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THE CHANGING CLIMATE: IMPACT AND OBSERVATIONS OF FISHER FOLK OF KERALA

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Abstract: Climate change is a serious issue the mankind face today. The impact of climate change is crucial in the agricultural and fisheries sectors that feed the human beings. A study was conducted in Kerala among the marine fisher folk with a view to know whether their livelihood is influenced by seasonal variations in fish landings. The study has covered all the nine coastal districts of Kerala wherein 7.71 lakh marine fisherfolk are living in 222 fishing villages. Data were collected from 1050 respondents. The study found that the availability of fish highly depends upon the climate conditions and the traditional fisher folk are aware of the changes taking place in the sea water. Factors viz., water temperature, colour of the sea water, change in the sea level, changes in humidity etc. were considered for the study.

Keywords: Climate Change, Kerala fisherfolk, Seasonal Variation

Introduction

Climate change is an established fact and its impacts on water, air, agriculture, health, bio-diversity, forest and socio-economic sectors are quite visible around the globe. According to IPCC (2007), developing and the least developed countries are expected to suffer more due to climate change as compared to the developed countries. This is true, if we scale down this fact to the community level; in case of any climatic anomaly the poor people face the consequences due to lack of resources and access to information (Ansari, 2002). Anthropogenic activities are mainly blamed to be responsible for the surging trend of climate related disasters occurring in different parts of the world and people who earn only a marginal income are the major group affected by such disasters.

The unequivocal warming of the climate system is now evident and felt across most part of the world including India. The intense heat wave condition that swept across India in 2015 could be another manifestation of an extreme weather event. The maximum temperature recorded in Allahabad, in Uttar Pradesh (India) was 47.3 ^{o} C on 30th May 2015 (Times of

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India, 3oth May 2015). On 19th May 2016, Phalodi in Rajasthan recorded the maximum temperature of 51^{o}C which is the highest ever recorded temperature in India. (www.imd.gov.in accessed on 21st May 2016). More than 2,000 people were succumbed to death due to the extreme heat waves.

Impact of Climate Change on Fisheries

There is increasing concern over the consequences of climate change and climate variability on fisheries production and marine ecosystems (Brander 2010; Cheung et al. 2010; Mora et al. 2013). The FAO estimated that, overall, fisheries and aquaculture assure the livelihoods of 10–12 percent of the world's population. This highlights the importance of fisheries for the world population (FAO, 2014). Marine and fresh water ecosystem are profoundly affected by process like ocean acidification, coral bleaching, industrial effluents and altered river flows, etc. with obvious impacts on fisher folk. Fisheries, which make a significant contribution to the food and nutritional security globally, will be very much affected due to climate changes. Studies are going on in different parts of the world on the impact of climate change on the environment and the human beings. Climate change will impact the productivity of marine fisheries through alteration of water temperature, currents and upwelling, as well as through the indirect (ecological) and direct (biological) effects of ocean acidification affecting reef fisheries, declines in dissolved oxygen and disruption of fish reproductive patterns and migratory routes (Allison et al. 2005; Cheung et al. 2010; Nurse 2011;Guillotreau 2012). According to Nurse, (2011) there already exists a good generic understanding of the potential impacts of climate change and climate variability on key factors and processes that influence recruitment, abundance, migration, and the spatial and temporal distribution of many fish stocks. The changes in fisheries productivity and potential yield will have socio-economic consequences. Such changes will have adverse socio-economic impacts on global fisheries which are already under pressure from other stresses including overfishing, loss of habitat, pollution, disturbance of coral reefs, and introduced species (Allison et al. 2005, 2009; Hoegh-Guldberg et al. 2007; Brander 2010). Allison et al.(2005) opined that the climate changes can lead to more frequent loss of fishing days due to bad weather, increasing loss of nets, traps and longlines, damage to boats and shore facilities, increased loss of life among fishermen, and increased damage to coastal communities, by means of houses and farmland. Based on the studies, Nicholls et al. (2007) confirmed that coasts are experiencing the adverse consequences of hazards to climate change and sea level rise and slow-onset changes.

Studies relating to the changes seen in the Indian coast also confirmed the adverse impact of climate changes. Prasannakumar et al. (2009) described that it is due to the global warming, the natural decadal cycle in the Arabian sea is disrupted and the rainfall during the monsoon has decreased. It was also observed that climate change induced distribution and abundance shifts in oil sardine and mackerel resources are becoming increasingly evident along the Indian coast (Vivekanandan et al., 2008*;* Krishnakumar et al.,2008). Analyzing the data on sea surface temperature (SST) and other parameters from a variety of global sources, Vivekanandan et al. (2009) confirmed warming of the sea surface along the entire Indian coast. The SST increased by 0.2^{o}C along the northwest, southwest and northeast coasts and by 0.3 ^{o}C along the south-east coast during the 45-year period from 1960 to 2005. The team has predicted that the annual average SST in the Indian seas would increase by 2.0^{o}C to 3.5^{o} C by 2099.

The sea level rise for Cochin (south-west coast) is estimated as 2 cm in the last one century (Das and Radhakrishna, 1993). However, the rate of increase is accelerating, and it is projected that it may rise at the rate of 5 mm per year in the coming decades. Considering this, it is possible that the sea level may rise by 25 to 30 cm in 50 years (Dinesh Kumar, 2001). Besides destruction through increased rates of erosion, the sea level rise increases the risk of flooding. This will damage or destroy many coastal ecosystems such as mangroves and salt marshes, which are essential for maintaining many wild fish stocks, as well as supplying seed to aquaculture. Higher sea levels may make groundwater more saline, harming freshwater fisheries, aquaculture and agriculture and limiting industrial and domestic water uses.

Regarding the impact of climate change in the livelihood of the fisherfolk, the observation made by Allison (2007) is very important. He observed that fishing livelihoods may be profitable but precarious in conditions where future production is uncertain in the long-term and fluctuates extensively in the short-term, where access rights over resources are insecure, working conditions unsafe and exploitative, and where there is a lack of social and political support for community development and poverty reduction. It is in this 'risk environment' that the added stress of future climate change takes place.

The marine and inland fisheries sectors in Kerala are likely to take a major hit as climate change affects fish stocks, resulting in decreased yield and loss of livelihood of fishermen. According to the State Action Plan on Climate Change prepared by the Department of Environment and Climate Change, diseases and migration of species could

lead to the depletion of fish stocks, while the damage or loss to coastal infrastructure could enhance the vulnerability of the fishing community. The report notes that sardines and mackerels, which were abundantly available off the Kerala coast, had moved away to deeper waters in recent years (The Hindu, April 20,2014).

Statement of the Problem

Understanding the impacts of climate change on fisheries is crucial as fisheries are important for food security, livelihood and employment and the generation of foreign exchange for national governments throughout the world (Monnereau, I., et al., 2013, Allison, E.,2011, FAO, 2012). The impacts of climate change are expected to be different within and between regions and nations, and thus it is important to investigate where climate change impacts on fisheries have greatest social and economic significance (Allison et al. 2009). The south-west coastal region has certain unique features that influence the fishery fluctuations of the important commercial species to a great extent. The area is subject to two monsoons viz. the south-west monsoon and the north-east monsoon. Any variation in the monsoon and the temperature in the sea are likely to result into changes in the volume of fish landings in the state. This will directly and indirectly affect the economic and social condition of the fisher folk in the coastal districts of Kerala. Therefore, a study on the impact of climate change on the socio-economic condition of the fisher folk will help to formulate policies for minimizing the negative effects of climate change. It is in this background, the present study has been undertaken with the major objective of knowing whether the livelihood of marine fisher folk of Kerala is influenced by the climate change and seasonal variations in fish landings.

Methodology

The study has covered the entire coast of Kerala (590 KMs) that is spread over 9 districts. The districts are Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Kozhikkode, Kannur and Kasarkode. Data relating to the period 2013-14 and 2014-15 were collected through an interview with the selected fishermen. There are 222 marine fishing villages spread over the nine coastal districts. It was decided to cover 35 marine fishing villages under the sample and also to collect data from 30 households from each fishing village. Stratified random sampling method was used for choosing the marine fishing villages giving proportionate representation to each district and then the selection of the sample fishing villages was done using lottery method. After selecting the sample fishing villages the households were selected on a simple random basis. Thus, a total number of 1050

households were covered under the study. The number of fishing villages from each district has been decided after giving due weight to the total number of marine fishing villages in each district. In addition to 1050 households, focused group discussions (FGDs) were also held for the purpose of collecting data from the fisher folk. Important factors indicating the socio-economic condition of the fisher folk were collected, analysed and conclusions are drawn. The findings of the study are discussed below;

Fishing Days Per Week

The number of fishing days in a week is an indicator of the availability of fish. It was found that 36.19 per cent of the respondents were not going to the sea on a daily basis for fishing as they are engaged in other occupations. Only 10 per cent of the fishermen were found engaged in fishing for six days in a week. Most of them were going for fishing only for two to four days in a week. The participants of the FGDs explained that nearly five years back, the fishermen were going for fishing for six days in a week regularly. Now, it is due to the non- availability fish, they are not going fishing every day.

Average Quantity of Fish Catch

The data relating to the average quantity of fish catch per month is given in Table 1.

Table 1. Average quantity of fish catch per head per month

Sl.No.	Name of District	Annual (Kgs)	Pre-Monsoon (Kgs)	Monsoon (Kgs)	Post – Monsoon (Kgs)
1	Trivandrum	180.36	29.52	82.51	68.34
2	Kollam	322.17	54.46	143.15	124.55
3	Alappuzha	214.20	30.04	98.95	85.21
4	Ernakulam	236.20	32.91	113.4	89.89
5	Thrissur	226.16	31.27	105.81	89.09
6	Malappuram	214.70	32.28	96.10	86.31
7	Kozhikkode	277.93	39.51	127.36	111.07
8	Kannur	160.02	25.77	74.20	60.05
9	Kasargod	162.89	29.73	71.02	62.15
	Kerala	**221.62**	**33.94**	**101.39**	**86.29**

Source: Primary Data

As shown in Table 1, the monthly average fish catch per head is 221.62 Kgs taking the State as a whole. The table shows that fish catch is very poor in Kannur and Kasargod

districts. Per head fish catch is high in Kollam district where large number of mechanised fishing vessels is in operation. Here, it is to be noted that the average catch per head is very less in the case of fishermen who are going for fishing in non- motorised vessels. The average catch per month in their case was between 50 – 60 Kgs only. Most of the fishermen who participated in the FGDs opined that traditional fishermen who fully depend on fishing for their livelihood is not in a position to meet the daily minimum expenses. This has forced the youngsters to keep away from fishing related activities. They said that a fisherman who goes to the sea in the early morning is not earning an amount of Rs. 100 in most of the days during the pre- monsoon period.

Table 1 shows that fish catch is more during the monsoon season; the State average catch per month is 101.39 Kgs. per head. Catch per head during the pre- monsoon season was found to be 33.94 Kgs in the State as a whole. This indicates the low earnings of the active fishermen during the pre- monsoon period. The declining volume of fish catch was pointed out as a very important problem faced by the fishermen. Nearly 82 per cent of the respondents have marked that the volume of fish catch has been shrinking over the last many years.

A recent Study by the CMFRI found that there is a 14.3 per cent decline in the total fish catch in Kerala during the year 2014 as compared to the catch during 2013 (Malayala Manorama, 3rd May, 2015). The report has pointed out that landing of Sardine has reduced by 37 per cent, Carangids by 19 per cent, Groupers by 32 per cent, Anchovies by 30 per cent and Trichurus fish by 25 per cent.

In the FGDs, the most important and very serious issue raised by the participants was the decreasing volume of fish catch, particularly during the off season. They have pointed out reasons such as uncontrolled fishing by the mechanised vessels and use of banned fishing gears. They pointed out that there is no action against such vessels which are frequently encroaching into the territorial waters.

Variety of Fishes Caught

Data relating to the variety of fishes caught were collected and analysed. The respondents were asked to name the variety of fishes they usually catch from the sea. The data so collected revealed that Sardine and Mackerel are the two most common varieties caught by them; 78.57 per cent of the fishermen catch sardine and 63.43 per cent catch Mackerel. As exhibited in Table 2, Prawn, Squid, Tuna, Carangids, Ribon fish, Pomfret and Seer fish are the other varieties caught by them.

Table 2. Variety of fishes caught by the respondents

Sl.No.	Species	No. of Respondents	Percentage
1	Sardine	825	78.57
2	Mackerel	666	63.43
3	Prawn	301	28.67
4	Squid	145	13.81
5	Tuna	137	13.05
6	Carangids	133	12.67
7	Ribbon fish	107	10.1
8	Pomfret	75	7.14
9	Seer Fish	85	8.1

Source: Primary Data

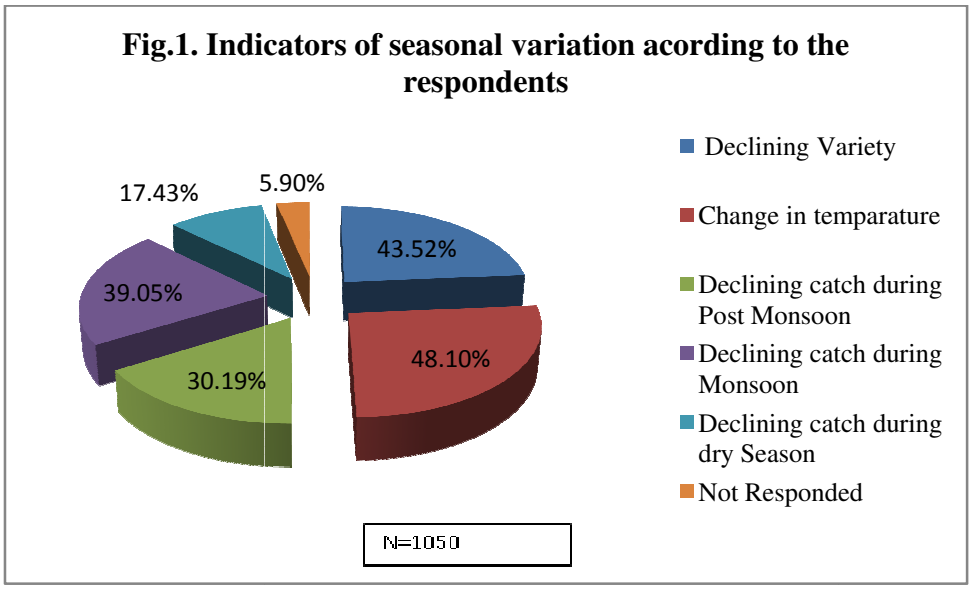
It was found that Mackerel and Sardine are the common varietied mostly caught by the fishermen from Kasargod, Thrissur and Ernakulam. Sardine is found common in all the coastal districts.

Awareness about Climate Change

The opinion collected from the respondents regarding climate change indicates that 73.14 per cent of them have noted many factors relating to the climate change. These include changes in the level of temperature, availability of rainfall, change in the sea water colour, availability of fishes, non -availability of certain species, change in the direction of flow of sea water, etc. Experience shared by the fishermen who participated in the FGDs brought to light that certain species are not at all available for the last few years. For instance, Anchovies, Aries and Johnius (big sized) are not available in the southern coast of Kerala.

Indicators of Seasonal Variation

Opinion of the respondents regarding the indicators of seasonal variations were collected and categorised. These indicators are declining variety, changing temperature, non availability of fish during post monsoon, declining catch during monsoon and declining catch during dry season.



Source: Compiled from primary data

Fig.1 shows that change in temperature is the indicator noted by most (48.1 per cent) of the fisherfolk. Similarly, declining catch during dry season (43.52 per cent), during monsoon (39.05 per cent) and during post monsoon (30.19 per cent) are the major indicators of climate change as observed by the fisherfolk.

Influence of Climate Change

Observations, of the fishermen, relating to the influence of climate change on the fisheries sector were collected. The data pertaining to this shows that change in water level, disappearance of traditional species, change in water temperature, change in water colour, etc. are the clear evidences for the changes in the climate and its influence on the fisheries sector.

Table 3. Influence of climate change as observed by the respondents

Sl.No.	Observed features	Nos.	Percentage
1	Change in Species Landed	491	46.76
2	Occurance of New Species	144	13.71
3	Disappearence of Traditional Species	704	67.05
4	Change in Roaring Sea	481	45.81
5	Change in Water level	571	54.38
6	Change in Water colour	551	52.48
7	Change in Water Temperature	505	48.10

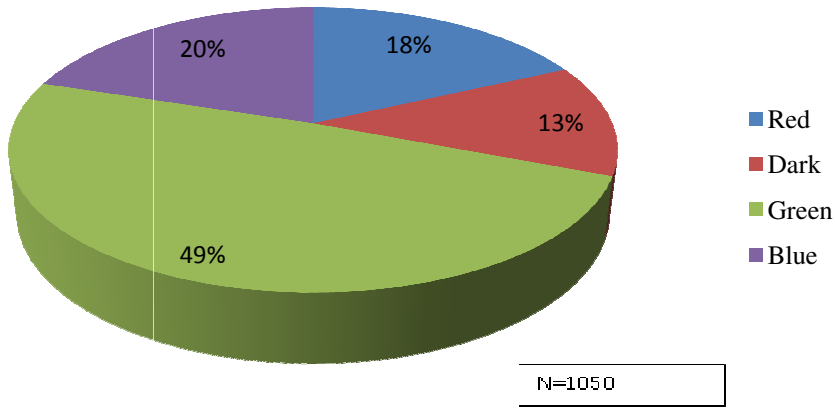
Source: Primary data

As shown in Table 3, majority of the fishermen have observed the changes taking place in different aspects. Nearly 67 per cent of the respondents have observed the non- availability of traditional species; 54.38 per cent noted the change in water level; 52.48 per cent noted change in water colour and 48.1 per cent noted change in water temperature (they reported that water temperature has been increasing over the years). Altogether, the observations shared by the respondents confirmed the impact of climate change in the fisheries sector of Kerala.

Water colour during May-August

The respondent fishermen reported different water colours at various parts of the Kerala coast during May – August, covering the monsoon season. The colour as reported by them is shown in Fig.2.

Fig.2. Water colour during May-August as reported by the respondents



Source: Primary data

As shown in Fig.2, 49 per cent of the respondents reported green colour during the period; 20 per cent blue colour; 18 per cent red colour and the remaining 13 per cent reported dark colour. Green colour was reported by fishermen of Ernakulam, Thrissur, Malappuram, Kozhikkode, Kannur and Kasargod. Dark colour was reported mainly by the fishermen of Trivandrum district; While Red colour was reported by the fishermen of Kollam and Alappuzha districts.

Presence of Algal Bloom

The water colour during the monsoon season is to be linked with the presence of algal bloom. Fig.3 shows the percentage of respondents who have noted the presence of algal bloom in different parts of the coastal waters of Kerala.

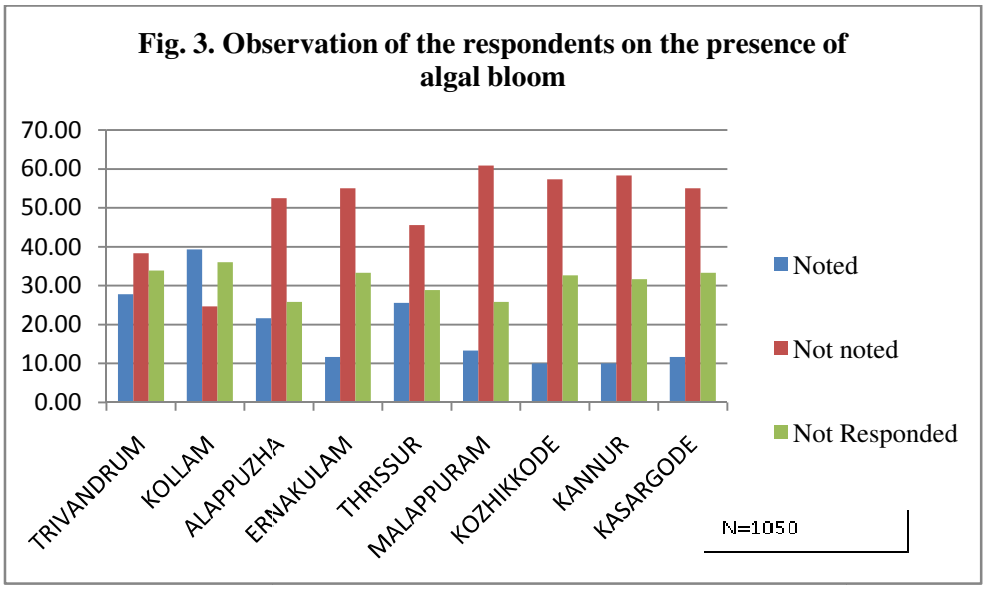


Fig. 3. Observation of the respondents on the presence of algal bloom

Source: Primary data

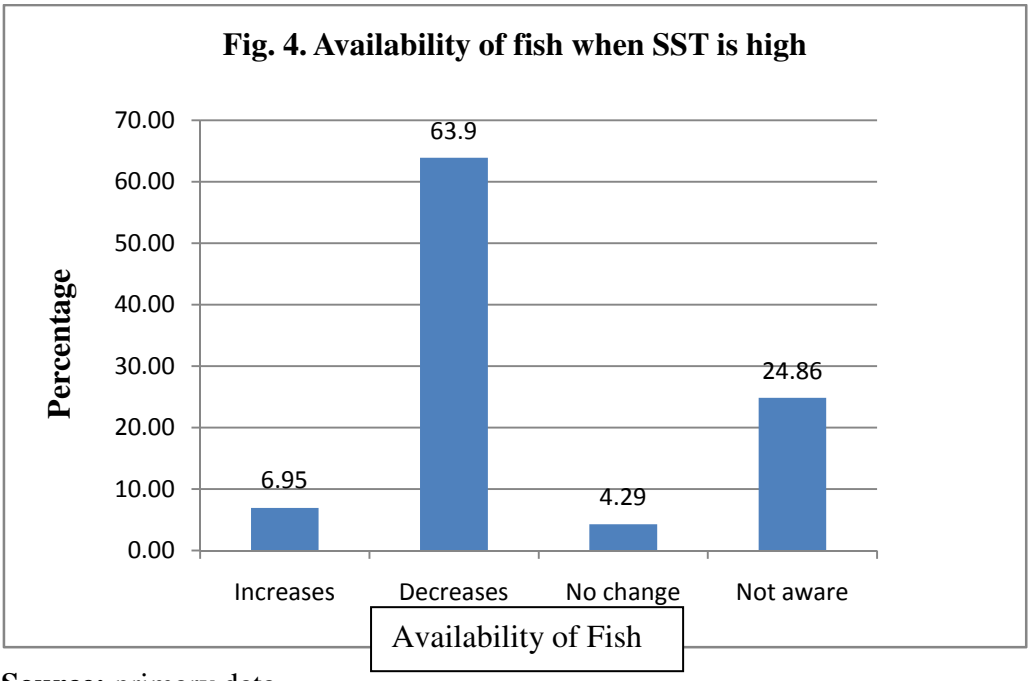
The data show that majority of the fishermen are not aware of the algal bloom or phytoplankton. It was found that nearly 29 per cent of the respondents have noted the presence of algal bloom during monsoon season; while 15.96 per cent have noted its presence during the post monsoon season. Regarding the type of algal bloom and its influence on the fishery resources scientific study is required to make any interpretation.

Sea Surface Temperature (SST)

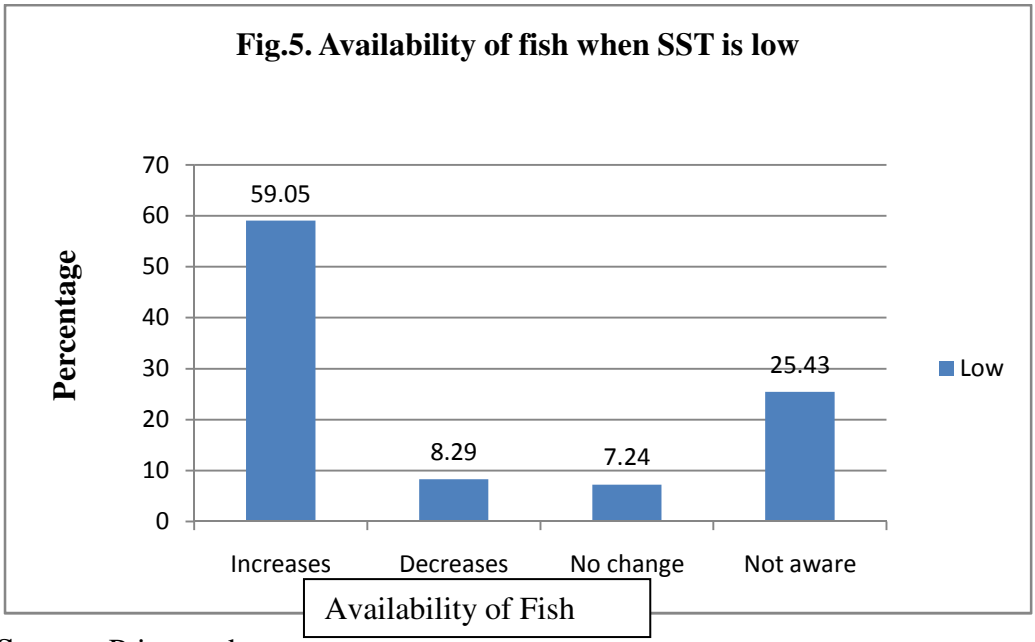
Global warming and the consequent increase in sea surface temperature is a serious concern before the mankind today. When water heats up, it expands disturbing the eco system which is fatal to most of the living organisms. Thus, the most readily apparent consequence of higher sea temperature is a rapid rise in sea level. Sea level rise causes inundation of coastal habitats for humans as well as plants and animals, shoreline erosion, and more powerful storm surges that can devastate low-lying areas.

The observations on the sea surface temperature were collected from the respondents and analysed. It shows that 63.9 per cent of the respondents believe that the availability of fish decreases as a result of an increase in the sea surface temperature. Similarly, 59.05 per

cent of the respondents opined that fish availability increases when the sea surface temperature is low.



Source: primary data



Source: Primary data

The increasing sea surface temperature and the rise in sea level were important concerns raised by the participants of the FGDs at different places. They explained that in many places, especially in Pollethei, Alappuzha, and Kanjhangad the private lands were eroded up to 50 metres within a period of five years. While explaining their experience, they

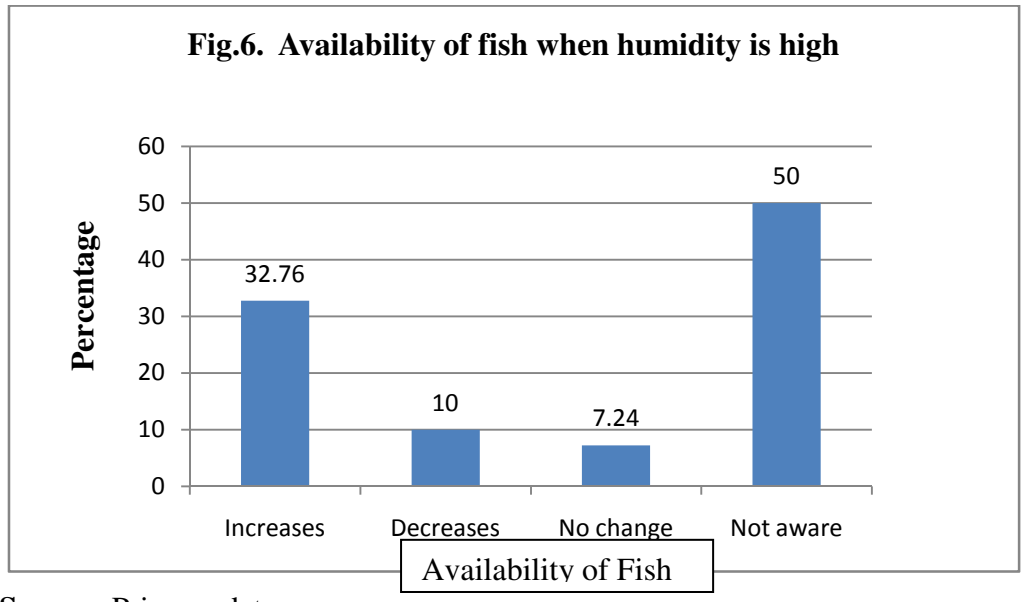
said that they can feel the water temperature simply by touching and can predict the chances of getting fish. The participants also confirmed that sardine has migrated to other places and those available in the Kerala coast, have gone to deeper waters.

According to Venkatesh (2012), one possible impact of rising sea-surface temperature being felt by the fishers might relate to the changing fish composition in their catches. The small-scale gillnet fishers of Andhra Pradesh have reported that the depth of the surface gillnets, which was four fathoms in the 1980s, has now gone up to nine fathoms; the fishers contend that the pelagic species have descended to the lower layers from the surface due to variation in surface-water temperature. The findings of the study by Vivekanandan et al. (2009) are most relevant here. The study concluded with the remarks that oil sardine fishery did not exist before 1976 in the northern latitudes and along the east coast as the resource was not available. With warming of sea surface, the oil sardine is able to find temperature of its preference especially in the northern latitudes and eastern longitudes, thereby extending the distributional boundaries and establishing fisheries in larger coastal areas. It is expected that the distribution may extend further to Gujarat and West Bengal coasts in forthcoming time assuming that other fishery related physical and biological parameters will not vary considerably. However, if the sea surface temperature in the southern latitudes increases beyond the physiological optimum of the fish, it is possible that the population may be driven away from the southern latitudes, which will reduce the catches along the south-west and south-east coasts in the future.

Humidity and Availability of Fish

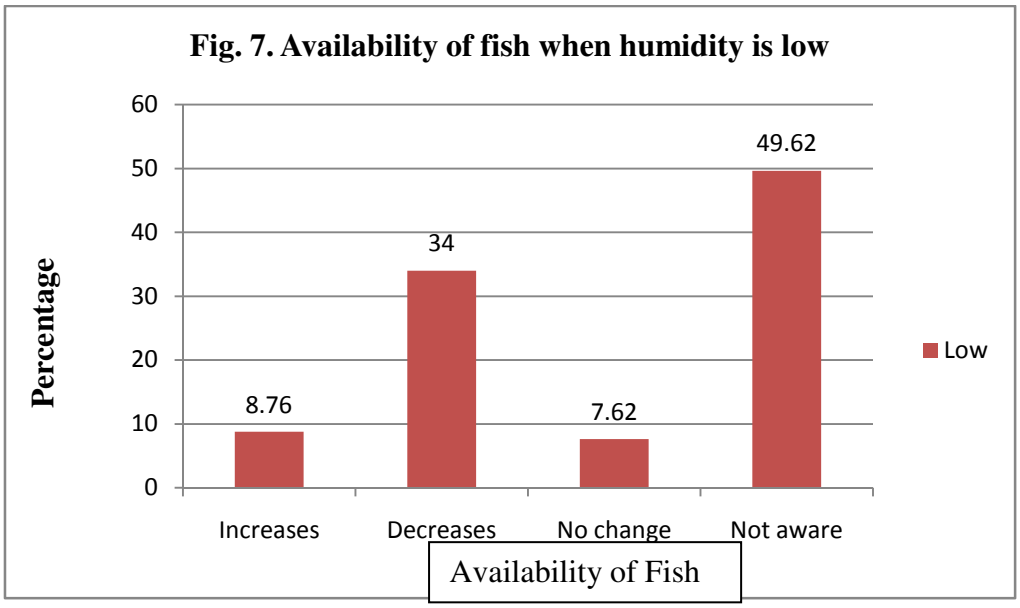
The relationship between humidity and availability of fish was tested using the chi-square test. It shows a positive correlation between the two. The analysis indicates that humidity and availability of fish are significantly correlated (chi-square = 283.224, df = 3, coefficient of contingency = 0.345, $P < 0.01$). Availability of fish is found to increase as humidity increases. Significant decline in fish availability is noted for lower levels of humidity.

The opinions collected from the respondents are shown in Fig.6 and 7.



Source: Primary data

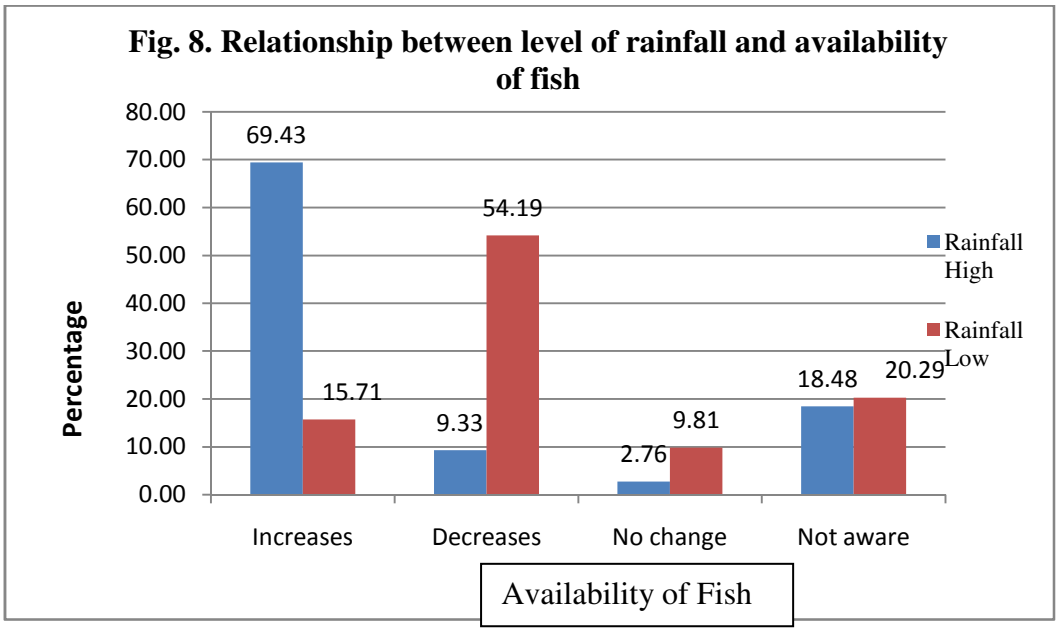
As it is evident from the Fig.6, 32.76 per cent of the respodents reported an increase in fish availability as a result of an increase in the level of humidity. Similarly, 34 per cent believe that availability of fish decreases when humidity is low. Ofcourse, this finding is simply based on the traditional knowledge and experience of the respondents.



Source: Primary data

Impact of Rainfall on Fish Availability

The study revealed that the availability of fish increases as a result of an increase in rainfall and vice- versa.



Source: Primary data

As shown in Fig.8, 69.43 per cent of the respondents opined that fish catch increases when rainfall increases. The chi-square test also supports this argument (Chi-square= 730.779, df=3, coefficient of contingency = 0.508, P< 0.01). The respondents also have pointed out that if there is a sudden rainfall when the temperature is high, availability of fish increases.

Thus, the most important factors influencing the availability of fish in the sea showed that it is closely related to the changes in these factors. Increase in temperature, decline in the volume of fish catch, changing colour of the sea water, increase in the sea level, changes in humidity , etc. are well noted by the fisherfolk in the State.

Conclusion

The impact of climate change is a very serious issue before the mankind today. The increasing temperature and the resulting sea level rise and the changes in the seasonal rainfall directly hit the human life. The marine and inland fisheries sectors in Kerala are likely to take a major hit as climate change affects fish stocks, resulting in decreased yield and loss of livelihood of fisherfolk. As far as the state of Kerala is concerned, marine fishery has a prominent place in its economy. It is the only source of livelihood for 7.71 lakh marine fisherfolk and out of this, around two lakhs of active fisher folk are engaged in fishing along the coastline, who are inhabited in the 222 marine villages. Therefore, even a slight depression in the marine fishery sector will adversely affect the livelihood of a major segment of the population and also the foreign exchange earnings of the country.

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