

# Climate Change Vulnerabilities on Livelihood of Fishing and allied Communities of Southwest Coast of India: A Case Study of Azheekkal Fishing Village, Kerala, India

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## ABSTRACT

Fishermen on the southwest coast of India have been increasingly vulnerable to the impacts of climate change over the past few years. Erratic weather patterns, fluctuating monsoons, frequent cyclones, and rising sea temperatures have significantly affected their livelihoods. The vulnerability indicator analysis following Garrett method in the current study indicates a marked reduction in fishing days, resulting in more jobless days and decreased income. Additionally, a decline in fish catch quality, and species loss due to overfishing, habitat destruction, lack of access to modern fishing technology, and pollution have compounded the challenges fishing communities face. Despite numerous government initiatives designed to uplift these fisher folk, many remain inadequately implemented or fail to reach those who need them most, leaving these communities educationally and economically disadvantaged. By bridging this knowledge gap and fostering scientific literacy among fishermen, these communities can be empowered to develop and actively implement effective adaptation strategies.

**Key words:** Erratic climate, Henry Garrett ranking, Fish diversity, Species loss, Overfishing, Sea temperature

## INTRODUCTION

Climate change is a pressing reality that demands global action. Its consequences are felt across all aspects of life, but marine environments are particularly vulnerable due to their unique position at the interface of land and water. It is estimated that 12 of the world's 16 largest cities, each with populations exceeding 5 million, are located within 100 km of the coast. Thus, marine environments play a vital role in the economy and ecology. Kerala, a coastal state on the south-western coast of India, is bordered by the Western Ghats to the east and the Arabian Sea to the west. This unique location has significantly shaped Kerala's history, economy, and social structure. Fishing is a crucial part of Kerala's economy, providing livelihoods for many. Beyond merely catching fish, this sector generates income through activities such as fish processing, beach work, small-scale vending, and the operation of peeling sheds. Although Kerala ranks third in marine fish landings, the state has experienced a substantial decline in recent years, raising concerns about food and livelihood security for fishing communities. Erratic weather patterns and shifting monsoon cycles, exacerbated by global warming, rising sea levels,

rapid warming of ocean, and increased cyclone activity, have demonstrably impacted Kerala's marine resources. A reduction in plankton, a primary food source for fish, has led to decreased fish production, directly affecting the catch and income of fishing communities. Moreover, traditional fishing equipment and vessels are often inadequate or unsafe during heavy monsoons and rough weather conditions that generate strong waves. Climate change presents a significant challenge to the livelihoods of fishing communities, leading to a cascade of economic, social, and financial hardships. The marine fisheries sector in India - of which Kerala is a prominent contributor - faces numerous interconnected challenges. Monsoonal environment fluctuations within the coastal ecosystem influence the movement and spawning patterns of aquatic species, thereby impacting fish species diversity. Marine fishery resources are typically categorized into four groups based on their biological characteristics and habitat preferences: pelagic, demersal, crustacean, and mollusca. While the fisheries sector offers significant direct and indirect employment opportunities worldwide, there is a lack of research on the effectiveness of fisheries development programs in addressing the evolving

needs of fishing communities in the face of climate change, ultimately leading to reduced fish landings. This study aims to bridge this knowledge gap by comprehensively examining these communities' vulnerability to climate change's impacts. It incorporates a case study of Azheekkal Harbour in Kerala's Kollam district to illustrate these challenges and explore potential solutions.

## MATERIAL AND METHODS

### Study area

The focus of this study was the Azheekkal fishing village, selected for its distinctive blend of traditional and modern fishing practices. This community remains largely insulated from the effects of modernization and trade liberalization, and local fishermen have not yet fully embraced the latest technological advancements in the fishing sector. Fishing harbours play a vital role as connecting hubs between fish production and market distribution, offering significant potential to promote sustainable

fishing practices. The Azheekkal Harbour features a landing wharf measuring 98.50 m in length and 5.30 m in width, a berthing jetty spanning 604.32 m and a basin area of 21,210 m<sup>2</sup>. The harbour has supporting infrastructure: a gear repair shed of 48.90 by 15.00 meters, a boat repair yard with a slipway measuring 35.80 by 21.20 meters, and a peeling shed of 36.30 by 14.00 meters. Additionally, it has two diesel outlets, a 20,000-liter overhead water tank, and a 50,000-liter sump. The harbour supports a fleet of 180 motorized boats, each equipped with less than 15 HP propulsion, utilizing monofilament nylon surface and bottom-set gillnets to target various fish species. The coordinates for Azheekkal Harbour are 9°07' 55.91642 2 N and 76°27' 49.93922 2 E, situated along the Arabian Sea (Fig. 1).

### Quantitative analysis

Quantitative data on livelihood and healthcare challenges and the adaptation strategies employed during erratic weather patterns and shifting monsoon cycles were gathered through a questionnaire

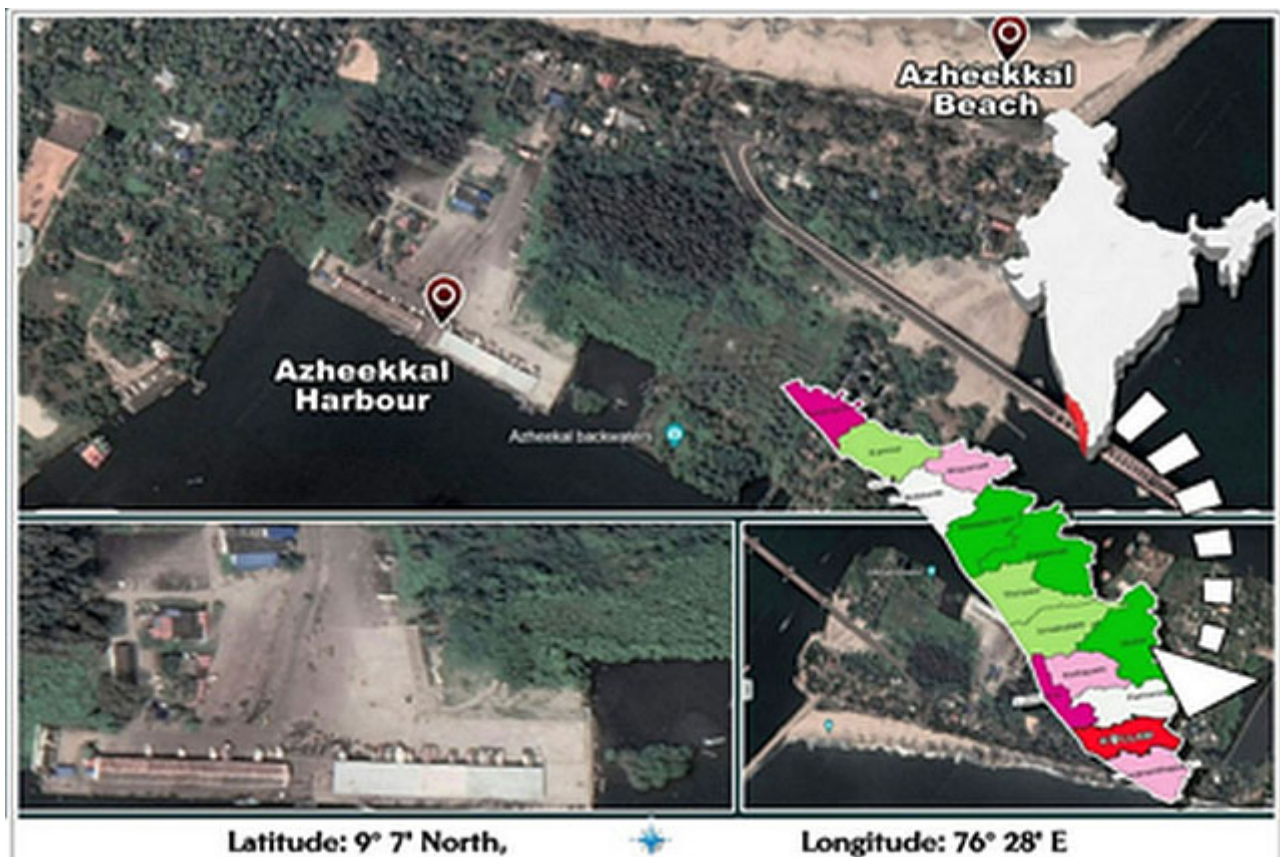


Figure 1. Study area - Azheekkal Harbour

administered to 247 respondents from the fishing community and related sectors. These participants included operators of small-scale motorized fishing units, traditional fishermen, women fish vendors, and local fishing workers. To ensure comprehensive data collection, a detailed questionnaire was developed in both Malayalam and English, covering five key areas: socio-demographics (personal and family background), livelihood (fish landings and job opportunities), climate change impacts (personal struggles due to erratic weather and shifting monsoons), health (healthcare access and health status), and government interventions (mitigation efforts by central, state, and local authorities). Following an explanation of the study's significance, oral consent was obtained from the participating fishing workers. Data was collected through interviews and surveys between October 2022 and May 2023. Additionally, focus group discussions (FGDs) provided qualitative data, offering deeper insights into these communities' perspectives (Johnson and Onwuegbuzie 2004, Bryman 2006).

### Qualitative analysis

The quantitative data collected from the questionnaire provided a foundational understanding of the challenges faced by fishing communities. To analyze the vulnerability of fishing communities in the context of climate change, key assessment factors were identified through a combination approach comprising of literature review, expert consultations, and a preliminary interaction with different stakeholders. To gain deeper insights into the underlying reasons for these struggles (Creswell and Clark 2011), qualitative data was gathered through focus group discussions (FGDs). Unlike surveys, FGDs allowed for in-depth inquiries, allowing participants to elaborate on their experiences with erratic weather patterns and changing monsoon cycles (Creswell and Poth 2018, Sarker et al. 2019). A total of 120 allied workers from a pool of 247 respondents were organized into 12 focus groups, each comprising 10 members. Representatives from all fishing industry sectors participated, discussing the impacts of climate change on their livelihoods, economic well-being, health status, and access to healthcare. By comparing and analyzing data from the questionnaires and FGDs, the study aimed to

develop a comprehensive understanding of the overall effects of climate change patterns and shifting monsoon cycles on these communities.

### Statistical analysis

The data analysis utilized a mixed-methods approach. Quantitative data from the survey questionnaire were subjected to descriptive statistical analysis, including percentage computations. To enhance our understanding of the experiences of fisher folk, these quantitative findings were triangulated with qualitative thematic analysis derived from focus group discussions (FGDs). Additionally, non-parametric tests were performed using IBM SPSS v27 software as needed. Finally the vulnerability indicator analysis following Garrett method was applied to identify the factors most significantly affecting fisher folk livelihoods.

### Vulnerability indicator analysis following Garrett's method

To identify the key challenges faced by the fishing community, this research utilized Henry Garrett Ranking Technique to prioritize eight identified impacts of climate change. Respondents ranked these factors from one to eight based on their personal experiences. Garrett's technique was instrumental in understanding respondents' preferences concerning climate change-related issues affecting their livelihoods. This method allows for identifying the factor that has the most significant influence on their practices. The ranking data was transformed into scores using the following formula:

$$\text{Per cent position} = 100(R_{ij} - 0.5) / N_j$$

where,  $R_{ij}$  represents the rank assigned to the  $i_{th}$  variable by the  $j_{th}$  respondent, and  $N_j$  denotes the total number of variables ranked by the  $j_{th}$  respondent. These per cent positions were then converted into scores using the table provided by Garrett and Woodworth (1969). The mean score for each factor was calculated by summing the individual scores, allowing us to identify the factor with the highest mean score as the most influential.

## RESULTS

### Socio-demographic characteristics

Fluctuations in the monsoon and unpredictable

climate not only pose a threat to ecological health and the long-term viability of marine resources but also negatively impact fishing communities' livelihoods and job opportunities. A significant number of people rely on Azheekkal Harbour for their livelihoods. Among the workers at Azheekkal Harbour, the distribution is 43.3% male and 52.6% female. In our survey, respondents ranged from 18 to 75 years of age. Notably, 49.4% of the workers attained primary education, 25.5% completed high school, and 25.1% achieved higher secondary education or beyond (Fig. 2).

### Vulnerability indicator analysis due to climate change in fisheries communities of Azheekkal Harbour following Garrett's method

In this analysis, the loss of fishing days is highest vulnerability factor, with a Garrett average of 76.53. Out of 247 respondents, 183 indicated that this is the most significantly impacted factor due to climate change. The quantity of fish in each catch is the second vulnerability factor, with a Garrett average of 66.81; 23 respondents identified this as a major factor, while 183 selected it as the second most affected factor due to climate change. Species loss is ranked as third vulnerability factor, presenting a

Garrett average of 60.77. Habitat destruction, overfishing, erratic monsoons, the need for updates in fishing methods and technology, and pollution are placed as fourth, fifth, sixth, seventh, and eighth vulnerability factors, respectively. The ranking of vulnerability factors affected by climate change, as reported by respondents, is presented in Table 1, with percentage positions and Garrett indicator values detailed in Table 2. An analysis of the vulnerability factors impacted by climate change in the fisheries communities of Azheekkal Harbour is summarized in Table 3.

#### *Loss of fishing days (Rank 1)*

The emergence of "Loss of fishing days" as the top-ranked vulnerability factor, with a Garrett average of 76.53, as reported by most respondents, underscores its significant impact on the community's economic stability. Fishing is the primary source of income for most of the population at Azheekkal Harbour. Therefore, any reduction in the number of days they can go to sea directly results in diminished earnings, making it increasingly difficult for families to meet their basic needs, such as food, shelter, and healthcare. This immediate financial insecurity due to restricted fishing opportunities can have cascading effects throughout

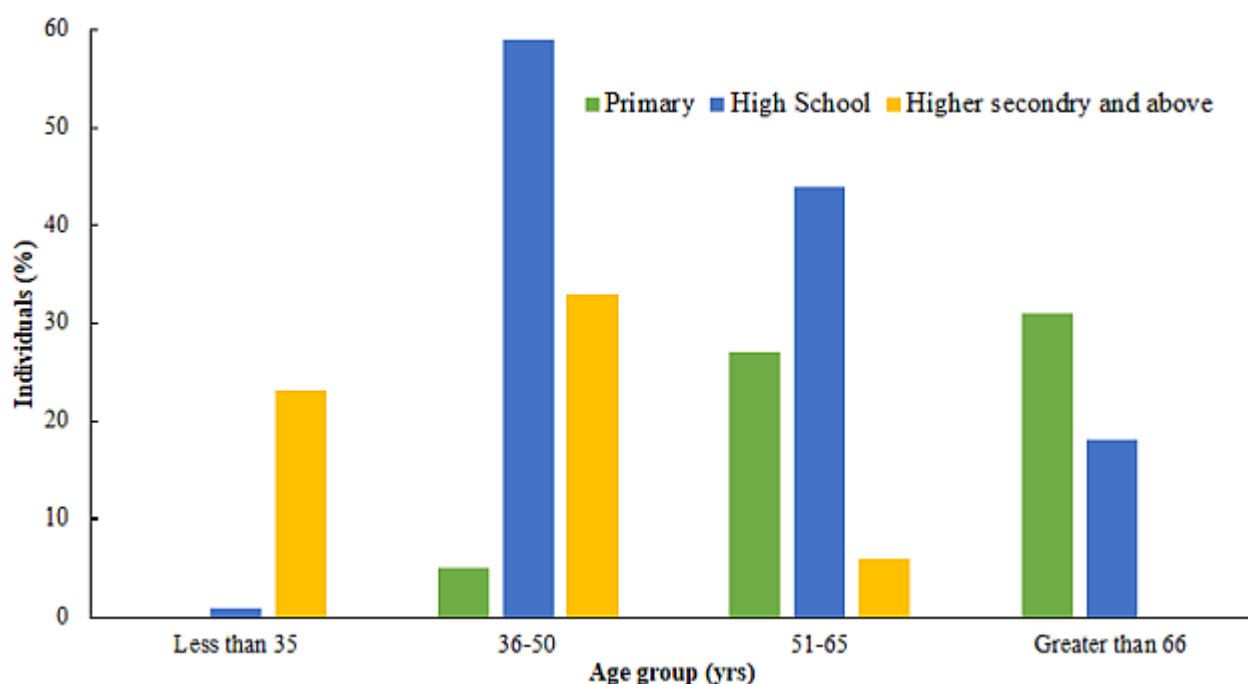


Figure 2. Age wise educational status of fishing and allied workers of Azheekkal Harbour in Kollam district (N=247)

Table 1. Preferences by the respondents

Factors affected by climate change	Respondents' preference values for the factors							
	1	2	3	4	5	6	7	8
Quantity of fishes in catches	23	183	16	14	11	0	0	0
Updating fishing methods & technology	0	0	0	0	0	0	186	61
Species loss	27	0	170	50	0	0	0	0
Loss of fishing days	183	53	11	0	0	0	0	0
Pollution	0	0	0	0	0	16	61	170
Over fishing,	0	0	0	0	186	61	0	0
Habitat destruction	14	11	50	156	0	0	0	16
Erratic monsoon	0	0	0	27	50	170	0	0

Table 2. Per cent position and Garrett's analysis value

Rank	per cent position	Garrett values
1	6.25	80
2	18.75	68
3	31.25	60
4	43.75	53
5	56.25	47
6	68.75	40
7	81.25	32
8	93.75	20

Table 3. Henry Garrett method analysis of factors affected by climatic change in fisheries communities of Azheekkal harbour

Factor	Name of factors affected	Garret average	Rank
1	Quantity of fishes in catches	66.81	II
2	Updating fishing methods & technology	29.04	VII
3	Species loss	60.77	III
4	Loss of fishing days	76.53	I
5	Pollution	24.26	VIII
6	Over fishing,	45.27	V
7	Habitat destruction	54.48	IV
8	Erratic monsoon	42.84	VI

the local economy, affecting related jobs and businesses that rely on the fishing industry, including fish processing units, transportation services, and local markets. Moreover, the desperation from losing

regular fishing opportunities may compel individuals to engage in risky activities to secure income. The study revealed that during heavy monsoons, fisher folk sometimes feel forced to undertake perilous ventures, such as navigating treacherous tides, to make a living. This situation highlights the community's extreme vulnerability and the difficult choices they must confront when unpredictable weather patterns disrupt their traditional livelihood.

*Quantity of fishes in each catch (Rank 2)*

Even on days when fishing is feasible, the second-ranked vulnerability factor, "Quantity of fish in each catch," with a Garrett average of 66.81, poses a significant threat to the economic viability of fishing as a sustainable livelihood in Azheekkal Harbour. Smaller catches directly lead to lower earnings per fishing trip, regardless of the effort and time invested. This consistent trend of diminished catch quantities contributes to long-term financial instability within the community, often resulting in increased indebtedness. When income from fishing falls short of covering daily expenses and necessary investments in fishing gear, families are frequently compelled to borrow money, often from private moneylenders who impose exorbitant interest rates, trapping them in a cycle of poverty. Compounding this issue is the concerning trend reported by fishermen at Azheekkal Harbour, highlighting a significant decline in fish caught. Fingerlings, rather than mature adults, increasingly dominate catches. The prevalence of juvenile fish in the catches serves as a critical indicator of unsustainable fishing practices, potentially exacerbated by the impacts of climate change on fish populations and their habitats.

Harvesting fish before they have had the opportunity to reproduce further depletes fish stocks, jeopardizing the fishery's future and exacerbating the already precarious situation the fishing community faces. This ecological crisis directly fuels the socioeconomic challenges encountered by the community.

#### *Species loss (Rank 3)*

The third-ranked vulnerability factor, "Species loss" with a Garrett average of 60.77, exacerbates the Azheekkal fishing community's financial vulnerabilities. The decline in commercially important fish species, such as sardines - once plentiful and affordable - directly undermines their financial stability. Sardines likely represented a significant portion of their regular catch and income, and their decline or disappearance from local waters signifies a substantial loss of a reliable revenue source. This loss makes it increasingly challenging for families to sustain their livelihoods and fulfil their financial obligations. The economic hardship stemming from species loss extends beyond financial concerns, significantly impacting family life within the community. The stress and uncertainty associated with reduced incomes can lead to heightened household tensions, food insecurity, and difficulties in providing for children's education and other essential needs. The erosion of a stable income source due to the decline of key commercial species can have profound social consequences, affecting the overall well-being and social cohesion of the Azheekkal fishing community.

#### *Habitat destruction (Rank 4)*

Habitat destruction that ranked as fourth vulnerability factor may be connected to climate change through rising sea temperatures that affect coral reefs or a growing frequency of intense weather events that impact coastal ecosystems. These changes further diminish the populations of fish upon which the community relies. The degradation of marine habitats reduces the habitats available for fish to grow, feed, and reproduce, ultimately leading to lower catch yields and a decline in species.

#### *Overfishing (Rank 5)*

Overfishing, which is ranked as fifth vulnerability factor, often driven by the economic need to make up for declining catches due to environmental factors, creates a harmful cycle of resource depletion.

Harvesting fish at a rate that exceeds their ability to replenish, along with the concerning trend of catching juvenile fish, puts the long-term sustainability of the fishery at significant risk.

#### *Erratic monsoon patterns (Rank 6)*

The erratic monsoon, that ranked as sixth vulnerability factor is marked by unpredictable timing and intensity, directly disrupts fishing schedules and heightens the inherent risks of going out to sea. These volatile weather conditions lead to a loss of fishing days and can also damage equipment and infrastructure related to fishing. In severe weather, coastal erosion may displace families, forcing them into temporary camps. Many respondents noted that this relocation adversely impacts children's education.

#### *Updating fishing methods and technology (Rank 7)*

The text suggests a nuanced relationship with modernization, which is positioned lower. While technological advancements have the potential to enhance efficiency, the current survey reveals that the advantages of technologies, such as mechanized boats, have not been distributed equitably. This disparity may exacerbate existing inequalities within the community and introduce new challenges for traditional fishermen. Out-dated fishing methods, rising fuel costs, limited boat availability, and damage to equipment from inclement weather further contribute to their struggles and poverty. Many workers rely on private moneylenders to acquire fishing gear and boats or replace damaged equipment, which leads to increasing debt that drives numerous families deeper into poverty.

#### *Pollution (Rank 8)*

Pollution from various land-based and marine sources that ranked as eighth vulnerability factor deteriorates the marine environment, adversely affecting fish populations and possibly making them unsafe for consumption. The study's findings, which highlight plastic waste replacing fish in fishing nets, emphasize the gravity of this issue and its direct consequences for the livelihoods of the fishing community.

### **Healthcare access and health status**

A survey conducted among the fishing communities of Azheekkal Harbour highlighted that climate change and poverty exacerbate health issues and

increase disease prevalence within these populations. Coastal erosion and the onset of monsoon seasons contribute to outbreaks of contagious diseases among workers due to unsanitary conditions. Many fishing villages lack adequate drinking water facilities and proper sewage systems, adversely affecting their quality of life. Additionally, poor housing conditions, improper waste disposal, and inefficient drainage systems heighten the vulnerability of these communities. Socioeconomic progress in Kerala's fishing villages has stagnated recently, leading many fishermen and women fish vendors to abandon their traditional livelihoods. Many female respondents expressed concerns regarding the socio-cultural decline of the community, noting that addiction and excessive consumption of alcohol pose significant health risks in the coastal area.

### Mitigation efforts

The data gathered from the survey and focus group discussions indicated that introducing mechanized boats has significantly increased fish catches and revenue. However, this benefit has not reached the traditional fishing community. Many workers at Azheekkal Harbour expressed concerns that while numerous government schemes and projects aimed at uplifting the traditional fishermen community, very few are executed effectively. The Kerala Government has initiated various programs to protect fish workers' social security and livelihoods. In addition to the fisheries department, organizations such as the Kerala Fisheries Welfare Fund Board and Matsyafed play a crucial role in these efforts. These initiatives encompass housing, insurance, pensions, a savings cum relief scheme, and income-generating opportunities for fish workers. Moreover, the Kerala government has implemented several sustainable livelihood programs, including the Society for Assistance to Fisherwomen (SAF), which focuses on empowering fisherwomen. The initiatives undertaken by SAF have been notably successful, with 60% of beneficiaries reporting enhanced living standards due to additional income from alternative livelihood activities. This economic uplift has significantly contributed to the region's overall socioeconomic development. During the heavy monsoon season, the Kerala state government provides free or subsidized food grains. Most

respondents indicated that the only cash income during this period came from the support received through welfare pensions and relief funds. The social welfare pension is consistently increased, and the state government has assured the timely distribution of pensions to eligible workers. Although various policies, schemes, and projects exist to support fishing communities, many have not been implemented effectively.

### DISCUSSION

Kerala's rich marine life, encompassing a diverse array of fish species and a skilled fishing community, has historically established the state as a leading producer and consumer of seafood (Aerthayil 2000). The population density in the coastal regions surpasses other geographical areas in Kerala, such as the midlands and highlands. The Arabian Sea, stretching from Kanyakumari to Kollam, is home to India's richest marine biodiversity, with habitats primarily consisting of coastal areas, deep seas, and estuaries. This study found that among workers engaged in fishing and related activities, women outnumber men. This higher proportion of female workers underscores their vital role in the regional fishing economy, extending beyond direct fishing to essential sectors like fish processing, local vending, and other supportive businesses (Anonymous 2020). Women play pivotal roles in fisheries, particularly post-harvest activities, including gear construction, fish sorting, handling, and processing. Fisherwomen are crucial to the value chain, facilitating the transformation of catches into marketable products. As key intermediaries between producers and consumers, they significantly influence the sustainability and economic viability of the sector. Furthermore, older workers often possess invaluable traditional ecological knowledge acquired through years of experience, essential for understanding local marine ecosystems and identifying subtle environmental changes (Berkes 2017).

The educational attainment within the community reveals a diverse landscape. A notable portion of fisher folk (49.4%) has achieved primary education, while a slightly larger group (50.6%) has reached higher levels of education. This includes a nearly equal distribution between those who completed high

school (25.5%) and those who attained higher secondary or further education (25.1%). These findings align with a recent shrimp and prawn industry study, which reported that 44% of workers possess higher secondary education or above (Bindu and Fathima 2022). This significant segment of the population equipped with secondary and tertiary education constitutes a valuable asset for the community. Higher levels of education are often associated with a greater ability to adopt new technologies, access information, and explore diverse income opportunities through alternative employment avenues (Anonymous 2012).

In our survey, most respondents indicated that erratic climate patterns and fluctuating monsoon seasons threaten the ecological health and long-term viability of marine resources and their livelihoods and job opportunities. The study ranks the reduction in fishing days as the most critical issue, with a Garrett average of 76.53. A decrease in the number of fishing days (Adger et al. 2009) and an increase in the frequency and intensity of natural disasters significantly impact agriculture, livelihoods, the economy, and other sectors in Bangladesh (Agrawala et al. 2003, Anonymous 2000, 2007, Al-Amin et al. 2013, Barua et al. 2017, Barua and Rahman 2018). The reduction in fishing days due to erratic monsoon (Salim et al. 2014a, b) leads to long-term financial instability, pushing families into cycles of indebtedness. The need to borrow money for daily expenses and operational costs, often from informal lenders with high interest rates, exacerbates their financial instability, creating a poverty trap that is challenging to escape (Amin et al. 2003). In the current study, the Henry Garrett analysis ranks species loss as the third most affected factor, with a Garrett average of 60.77, followed by habitat destruction, overfishing, and erratic monsoon conditions as the fourth, fifth, and sixth affected factors, with averages of 54.48, 45.27, and 42.84, respectively. The scarcity of once-abundant and commercially important species, such as sardines, represents a significant economic blow. These species were likely a reliable and substantial source of income for the fishing communities. Modifications in fishing gear and increased efforts and operational areas have contributed to the decline in sardine populations due to overfishing (Kripa et al. 2018).

For the past century and a half, small seines have been used for sardine fishing in India, but these seines have since been enlarged (Anonymous 1971, Pillai et al. 2003). Fisheries-induced changes in age structure, stemming from the exploitation of juvenile fish, also result in declining sardine stocks (Rouyer et al. 2011). Overfishing affects the relative abundance of various fish species. In the long run, these changes may disrupt community structure, biodiversity, and ecosystem functioning (Jackson et al. 2001). The decline or disappearance of fish species from local waters signifies the loss of a crucial revenue stream, making it increasingly difficult for families to sustain their livelihoods and meet financial needs (Cheung et al. 2005). The economic difficulties stemming from declining catches and species loss extend beyond mere financial concerns, profoundly affecting the social fabric of the Azheekkal community. This has reduced fishing communities' income, increased unemployment, and more jobless days during heavy monsoon seasons. As species respond specifically to climate change factors, coastal and marine food resources will significantly alter (Salim et al. 2018).

Our study found that many families are displaced and relocated to temporary camps due to coastal erosion, particularly during heavy monsoon seasons, which disrupts their children's education. The damage to equipment, rising fuel costs, out-dated fishing methods, and limited availability of boats have exacerbated their suffering and poverty. The stress and uncertainty arising from dwindling incomes can increase household tensions, contribute to food insecurity, and hinder families' ability to meet essential needs, including children's education and healthcare (Ellis 2000). Environmental pressures, such as destroying natural fish habitats due to warming seas, overfishing, the increasing frequency of hurricanes, and pollution, are causing a significant decline in fish stocks across all seasons. Extreme weather changes, rising sea levels, and the resulting alterations in habitat, along with variability in catch and revenue, represent the main impacts of climate change on marine fisheries (Vivekanandan 2007).

Large-scale environmental changes seriously threaten the lives and livelihoods of those relying on marine resources (Islam et al. 2014). The fishing community is often socially and economically

disadvantaged. Most fishers worldwide live in poverty and lack education, which limits their ability to pursue alternative occupations or adaptive measures (Koya et al. 2017).

According to Henry Garrett's method analysis, updating fishing methods and technology ranks seventh in our study, with a Garrett average score of 29.04. In contrast, the pollution of marine ecosystems ranks eighth, with a Garrett average of 24.26. Research indicates that changes in temperature in southeast Australia (Frusher et al. 2014) and ocean acidification in the Arctic (Mathis et al. 2015) are impacting the distribution and abundance of fish species. These shifts in marine life compel communities, industries, and governments to develop adaptation strategies grounded in a thorough understanding of the changing climate's physical, biological, and social dimensions (Barange et al. 2014, Frusher et al. 2014). Moreover, inadequate drinking water facilities, substandard housing conditions, improper waste disposal, and ineffective drainage systems exacerbate the challenges faced by fishing communities. Insufficient government support during adverse weather events and declining fish populations expose these communities to health risks (Kalikoski et al. 2010). It is imperative that government initiatives aimed at uplifting fishing communities effectively reach those in needs. Many individuals remain unrecognized despite the fisheries sector encompassing various livelihood activities - from production and processing to marketing and support functions (Salagrama 2012). A comprehensive approach is essential to alleviate poverty and enhance the resilience of fishing communities, which should include implementing multifaceted policies and sustainable development strategies.

## CONCLUSIONS

The west coast of India, particularly the waters of Kerala, is rich in biodiversity and species diversity. A significant portion of the population in Kerala relies on the sea for their livelihoods. Unfortunately, the coastal communities in Kerala face severe impacts from climate change. The Garrett analysis highlights a structured approach to understanding the multifaceted effects of climate change and

underscores the need for adaptive strategies. These strategies should incorporate environmental conservation, sustainable livelihoods, and community resilience to mitigate current and future challenges posed by climate change. Collaborative efforts among policymakers, researchers, and stakeholders are essential in developing practical solutions to protect fishing communities' socioeconomic and environmental well-being.

## Ethical issues

To ensure ethical conduct, the study prioritized participant anonymity throughout the questionnaire survey and focus group discussions (FGDs). Researchers ensured participants were fully informed about the research goals before participation. This included a clear explanation regarding the confidentiality of all collected data.

**Authors' contributions:** Both the authors equally contributed in the design and conduct of the experiment, data analysis and preparation of the manuscript.

**Conflict of interest:** The authors declare no conflict of interest.

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