying of Fishes at Anchuthengu

Source: Author's own (2017)

Traditionally women are more active in dried fish industry, they collect surplus fish at cheaper rate from the boats and sundry them on the shore. As majority of fishermen in Kerala are marginal land holders, with the erosion of coastline, dried fish industry is disappearing. This has greater toll on the women and their economic independence in the coastal regions. For the women of Alappad fish drying has reduced to a household chore; they sundry the fish on roof tops of their houses just for domestic consumption. The women identify coastal structures as a factor behind extended erosion and disappearance of beach which eventually elevated their economic vulnerability.

From the analysis on effectiveness and impact of structural adaptation measures one can understand that such measures not only change the coastal ecology but also the social structure of the coastal community. As the traditional fishing practices changes, the social structure and community welfare systems attached to it changes. For example, the '*Karanila*' system associated with shore seine fishing practice ensured that a share of catch goes to widows and elderly in the community. There were dispute settlement courts headed by experienced elderly members to settle any dispute within or outside the sea regarding fishing practices. Construction of hard structures initiated a cultural shift in many fishing villages; it made women and elderly more vulnerable. Such formal adaptation measures are examples of mal-adaptation as it reduces the adaptive capacity of a community and hence elevate their vulnerability to disasters.

4.6.3 Ban on Mining as an Adaptation Policy for Coastal Protection

This part addresses 2 questions; (1) How mining extends erosion and affects the hard structures and (2) Why a ban on mining has to be part of adaptation policy.

Alappad was once known for coir making in international markets which eventually led to the establishment of mining companies in its soil starting with a German company in 1911. Later in 1932 F.X Perera and Sons, Hopkins and Sons (both are foreign companies) and T.N.P established (Alappad Grama Panchayat, 2020). After independence, from 1960's two public sector undertakings (India Rare Earth of central government and Kerala Metals and Minerals Limited of Kerala government) are engaged together in mining (Mathrubhumi News, 2019). Mining on the black soil still continues by government companies as it contains ilmenite, rutile, zircon, rare earths, leucoxene (brown ilmenite), sillimanite and Zirflorwhich can be used for aerospace, defence, industrial and atomic energy purposes (Indian Bureau of Mines, 2015). These companies lease out land and engage in inland and sea mining of black sand. But the non- sustainable extraction through unscientific methods have escalated coastal erosion in Alappad.

The pattern of natural sediment transportation is inflow to south during monsoon and refilling in north during September to April. But engineered structures on the coasts along with unscientific mining have altered this natural phenomenon. One such example of unscientific mining activity is that of beach washing and filling of mining pits. Beach washing is a process of digging out beach sand from dunes and filtering for mineral extraction. When the sand is collected from the beach for mining, the pits formed by it must be refilled to avoid coastal erosion. The company says that they fill them with mining residues and gravel. As the humus content in gravel and silt is more than 60 per cent, they easily dissolve in seawater. And as Sekhar and Jayadev points out "The density of sand that is found along this (Valiazheekal to Thottappally) coast is 0.45 gm/ccm; no other compound known to mankind that can be cost effectively used to fill the mined area, has a density more than 0.25 gm/ccm"(Sekhar & Jayadev, 2003).Thus the low density replacements with gravel as a replacement material naturally extend erosion and saline water intrusion (Sekhar & Jayadev, 2003).

The villagers' claim that instead of refilling the pits, parts of residual sand after the filtering is being sold by KMML to outsiders as there is greater demand for sand by construction

industry. So, if pits are not refilled in a coast with frequent high wave action, through the natural process waves refill them by taking sand from adjacent coasts. And we know that because of groin fields, this region experiences net drift towards north. Thus, mining company being placed in the southernmost part of the panchayat, it erodes the entire coast of Alappad.

The process of beach washing and erroneous refilling are anthropogenic factors contributing to erosion and they wane the strength of hard structures. So, as long as beach washing and sea mining continues, allocating more funds on the construction and maintenance of hard structures is futile for effective coastal protection. Members of Alappad together as a community are on relay hunger strike for the implementation of total ban on beach washing and other mining activities on the coast. They have decided to continue their hunger strike until the demands are met by both Central and State owned companies. Given the current erosion rate, environmental impact study must be conducted at the earliest to study the feasibility of sand mining in Alappad coast.

4.7 Effectiveness of Autonomous Adaptation Policies

Lack of vigour in individual actions are directly related to their socio economic vulnerabilities, therefore in order to uplift them from this position, government needs to invest into capacity building among marine fishing communities. Once the human capital is strengthened community will be able to effectively respond to the impacts of coastal hazards.

Women and elderly who depended on fish drying, coir making and shore seine need to find alternative employment for economic self sufficiency and survival, thus the government should come up with alternative employment opportunities. With resource depletion as marine fishery is struggling, inland fishery should be boosted through incentives. Issue of landlessness also need to be settled with allocating land to those living in ‘poramboke’.

Due to the peculiarities of their job marine fishing community in general do not hold regular earnings and they borrow high amounts for fishing equipments which are expensive. Consumption rate of intoxicants are high among them. Clubbing these factors together explains the weak savings pattern among fishermen compared to other communities. To strengthen them financially, practice of marine fishing should go economically viable, sustainability of fishery should be ensured and inland fishing encouraged. Savings and

borrowings through communal pooling or self help groups should be promoted to avoid the moneylenders and middlemen. In order to have direct control over sales for fishermen, the fish markets should be constructed and e-auction should be executed. Youngsters must widen their skills to other areas or reduce their dependency on natural resources.

In case of social welfare measures, when asked about what they require the most from the government, uninterrupted supply of quality drinking water was the prime response of people in Alappad. They also demand a hospital which can accommodate accident cases throughout the day as they observe that those fishermen who gets into accident at sea manages to reach to the harbour but transportation from harbour to the nearest hospital delays their chances of survival. Another demand from Alappad is higher educational institutions. Anchuthengu shares the same demands as Alappad. Considering the nature of their requirements, they are basic needs which are essential to strengthen the agency of people.

The development gap in Anchuthengu is so severe that people are incapable of identifying their welfare rights. Many facilities associated with basic needs provided by government and widely available in other parts of Kerala cannot be found in Anchuthengu. The panchayat face acute drinking water scarcity, sanitation problem and landlessness among community members. Public transport system to connect all the wards is unavailable. Very recently they completed electrification of all wards and they are yet to complete construction on toilets in every household. They lag behind the state average in literacy rate and experience high dropout rates in schools. Though there are community health centre, homeo and ayurveda dispensaries there is no hospital with beds or accident care service; Anchuthengu reports repeated accidents while landing the boats in harbour.

Though the Anchuthengu panchayat lag behinds in education, health, sanitation, drinking water, housing, transportation and in other aspects to ensure quality life, people seldom complaints as they are unaware of their rights. The local governance body is proposing a ‘People Friendly Centre’ to make community members aware of various government schemes. Given this background one has to understand why only 4 out of the 151 households (Table 4.3) surveyed were ready to ask for sea wall as a measure for coastal protection. More than ignorance, their deprivation intricate the ‘uncertainty’ problem, thus filling the developmental gaps are essential to build resilience capacity to adapt to hazards among marginalised communities.

4.8 Effectiveness of Community Based Adaptation Policies

Community Based Adaptation exists on the fundamental assumption that collective choices can generate potential changes in outcome (McGinnis & Ostrom, 2014). In case of natural resource management the collective behaviour influences the adaptation from the 'tragedy of commons' time. Later on for decades, studies analysed the socio- economic and organisational factors which affects the common management of shared resources (Ostrom, 1990; Agrawal, 2001) but these studies have not considered exogenous factors such as climate variability or changes in land use pattern (Murtinho, 2016).

The impact of exogenous factors like coastal hazards acts as an additional challenge to the community, therefore existing vulnerability and political and governance factors play much crucial role in addressing the same. It is observed that people in Alappad are more involved in community based adaptation than those in Anchuthengu. Addressing the reason behind differences in such collective behaviour also helps to understand the factors which influence the collective adaptation when affected by exogenous forces.

i. Income: People in Alappad are economically better off than people of Anchuthengu. Higher earnings are a signal that they are more capable of mobilising fund internally or from external sources to access necessary infrastructure and technology (Pretty & Ward, 2001; Murtinho, 2016).

ii. Education: Alappad performs better than the state literacy rates but Anchuthengu underperforms. Educational backwardness generates uncertainty and restrict knowledge on various adaptation options (Wamsler, Brink, & Rentala, 2012)

iii. Public Action: public action involves public itself (collective action) and government (Sen, 1994). Not having the bargaining power or visibility encircles into deeper vulnerability as collective inaction keeps them invisible from mass media and policy makers. People in Alappad are more aware of their rights and they are involved in public action than the more vulnerable Anchuthengu population. As people in Alappad protest and mobilise eminent personalities to participate in their protests, they capture the attention of media and politicians better.

iv. Good governance: a decentralised indigenous leadership can effectively aggregate local knowledge and guide individual strategies in hazard mitigation (ILO, 2017).Being well equipped with educated minds, governance body performs more effectively in Alappad. In Anchuthengu they lag in implementation of policies due to the inefficiency of governing body to arrange enough funds.

From the various factors discussed above it can be concluded that social capital determines both individual and collective behaviour. Thus, strengthening the social capital is essential in strengthening the scope of community based adaptation. When exogenous factors alter the landscape, individual actions seem less effective in adapting to the changes. So, for marginalised communities affected by climate variability more than individual actions, community based actions produce efficient outcomes.

4.9 Conclusion

Climate change and sea level rise can increase the frequency and intensity of coastal hazards. Adapting to the changed environment is essential to cope with the future events for the affected communities. In this chapter various planned, autonomous and community based adaptation measures practiced in the coastal communities of Anchuthengu and Alappad are discussed. Coastal areas are heavily dependent on engineered structures and community members are passive towards private adaptive measures. Various government schemes like voluntary rehabilitation of population living near to the coast to places which are safer have not seen much effect in Kerala. Also, the scientifically proposed hard structures are found to be more destructive than expected due to various reasons. Considering these factors, the emphasis should be on community participation in policy formation. Being socially and economically marginalised, fishermen community produce better outcome through the participation in community based adaptation measures. And CBA is best source to reduce the development gaps.

Understanding of social structure of the community and nature of their livelihood is important when designing the adaptation policies. There are many non-economic factors which play crucial role in their decision making. Leaving the coast for a traditional fisherman is equivalent to leaving his trade. That's the major reason why Kerala government struggles to rehabilitate them to non-sea geographies or to implement NRZ, 2011 or 2019. Thus, adaptation strategies planned for traditional and mechanised fishermen should vary. Every adaptive policy by the government has to be location specific and more over stake holders' participation must be ensured.

CHAPTER 5

CONCLUSION

5.1 Introduction

In this blue planet with two third of water, a thread that connects oceans to the land is the coastline. With global warming, oceans began experiencing acidification and rising water level which is causing transgression or sea forwarding, increased flooding, coastal erosion, submergence and destruction of coastal ecosystem. It also distresses the socio-cultural structures associated to the ecosystem. Hazard impacts have differentiated effect on the public based on the inequalities and vulnerabilities one experience, even when the hazard has universal exposure. This study has looked into the vulnerability and adaptation strategies of marginalised marine fishing communities.

The marine fishing communities of Kerala were segregated by caste from vedic period, with limited mobility and social interactions fisheries remained a subsistence occupation. Mechanisation after independence gave wings to the fisheries. Fisheries became major source of foreign exchange, but over-fishing and mechanised fishing contributed to resource depletion and dwindling production. More than 50 per cent of fishermen still continue to fall below the poverty line category. The structural vulnerabilities of the past and occupational vulnerabilities advanced their current socio-economic vulnerabilities. Another factor which induced their susceptibility is the climatic variations. Increased intensity and frequency of hazard events have undone the economic growth the regions attained. This was experienced by the marine fishermen of Kerala in the 2004 tsunami and 2017 cyclone Ockhi.

Adaptation strategies of individuals or a community are directly related to their adaptive capacity or agency to adapt. So, developmental gaps in a community can transform into adaptation gaps. When a marginalised community adapt, their past and present vulnerabilities, political hold or representation, efficiency of local governance system etc can influence those decisions. To enhance the coping capacity of marine fishing community their livelihood needs, development needs and existing inequalities should be addressed.

To understand the dynamics of various vulnerabilities and adaptation policies in the selected regions, the study set forth three research questions. Each research question has been answered in individual chapters. The first question is what are the impacts of mechanization

and resource depletion on the vulnerability of marine fishing communities? To answer this, a detailed study of marine fisheries history has been done on a decadal basis. The second question pertaining to vulnerability is what are the determinant factors of vulnerability among marine fishermen? And why does income based vulnerability assistance fails? To answer this, chapter 3 provides in-depth investigation of various types of vulnerabilities existing in the field and identifies the major factors triggering vulnerability among marine fishing communities of Kerala. The chapter also critically examines income based relief package distribution methods. The final research question is how does a marginalized community adapt to coastal hazards and what are the factors influencing their adaptation decisions? The forth chapter of the study provides a clear answer to this by collecting various adaptation strategies practiced in the field and by critically examining each one of them.

The area of study selected to answer the research questions are Anchuthengu panchayat of Thruvananthapuram and Alappad panchayat of Kollam distrcts. Both the panchayats are victims of major disasters (tsunami of 2004 and cyclone Ockhi of 2017) with in the past two decades and face extreme coastal erosion. The study has 2 questionnaires, one at household level and one at individual level to fulfil the data requirements. Questionnaire at the individual level was to collect data regarding occupational vulnerability among fishermen. In total the study collected 302 household samples and 50 fishermen specific samples. Though unit of scheduled questionnaire was individuals, each individual interviewed represented different fishing units/vessel. After identifying the panchayats, for sample selection purposive sampling was used for fishermen specific questionnaire and random sampling for the household questionnaire.

The methodology used in answering each research question varied. For chapter 2, decadal data analysis regarding marine fisheries history is executed through literature review and the gaps were filled with anecdotes from the study area. For chapter 3, structural vulnerability is analysed from oral history as well as from literature. Occupational vulnerability is purely the perspective of active marine fishermen collected through personal interviews and the data for socio- economic vulnerability is from household questionnaire. Critical analysis of income based vulnerability assessment is done from Kerala disaster management authority's report on Ockhi relief packages. For the forth chapter various adaptation strategies are identified from the field through questionnaire data. Critical assessment of planned adaptation is performed on the basis of field observations and review of existing literatures.

5.2 Findings

Chapter 2

The two major problems contributing to the occupational vulnerability of Marine Fishing Community in the coastal Kerala are resource depletion and rising frequency and intensity of coastal hazards. Resource depletion is partially due to anthropogenic hazards by unregulated mechanisation and overfishing from mid-1970's (Kurien, 1990). Marine fishermen of Kerala followed traditional fishing practices until the introduction of small trawlers through the Indo-Norwegian project. Thereafter Kerala witnessed phenomenal increase in the number of trawlers as the demand and value for prawns skyrocketed in the international market. Increased production was not through boosting productivity instead many invested in larger trawlers and new gear and traditional fishermen increased their collection by introducing new variety nets (Kurien, 2004). Major investors in large trawlers were non-fishermen, who had no experience or skills in fishing and were not used-to with the culture and ethos of marine fishing community. The open access nature of fishery could not stop the entry of these 'outsiders' into the fish economy which led to unsustainable practices in marine fishing and eventually resource depletion.

Chapter 3

Rising ocean temperature is another reason for resource depletion as well as frequent and intense coastal hazards (Taherkhani, Vitousek, Barnard, Frazer, Anderson, & Fletcher, 2020). Sea level rise transforms into coastal hazards with wetland loss, salinity intrusion, flooding and erosion as its implications (IPCC, 2014). And rising temperature leads to resource depletion as it can affect the seasonal activities, migration pattern and geographical range of fish species (IPCC, 2014). Fishermen during the interview claimed with high confidence that compared to past 10 years they experience temperature hike and more humid winds as they travel towards deep sea. They have also observed the disappearance of 3-4 fish species which were widely available in the past, and changes in the expected catch composition during different seasons.

Along with climate and occupational vulnerability what contributed to the vulnerability of fishermen community is the reminiscence of historic social structures. Their identity as 'untouchables' in the caste system restricted their mobility, social interactions and thereby expansion of trade. For fishermen of south Kerala, their acquired identity as 'real' fishermen

restricted themselves from practising machine oriented mechanised fishing, it continues even today in Thiruvananthapuram district upon sustainability concerns. Being in the geographical margins with delay in organising trade unions, they were neglected and remained 'outliers' of Kerala model of development. Therefore today they lag behind the mainstream in health, educational achievements, physical infrastructure and economic wellbeing.

The coastal vulnerability index constructed to find the degree of influence of each selected indicator to the vulnerability of the community has given the result that Anchuthengu panchayat experience greater vulnerability compared to Alappad, given the socio- political and occupational differences. The identified drivers of vulnerability common in marine fishing villages are poverty, high borrowings, low savings, dependency on natural resources, low participation of women in workforce, high proportion of dependent population, lack of political representation and proximity of the community to the sea. Vulnerability aggravating factors specific to Anchuthengu panchayat is the infrastructural deficiencies. Poorly constructed houses and roads, inaccessibility to schools and formal credit sources and landlessness with high density of population makes them extremely susceptible to externalities. These indicators of vulnerability are greatly associated to the inefficiency of local governing bodies over a period of time.

The identification of drivers of vulnerability gave insights into the fallacy of monetary compensations and income based relief packages to the hazard victims. Income based assessment of hazard impacts are biased and they only re-establish the pre-existing inequalities in the society. When the absolute economic vulnerability to the hazards is emphasized, the need for structural changes is neglected. To make it clear the study conducted an assessment of cyclone Ockhi relief assistance pattern and finds that absolute economic vulnerability only reiterate that those with more income are more vulnerable to hazards. Therefore, the study comes to the conclusion that every hazard should be considered as an opportunity to build adaptive capacity among coastal communities so that they have better resilience to face future hazards.

Chapter 4

Socio-economic and educational backwardness of the population is imprinted on the adaptation strategies they practice. In both panchayats households are passive to the protection oriented measures of adaptation. Given the scale of hazard incidence they identify

themselves as resource scarce to respond to the adaptation needs at household level. As a community, coastal population actively participates in adaptation strategies, but majority of those strategies are livelihood centric. Other than fishing related strategies, high participation is observed in communal pooling decisions like self help group participation and sharing of wedding expenditure. Therefore to build better adaptation strategies adaptive capacity of the people needs to be boosted with structural interventions.

Adaptation strategies by the Kerala government on coastal protection always focused on engineered structures. From literature the study traced the history of engineered structures to 1890 (Moni, 1972).These engineered structures have in-built problems. Bottom scour process by waves can eventually destroy sea walls, and groynes by nature of construction itself cause erosion in one side and that needs to be corrected with sand bypassing. Public understanding of these constructions are vivid, it has developed uncertainties among them. But in general public is of the opinion that engineered structures alone would not regulate the erosion, if it could their coasts would not be constantly eroding. Some community members pointed fingers on the implementing institutions; they claim that fund crunch and unscientific constructions fails the structures and not the structures themselves. Uncertainty regarding these structures continues but they provide sense of protection to the community members.

The impact of beach erosion and engineered structures among the community members were dissimilar. Women and elderly had to face the major brunt as the traditional fishing practices were destroyed by it. With the sea walls blocking access to sea, shore seine disappeared from the coasts and those elderly fishermen who are physically unable to venture into sea and participated in shore seine activities became economically dependent. In the same manner with beach erosion fish drying and prawns peeling on the beach by women are vanishing. This limits the earning possibilities of fisherwomen who are already banned from fishing by the community customs. Their economic dependency needs to be read along with the fact that women and elderly are more vulnerable to climate related shocks.

From the field analysis the study finds that factors determining effective adaptation are income, education, public action and good governance performances of the community. Income and education determines the adaptive capacity of the population, public action ensures that their voices are heard by the policy makers and politicians and only efficient governing bodies can gain trust and guide a marginalised community to take up mutually beneficial adaptation strategies. In order to rectify the mal-adaptation or any adaptation gap in

the field, all the past and present social structures and policies linked to these variables need to be addressed.

5.3 Policy Implications

The study proposes few region specific policy suggestions which can reduce the vulnerability and produce better adaptation results among marine fishing communities. First and foremost the basic infrastructural needs (water, health, sanitation, and education) of the community should be addressed. The landless, those living in 'poramboke' land of government and those who lost houses in coastal erosion and continues to pay land tax, should be included in the LIFE mission (Livelihood Inclusion and Financial Empowerment) policy of Kerala's current government which promises 3 cents of land to all landless in the state. Formal credit system should be encouraged by making it more fishermen friendly. Traditional fishing practices should be promoted and mechanized fishing regulated to ensure the sustainability of fishery. Warning mechanisms should be strengthened and GPS should be provided to all fishermen as better connectivity reduces hazard risks and it would be easier to trace the missing boats. For reducing the impact of hazards, more bridges should be constructed to ensure better mobility with neighboring panchayats. Financial assistance should be provided to households to concrete their house roofs as tiled and thatched houses are extremely vulnerable to hazards. Maintenance of the engineered structures should be done by local governance body as private agencies are vulnerable to corruption. In short coastal adaptation policies should take a holistic developmental approach to reduce the hazard impacts as more resourceful the people are, better would be their adaptation capacity.

5.4 Limitations

Dynamics of vulnerability is better understood with cross sectional time series data, with limited time and resources, the study could not conduct repeated surveys. The study is purely anthropocentric and does not incorporate impact of coastal hazards on the physical geography, ecology and livestock population. Also the study has not looked into the impact of geophysical changes on the adaptation strategies. A GIS mapping of the region would have given a better picture of the geographic vulnerability.

The thesis can widen its scope by providing a gender perspective to the analysis of vulnerability and adaptation assessment and also by narrating how the historic social structures are connected to their present vulnerability by assimilating the existing oral history.

Also the role of government in re-establishing inequalities after every hazard through income based relief package grabs the attention for a further detailed study.

5.5 Conclusion

With this briefing the study concludes that hazard adaptation policies should focus on people than technology. While adapting to hazards, coastal communities are forced to accommodate the changes made by the techno-centric solutions in their adaptation strategies. In the absence of indigenous community participation in policy formulation, a foreign 'technical' solution can endanger their livelihood and even the culture of the land. Thus community members should be heard. Traditional knowledge of the community are evolved with trial and errors through centuries and developed based on the regional geography for the community sustenance. Therefore, that knowledge should be incorporated in adaptation policy formulation as the community themselves understands their problems and needs better.

Vulnerabilities a community experience are reflected on their adaptation practices, for better adaptation, factors leading to vulnerability among the community members should be addressed. For which mere monetary relief packages are not sufficient, structural changes are required. For example addressing the vulnerability among fishermen community requires poverty reduction, employment generation, skill development, infrastructural development, and political representation from the community. For vulnerability reduction region or community specific adaptation policies are a necessity as vulnerability triggering factors in various regions differs. The field study exposed that even among the marginalised fishing communities of neighbouring districts, factors triggering vulnerability varied, Anchuthengu experiences greater vulnerability due to structural inadequacies. Thus at the panchayat level local governing bodies should be given more power, fund and space to formulate adaptation policies which could accommodates the community culture and other social fabrics. This is more relevant in case of fishing community as their livelihood practice itself is community based.

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Appendix –I

Household Level Questionnaire

Name of the Study: Vulnerability and Adaptation Assessment of Coastal Hazards: Study of Marine Fishing Communities in Southern Kerala
Abstract:
Date of Survey:
Place of Survey:
Type of Survey: Rural
Number of Respondents: 302
Conducted by: Research Scholar, School of Economics, University of Hyderabad.

Vulnerability and Adaptation Assessment of Coastal Hazards:

Study of Marine Fishing Communities in Southern Kerala

SCHOOL OF ECONOMICS
University of Hyderabad, Hyderabad – 500 046

S.No _____ Date: ____/____/2011 Ward No: Name of Interviewer: _____

1. BASIC HOUSEHOLD CHARACTERISTICS

HH Size 1.1	Religion 1.2	Social Group 1.3	Ration card 1.4	APL/BPL 1.5

2. BASIC PARTICULARS OF THE HOUSEHOLD MEMBERS

Sl. no: (2.1)	Name (2.2)	Sex (2.3)	Age (2.4)	Marital Status (2.5)	Activity Status (2.6)	If fishing, then specify occupation (2.7)	Highest Education Level (2.8)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Item 2.3: Female-1; Male-2; Transgender-3.
Item 2.5: Married-1; Unarried-2; Widowed-3; Divorced-4.
Item 2.6: Fishing-1; Self-Employed- 2; Regular wage/ salaried-3; Casual wage labourer-4;Student-5; Housekeeping-6; Unemployed-7; Pensioner/retired-8; physically unable to work-9.
Item 2.7 If fishing; crew in trawler-1; crew in motor boat-2; traditional fisherman-3; boat owner cum crew-4; owner-5; processing work-6; marketing work-7.

SOCIAL VULNERABILITY MATRIX (Socio-Economic Status- Economic Status)

3. Asset Ownership (House, land, vehicles, business, fishing equipment)

3.1. House: ( ) Own ( ) Rented ( ) Parents/relatives ( ) own but part of rehabilitation project

3.2. House: ( )Pakka ( ) Semi Kacha ( ) Kacha

3.3. House: ( ) Single storey ( ) Multi Storey

3.4. Floor: ……

3.5. Since how long are you staying in this house?.....locality?.....

3.6. How far is your house from sea?

……

3.7. Do you own any land in this region? ( ) Yes ( ) No

3.8. If Yes, Land size:

……..

3.9. Do any of the family members own a business outlet here? ( ) Yes ( ) No

3.10. If Yes, which type? () No () small () medium

3.11. How many family members are participating in business?.....

3.12. Monthly income earned from business outlet:……

3.13. Do you have any vehicles? ( ) Yes ( ) No

3.14. If Yes, what are they? ( )Cycle ( )Bike ( ) Car/Jeep ( )Tempo/Business Utility vehicle

3.15. Have you rented it or bought it on loan?

3.16. Does your family own any fishing equipment? ( )Yes ( ) No

3.17. If Yes, which type? ( ) Kattamaran ( ) Traditional with out board engine ( ) mechanised boat ( ) Shore Seine ( )

Others……..

4. Earning Pattern of the House Hold

4.1. Total earners: Male: ☐ Female: ☐ Total: ☐

4.2. Monthly Household Income

Source	Income
Fisheries	
MNREGA	

4.3. Monthly Consumption Expenditure

ITEMS	AMOUNT
Essential Food Items	
Education	
Transportation (travelling, petrol, diesel)	
Telephone, electricity, water charges	
Pan, tobacco, liquor & other intoxicants	
Others (rent, legal expenses, clothing, bedding)	
Medical expenditure	

5. Savings Debt & Insurance Pattern

5.1. How do you manage your excess expenditure? ( )Income ( ) Savings ( ) Borrowings ( ) Mortgage

5.2. Do you have any savings?

5.3. Do you have any borrowings?

5.4. If Yes, Source? ( ) relatives ( ) money lenders ( ) loan from bank ( ) mortgages ( ) others……

5.5. What's the rate of interest you pay?

5.6. Do you have any Insurance?

5.7. If yes which type? ( ) health ( ) fishing accident ( ) others

5.8. From where have you taken insurance? ( ) govt. ( ) pvt.( ) matsyafed.

6. Social Safety Nets / Social Security Benefits

Type of Benefit (6.1)	Y/N	Agency	Type of Agency Panchayat: 1 Marsyafed:2 NGO:3 FISHCOPFED:4 Others:5
Housing			
Toilet			
Well			
Fishing Equipment			
Old Age Pension			
Free Ration			
Savings cum Relief programme			
Widow Pension			
Other			

7. Entitlement Programmes

7.1. Are you participating in any govt. capacity development/training programme?

7.2. Does anyone in your family got job after such training programme?

8. Community Life

8.1. When you need, do you get help from the society?

8.2. Are you participating in any social activities?

8.3. How depended are you to the community? () less () medium () highly

Social Organisations	Year of Joining	Current Status	Main activity of the organisation involved
		Active:1; Passive:2; Non Member:3; Others:4	
Self Help Groups			
Credit Co-operatives			
Marketing Co-operatives			
Other Co-operatives			
Fishermen Organisation			
Religious			
Sports & Arts Club			
Political Organisation			
Trade Unions			
Others, specify			

9. Potential Employment Loss during disaster

9.1. No. of days employed in a regular month? OR No. of times went for fish catch?

9.2. No. of times fishing possible during monsoon/June-July?

9.3. No. of days employed right after flood/monsoon month (to know the pace of recovery)

10. Infrastructure & Lifelines (Bridges, water, communication, transport)

10.1 Source of light? ( ) Electricity ( ) Kerosene lamp ( ) others

10.2 Source of cooking energy? ( ) LPG ( ) wood ( ) others

10.3 Source of drinking water? ( ) well ( ) pipeline ( ) others

10.4 What are the drinking water schemes in panchayat?

10.5 Do you get good quality water (color/taste) & sufficient quantity?

10.6 What are the ways in which disaster gets communicated to you?

10.7 What are the equipments used for communication while fishing? () mobile () GPS () Echo sound () Others

10.8 Are they adequate to provide you hazard warning?

10.9 Do you have any transportation facility to reach harbour?

10.10 Additional time/cost/sleep disturbances for commutation?

10.11 Are you dependent on inland water transportation?

10.12 How secure is it during the period of sea erosion?

11 Health Infrastructure

11.1. Kinds of sickness you face during monsoon season?

11.2. Does anyone in your family is terminally ill?

11.3. Do you have a primary health care centre/hospital within 3kms of your area?

11.4. Does the hospital have adequate doctors/nurses/medicine/other facilities?

11.5. Does the hospital get affected during monsoon?

12. Special Need Population (terminally ill/challenged/aged)

12.1. Do you have a differently abled family member?

12.2. If yes, how do you meet the medical cost?

13. Political Participation

13.1. Do you participate in election?

13.2. Have you cast your vote in last election?

13.3. Has any member of your community become an MLA/MP in past 20 years?

13.4. Do you think that your voices are heard?

14. Direct Impact of Coastal Hazards& Resilience measures

14.1 Have you been affected by coastal hazards?

14.2 Any life/asset/livelihood loss?

14.3 Have you faced sea intrusion last year?

14.4 As your livelihood depends on sea, how do you meet your expenses during monsoon?

14.5 Have you ever been evacuated/rehabilitated from coastal area?

14.6 Have you experienced any change in property value over time?

14.7 What can be the reason for change in property value? ( ) Mineral mining ( ) high demand ( ) coastal erosion ( ) others

14.8 What do you do to secure your life and property?

14.9 Have you taken/ intend to take any precautionary measures to protect your H.H/ Business from sea erosion?

If No, Why so?.....

15. Direct Impact on Fish processing

15.1. What are the various fish related activities practiced on shore? () fish drying () fish processing () collecting the small fishes () shore seines/kambavala.

15.2. Which gender/age group is more affected by the shore line loss? ( ) elderly ( ) adults ( ) children; ( ) men ( ) women

15.3. How do you balance this gap? Any alternative?

16. Impact of Salination

16.1. What are the effects of salination on land & property? () crop failure () lower productivity of soil () others…….

16.2. What are the effects of salination of drinking water?

16.3. What are your remedial measures? () change in crop…….

17. Impact of Adaptation Policies

Structural Measures (Groins & Sea wall)

17.1 Does the construction of Sea Wall &Groyance have any effect on your life?

17.2 Problems you face due to lack of direct access to sea?
( ) no more traditional fishing practises ( ) loss of traditional fishing related jobs ( ) dependence on larger boats for fishing ( ) additional travelling expense to reach harbour ( ) no more community level fishing on the shore ( ) others

17.3 Effectiveness of sea wall: () reduce the erosion ()no impact ()more erosion

17.4 Effectiveness of Groynce: () accretion of soil ()greater erosion () no impact

Non-Structural Measures (CRZ)

17.5 Are you aware of CRZ policy?

17.6 Do you face any difficulty from panchayat in reconstruction of your house?

17.7 Do you want more business establishments in your locality?

17.8 Are you willing to relocate from this region (knowing all the potential risk of erosion), if gov. provides you housing and property in non-coastal area? If No, why?

17.9 Do you prefer to live near to the sea? If yes, why?

17.10 Various adaptation strategies among members of the fishing community

Mobility	**Storage**	**Diversification**	**Communal pooling**	**Market exchange**
Migration	Drying fish	Season based fishery	Micro credit group	Borrowing money
Shifting from		Occupational shift	Wedding exp sharing	Selling labour
Traditional fishing		Parallel occupation		Mortgaging assets
Ground				

18. Perceptions: Have you observed any change in the intensity of monsoon wave height/coastal erosion over time? ( ) Increased ( ) Decreased ( ) Remains same

Appendix –II

Fishermen Specific Questionnaire

Name of the Study: Vulnerability and Adaptation Assessment of Coastal Hazards: Study of Marine Fishing Communities in Southern Kerala
Abstract:
Date of Survey:
Place of Survey:
Type of Survey: Rural
Number of Respondents: 50
Conducted by: Research Scholar, School of Economics, University of Hyderabad

Basic Details

1. Type of fishing engaged in: () Traditional ()Motorized ( )Mechanized ( ) Shore seine
2. Ownership of the boat: () Own () Rented individually () co-operative ownership () worker/crew

Employment Details

3. No. of fishing days & Income

	No. of fishing days in a month	Fish Verities	Income
March-May (Pre-Monsoon):			
June-August (Monsoon):			
Sep-Nov (Post Monsoon):			
Dec-Feb (Calm season):			

4. What kind of fish species do you target?

5. Why target these species?

Abundant and widely available	1. Yes 2. No
More income from these species	1. Yes 2. No
Gear/materials are available	1. Yes 2. No
More demand for the fish in local area	1. Yes 2.No
Other reasons (specify)	1. Yes 2 No

6. How many days do a fishing trip takes? ( ) 1 ( )……

7. Reason for long fishing trips? ( ) Non availability of targeted species () to fill the targeted quantity ( ) others-specify.

Employment Mobility

8. At what age have you started fishing, as a job?

9. Have you ever tried for an alternative job? Why?

10. What job can you take as an alternative to fishing?

11. Do you prefer a stable income job over fishing?

Resource Depletion

12. Changing pattern of fish species

Species	Increased/Decreased/ No change	Reason	Reason Motorisation-1 Species moved to other location-2 Destructive fishing-3 Modern tech. fishing-4 Unfavourable Climate-5 Others(specify)-6

13. Is depletion prominent in () inshore area () territorial water () others?

14. Do you think that resource depletion is affecting the day to day life of fishing community? ( ) Yes ( ) No.

Why?.....

……

15. How do you manage the situation of fish stock depletion?

…….

Impact of climate variations on fisheries

16. Have you noticed any change in the fishery during the last 30 years? Y/N

Are you forced to travel farther than earlier for attaining the targeted quantity?

Have you observed stock depletion in some fish species?

Do you think that reduction in Mackerel stock is due to rising sea temperature or ocean acidification?

17. If yes, what component of the fishery you have been observed in changing**?**

	Changes (17.1)	Reason(17.2)
Total fish catch		
Catch composition of various fish		
Fish aggregation migratory/ spawning pattern		
Average fish size		

17.1: Increased -1; Decreased-2; No changes- 3; Don't Know-4

17.2: Over fishing-1; resource depletion-2; climate variation/weather uncertainty-3; migration of fishes to cooler areas-4; Heat waves-5; Pollution-6; Wind patterns-7; Sea currents-8; Increase in sea temperature-9; others-10

18. Does any of these changes are seasonal/occur only in particular season?

19. Cost of fishing operations (Mechanised boats)

Fishing operations	Pre monsoon	Monsoon	Post Monsoon	Calm season
Diesel oil consumption in liters				
Distance travel in Kms				
Average kg of fish available per trip				
Average kg of prawn available per trip				
Average price per kg of fish obtained				
Average price per kg of prawn obtained				
Ice per trip In quantity (kgs)				
Cost of ice per kg in Rs.				
Labour cost per trip				
Income per trip in Rs.				

Fishing operations	5 years back	10 years back	15 years back	Remarks
Diesel oil consumption in liters				
Per litre cost				
Distance travel in KMs				
Average kg of fish available per trip				
Average kg of prawn available per trip				
Average price per kg of fish obtain ed				
Average price per kg of prawn obtained				
Ice per trip In quantity (kgs)				
Cost of ice per kg in Rs.				
Labour cost per trip				
Income per trip in Rs.				

20. Changes over time

Particulars	5 years back	10 years back	15 years back	Remarks
Water level				
Wind power				
Temperature				

21. Perception on climate change impacts

Perceptions on	Yes	No
Changes in fish breeding cycles		
Fish production and survival rates		
Fish migrated to other places for food and cooler places		
Decline in fish production		
Sea coast erosion		

Future outlook

22. What would be the status of fishing in future as an occupation? ( ) better ( ) worse ( ) no change ( ) why
……
23. Do you want your children to take up fishing as their occupation? Y/N
why?.....
24. Do you think in future your children would be FORCED to take up fishing as their occupation? Y/N Why?.....

Others

25. Whether traditional/mechanised fishing is beneficial for you?
26. Does the construction of sea wall/groynes is affecting the fishing?
27. If yes, how? () accidents () traditional job loss
28. How the traditional job loss affected community life?
29. Have you taken any loan/borrowed money for fishing needs?
30. Other than fishing do you use any other resource from sea for livelihood like catching crabs/oysters?
31. Did you change your fishing techniques in the years that you have been fishing?
32. If yes, what changed and why?
33. What is your understanding of climate change/ climate variation?
34. Have anybody conducted awareness programmes for you on climate change and adaptive measures to be taken?
35. If yes, who conducted the awareness camps ?

    1. NGO 2. Govt. Agencies 3. Community leaders
    4. Co-operative society 5. Others (specify)

36. Did you attend the Programme?1.Yes 2.No

Appendix –III

Cyclone Ockhi District wise House Damage Estimates

Table 1: District wise house damage estimates (Amount in crores)

District	Pucca houses				Huts	
	Fully Damaged		Severely Damaged		Fully Damaged	
	No	Amount	No	Amount	No	Amount
Thiruvananthapuram	121	6.05	256	12.8	100	1
Kollam	12	0.6	67	3.35	35	0.35

Source: (Government of Kerala, 2018)

Appendix –IV

Calculation of Coastal Vulnerability Index

Dimension 1: Social & Demographic Structure Indicators Value

Social Category (+)

Percentage of population in Backward Social Category= $\frac{\text{Backward Category population}}{\text{Total population}} * 100$

Anchuthengu

Backward Category population = 151 OBC households
Total population= 151 households
Percentage of population in Backward Social Category = 151/151*100= 100%

Alappad

Backward Category population = 150 OEC households + 1 SC household
Total population= 151 households
Percentage of population in Backward Social Category = 151/151*100= 100%

Normalization of Indicator Value

Dimension Index= $\frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$

Anchuthengu= 100 – 0/ 100-0= 1

Alappad= 100 – 0/ 100-0= 1

Indicator Value	Anchuthengu	Alappad
	1	1

Rural/Urban (+)

Percentage of Rural population = $\frac{\text{Population in Rural Area}}{\text{Total population}} * 100$

Anchuthengu

Population in Rural Area= 151 households
Total population= 151 households
Percentage of Rural population= 100%

Alappad

Population in Rural Area =151 households
Total population= 151 households
Percentage of Rural population= 100%

Normalization of Indicator Value

$$\text{Dimension Index} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

Alappad= 100 – 0/ 100-0= 1
Anchuthengu= 100 – 0/ 100-0= 1

Indicator Value	Anchuthengu	Alappad
	1	1

Larger Households (+)

Percentage of Larger households= $\frac{\text{No.of families with Household size} \geq 5}{\text{Total Number of Households}} * 100$

Anchuthengu

Percentage of Larger households = 53%

Alappad

Percentage of Larger households = 24.6%

Normalization of Indicator Value

$$\text{Dimension Index} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

Anchuthengu= 53-0/ 100-0= 0.53

Alappad = 24.6-0/ 100-0= 0.2

Indicator Value	Anchuthengu	Alappad
	0.53	0.25

Dependent population (+)

Percentage of dependent population = $\frac{\sum \text{population(aged} < 15 + aged \geq 60)}{\text{Total population}} * 100$

Anchuthengu= 21.2%

Alappad = 15%

Normalization of Indicator Value

$$\text{Dimension Index} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

Anchuthengu= 21.2-0/ 100-0= 0.21

Alappad = 15-0/ 100-0= 0.15

Indicator	Anchuthengu	Alappad
Value	0.21	0.15

Special Needs Population (+)

Percentage of special needs population= $\frac{\text{(Terminally ill + Differently abled population)}}{\text{Total population}} * 100$

Anchuthengu= (12+10)/739 *100= 2.98%

Alappad = (19+12)/613 *100 = 5.06 %

Even with better education, health and socio economic status, people in Alappad face more terminal illness and disability. Many studies associate this with the mineral mining on the field.

Normalization of Indicator Value

Dimension Index= $\frac{\text{Actual Value – Minimum Value}}{\text{Maximum Value – Minimum Value}}$

Anchuthengu= 2.98-0/ 100-0= 0.03

Alappad = 5.06-0/ 100-0= 0.05

Indicator	Anchuthengu	Alappad
Value	0.03	0.05

Single parent headed households (+)

Single Parenting Households= Single Female Headed Households (SFHH) +Single Male Headed Households (SMHH)

Percentage of Single parenting households= $\frac{\text{No.of SFHH + SMHH}}{\text{Total no of households}} * 100$

Anchuthengu= (15+1)/151 *100= 10.60

Alappad= (5+1)/151 *100= 3.97

Normalization of Indicator Value

Dimension Index= $\frac{\text{Actual Value – Minimum Value}}{\text{Maximum Value – Minimum Value}}$

Anchuthengu= 10.60-0/ 100-0= 0.106

Alappad = 3.97-0/ 100-0= 0.04

Indicator	Anchuthengu	Alappad
Value	0.11	0.04

Average age of head of the households (+)

Average age of head of the households= $\frac{\sum \text{Age of head of the household}}{\text{Total Households}}$

Anchuthengu= 49.61 years

Alappad= 50.31 years

Normalization of Indicator Value

Dimension Index= $\frac{X^{-} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$

Anchuthengu =

Minimum value= 27 years
Maximum value= 77 years
Index Value = 49.61- 27/ 77-27= 0.45

Alappad

Minimum value= 26 years
Maximum value= 72 years
Index Value= 50.31-26/ 72-26= 0.53

Indicator	Anchuthengu	Alappad
Value	0.45	0.53

The Infant Mortality Rate (IMR) (+)

Infant mortality rate = $\frac{\text{Number of infant deaths during the year}}{\text{Number of live births during the year}}$X 1000

Table 3: Infant Mortality Rate

	Rural	Urban	Total
Thiruvananthapuram	2.8	5.21	3.71
Kollam	1.6	4.46	2.29
Kerala			5.59
India			34

Source: (Government of Kerala, 2017)

The statistics available is of district level data, with urban – rural segregated. Since both our panchayats come under rural section, we take that particular statistic for calculation of index. Now we will compare the IMR performance of the district with state average, to measure the variable in a scale of 0 to 1.

IMR in Anchuthengu = 2.8 / 5.59 = 0.5

IMR in Alappad = 1.6 / 5.59 = 0.28

Normalization of Indicator Value

$$\text{Dimension Index} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

Anchuthengu = 50 – 0/ 100 – 0 = 0.5
Alappad = 28 – 0/ 100 – 0 = 0.28

Indicator Value	Anchuthengu	Alappad
	0.50	0.28

Dimension 2: Access to Resources

Poverty Level (+)

$$\text{Percentage of population in BPL category} = \frac{\text{BPL card holding households}}{\text{total Households}} * 100$$

Anchuthengu= 141/151 *100= 91.4%

Alappad= 89/151 *100= 57.6%

Normalization of Indicator Value

$$\text{Dimension Index} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

Anchuthengu= 91.4-0/100-0= 0.91

Alappad= 57.6-0/100-0= 0.58

Indicator Value	Anchuthengu	Alappad
	0.91	0.58

Borrowings (+)

Percentage of households in debt = $\frac{\text{No.of households in debt}}{\text{total no.of households}} * 100$

Anchuthengu= 140/151*100 = 93.3%

Alappad= 136/151 *100 = 90.1%

Normalization of Indicator Value

Dimension Index= $\frac{\text{Actual Value – Minimum Value}}{\text{Maximum Value – Minimum Value}}$

Anchuthengu= 93.3-0/100-0= 0.93
Alappad= 90.1-0/100-0= 0.90

Indicator Value	Anchuthengu	Alappad
	0.93	0.90

Savings (-)

Percentage of population with savings= $\frac{\text{No.of households with savings}}{\text{Total no.of households}} * 100$

Anchuthengu= 3/151*100 = 2%

Alappad= 14/151 *100 = 9.3 %

Normalized Value = $\frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$

Anchuthengu= 100 - 2/100-0= 0.98

Alappad= 100 – 9.3/100-0= 0.91

Indicator Value	Anchuthengu	Alappad
	0.98	0.91

Diversity of income sources (-)

Percentage of households with multiple income sources =

$$\frac{\text{No. of households with multiple income source}}{\text{Total number of households}} * 100$$

Anchuthengu

Households with multiple income sources= 45
Percentage of households with multiple income sources= 45/151 *100 = 29.80%

Alappad

Households with multiple income sources= 20

Percentage of households with multiple income sources = $20 \div 151 \times 100 = 13.25\%$

$$\text{Normalized Index Value} = \frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

Anchuthengu= 100- 29.80 /100-0 = 0.70

Alappad= 100 – 13.25 /100-0= 0.87

Indicator Value	Anchuthengu	Alappad
	0.70	0.87

Dependency on Money Lenders (+)

Percentage of Households borrowed from money lenders

$$= \frac{\text{No.of households debted to money lenders}}{\text{Total no.of households}} * 100$$

Anchuthengu= 76/151*100= 50.33%

Alappad= 15/151*100= 9.93

$$\text{Dimension Index} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

Anchuthengu= 50.33-0/100-0 =0.5

Alappad=9.93-0/100-0 =0.1

Indicator Value	Anchuthengu	Alappad
	0.50	0.10

Insurance (-)

Percentage of people who have any form of life or property insurance

$$= \frac{\text{No.of households with Insurance}}{\text{Total no.of households}} * 100$$

Anchuthengu= 128/151*100= 85.4%

Alappad= 141/151*100= 93.4%

$$\text{Dimension Index} = \frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

Anchuthengu = 100- 85.4/100-0 =0.15

Alappad = 100- 93.4/100-0 =0.07

Indicator	Anchuthengu	Alappad
Value	0.15	0.07

Social Security Benefits (-)

Percentage of households availed any SSB $= \frac{\text{Households availed any SSB}}{\text{Total no.of households}} * 100$

Anchuthengu= 148/151*100=98.01%

Alappad= 150/151*100=99.33%

$$\text{Dimension Index} = \frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

Anchuthengu= 100- 98.01/100-0 =0.02

Alappad=100- 99.33/100-0 =0.007

Indicator	Anchuthengu	Alappad
Value	0.02	0.007

Non-Earning members (+)

Percentage of non earning members=100 - Percentage of earning members

Percentage of earning members =

$$\frac{\sum (fishing + \ casual\ wage\ laborers + \ self\ employes + \ regular\ wage\ laborers)}{Total\ population} * 100$$

Anchuthengu= (252+22+23+14)/739 *100 = 42.20%

Alappad= (175+1+5+17)/613 * 100= 32.30%

Percentage of non earning members

Anchuthengu= 100 - 42.20= 57.80%

Alappad=100- 32.30= 67.70%

$$\text{Dimension Index} = \frac{Actual\ Value - Minimum\ Value}{Maximum\ Value - Minimum\ Value}$$

Anchuthengu= 57.8 -0/100-0 =0.58

Alappad=67.7-0/100-0 =0.68

Indicator	Anchuthengu	Alappad
Value	0.58	0.68

Participation of women in labour force (-)

Percentage of women in the overall workforce = $\frac{Women\ in\ the\ overall\ workforce}{Total\ population} * 100$

Anchuthengu= 26.05%

Alappad = 5.55%

Normalized Value = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Anchuthengu= 100- 26.05/ 100-0= 0.73
Alappad = 100-5.55/ 100-0= 0.94

Indicator	Anchuthengu	Alappad
Value	0.73	0.94

High school passed population above 15years (-)

Percentage of high school pass outs above 15= $\frac{Population\ above\ 15\ passed\ high\ schoo}{Total\ population} * 100$

Anchuthengu= 38.02%

Alappad = 79.7%

Dimension Index= $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Anchuthengu= 100- 38.02 /100-0 =0.62

Alappad=100- 79.7/100-0 =0.20

Indicator	Anchuthengu	Alappad
Value	0.62	0.20

Ownership of land (+)

Percentage of land holding population = $\frac{Land\ holding\ households}{Total\ households} *100$

Anchuthengu= 130/151*100= 86.1%

Alappad= 144/151*100= 95.4%

Dimension Index= $\frac{Actual\ Value - Minimum\ Value}{Maximum\ Value - Minimum\ Value}$

Anchuthengu= 86.1 – 0 /100-0 = 0.86

Alappad=95.4 – 0 /100-0 = 0.95

Indicator	Anchuthengu	Alappad
Value	0.86	0.95

Local community support (-)

Percentage of community cooperation= $\frac{Cooperating\ Household}{Total\ Households} * 100$

Anchuthengu= 123/151*100= 81.5%

Alappad= 145/151*100= 96%

$$\text{Dimension Index} = \frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

Anchuthengu= 100- 81.5 /100-0 =0.19

Alappad=100- 96 /100-0 =0.04

Indicator	Anchuthengu	Alappad
Value	0.19	0.04

Political representation from the community in past 30-50 years (-)

Percentage of political participation = 0

$$\text{Dimension Index} = \frac{\text{Maximum Indicator Value} - \text{Actual Indicator Value}}{\text{Maximum Indicator Value} - \text{Minimum Indicator Value}}$$

Anchuthengu= 100 -0/100-0 = 1

Alappad=100-0/100-0 = 1

Indicator	Anchuthengu	Alappad
Value	1	1

Dimension 3: Built Environment

INFRASTRUCTURAL INDEX

Methodology

The data on infrastructure or the selected indicators for the index construction is from Panchayat level statistics (2011) of both the districts. Presence of the given infrastructure within one kilometer proximity is marked as 1 and instead of marking absence as zero, a common practice; present study has followed the methodology of (Mishra, 2012). In his study the author has taken distance at which nearest facility available as denominator and

normalized the data. Thus in this study we followed the same pattern to normalize the data. Once the value of indicators are derived, simple average is used to find the composite index value for the infrastructure.

Anchuthengu panchayat

The variables selected for the analysis are drinking water establishments, educational establishments, medical institutions, banking and cooperative institutions, communication establishments, public distribution system establishments and social and cultural institutions. These were the variables given under infrastructural facilities in the panchayat level census statistics.

Drinking water establishments in 1 square kilometer (-)

Drinking water establishments in 1 sq. km.= $\frac{No.of\ drinking\ water\ \square stablishm}{Total\ area\ of\ the\ pnchayat}$

Anchuthengu

Total drinking water establishments= 67

Total area of the pnchayat= 3.36

Drinking water establishments in 1 square kilometer = 67/3.36= 20

Since there is 100% facility available within one sq. km, we are giving it the maximum value of 1.

Drinking water establishments in 1 square kilometer = 1

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Ind\square cator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-100/100-0 = 0

Educational establishments in 1 square kilometer

Educational establishments in 1 square kilometer = $\frac{No.of\ educational\ establi\square hments}{Total\ area\ of\ the\ pnchayat}$

Since the data is available only at block level for Anchuthengu panchayat, we measure it at block level.

No. of educational establishments in Chirayinkeezhu block =17

Total area of the Chirayinkeezhu block = 84.64

Educational establishments in 1 square kilometer = 17/ 84.64 = 0.2

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-20/100-0 = 0.80

Medical institutions in 1 square kilometer

Medical institutions in 1 square kilometer = $\frac{No.of\ medical\ institutions}{Total\ area\ of\ the\ pnchayat}$

Anchuthengu has 1 community health centre, 1 ayurvedic dispensary and 1 homeopathic dispensary.

Medical institutions in 1 square kilometer = 3/ 3.36= 0.9

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-90/100-0 = 0.10

Banking and Cooperative institutions in 1 square kilometer

Banking and Cooperative institutions in 1 square kilometer =$\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Banking and Cooperative institutions in 1 square kilometer = 3/3.36= 0.9

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-90/100-0 = 0.10

Communication establishments in 1 square kilometer

Communication establishments in 1 square kilometer = $\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Two sub- post offices are the communication facility available to the panchayat members, thus

Communication establishments in 1 square kilometer = 2/3.36 = 0.6

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-60/100-0 = 0.40

Public distribution system establishments in 1 sq. km

Public distribution system establishments in 1 sq. km =$\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Panchayat got 15 ration shops and 1 *Maveli* store in total.

Public distribution system establishments in 1 square kilometer = 16/3.36= 4.8

As it suffices the condition of 1 establishment in a square kilometer, indicator gets the maximum value of 1.

Dimension index = $\frac{Maximum\ Indicator\ Value - Act\square al\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-100/100-0 = 0

Social and cultural institutions in 1 square kilometer

Social and cultural institutions in 1 square kilometer = $\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Panchayat has 2 public libraries, 2 reading rooms, 24 Anganwadis, 1 common hall, 3 sports clubs, 2 arts clubs and 1 common television set. As it suffices the condition of 1 establishment in a square kilometer, indicator gets the maximum value of 1.

Social and cultural institutions in 1 square kilometer =1

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-100/100-0 = 0

Alappad panchayat

Drinking water establishments in 1 sq. km

Drinking water establishments in 1 sq. km. = $\frac{No.of\ drinking\ water\ establishments}{Total\ area\ of\ the\ pnchayat}$

Total drinking water establishments= 520

Total area of the panchayat= 7.38

Drinking water establishments in 1 square kilometer = 520/7.38= 71

Since there is 100% facility available within one sq. km, the indicator gets the maximum value of 1.

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-100/100-0 = 0

Educational establishments in 1 square kilometer

Educational establishments in 1 square kilometer = $\frac{No.of\ institutions}{Total\ \square rea\ of\ the\ pnchayat}$

Alappad has 5 lower primary schools, 1 upper primary school, 1 high school, 1 higher secondary and 1 vocational higher secondary. There is 1 educational establishment in every 1 sq.km. Thus the indicator gets maximum value of 1.

Educational establishments in 1 square kilometer = 1

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Va\square ue}$

Indicator Value =100-100/100-0 = 0

Medical institutions in 1 square kilometer

Medical institutions in 1 square kilometer = $\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Alappad has 2 public health centers, 7 family welfare centers, 1 community health centre, 1 ayurvedic dispensary and 3 homeopathic dispensaries. Since there is 1 medical establishment in every 1 sq.km, the indicator gets maximum value of 1.

Medical institutions in 1 square kilometer = 1

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-100/100-0 = 0

Banking and Cooperative institutions in 1 sq. km

Banking and Cooperative institutions in 1 sq. km. =$\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Banking and Cooperative institutions in 1 square kilometer = 5/7.38 = 0.7

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-70/100-0 = 0.30

Communication establishments in 1 square kilometer

Communication establishments in 1 square kilometer = $\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

There are 4 post offices and 1 telephone exchange in the panchayat, thus

Communication establishments in 1 square kilometer = 5/ 7.38 = 0.7

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-70/100-0 = 0.30

Public distribution system establishments in 1 sq. km

Public distribution system establishments in 1 sq. km. = $\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Panchayat has 22 ration shops and 1 *maveli* store. Since there is 1 public distribution establishment in every 1 sq.km, the indicator gets maximum value of 1.

Public distribution system establishments in 1 square kilometer= 1

Dimension index = $\frac{Maximum\ Indicator\ Value - Actual\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100-100/100-0 = 0

Social and cultural institutions in 1 square kilometer

Social and cultural institutions in 1 square kilometer = $\frac{No.of\ institutions}{Total\ area\ of\ the\ pnchayat}$

Panchayat has 4 public libraries, 4 reading rooms, 28 Anganwadis, 1 common hall, and 20 sports and arts clubs. As it suffices the condition of 1 establishment in a square kilometer, indicator gets the maximum value of 1.

Social and cultural institutions in 1 square kilometer = 1

Dimension index = $\frac{Maximum\ Indicator\ Value - Actu\square l\ Indicator\ Value}{Maximum\ Indicator\ Value - Minimum\ Indicator\ Value}$

Indicator Value =100 - 100/100- 0 = 0

Quality of dwelling (+)

Percentage of non-concreted roofs = $\frac{Households\ without\ concrete\ roofing}{Total\ households} *100$

Anchuthengu= 110/151*100 = 72.8%

Alappad= 6/151*100 = 4%

Dimension Index= $\frac{Actual\ Value - Minimum\ Value}{Maximum\ Value - Minimum\ Value}$

Anchuthengu= 72.8 -0/100-0 =0.73

Alappad=4-0/100-0 =0.04

Dimension 4: Spatial proximity to hazards

Percentage of population living in No Development Zone

Percentage of population living in No Development Zone = $\frac{\text{Households in NDZ}}{\text{Total households}} * 100$

Anchuthengu= 149/151*100 = 98.7%

Alappad= 154/151*100= 95.4 %

Dimension Index= $\frac{\text{Actual Value – Minimum Value}}{\text{Maximum Value – Minimum Value}}$

Anchuthengu= 98.7 -0/100-0 =0.99

Alappad=95.4 -0/100-0 =0.95

Coastal length (+)

Coastal length = $\frac{lengthofthecoas}{lengthofthepanchayat} * 100$

Coastal length in Anchuthengu = 100%

Coastal length in Alappad =100 %

Dimension Index= $\frac{\text{Actual Value – Minimum Value}}{\text{Maximum Value – Minimum Value}}$

Anchuthengu= 98.7 -0/100-0 =0.99

Alappad=95.4 -0/100-0 =0.95

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