



# Climate Change Induced Occupational Shifts of Fishermen in Selected Coastal Areas of Central Kerala: Fishermen Perspective

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## Abstract

Traditional coastal fisher-folks are highly vulnerable to climate change as they face limitations on occupational flexibility, leading to economic constraints. The distribution and availability of coastal fishery resources, which determine the livelihood of the traditional fisher-folks, are being influenced by factors such as sea surface temperature, salinity, wind patterns, tide levels, coastal erosion, etc. Climate induced variations influence distribution of fish and catch per unit effort, which necessitate modification in fishing strategies and adaptation practices. The goal of the current study was to rank the weather-related parameters influencing the occupational shifts of traditional fishermen in the coastal state of Kerala's three fishing villages of Thrikkunnappuzha, Chellanam, and Elamkunnappuzha in terms of fishermen's perspective. Additionally, the study tries to evaluate the various occupational transitions. The methodology involved extensive field visits and interactions with fishers, fishermen groups, local organizations, self-help groups and non-government organizations. Rising sea surface temperature, among other weather-related characteristics, was the main contributor to the change in occupation, according to fishermen. Additionally, it was noted that 41 % of respondents said that fisherfolks of study area opted for alternative jobs and changed their operational area to combat the climate change risks. To develop effective adaptation measures, the complex interaction of social,

economic, and environmental systems must be studied, and community-oriented adaptation strategies should be developed along the coast. For the mitigation of climate-related uncertainties, the local community and public institutions should implement reactive or anticipatory action plans.

**Key words:** Occupational shift, traditional fishers, coastal fishing communities, climate change adaptations

## Introduction

Global average contribution of the fisheries and aquaculture sector to GDP is between 0.5 and 2.5 percent, but it can surpass 7 percent in some nations, which is substantially different from the GDP of the agricultural sector. Directly or indirectly, fishing and aquaculture provide a living for millions of people worldwide. There are currently 58.5 million people employed full- or part-time as fishers and fish growers, the majority of whom live in developing nations, primarily in Asia (FAO, 2022). The fishing sector's contribution to the overall GDP of India (at current exchange rates) increased by 157 %, from 0.40 % in 1950–1951 to 1.03 % in 2017–2018. The industry gave the GDP a contribution of Rs.1,75,573 crores (Current prices) during FY 2017–18 to Indian economy (Anon, 2020a).

At the primary level, fisheries sector of India supports the livelihoods of over 16 million fishers and fish growers, and nearly twice that figure along the value chain (Anon, 2020b). The socioeconomically deprived artisanal and small-scale fishers, whose lives are intricately entangled with the oceans and seas, dominate the marine fisheries sector. The dependence of traditional marine fishers on marine capture fisheries for their livelihoods has been

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growing despite a stagnation in the growth of marine capture fish production over the years.

Climate change is projected to cause an increase in the danger to livelihoods and employment possibilities in coastal areas as the frequency of extreme weather events rises quickly (Shameem et al., 2014). The fifth assessment report of Inter-Governmental Panel on Climate Change (IPCC) highlighted the socioeconomic impacts of climate change on coastal communities. Coastal communities are among the most vulnerable to extreme climatic events, such as cyclones and accompanying tidal surges, it is crucial to explore livelihood options, adaptation, and resistance to natural hazards (IPCC, 2012). As the frequency of extreme weather events is rapidly increasing due to climate change, it is critical to examine the occupational shifts of fishing communities to identify and characterize timely actions needed to be taken in order to combat with the negative impacts of climate change, and develop climate resilient adaptation options for the stake holders in future (Shameem et al., 2014; Davies, 1993).

The coastal fishermen are more exposed to various types of climate change vulnerabilities. Impacts due to cyclones, tidal surge, coastal erosion, water logging during monsoon, dynamic changes in water currents etc. have adversely affected the livelihoods of coastal fishers in this part of the state. Considering the importance of the area in terms of vulnerability to natural hazards and presence of traditional coastal fishing communities, the study was undertaken with the objectives of understanding various forms of occupational shifts among the traditional fishermen and to identify the factors influencing the occupational shifts under the climate change perspective. This study was carried out in 3 coastal *panchayaths* of central Kerala viz., *Thrikkunnappuzha*, *Chellanam* and *Elankunnappuzha*. These *panchayaths* are distributed in *Alappuzha* and *Ernakulam* districts of Kerala. About 90 percent of active fishermen along this area belongs to small scale traditional sector. In addition to active fishermen, there are fishers living on other economic activities such as trade, processing, transport, retail as well as people work in ancillary industries like boat building yards, net making/repairing yards, ice-plants, marine engine workshops, supply of water and ice to fishing boats, etc.

## Materials and Methods

Primary data was collected through structured questionnaire from three selected *panchayaths* viz, *Chellanam* and *Elankunnappuzha* in Ernakulam district and *Trikkunnappuzha* in *Alappuzha* district both belonging to central Kerala. *Chellanam*, a narrow landform about 17.5 km coastline accommodates eight fishing villages viz, *Chellanam*, *Maruvakkad*, *Chalakkadavu*, *Kandakkadavu*, *Puthentode*, *Kannamaly*, *Cheriyakadavu* and *Kattipparambu*. Majority of the locals along this stretch make a living off of fishing. *Chellanam panchayath* has a total population of 16,719, of which 7,434 are males and 9,285 are women, according to the 2022 census and 4,200 of them are active fishermen.

There are 26,092 people living in *Elankunnappuzha*, of which 12,572 are men and 13,520 are women, among the male 16 % are engaged in fishing. *Trikkunnappuzha* is a village near *Harippad* in *Alappuzha* district, which is one of the gateways to the inland water bodies of *Alappuzha*. This place has network of backwaters where canals, lagoons, rivers, and land meet. Total population of about 26,790 inhabit this area.

Statistical analysis was carried out to rank the weather-related parameters viz., storms/cyclones, rising sea surface temperature, high tide, coastal erosion and changes in water currents as perceived by fishers and its influence on livelihood security of traditional fishermen in the selected area. Further analysis was made to identify the forms of occupational shifts among fishers, such as seeking employment in a different location, initiating insurance for fishing equipment and life, adopting self-control measures on fishing operations through mesh size restrictions, and modifications to fishing technique; to reach conclusions on trends in occupational shift of fisher-folks in the study area.

Data on occupational details and socio-economic aspects of coastal communities from the selected areas were collected during the period from December 2018 to November 2019 from the respondents located at the selected areas, through systematic random sampling by drawing 10 % of units. Accordingly, 300 households were brought randomly under survey and subjected to statistical analysis by using SPSS Windows program (version 17.5). Secondary data was collected from various publications, journals, annual reports etc.

## Results and Discussions

Traditionally, fishermen acquire knowledge about fishing through repeated interaction with sea and children of fishermen were following ancestral jobs in fishing as they attain maturity. They acquired fishing skills through their traditional knowledge and work experience. However, now a days fish finding and navigational aids are extensively used to locate fish. Skill development training programmes on fishing technology and responsible fishing practices are also being provided by different governmental agencies and non-government organisations. However, the present generation of fishers along the study area looks for alternate jobs outside the fisheries sector due to the inherent uncertainties and climate linked issues. As the traditional marine fishing sector along the area under study is now in the transformation phase with adoption of modern technology, capital investment requirements are high and individual fisherman are constrained to continue the fishing occupation.

To manage their finances and minimize the hazards brought on by their substantial economic dependence on natural resources, many households in coastal towns engage in a variety of livelihood supporting activities (Bailey & Pomeroy, 1996). Season, access to the resource (whether fishing grounds or farmland), access to capital, skill set, education level and risk tolerance play vital role in the determining livelihood strategies (Robert et al., 2006). Fishing gear modifications and new techniques are used by fishermen to adapt to the shifting weather patterns and changes in the distribution of fishery resources. It was found that between 12 and 30 percent of fishermen in the study area changed their fishing methods and their gear (Fig. 1). Adoption of new technologies has also paved way for new employment opportunities in traditional fishing sector. The introduction of outboard engines in traditional fishing crafts facilitated opening of supporting activities and ancillary industries like out-board motor repair work-shops, spare parts supply outlets, kerosene bunks, engine oil selling shops netting material stores etc. where many people from the coastal areas got employed.

Migration and occupational shifts are two different adaptation strategies fishers follow globally as a livelihood security measure. As most of the commercially important species are seasonal, fishers who depend on such resources need to change their

fishing strategy and are sometimes forced to shift their area of operation according to the availability of the target resources. The proliferation of ring seines along the coastal belt of Kerala also contributed towards large scale migration of traditional fishermen across the coastal districts and fishing villages as the purse seiners require labour strength of 40 to 60 people in a vessel to operate the huge nets. Fishers migrate in response to mitigate declines in catches and shift the fishing area on a seasonal basis and they seek employment in alternative non-fishing activities or temporarily travel to nearby areas for short duration and engage in other activities (Fatunla, 1996).

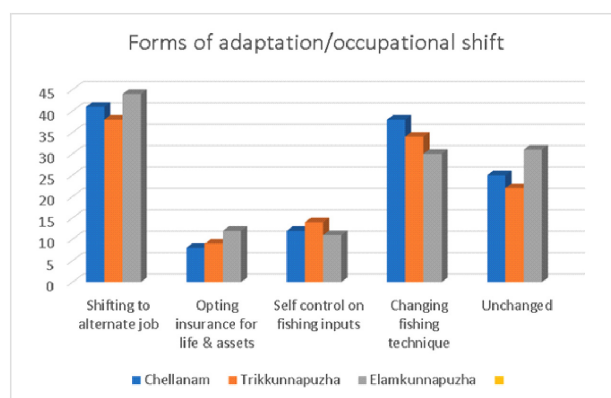


Fig. 1. Forms of adaptation/occupational shift along the study area

Both inter and intra generational shifts are existing along the coastal area under the study. Intergenerational shifts are measured in terms of how far the respondent has shifted away from his parents' occupation due to natural hazards whereas, intergenerational shifts happen when one individual shifts traditional occupation and get employed in another sector. According to the study, in *Chellanam Panchayath*, 38 % of respondents have reported an inter-generational shift and along the coastal area of *Trikkunnapuzha* and *Elamkunnapuzha* it was 34 and 30 % respectively (Fig. 2). In the *Chellanam* and *Elamkunnapuzha* areas during the monsoon months, traditional fishermen go for fishing and used to get a higher volume of fish catch. However, during the off season from December to March, as landings are low, these fishermen go for other jobs like construction work, carpentry, painting work, etc. This can also be called an inter-sectoral shift, i.e. from fishing to non-fishing and vice versa.

Three fishing villages of *Chellanam*, *Elamkunnappuzha*, and *Thrikkunnappuzha* are exposed to the frequent threats of natural calamities. Among the three centres, the coastal communities of the *Chellanam* area always struggle with natural hazards; as a result, they are forced to shift from traditional occupations.

About 40 % of the samplers from the three chosen communities had completed primary education, 16 % had finished secondary school, and 8 % had gone on to higher education. The selected centres had an average literacy rate of 92 %. The higher rate of livelihood diversity along the research region (Table 1) may be attributable to the coastal community's better literacy status, which is consistent with earlier observations in this direction by Shameem et al. (2014).

In the selected areas, which are coastal panchayaths, people mainly depend on natural resources for their livelihood. In *Chellanam*, 60 % of people are active fishermen, 15 % work as farmers, and 25 % have other occupations. During the study, it was observed that most of the fishermen couldn't meet the daily household expenses during the lean fishing season. During the lean season, 72 % of respondents' monthly income level was below 10,000 rupees, which is not sufficient to meet the expenses of a family. According to fishermen, during the four-month lean period, the sea surface temperature is high and this leads to the migration of surface shoals, which results in poor catch and loss of profit as they spend more fuel to catch scattered shoals. Reports on shifts in the migration pathways of commercially important fishery resources due to climate change induced weather conditions are available from different parts of the world (Chavez et al., 2003; Vivekanandan et al., 2009). Most of the fishers fall into debt traps during the lean months and are forced to approach money lenders and

middlemen to meet their operational expenses, which compel them to seek alternate occupations in other sectors. In *Chellanam*, 41 % of the fishermen seek alternate employment like construction activities, painting, carpentry work, etc., during the lean season, this could be related to higher literacy rate, as literacy rate increase fishers response to climate change with adaptation practices.

Due to natural hazards like tidal upwelling, floods, etc., caused by weather change, fishers adapt themselves to alternate occupations as they cannot go fishing. When the sea is rough, they shift fishing from the marine sector to backwaters to cope with the situation. 47 % of active marine fishermen depend on backwaters during the rough season. When the fishing pressure on the resources is increasing, the catch per unit effort reduces. This also triggers fishermen to switch their operational areas to find better opportunities. About 20 % of fishermen from *Chellanam* migrate to adjacent districts up to the *Kollam* coast for fishing during the monsoon months to get a better catch.

In *Chellanam*, 25 % of the respondents who belong to the age group of above 70 have been actively engaged in fishing as an occupation for the past 5 decades. Such groups have their own fishing input, and they are quite passionate about fishing as an occupation. Hence, they are involved in the repair and maintenance of fishing implements during the lean period. They refrain from seeking employment in other sectors and remain jobless during lean fishing months. In *Elamkunnappuzha*, 22 % of senior respondents and 31 % of respondents in *Thrikkunnappuzha* have been involved in fishing for the past 50 years. However, the younger generation mainly opts for alternate employment during the lean season. The ancestors of these groups were also active fishermen. The senior respondents have traditional knowledge about fishing. About 87 % of

Table 1. Occupational status of the respondent's in the selected coastal areas of central Kerala

	<i>Chellanam</i>	<i>Elamkunnappuzha</i>	<i>Thrikkunnappuzha</i>
Fishermen	86	75	82
Fish farmers	8	12	9
Agrolabourer	4	9	4
Prawn Farmer	2	4	5

Source: Field survey



traditional fishermen opined that due to changes in environmental and sea conditions like sea surface temperature and changes in the pattern of water currents, the availability of surface shoals like sardines and mackerel is less compared to the past couple of decades.

Frequency and severity of natural disasters are found to be increasing during the recent years along the coast of Kerala. Many low-lying and coastal areas in the state of Kerala were flooded during heavy rains in 2018, 2019, 2020 and 2021. The survey data reveals that in 2018, the *Ockhi* cyclone that struck along the coast of central Kerala, caused severe damage to fishermen's dwellings, fishing inputs, and subsidised kerosene which was stored in sheds near the sea. A large number of fishing crafts anchored near to the coast were also damaged and lost during the disaster in 2018. The incidence of coastal high tides has also been common during the recent past. During the present study, 92 % of responders opined that the severity of climate change induced weather changes, natural disasters and weather-related issues were the "most likely" factors behind the occupational shift among the coastal communities. 8 % of respondents were of the view that 'likely' and there were no respondents who consider natural disasters and climate related factors have 'least likely' contribution towards the occupational shift along the coastal areas.

Coastal areas of central Kerala, especially the *Chellanam* and *Elamkunnappuzha* areas, are always seriously affected by natural disasters and high tides. The major reasons for the severity of the issues, according to the local communities, are unscientific coastal planning, negligence of authorities, lack of support and coordination between different government agencies and departments. About 67 % of respondents in the study area shared the view that unscientific coastal planning is triggering the impact of natural disasters on the lives and livelihoods of coastal communities. 33 % of coastal people were of the view that the administrative bottlenecks were seriously affecting their struggle for existence against natural disasters.

The study revealed that the frequency of natural disasters forced people to migrate to safer areas. Affected people who have lost their houses and fishing implements are forced to migrate as they have no livelihood security in the area. They migrate to other places and settle there for occupational

stability. In this study, 4 % of coastal people migrated from their native places and moved to other places in search of occupation due to the fear of occurrences of natural calamities due to climate change. Out of the 4 % who migrated, 3 % continued their current occupation, i.e., fishing, and 1 % changed their occupation to a non-fishing sector.

Capture fishing is one of the most hazardous occupations in the world, where 32,000 fishermen lose their lives while engaged in fishing operations each year (Martinez & Anrooy, 2020). This study found that 8 to 15 % of coastal fishermen in the study region had adopted insurance coverage for their life and fishing equipment, and the number of fishermen with insurance is increasing, which can be considered one of the methods for adapting to climate change (Fig. 1). In this study, it is noticed that children, women, and elderly people are also vulnerable groups during natural hazards. About 70 % of the respondents said that women are the most vulnerable group as they have to save their household items, livestock, children, and elderly people. During the *Ockhi* cyclone, at *Chellanam*, 16 fishermen families lost belongings as water entered inside houses and destroyed everything.

Shift in employment is also evident at the gender level. The female counterparts of fisher-folk who were traditionally involved in fish trade and drying have transitioned from selling fresh fish to selling fish pickles, selling snacks, and working as housemaids in urban and sub-urban areas. Case studies from various regions of the world demonstrate that female fisher peers' income-generating activities exhibit seasonal fluctuations as well (MRAG, 2003; Gnimadi et al., 2006). There are additional reports from other regions of the world on the harvesting and sale of wild fruits and vegetables, as well as the participation of fisher-women in agro-processing activities (Massamba, 2005).

Multiple income-generating activities are observed to coexist in the same coastal community among various western Indian Ocean countries, highlighting diversity and complementarities (Ireland et al., 2004). Apart from fishing, agriculture and fish culture are some of the major income generating activities of the coastal communities along the *Chellanam* and *Elamkunnappuzha* area. Fish production in the coastal area has declined in the recent past due to changes in the hydrological and physico-chemical parameters of the aquatic environment due

to the natural disasters induced by climate change. Intrusion of saline water into the fish ponds/farm changes the salinity pattern and retards the growth of shrimps and fishes and also create favourable aquatic conditions for outbreak of viral/bacterial infections to the farm stock. Inundation of farms due to flood water results in escape of juvenile fish and shrimp from the stocking ponds.

Agriculture activities in *Chellanam* is limited to paddy culture popularly known as “Pokkali cultivation”, which is carried out as a rotational crop in organic way along with fish culture. In this farming practice, the paddy cultivation is scheduled for 7 to 8 months and fish/shrimp culture will be carried out for 3 to 4 months. Recent years witnessed dwindling of *Pokkali* farming practices both in *Chellanam* and *Elamkunnappuzha* areas mainly due to the changes in the aquatic environmental conditions. During 1990’s there was an area of about 1650 acres of *Pokkali* paddy fields at *Chellanam panchayath* under cultivation which is now limited to an area of 5 acres. About 86 % of the respondents informed that due to increase in the rate of sea level rise the paddy crop fully get submerged under saline water and destroys the crop which cause huge financial loss to farmers therefore about 14 % of the farmers discontinued *Pokkali* farming along the *Chellanam* area.

According to 38 % of respondents, disruptions in employment and unstable livelihoods among coastal residents were largely caused by variations in sea surface temperature and water current. Such negative effects of meteorological parameters brought on by climate change contribute to a larger incidence of food insecurity, particularly during crisis periods (Table 3). These changes, in the opinion of residents, became apparent after the Tsunami struck along Kerala’s coastal stretch. A few fishermen also claimed that the *Ockhi* cyclone altered the shorelines of the fishing settlements, having an influence on the coastal region. Shoreline erosion is one of the major dangers that coastal communities in the study region must deal with as it has contributed 10 to 15 percent towards occupational changes and livelihood. Due to coastal erosion in recent years, homes near the ocean frequently sustained severe damage. Coastal erosion brought on by climate change has periodically resulted in hundreds of households losing their homes and other valuables (Table 2). Therewere 692 homes in *Chellanam Panchayath* alone, all within 50 metres of the high tide line (HTL). About 4 percent of the households shifted out of the 50-meter zone as part of the government of Kerala’s most recent rehabilitation programs. These intervention also caused changes in the coastal fishers’ areas of employment.

Table 2. Percentage details of fisherfolk occupational parameters in relation to climate change in central Kerala (N=100 in each *panchayath*)

Occupational parameters	Name of coastal <i>panchayath</i>		
	Chellanam	Thrikkunnappuzha	Elamkunnappuzha
Loss of fishing days			
Yes	98	95	93
No	2	5	7
Loss in the fish/prawn culture sector			
Yes	87	84	91
No	13	16	9
Loss of fishing inputs			
Yes	38	68	43
No	62	32	57
Loss of houses and household items			
Yes	53	43	34
No	47	57	66

Source: field survey Socio economic variables N=100 in each *panchayath*

About 81 % of respondents in selected areas engage in fishing operation in marine sector and 10 % of the coastal fisher communities are involved in fish cum prawn farming operations (Table 1). About 90 % of respondents agreed that due to the natural hazards such as rise in sea surface temperature, variations in water currents etc. fishermen failed to get sufficient catch to make fishing jobs feasible during the lean months and most of them remain jobless. Majority respondents also expressed the view that salinity intrusion in the soil affect the productivity of culture sector and fish farmers also suffer loss of income due to such weather induced environmental issues. The government interventions are insufficient to address the detrimental effects of climate change-induced weather changes on the coastal fishers inhabiting along the study area, as evidenced by the high percentage of respondents who reported increased frequency (three to five times per year) of weather-induced natural disasters

and very high degree of suffering after the disaster (Table 4).

Implementing flexible government programmes and policies that encourage diversification, such as removing financial, legal, and fiscal barriers (like market access, transportation, and commodity taxes) to the uptake of new activities, while taking into account regional/local specificities and households' motivations for diversification, should be prioritised in order to address the climate-related vulnerabilities and improve the livelihood security of the communities (Ellis, 2000; Carter & May, 1999; Reardon et al., 1992).

Coastal belt of *Chellanam* and *Elamkunnappuzha* are considered as most vulnerable areas along the coastal stretch of Kerala facing the severity of gradual climate change. The present study aimed to identify the weather-related factors contributing

Table 3. Fishers' perspectives on the impact of climate change-induced weather parameters on living conditions and livelihoods in the study area (N= 300)

	<i>Chellanam</i>	<i>Trikkunnappuzha</i>	<i>Elamkunnappuzha</i>
Weather related Factors influencing fish production			
Rising sea surface temperature	111	117	110
Changing water currents	102	54	63
Coastal erosion	49	58	64
Storms/cyclones	23	43	29
High tide	15	28	34
Impact on fish production			
Yes	278	289	292
No	22	11	8
Impact on essential commodities			
Year round deficit on food grains and essential commodities	68	89	102
Food insecurity only during the disaster time	232	211	198
Impact on essential commodities			
No impact on food security	157	144	133
High impact on food security	143	156	167
Access to food and water			
No shortage of water and food	123	111	132
Lack of food and drinking water	177	189	168

Source: field survey

Table 4. Fishers perspective on incidence of natural calamities and its impact on the coastal people in the selected area (in percentage)

	<i>Chellanam</i>	<i>Thrakkunnappuzha</i>	<i>Elamkunnappuzha</i>
Frequency of natural disasters occurred during the last 5 years			
1 – 2 times	11	14	19
2 – 3 times	32	29	30
3 – 5 times	40	39	39
Above 5 times	17	18	12
Degree of suffering before the disasters			
Extreme	25	22	22
High	30	26	30
Low	45	52	48
Degree of suffering after the disasters			
Extreme	68	72	64
High	20	14	17
Low	12	14	19

Source: field survey

towards occupational shifts of traditional fisher folks. The major finding of the study is that the area witnessed occupational shift among the traditional fishers and climate change adversely affected the livelihoods of the coastal communities. According to the study, storms, floods, and tidal surges have increased in frequency, and the intensity of natural hazards is seriously endangering the lives and livelihoods of coastal people. Even though coastal communities have developed adaptation strategies based on the traditional knowledge to cope with the challenging situations, there is urgent need for equipping them on disaster preparedness and scientific mitigation strategies for augmenting occupational and livelihood security.

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