Marine Fishermen’s Perception about Consequences of Climate Change on Fisheries in Tamil Nadu State, India

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Abstract: Global climate change has become a critical barrier in the twenty-first century and it alarms the marine fishermen to respond and react until conditions become more adverse. Interaction with climate by humans occurs at all levels, but recent research has focused on industries, technological and demographic aspects. So far, less attention has been paid to investigate the factors which affect perception and decision-making at the individual level. The uncertain condition of climate on marine fisheries from the last two decades had created drastic change in ecosystems as well as in the fishers’ livelihood. Fishers are the group who first experiences the bitter conditions of climate change on marine fisheries because their livelihood depends highly on the marine resources. Therefore, the fishers’ perception about the consequences of climate change on fisheries may help to emerge the fisheries by implicating certain productive management measures. The research has been carried out in the two southern coastal districts of Ramanathapuram and Kanyakumari, Tamil Nadu state to find out the fishers’ perception of the consequences of climate change on fisheries. A sample size consisting of 120 marine fishermen were randomly selected and interviewed. The results inferred that increase in cost of fishing, increase in fishing investments, decline in fishing days, reduction in fish diversity and fish catches were the major consequences faced by fishers due to the climate change.

Keywords: Marine fishermen, perception, climate change, consequences, constraints.

1. Introduction

Fisheries play a vital role in the provision of food security and livelihoods of millions of people for their social, economic and nutritional benefits. In addition, this sector contributed about 0.91% of the total gross domestic product (GDP) and 5.23% of the agricultural GDP of India [1]. By 2050 fisheries sectors as well as humans will be confronted to secure food and livelihood as ever increasing population is likely to exceed nine billion [2]. This challenge will be reflected, on sustainable management of natural resources. An additional consideration of the above challenge is that it should deal at the same time with the effects of climate change, which are increasing prominently. Climate change and increasing population were the major threats to food security at present. The foremost environmental problem of the 21st Century was climate change which has been a subject of an issue and point of discussion currently. Climate change phenomena started to curb the ecological condition, which in further, lastly affects the economic status of fishers. The same issue exists in the fisheries sector, too. The consequences led by climate change have been widely researched to claim the seriousness of this phenomenon in the years to come. In this regard, the aim of the study was decided as perception of fishers’ about the consequences of the climate change on fisheries.

Tamil Nadu state borders southern side mostly with Gulf of Mannar and Indian Ocean. The Gulf of Mannar is home ground for the wide array of biological diversity like coral reefs, estuaries, fish
spawning grounds, nursery area and sand mangroves [3]. Along with its rich source of biodiversity, the Indian Ocean is also responsible for the formation of some of the strongest and deadliest tropical cyclones in the world. From the last two decades, a series of tropical cyclones every year and tsunami in 2004, have devastated social activities, fisheries infrastructure and human lives, too. Increase in the occurrence of natural disasters often will affect the safety and consistency of fishing operations, which leave the foot prints on fisheries and as well as fishermen. Fishers who mainly reside along the shore side are more likely to expose the consequences occurring due to climate change. They are the most vulnerable group to the effects of intensified climatic variability.

Fishers’ perceptions hold chief utility to establish the fact that the particular region is experiencing direct or indirect constraints in fisheries and its related activities due to climate change. Consequently, understanding the perception of climate change by fishers is significant as perception can shape the preparedness for them to adapt and change their fishing activities. Research on perception, local knowledge and adaptive strategies at the individual and community levels, as well as lessons learned, could provide the basis for the concepts and methods of assessing the climate change impacts, vulnerability and adaptation activities of the local fishers.

India’s coastal population is highly dependent on fisheries and is extremely vulnerable to climate change. From the last 15 years, climate related disasters accounted for more than 80% of all disaster events, which is widely impacting the social and economic conditions of populations. Not all extreme events have impact on fisheries; it depends on to which extent the socio-ecological systems were exposed and vulnerable. The model projections in marine regions were suggesting decrease in maximum catch potential in the world’s exclusive economic zones of between 2.8% and 5.3% by 2050 according to the greenhouse gas emission scenario Representative Concentration Pathway (RCP) 2.6, and between 7.0% and 12.1% according to greenhouse gas emission scenario RCP 8.5, also by 2050 [2]. Greenhouse gas emissions may rise continuously beyond 2020 [4]. An average annual mean warming will be about 3 °C by the year 2050s and about 5 °C in the year 2080s over the Asian land mass, with temperatures on the Tibetan Plateau rising substantially [5]. Likewise, many factors are major reason for climate change which leads to ocean acidification and degrades the aquatic ecosystem which reflects on fisheries as well as fishers’ livelihood [6-8]. Similarly, India also suffers a lot of climatic threats in fisheries such as raise of temperature, cyclones, storms, rough waves, stronger winds, lightning, sea level rise, erosion, changing seasonal patterns, salinity intrusions, earthquake, etc. Climate driven changes will affect fish availability, quality and trading, food security and livelihood [9] i.e., fish prices, and fluctuate fish related income, access to food and markets. Therefore, it is essential to have a study on fishers’ perception of climate change conditions and how they cope with the adverse conditions.

2. Materials and Methods

Tamil Nadu lies in the southernmost part of India and its coastline is located on the southeast coast of the Peninsula. It forms a part of Coromandel Coast of Bay of Bengal and Indian Ocean. It has 1,076 km long coastline and the second longest coastline in the country, which consists of 13 maritime districts with 15 major ports and harbours, lakes, sandy beaches and estuaries. It is the only state of India, which shares territory on both the eastern and western coastline [10]. It has six major and three medium fishing harbours, 254 fish landing points and 1.07 million fishermen population. The marine fish production of the state during the year 2017-2018 was 0.5 million tons [11]. Among the 13 coastal districts of Tamil Nadu only two coastal districts, namely
Ramanathapuram and Kanyakumari were selected for the study as they rank the highest fishermen population among the other southern coastal districts of Tamil Nadu. There are approximately 0.1 million active fishermen in these two districts [12]. From each of the districts, two fishing villages were selected based on the maximum number of fishermen population. Thus, a total of 120 respondents were selected for the study through a proportionate random sampling method, who were distributed in four coastal fishing villages namely Rameswaram, Mandapam, Kanyakumari and Colachel. The respondents include fishermen from traditional, motorized and mechanized sectors. The fishing gears such as trawl net, gillnet and hook and line were mainly used for fishing in these villages. The primary data were collected through personal interview by a well-structured and pre-tested interview schedule. Based on their knowledge and experience, they conveyed their view regarding the climate change and aspects that bother them due to the climate change. The duration of the study was six months from November 2018 until April 2019.

3. Results and Discussion

3.1 Perception of Fishers about Consequences of Climate Change

The study attempted to identify the consequences of climate change in fisheries because fishers are the best judge of their personal affairs and they alter their fishing operations to get adapted to ever changing climatic conditions through innovative ideas and the results are given in Table 1. Increase in cost of fishing and fishing investments were the most important consequences of climate change as it was agreed by 100% of the respondents in the study areas. Due to sudden climate change, consumption of fuel would be high which increases the cost of fishing. However, low price for the catches and fishing investment such as repair of damaged nets, boats, etc., would also be higher in order to cope up the ever changing climatic conditions [13].

Reductions in fish diversity (95.83%) and loss of fishing grounds (95.83%) were also significant consequences of climate change agreed by the fishers. The fishers indicated that fishes previously found in the near shore habitats are now abandoning their usual territories and moving into deeper waters [14]. Owing to the change in productive fishing sites and the loss of traditional fishing grounds, many important and commercially valuable species have been extremely declined or disappeared altogether [13]. Some demersal species, including shrimp, which were caught in the near shore region, are now caught in deeper waters. Further, several important and commercially valued species have been extremely declined or completely disappeared as seen from their regular catches due to loss of fishing grounds. Fishers opined that seasonal cycle is influencing significantly the advent of specific varieties of fish in different seasons, which is variable and becoming more uncertain; availability of a fish in the wrong season is considered as a major problem [8]. Monsoonal fluctuations, substantial decrease in rainy days over the years and erratic monsoon were remarkably noticeable climatic changes [15].

Loss of traditional fishing skills was also an important consequence agreed by 93.33% of the respondents. The ever changing weather and the climatic conditions, with consequent changes in fish behavioural patterns, have led traditional fishing skills to become highly ineffective in fishing activities but the possibilities for restoration of resources to be remote due to the technological innovations. Changes in current and wind patterns and distances required to be travelled to the actual fishing grounds, have made traditional fishing skills like using sails and oars for propulsion of a fishing vessel tough, but now innovative fishing such as trawlers, synthetic fishing gears, highly efficient inboard and outboard engines, electronic gadgets (echo sounder, sonar, global positioning system (GPS), etc.) made traditional practices unusable. Similarly, in Tamil Nadu also a
few (25%) fishers confessed to alter their fishing gear from traditional to gill or trawl nets [14].

Among the respondents, 91.67% of them agreed that a reduction in the application of indigenous technical knowledge (ITK) in fishing was a consequence due to climate change. As a consequence of the changing climatic conditions in the recent past, use of ITK in fishing such as identification of fishing grounds, time of fishing, birds as indicators of fish shoals, determination of depth, speed and direction water, prediction of weather, light as fish aggregating device, etc., has been declining [16]. A majority of the respondents (90.83%) agreed that the overall number of fishing days was reduced due to climate change and most of the fishing trips do not recoup their costs. During unfavourable weather conditions the fishing boats lie idle at the jetties or beaches for extended periods and lacking regular maintenance, which pose a life-threatening risk to the safety of the crew at sea. Due to the climate change events, the fishers lost 25 fishing days per year (average) which is equal to a loss of about US$615.24 (average). Reduction in fishing days, declined income due to floods [9, 13].

The majority of the fishers (89.17%) agreed that increase in access time to fishing grounds was a consequence. There was a wide uncertainty in wind pattern after 2004 tsunami which was considered as a crucial consequence at present. Additionally, wind has changed mostly in last 20 years [17]. Wind stress, wind shifts [18-20], wind curl and change of wind pattern in the South Indian Ocean [2, 21-24] have clearly visible impact on fishing as well as sea dynamics. Increase in wind speed has critical impact on fishing vessels and fishing operations [25]. Due to sudden strong winds, current access time to actual fishing grounds increases, which eventually increases the cost of propulsion and in turn reduces the profit. A significant portion of the respondents (78.33%) agreed that alteration in fishing seasons was a consequence which leads to changing the species diversity and resulting in loss of income [1, 9, 26].

The majority of the respondents (73.33%) agreed the decrease in inshore fishery resources due to climate change. Life cycles of marine organisms are mostly relying on inshore resources. They are the plots of spawning, nursery and reproduction areas of many commercial marine species. Inshore resources consolidate strong relationship between sea and land. Moreover, increase in sea level [13, 27], coastal erosion [15], and ocean acidification on calcifying organisms [28] were the ultimate threats and disturbing factors of climate change on inshore stocks. Further, climate changes would disturb the sensitive balance of the mangrove ecosystems by bringing out visible changes in them [27]. Fishers opined that deterioration of fishery environments was damaging the sensitive habitats like mangroves, sea grass beds and coral reefs which adversely affect the recruitment of juveniles to the fishery and thereby increase the exposure of the fishers to the climate change [13].

3.2 Constraints Faced by Fishers

The present study also assessed the constraints as experienced by the fishers in using various coping mechanisms to mitigate adverse effects of climate change on fisheries and the results are presented in Table 2. The major constraints to coping with climate change faced by fishers in the study area included, unpredictable direction and speed of the wind (Rank-I, 83.33%). The fishers could not be able to predict the wind direction and its speed which sometimes forced them to drift into another district, state or even another nearby countries. It is the most soaring factor disrupting fishing operations and sea conditions [17, 25].

Inefficient source of communication (Rank-II, 76.67%) regarding climate change was also considered as a constraint in lists of fishers. The cell phone signal covers approximately 15-20 km within the sea and beyond that the fishers just have to rely on VHF wireless devices to communicate with the fellow fishermen. However, during the bad weather conditions, the coverage of VHF set signals is also very
weak. Most of the fishing boats were not yet equipped with communication and early warning facilities, which greatly decreased their adaptive capacity against the hazardous effects of climate change [13]. It can be taken as one of the best mitigation and adaptation strategies if proper execution is possible. Designing effectual communication sources and validation of communication tools by participatory action research mode at least in selected locations in the country would help the fishermen. In addition, using advanced ICT tools for continuous communication and exchange of information on various climate change events helps multi-stakeholders to cope with unforeseen natural calamities [29]. Damage to crafts and gears in unfavourable climatic conditions was another major problem for the fishers (Rank-III, 73.33%). During cyclones, storm and high winds, the crafts and gears which are kept in the jetties are getting damaged due to its velocity [13, 30, 31] and the fishermen themselves have to pay a huge amount for repairing them.

In addition to the above, unseasonal rains (Rank-IV, 67.5%), rise in sea level (Rank-V, 65%) coastal erosion (Rank-VI, 60.83%) were also some of the other important constraints faced by them due to climate change. The unusual weather conditions in the sea may have an adverse impact on fishers and sometimes the fishing boats get stuck on the deep sea due to unseasonal rains [8, 13]. Sea-level rise is considered to be an important manifestation of global warming [2, 26, 32, 33]. Ocean warming and sea-level rise, had a direct impact upon the lives and livelihoods of coastal fishing communities. In addition to this, coastal areas are also vulnerable to severe erosion due to rise in sea level [6, 8, 15]. Living space of fishers has been lost and the space available for recreation and post-harvest operations itself has been reduced in erosion-prone areas. Many of the houses of fishers were damaged due to coastal erosion in Kanyakumari.

### Table 1  Perception of fishers’ about consequences of climate change.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Consequences</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increase in cost of fishing</td>
<td>120</td>
<td>0</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>Increase in fishing investments</td>
<td>120</td>
<td>0</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>3</td>
<td>Reduction in fish diversity and catch</td>
<td>115</td>
<td>5</td>
<td>4.17</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>Loss of fishing grounds</td>
<td>115</td>
<td>5</td>
<td>4.17</td>
<td>120</td>
</tr>
<tr>
<td>5</td>
<td>Loss of traditional fishing skills</td>
<td>112</td>
<td>8</td>
<td>6.67</td>
<td>120</td>
</tr>
<tr>
<td>6</td>
<td>Decline in fishing days</td>
<td>109</td>
<td>11</td>
<td>9.17</td>
<td>120</td>
</tr>
<tr>
<td>7</td>
<td>Reducing in application of indigenous technical knowledge (ITK)</td>
<td>110</td>
<td>6</td>
<td>5.00</td>
<td>120</td>
</tr>
<tr>
<td>8</td>
<td>Increase in access time to fishing grounds</td>
<td>107</td>
<td>3</td>
<td>2.50</td>
<td>120</td>
</tr>
<tr>
<td>9</td>
<td>Alteration in fishing seasons</td>
<td>94</td>
<td>16</td>
<td>14.16</td>
<td>120</td>
</tr>
<tr>
<td>10</td>
<td>Decrease in inshore fishery resources</td>
<td>88</td>
<td>20</td>
<td>16.67</td>
<td>120</td>
</tr>
</tbody>
</table>

### Table 2  Constraints faced by the fishers on climate change.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Constraints</th>
<th>Frequency</th>
<th>%</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unpredictable direction and speed of the wind</td>
<td>100</td>
<td>83.33</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>Inefficient source of communication</td>
<td>92</td>
<td>76.67</td>
<td>II</td>
</tr>
<tr>
<td>3</td>
<td>Damage to crafts &amp; gears in unfavorable climatic conditions</td>
<td>88</td>
<td>73.33</td>
<td>III</td>
</tr>
<tr>
<td>4</td>
<td>Unseasonal rains</td>
<td>81</td>
<td>67.50</td>
<td>IV</td>
</tr>
<tr>
<td>5</td>
<td>Rise in sea level</td>
<td>78</td>
<td>65.00</td>
<td>V</td>
</tr>
<tr>
<td>6</td>
<td>Coastal erosion</td>
<td>73</td>
<td>60.83</td>
<td>VI</td>
</tr>
<tr>
<td>7</td>
<td>Entry of invasive species</td>
<td>72</td>
<td>60.00</td>
<td>VII</td>
</tr>
<tr>
<td>8</td>
<td>Damage to biological diversity</td>
<td>70</td>
<td>58.33</td>
<td>VIII</td>
</tr>
<tr>
<td>9</td>
<td>No proper rescue operations</td>
<td>69</td>
<td>57.50</td>
<td>IX</td>
</tr>
<tr>
<td>10</td>
<td>Differences among fishers</td>
<td>60</td>
<td>50.00</td>
<td>X</td>
</tr>
</tbody>
</table>
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district. Monsoonal fluctuations, substantial decrease in rainy days over the years, substantial increase in sea level and coastal erosion are the highlighted phenomenon of fishermen regarding climate change [15]. Climate change may influence (directly or indirectly) considerable shifts in species and favor the entry of invasive fish species [22, 34]. Introduction of invasive species has impact not only on ecosystem and natural biodiversity but also fishers’ livelihood. Entry of invasive species (Rank-VII, 60.00%) has also been recorded as one of the major constraints.

4. Conclusions

In the present study area, fishers stated that loss of income has been prevailing due to reduction in fishing days, resulting in greater disproportion between investment and income. Increase in cost of fishing, increase in fishing investments, decline in fishing days and reduction in fish diversity and catches were some of the consequences faced by fishers due to climate change. Due to the climate change events, the fishers lost 25 fishing days per year, which is equal to a loss of about US$615.24. Unpredictable direction and speed of wind, inefficient sources of communication and damage to crafts and gears were the most constraints faced by the fishers.

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