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**Vulnerability Assessment of Fishing Communities in Kerala,
Towards the Impact of Climate Change-With Special
Reference to Cherai**

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Abstract: The fisheries sector in India and Kerala, though performing well, faces serious challenges such as socio-economic conflicts, low income to the common fishermen, low catch per unit effort, over exploitation of marine resources, unsustainable harvesting and also susceptibility to hazards related to climate change. These affect the production and progress of fisheries sector, which depends on the marine resources. The ill effects of climate change can take many forms including natural hazards, and can affect the livelihood of the farmers economically, socially, environmentally, and even physically. This can be addressed through regulation to over exploitation, diverting the fishermen to other livelihood sectors and by means of active participation of all the stakeholders in increasing the adaptive capacity through sustainable and planned capacity building strategies and development measures. This study deals with the socio economic characteristics of fishermen in Kerala and specifically studies the vulnerability assessment of fishing communities towards the impacts of climate change.

Keywords: Vulnerability, Fishing Community, Climate Change, Sustainability, Fisheries

Introduction

The vulnerability of fishing community towards the climate change, being a subject of great concern all over the world, takes the form of social, economic and even geographical and biological issues. Climate change being the buzzing word of the hour, have gained a lot of attention from all over the world, from all stakeholders, administrators, politicians, environmentalists, scientists, scholars and even the technocrats. The climate change can have the impact on changes in various aspects affecting the fishing activities, namely, the availability, stability, accessibility and utilization. "A coastal area profile presents a variety of information required for effective decision-making and planning, including environmental and socio-economic information and the analysis of problems and opportunities for sustainable coastal development" (FAO,2004).Fishing communities being the most vulnerable in this category, faces a lot of harmful backwash effects of the climate change. Fisheries, being the important contributor of food security and livelihood, are responsible

for providing essential nutrition for 3 billion people and about 50 percent of animal protein for the people of the poor countries. The climate change can have the impact on changes in various aspects affecting the fishing activities, namely, the availability, stability, accessibility and utilization. In 2014-15, the country exported over 10,50,000 metric tonnes of fish to 75 countries, earning over \$5.51 billion to the country. India, being a peninsular country, and fishing, being a major industry of the coastal states which employs over 14 million people, the fishing communities here, are undeniably susceptible to after effects of climate variations.

Fisheries sector plays an important role in the economic activity of the nation, through its contribution to national income, foreign exchange, food and employment. About 12.49 lakh fisher folk operate using diverse types of craft-gear combinations with regional and seasonal variations all along the Indian coastline. It is estimated that fishery and allied activities provide livelihood security to about 30 million people (Sathiadhas et al, 2007). The density of population is relatively more all along the coastline as compared to the other regions like midlands and the highlands.

Kerala was made a leading producer and consumer of fish, due to the presence of a very rich marine wealth with a large variety of fish and a highly skilled population of (Aerthayil, 2000). Kerala, the major coastal state of the nation with 590 km of coastline, having 222 fishing villages and 187 landing centres, also being an important exporter of marine products and host of various fishing communities is also facing a crunch due to both uncontrolled fishing activity, the resultant over exploitation of resources, as well as the effects of climate change. The marine fish production has been over 6.6 lakh tonnes with the people involved the primary and secondary sector amounting to around 2.1 lakhs. Kerala houses a fishermen population of around 6,10,165 with a density of population 2740 people per fishing village which is much higher than the country average of 1099. (Marine Fisheries Census 2010). However, emphasis on mainly technical studies can be linked to the important crisis in the present scenario in which the impacts of climate change affects the fishing sector negatively. The ideas, knowledge, suggestions and propositions are often sidelined. Most of the national level or state level action plans and schemes lack specific emphasis on these issues of the coastal line and the fisheries, thereby increasing the problems already faced by them. They would not be able to avail the benefits of the schemes and thus become further marginalised and susceptible to the growing backwash effects of climate change (Salagrama,2012). The dimensions of poverty can be varied and diverse which includes the low quality and quantity of consumption, and backwardness culturally, socially or politically (Franata, Marwa, Yusuf, 2017).

About infrastructural development required for fisheries sector growth, apart from the basic facilities of road and transportation, power, housing and social infrastructure aspects like health and education, the governments must take it into their utmost concern to provide them with adaptive capacity skills and training sessions too. The roads in coastal regions are mostly susceptible to damage due to coastal erosion and flooding, especially during monsoon. Similarly, the access to transportation and marketing facilities are of utmost importance. For the sector's development, harbours, ports, fish landing centres, processing units and storage facilities, chilled storage facilities, peeling houses, etc. can be set up. Apart from these, logistics and financial support can be provided. Subsidies and financial aids through banks, post office schemes, etc can be provided to ensure the security of poor fishermen's lives.

Vulnerability of fishing communities towards the effects of climate change can be detailed as follows:

Vulnerability is a condition of ‘exposure and sensitivity’ to unfavourable situations or incidents of shocks. Some authors have emphasised the “internal ability or lack thereof to cope, recover and adapt to such stress” (Kasperson et al., 2001). In the social domain it is the disclosure of groups or individuals to stress and crisis as a result of climate variability and change. It complements notions of physical vulnerability to the impacts of natural hazards that concentrate on the physical dimensions of risk (Vijayakumaran, K. 2008). Vulnerability to climate change is defined by IPCC (2007:883) as “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, indicating climate variability and extremes” and is a “function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity”. According to Vivekanandan (2007), the main impact of climate change affecting the marine fisheries were sea level rise and consequent changes in habitat, frequency of extreme events, variability in the catch and revenue. However, the main participants in the climate change adaptation and mitigation process lacks awareness and knowledge, leading to lack of active participation. Their attitude, responses, perceptions and suggestions towards the issues should be considered in every stage to encourage their proactive participation. Climate change induced seasonal variability can have broader consequences, which seeks the world wide attention regarding issues ranging from water pollution, resource depletion to conflicts led by heavy competition for (Romsan, 2017).

Statement of the Problem

The marine fisheries sector in India and Kerala, are facing a lot of issues which are simultaneously deteriorating the ecological balance and sustainability as well as increasing the susceptibility of the fishing community to the harmful impacts of climate change. There is a lack of attempts in analysing how far the objectives of fisheries development have been put into effect for the development of the fisher folk in the background of influences of climate change impacts. The present study is a detailed attempt to analyse vulnerability of the fishing communities towards the climate change impacts, and the objectives fisheries development specifically in terms of public and private infrastructure. The work includes a case study in Cherai village of Vypin, Ernakulam district, Kerala.

Objectives

The study has been undertaken with the major objective of assessing the vulnerability level of fishing community in Kerala towards the impacts of climate change. The following are the specific objectives: To study the socio economic conditions of marine fishing community. Second is to assess the vulnerability level of marine fishing community to the impacts of climate variability and change. And third to study the infrastructural facilities available for the marine fisher folk.

Methodology

Methodology is the description explanation and justification of various methods of conducting research. Cherai village in Ernakulam district of Kerala has been chosen for the study. The study was done through survey by simple random sampling technique. For conducting the field survey a sample size of 60 respondents of fishing community were randomly selected. To assess the vulnerability a focus group discussion among a sample comprising of traditional fishermen, motorised fishermen, mechanised fishermen, local fish

traders, middlemen and fish exporters, was conducted. The study was carried out by Participatory Vulnerability Assessment (PVA) method. This study is mainly based on primary data acquired from field survey and focus group discussion. Common sources of secondary data for social science include census, information collected by government departments, organizational records and data from Cochin Marine Fisheries Resources Institution (CMFRI) Annual Reports, Economic Reviews, Fisheries Department reports, etc. that was collected for research purpose.

Socio Economic Conditions of Fisher Folk

As the world fisheries sector strengthens against the numerous odds, with more produce and income generation, directly contributing to the food security of a majority of the population, in 2016; is responsible for providing essential nutrition for 3 billion people. Globally, If in 2002, out of 38 million total commercial and subsistence fishermen in the world, 74 percent engaged in capture fisheries and 26 percent in aquaculture, there were 38 million commercial and subsistence fishermen and fish farmers all over the world. Of this total, 74 percent are engaged in capture fisheries and 26 percent in aquaculture with a total production of 133 million tonnes, that is an average productivity of 3.5 tonnes per person. In 2006, this increased to 43.5 million and the total fishery production to 143.6 million tonnes with an average productivity of 3.3 tonnes per person (FAO, 2011).

In Indian context, According to 2001 census out of India's total population of 1,027,015,247, fishing community includes 5959144 people. However, the small scale fisheries sector are trapped in severe poverty. With poor awareness of the socio economic conditions of marginalised fishing community, the governments cannot properly implement the needed policies and welfare schemes. For achieving the required and feasible solutions to the existing problems, attempts in multidimensional direction needs to be adopted, that encompasses the problems and suggestions on the part of the fisher folk and other stakeholders amply, and thereby concludes in formulating and implementing necessary action plans and welfare schemes. For this, the issues that concern the various aspects of the livelihoods of the fisher folk need to be taken into consideration, thereby ensuring the active participation by all the participants. This acts as the main inputs for formulating necessary development strategies (Bijayalakshmi, AjithKumar,2014). The contribution of this sector to foreign exchange earnings is substantial and forms 1.4 percent of GDP more than 6 million fishermen in the country depend on fisheries for their livelihood.

In Kerala, Directly providing employment to about 3.86 lakh people and indirectly to more than that, the Kerala fisheries sector is on its way to progress amidst many inherent socio economic issues prevailing in the sector (Jasna P. T., Palai, Sanghamitra) (2016). The tropical climate with heavy rainfall and a large number of rivers makes the coast rich in marine resources. Mud banks are increasingly found in Kerala coasts, which is the formation of the clay and organic matters on the coast that occurs post monsoon when the sea is calm, thereby providing a good harvest of fish. Kerala has the eighth position, in terms of the fisher folk population among the fourteen coastal states of India. The following table provides the district wise information on the same.

Table.1. District wise details of fisher folk population and coastal length

Districts	Coastal Length (km)	Fishermen population	Active fishermen	Population density
Thiruvananthapuram	78	167754	50899	2096
Kollam	37	92500	18561	2418
Alappuzha	82	127776	25900	1307
Ernakulam	46	72119	13230	1543
Thrissur	54	55657	5803	1314
Malappuram	70	89365	31479	1113
Kozhikode	71	97987	21769	1336
Kannur	82	37627	5786	658
Kasargode	70	43115	9983	606
Total	590	783900	183410	1307

Source: Kerala Fishermen Welfare Fund Board, @Directorate of Economic and Statistics (2016)

Mostly the marine fishermen is more based in Trivandrum district, followed by Allapuzha, Kollam and Kozhikode districts respectively. Upon studying the socio economic conditions of the fisher folk in India and Kerala we must consider certain indicators, such as , age, education, size and nature of family type, religion, habitation, public facilities available to access, nature of occupation, technological advancement, welfare programmes, organisations or action groups existing, social participation and the gender perspective in active participation. The backward socio economic condition of the fishing population compared to the general population acts as a catalyst to the further marginalisation of them. However, globalisation and the resultant developments have had mixed effects on their progress into commercial and diversified enterprise from a traditional sector.

Demographically, so it is evident that around 43 percent population belongs to the middle age group on an average. They constitute most of the working population. The number of aged people is very less among the marine fisher folk in Kerala. Around 94percent are below 60 years of age. People above 60 years constituted only around 5.93 percent. Education wise, while many members of the community were dropouts at primary level or secondary level owing to many reasons, only a few have been able to pursue higher studies. On considering the religion, Hindu fisherfolk are mostly found in the central and northern districts of Kollam, Allapuzha, Thrissur and Kasargode districts of Kerala ,who belong to the caste groups of '*arayans*', '*velan*', '*mukkuvas*' and the '*marakkans*', respectively. In Kerala, fisherfolk still continue the joint family system, despite a general shift to the nuclear ones generally. District-wise, unemployment among the fisher folk is higher (66.04 percent in Kasargod followed by Malappuram (61.99percent) and Kozhikode (61.66 percent) respectively. The unemployment range is comparatively lower in Ernakulam and Alappuzha. (Pavithran.A.P, Sachin; Devi.D,Sarada, 2017). From the study, it was found that about 93.43 percent of the fishermen have bank- or post office accounts, 49.05 percent have opened accounts with nationalised banks, 22.67 percent with scheduled banks, 20.38 percent with cooperative banks and 1.33percent with post offices, whereas, 6.57 percent have no bank account. Mostly they spend the money on liquor, playing cards or other purposes than saving. Mechanisation was introduced in Kerala from mid 1960s, which led to the further marginalisation and poverty of traditional fishermen, who with their canoes and small vessels were unable to compete effectively with the trawlers, thereby affecting the livelihood of the traditional fisher folk adversely. As a result to escape poverty, they tried to avail loans in banks, many of which were rejected owing to the lack

of required collateral security needed for the same. Owing to the uncertainty and seasonality of occupation, poor earnings, low savings, fishermen are forced to borrow money. The burden of indebtedness was high in Trivandrum (78.33 percent), followed by Kollam (68 percent), with FGDs reports showing that they borrow money from the money lenders in the landing centre at unbelievably higher rate of interest of 19.21 percent p.a. They were familiar with and used the services of mass media as well.

Social coherence and ties:

Kerala's fishing communities have coherently utilised the marine resources and fostered close social and economic relation with each other despite cultural and religious differences. According to the study by Chekutty, N. P (2010) ,with the advent of globalisation and mechanisation in fisheries. This paved way for attaining international subsidies, and there arose the stringent conditions of global trade, and intense competition for fishing. All these led to a sharp decline in fish catch and thereby the subsequent profits will decline, leading to poverty, deprivation and consequent anger and discontent amongst the fisher folk. This has even paved way to causal factors for increasing instances of communalism and violence among the fisher folk in Kerala over the last few years.

Mechanisation

Mechanisation was introduced in Kerala from mid 1960s, which led to the further marginalisation and poverty of traditional fishermen, who with their canoes and small vessels were unable to compete effectively with the trawlers, thereby affecting the livelihood of the traditional fisher folk adversely. As a result to escape poverty, they tried to avail loans in banks, many of which were rejected owing to the lack of required collateral security needed for the same. So they borrowed from money lenders and other such unconventional sources like middlemen, with exorbitant interest rates, which often worsened their situations. However, a new class of entrepreneurs, the moneylender-cum-boat-owners emerged, who increasingly took economic control of the villages, which has often acted as catalysts for clashes between the mechanised boat owners and traditional fisher folk (Chekutty, N.P., 2010). Salagrama (2006) had identified that, even if the fisheries sector as including various types of livelihood activities, from production and processing to marketing and ancillary functions, still many of the people engaged in this activity remained unrecognized. So, to reduce the poverty and vulnerability of the fishing community multidimensional policies and sustainable development strategies are to be implemented.

Impacts of Climate Change on Coastal Zone and Fisheries Sector:

Global warming, being the rise in the average temperature of the Earth's surface and its atmosphere, is the most closely related aspect of climate change, being both its cause and result. The greenhouse gases, emission, aerosols and soot, solar activity all being the causes of it. The outcomes of this phenomenon being sea level rise, sudden and extreme weather fluctuations, climate changes, ecological imbalance, and other long and abrupt impacts. All of these, being the repercussions of one another, often creating imbalance in the vulnerable ecology and even human lives, like inundation from sea level rise disturbing the infrastructure and human settlements. Upon considering the views of the community level actors, both pollution and rising fishing pressure that leads to increased exploitation of the marine resources, are also considered as major stressors on fisheries resources. (Vivekanandan, 2011).Coastal zone has various uses or resourcefulness which the people exploit for livelihood and other purposes.

In India, Often, it is the traditional and the small scale fishermen (fishers, fish processors, traders and ancillary workers, especially of rural coastal areas) who faces the negative effects of the climate variations more, due to the consequences from the changing fisheries ecosystems, habitat destruction and resource depletion, to name a few. Coastal areas are mostly under stress due to the various planning figures, information, economic market and policy intervention failures. Integrated coastal zone management, and thereby, vulnerability issues addressing measures are urgently required to guide the co-evolution of natural and human systems (Turner et al. 2003). In Kerala, the problems that arise in the coastal area, are mainly due to the high density of population, coastal erosion, sand mining, pollution, drastic morphological and shoreline changes due to shore structures, destruction and reclamation of wetland including mangroves, saline intrusion, resource depletion, decreasing fish catch, degradation of the environment and violation of the provisions of CRZ. The coastal community, as a result of all these factors periodically loses dwelling places due to erosion. The destruction of natural habitats in the form of reclamation of wetlands, cutting of mangroves and dumping of industrial and urban wastes worsens the plight of the coastal communities. Even though the process of climate change is a global phenomenon, the regional or the local effects are far reaching, especially for the native vulnerable communities, like the marine fisher folk. The studies show that such effects on the local fishery communities will have far reaching consequences in the balance of the ecosystem as well as in the livelihood of the fishing communities. The main impacts of climate change that affects the most include the change in sea level, uncertainty about upwelling, changes in sea-surface temperature, salinity, local rainfall and monsoonal variability, hazardous algal bloom, and increased illnesses, to name a few (Pavithran.A.P, Sachin ;Menon, N.R. and Sankaranarayanan,K.C, (2014)).

There are a lot of studies proving the impact of climate change upon the marine environment and the fishing industry. But it is regional rather than global climate models that are appropriate for observation and study of climate change impacts. Studying various data on sea surface temperature (SST) and other parameters from a variety of global sources, Vivekanandan et al. (2009) concluded the presence of warming of the sea surface along the entire Indian coast. The sea surface temperature increased by 0.2°C along the northwest, southwest and northeast coasts and by 0.3°C along the southeast coast during the 45-year period from 1960 to 2005. It was predicted that the annual average SST in the Indian seas would increase by 2.0°C to 3.5°C by 2099.

The major coastal zone threats arising from climate change backwash effects can be natural or manmade. Natural threats or the impacts include, coastal erosion, seawater ingress, global warming and sea level rise, natural disaster from floods, storms, hurricanes and cyclones, outbreak of diseases and sedimentation to name a few. Likewise, there are various impacts are triggered by man. These manmade threats include, population pressure and urbanisation, land use changes including reclamation and construction, shore protection works such as seawalls, groins and bulkheads, overfishing and inshore aquaculture, destruction of habitats and biodiversity including mangroves, coral reefs and benthos, mining, impact of ports and marine transport, uncontrolled tourism, manufacturing and processing industries, domestic, industrial and agricultural discharges, to name a few.

Sea level rise: Sea level rise can lead to some coastal villages being exposed to inundation due to a projected 1-m rise in sea level, expected to happen over 20-50 years. The Intergovernmental Panel on Climate Change (IPCC, 2001) has projected that the global annual seawater temperature would rise by 0.8 to 2.5°C by 2050.

Upwelling: In case of Kerala upwelling depends on the monsoon activity of the region changes in this can have positive or negative impacts, but this is as of yet uncertain. “Upwelling brings nutrient-rich deep waters to the surface, where algae can thrive in the sunlight, feeding the fish. Without nutrients, no algae, and without algae, no fish, so the uncertainty about upwelling is a serious hazard to the fishermen communities” (Pavithran.A.P, Sachin,. Moors,Eddy., Singh, Tanya, Menon,N.R., 2015).

Sea Surface Temperature: The sea surface temperature or SST changes with climate change. It being an indicator of ocean variability and more complex ocean processes, it has been reported that temperature have increased both at surface and bottom of the sea in the past few decades. It changes the fish composition in certain depths and the fishermen’s catch.

Salinity: Incursion of sea water into the coastal villages and upstream makes groundwater more saline which can potentially harm the inland fisheries specially the fresh water fisheries and aquaculture. There is much evidence of increase of salinity in the creeks, river and coastal villages of Kerala.

Rainfall Variability: Upon studying the rainfall pattern of Kerala over 100 years, it was found that a trend of heavy downpours in some years being followed by below average rainfall in the recent years was found.

Hazardous Algal Bloom: Since the fisheries mainly depends on the coastal areas, it is especially sensitive to constraints from red tides and toxic microalgae. HABs can make substantial consequences on the growth, recruitment and mortality of fish population, especially fish–killing algal blooms that cause direct and severe damage to coastal fishing industries, through depletion of the fish resources.

Illness: When the temperature increases, it can indirectly affect the livelihood of humans by increasing the chances of occurrence of diseases in the region. Increasing illness and endemic disease in fishermen resulted in the loss of sales of fish and fisheries industry.

Vulnerability of Fishing Community towards the Impacts of Climate Change:

Various research works carried out by the Indian Council of Agricultural Research (ICAR) and Central Marine Fisheries Research Institute (CMFRI), concluded that the climate change impacts the distribution, phenology and abundance of marine fish species (Vivekanandan, 2010).The conditions, situations and indicators related to the vulnerability framework and concepts takes the following aspects and dimensions, including geographical, social, environmental, technical, sectoral, equity related, policy related, gender specific, and so on.

Geographically, along the coastal areas, coastal erosion and the measures taken to control it have together led to the loss of several beaches. The barrier beaches & backwater islands of Kerala are very sensitive environmentally, socially and economically as a large population depends on the system. Technically, mechanisation in the fisheries industry have brought about a lot of changes, like fishermen with mechanised devices and boats being able to acquire better catch, and thereby more profits too. Non-motorised boats with low mobility for comparatively poor fishermen also adds to the problem of catch fluctuations. Also, the stock of resources is reported as depleting and the resulting conflict prevails between the traditional fishermen and the capitalists. The sole dependence of people on marine fishery for their livelihood itself is a major challenge. The stock of resources is reported as depleting and the resulting conflict prevails between the traditional fishermen and the

capitalists. With climate change and the resultant sea level rise and rise in sea surface temperature, many indigenous are dying out as they reach the limit of their threshold, whereas certain species which adapt to higher temperatures are becoming dominant. Most of the fishermen are severely indebted, addicted to alcohol & drugs, under educated and lacking skills for alternate employment. It helps occasionally in mushrooming of the illegal activities and attracts more and more unemployed youth.

“Increased incidence of extreme events such as storms, floods and drought will affect the safety and efficiency of fishing operations, flow of rivers, area covered by wetlands and water availability and will have severe impacts on fisheries. Sea level rise will have effects on the coastal profile and livelihoods of communities. The potential outcome for fisheries may be decrease in production and value of fisheries, and decline in the economic returns from fishing operations” (E. Vivekanandan). The recent occurrence of the cyclone, Okhi along the Kerala coast is a relevant example of how the livelihood of the fishing community was affected. Storm surges, which curb the boats from going in the offshore areas, also reduce the prospects of a better catch. . Fishing is mainly dependent on seasons and a poor or delayed monsoon, which affects the indigenous and seasonal fishes and thereby, the seasonal harvests also. Floods can hamper the livelihoods of the fishing community, affecting the poor infrastructure and fishing activities. Sea level rise can cause the various outcomes of variation in currents and bottom pressure in the near shore regions, variation in tidal activities, changes in wave patterns, and so on. Coastal erosion, is reported to affect about 23percent of the shoreline along the Indian mainland (Vivekanandan,2011). Fish availability can change with respect to tabulations in the weather pattern and it manifests in the forms of changes in the migration and breeding seasons of fish varieties, or even endangering some of the fish varieties eventually.

Pollution is a major evil affecting the marine ecosystem balance. Its effects can impart in the forms of resource depletion, contamination of sea bed and water resources, salinity and increased presence of toxic chemicals in sea water. Bio-magnification is a case of this. Similarly, It is the open-access or common property nature of the sea that attracts large numbers of poor people to find their livelihoods there, and they are badly affected when the terms of access to the resource change.

Open access allows the entry of bigger players into the sector, which comes to dominate or even monopolize access to resources – often with the facilitation of the state – and marginalize traditional stakeholders. About the societal issue faced by the fishing communities due to climatic change, the primary challenge to the fisheries and aquaculture sector will be to ensure food supply, enhance nutritional security, improve livelihood and economic output, and ensure ecosystem safety.

About participatory aspect, Trade policy tools like tariffs, subsidies and standards, can also affect the fishers. Likewise, a major problem of competition with more powerful forces, coupled with the community based governance systems and the absence of institutional mechanism among the fishers, can be addressed by promoting cohesion within the fishing communities, imparting awareness about new laws and schemes that which restrict or promote the fishing activities and to encourage capacity building. On a different note, adaptive capacity can be increased through equal distribution of resources. It is related to the resource conservation and participation in management, which are in turn linked to the aspect of technology of harvesting, certain historical rights and even certain value premises. Within each zone of Kerala coastline, geography, fishery resources, infrastructural and mechanical facilities and market access are relatively same. Thus, the fishing community

can have greater involvement in the development and conservative management of fishery resources with the united efforts of active fishermen, social workers, social and physical scientists and voluntary associations concerned with socio-economic and ecological issues. However, artisanal fishermen are more affected, leading to poverty. Open and regulated access to new technologies can be emphasised.

Finally, on the gender perspective, the fisherwomen in Kerala play an important role in the fisheries sector in terms of their involvement in fishery related activities viz., fish vending, fish drying, prawn peeling, sorting, grading, fish packing, and net making. However, they are more vulnerable than men in receiving the after effects of the impacts. The highest level of gender discrimination faced by all the respondents across the four different occupational groups were in handling, transporting and storing bulk quantities of fish resources. So gender specific strategies are to be initiated and implemented, like establishment of self-help groups, etc., thereby creating additional livelihood opportunities for them. Measures In response to shifting fish population and species, the sector may have to respond with the right types of craft and gear combinations, on-board processing equipments etc.

Governments should consider establishing Weather Watch Groups and decision support systems on a regional basis. Allocating research funds to analyze the impacts and establishing institutional mechanisms to enable the sector are also important (E.Vivekanandan, 2010). So, altogether, for the betterment of the condition of the fishing communities, development of regional adaptation networks is a necessity. According Sunil Santha, “formal adaptation strategies are highly techno-centric, costly, and do not take into account the vulnerabilities of the fishing community. Instead, they have contributed to ecological, livelihood, and knowledge uncertainties. The adaptation strategies of the fishing community are a response to these uncertainties.” So, evidences are to be generated, gathered and documented. Linkages between scientific aspects, policies and practice should be strengthened. Establishment of the network between the members and identifying the location’s priority needs helps in addressing the problems more systematically and efficiently.

Vulnerability Assessment of Fishing Community in Cherai towards Climate Change: Analysis

Cherai fishing village is located at ward 14 of Pallipuram Gram Panchayat. The village has a total of 382 houses and 423 households are living there. Among them, 43 households are landless or presently living as a joint family. Regarding the housing situation in the village, it is noted that 58.64 percent houses are pucca, 28.53 percent are semi-pucca and 12.83 percent houses are kachha houses. About 97.91 percent of the existing houses in the village have sanitary toilets. Safe drinking water is available to 81.94 percent of the existing houses. Most of the houses in the village (90.58 percent) are electrified. It is noted that 191 persons from the fisher folk community are insured with the Fisheries Board (Matsya Board). And 19 persons are covered under the old age pension scheme and 4 persons are covered under widow pension scheme during 2007-08 in this village. Regarding the community specific facilities, this village has no hospital facility. The village has four LP schools and one High School. One anganawadi is functioning in this village and it is functioning in rented building. This village has a network of 7 roads of length 7.62 Km and one culvert. The village has 36 street lights and 16 of them are functional. About the fisheries specific infrastructure and facilities, it is noted that 15 country fishing boats are available in this fisheries village. And a total of 84 kerosene permits are issued to the fisher folk in this. The

village has three ice plants. The village has a protected coastal length of 1.50 km. Consumption of liquor and narcotic drugs are acute in this village.

The present study included surveying of 60 respondents who were selected by simple random technique, belonging to fishing community from Cherai fishing village of Ernakulam district.

Table.2. Influence of Climate Change as Observed by Respondents:

Indicators	Agreed respondents		Disagreed respondents	
	Nos.	Percent	Nos.	Percent
Change in species landed	2.00	3.34	58.00	96.66
Occurance of new species	4.00	6.67	56.00	93.33
Disappearance of indigenous species	8.00	13.33	52.00	86.67
Change in roaring sea	16.00	26.67	44.00	73.33
Change in sea water level	48.00	80.00	12.00	40.00
Change in sea water colour	44.00	73.34	16.00	26.66
Change in sea water temperature	26.00	43.34	34.00	56.66

Source: Primary Data

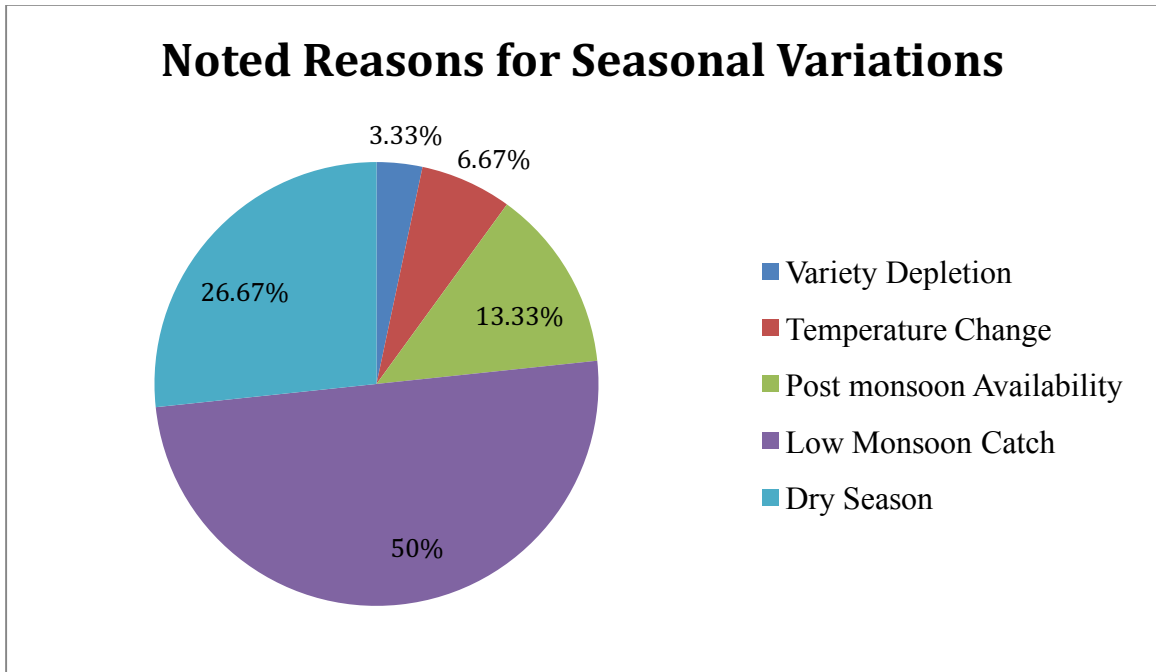
Upon analysing the surveyed data on the various observed indicators which were influenced by climate change, it was found that majority of the respondents (80 percent, i.e., 48 persons) had agreed in noticing the change in sea water level, whereas 12 people (40 percent) failed to notice it. When 44 persons forming 73.34 percent observed the change in sea water colour, 16 people failed to notice it. Also, only a meagre 3.34 percent (2 persons) agreed that there is a change in the species of fishes and marine organisms landed. A majority of 58 percent could not agree to it completely. However, 4 people agreed that there is the occurrence of new species in the area, forming 6.67 percent of the sample surveyed. Here, 56 persons disagreed. 8 persons agreed to the fact that there is disappearance of indigenous fish species, forming 13.33 percent, whereas the rest of 86.67 percent failed to do so. The change in roaring sea was agreed upon by 16 persons, amounting to 26.67 percent, whereas the rest 73.33 per cent could not agree to it completely. The fluctuations in sea water surface temperature were noticed by 26 respondents, forming 43.34 percent, when 34 persons (56.66 percent) disagreed to the same.

Table .3. Distribution of Respondents who noted the Seasonal Variations in Climate and their Indicators

Cate gory	Seasonal variation		Total	Indicators					Total
	Noted	Not noted		Variety depletion	Temperature Change	Available in Post monsoon	Monsoon catch low	Dry season (fish decrease)	
Nos.	28.00	32.00	60.00	2.00	4.00	8.00	30.00	16.00	60.00
Per Cent	46.67	53.33	100.00	3.33	6.67	13.33	50.00	26.67	100.00

Source: Primary Data

Figure.1. **Noted Reasons by the Respondents for Seasonal Variations in Climate Change**



Source: Primary Data

Out of the 60 respondents surveyed, 28 persons, forming 46.67 percent had noted the seasonal variations in climate and their indicators. But, 32 persons failed to note such variations in climate properly, forming 53.33 percent of the total sample taken. Upon analysing the indicators of seasonal variations, like depletion of variety of fishes, temperature change, availability of fish in post monsoon season, fluctuations in monsoon catch, depletion of resources in dry season. When two respondents claimed that variety depletion is present, forming 3.33 percent of the sample taken, 4 persons forming 6.67 percent responded that sea surface temperature change is present with seasonal variations in climate. Eight persons (13.33 percent) had observed that there were changes in availability of fishes in post monsoon season, and 505 of the respondents, i.e., 30 people claimed that monsoon catch was deteriorating recently with climate change. The rest 16 persons (26.67 percent) stated that there is a decrease in fish availability during the dry season. So this suggests that the depletion of fish resources during monsoon season is the most prominent indicator of all, with 505 of the respondents having observed the same.

Vulnerability Assessment

In this study, Participant Vulnerability Analysis (PVA) method is used to assess the vulnerability level of the fisher folk in Cherai towards the harmful impacts of the climate change. PVA is a qualitative method to analyse vulnerability, involving the participation of the vulnerable people. By analysis, it includes the breaking down of the various components and coming to an idea about the vulnerability level of the community. Further measure to address the issues must be taken then. Here, fisher folk families were selected at

random and focus group discussion was conducted about the issues faced by them and the natural hazards, in relation to the harmful effects of climate change

Table 4. Vulnerability assessment of fishing community in Cherai

Category of Fisher Folk surveyed	Harmful effects of Climate Change						Overall vulnerability score
	(1) Sea level rise	(2) Uncertainty about upwelling	(3) Increasing SST and salinity	(4) Hazardous Algal Bloom	(5) Monsoon Variability	(6) Increased illnesses	
(1)Traditional fisher family	28	26	32	38	39	47	35
(2)Motorized fisher family	16	24	22	24	34	27	24.5
(3)Mechanized fisher family (trawler)	7	12	18	10	29	9	14.167
(4)Local fish traders	10	22	22	20	36	25	22.5
(5)Middle men	5	13	15	8	21	24	14.33
(6)Fish exporters	6	27	19	32	18	10	18.66

Source: Primary Data

0 = No vulnerability 1 = Low vulnerability 2 = Medium vulnerability 3 = High vulnerability 4= Very high vulnerability

Upon analysing the first category, that is, the traditional fisher folk, it is found that, they are affected the most by illnesses. The evils of poverty, pollution and financial burden have increased their susceptibility to increasing illnesses. Their standard of living is poor and due to the lack of resources, they are highly vulnerable to the problem of frequent occurrence of illnesses. This is followed by monsoon variability, HABs, salinity and rise in SST, sea level rise and least by the uncertainty about upwelling. The uncertainty about the upwelling on the fish stocks affects the traditional fishermen a lot partly because of their low saving capacity owing to the limited fishery resources available, and partly because they are unaware to make such plans to save and tide over the time of low catch. So they are highly sensitive to this problem due to their low adaptive capacity. Motorized fisher folk,who even though have access to motorized vessels, are considered to be similarly exposed and sensitive to hazards as the traditional families. Still, their adaptive capacity is much higher than the former group, owing to increased accessibility of resources. Upon analysing the trawlers, they have even more capacity to face the odds than the former two groups considered.

This is because they have motorized vessels and have more access to the resource and can diversify their fishing habits as well. The local fish traders mainly depend on the fishermen for their trade, and as a result they are also vulnerable to these hazards and ill effects that affect the fishermen. However, they are less sensitive as they can opt for other means of income during times of low catch. Due to availability and accessibility to more resources from different sources, middlemen have a much higher adaptive capacity to all these hazards. They are less vulnerable than the local traders. Fish exporters are less vulnerable than the local traders and middlemen. This can be attributed to the increase in accessibility

to resources than all the other former groups and this adds to their adaptive capacity. Still, if they are concentrating on exporting only specific species of fish, then any hazards that affect that species of fish, like HABs, etc. can affect their trade. So, this adds to their vulnerability towards these hazards due to climate change.

So, we can conclude that the traditional fishermen are the most vulnerable with an overall vulnerability score of 35, followed by the other fisher groups. This is mainly because of their vicious circle of poverty, due to indebtedness, lack of resources, illness, and most of the other insecurities they face.

Conclusion

From the study it was found that the long term effects of climate change weren't felt much among the fisher households. The fishers could only realize immediate issues such as loss in fishing days and erratic monsoon resultant which in turn leads to economic losses. Relatively poor technology, infrastructure, economical factors of cost and revenue, barriers and laws, along with the equity issues related to the accessibility, poor linkages and gender related social and economic barriers adds up the crisis. This can be effectively addressed through sustainable management and ensuring equitable resource distribution, capacity building, promoting adaptive capacity, spreading awareness on various laws and schemes, establishment of institutions, taking measures to protect the environment and by emphasizing the gender sensitive strategies.

The traditional fishermen are the most vulnerable of all the other fisher folk groups, owing to their poor living conditions and limited accessibility to resources. Lack of income generated is another issue. This may be due to resource depletion, competition, trawl ban, natural hazards or illnesses. So these issues are to be addressed. Lack of resources like ownership, access, availability, control over, utility, technical knowledge, skill development, marketing, protection, conservation, prevention, etc. are the major problems faced by the fishermen. Among them, traditional fishermen are the most vulnerable. There are certain issues relating to bureaucratic hurdles, delay of time, corruption, making of fake documents, etc. in terms of availing loans or sanctions to construct houses, which forms the common problems faced by them. Sustainability includes the efforts to avoid resource depletion, and maintaining an ecological balance. It ensures the preservation and conservation of resources for the future generations. So it is important that the measures taken must be in accordance with this concept, that is, in a holistic approach. Illiteracy made them incapable to opt for better jobs, during the time of low catch or low financial stability. Also, still, gender inequality prevails in the sector, with the women's contribution remaining unacknowledged mostly. But, it was found that the efforts of Matsafed, Kerala State Co-operative federation for Fisheries, and flagship programmes of Theeramythri, SAF, Dept of Fisheries of Kerala government, etc. have been fruitful only up to a limited extent. Various welfare schemes and programmes should be implemented for removing indebtedness and financial instability and also to address the effects of natural hazards like encroaching sea, sea level rise, storms, etc. a holistic approach is the need of the hour in this regard, by encompassing all the sustainable development goals in achieving a better future for the fisher folk.

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