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Livelihood Vulnerability of Small-scale Fisher Households to Climatic Hazards: A Gendered Analysis in the South West Coast of India

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ABSTRACT

The experiment was conducted during January–March, 2021 at Ernakulam district of Kerala state, India to study the livelihood vulnerability of small-scale coastal fisher households to climatic hazards in a gendered perspective. The state of Kerala along the south west coast of India has been identified as one of the climate vulnerable hotspots threatened by extreme events including sea level rise. Coastal fisher communities across the world are highly vulnerable to climate change in view of the dependence on fishery-based livelihoods, depletion of marine resources, low resource possession, lack of fishing rights and other environmental hazards. Considering the low resilience of women to climate change, gender-based livelihood vulnerability assessments are essential for effective decisions on adaptation strategies within the constraints of local resources and infrastructure. The paper depicts the results of the gendered vulnerability assessment of small-scale fisher households in Ernakulum district of Kerala state. A composite livelihood vulnerability index (LVI) was developed based on the data on 400 small scale fisher households. The LVI was constructed across 8 major components consisting of socio-demographic particulars, health, water, food, natural and physical capital, financial capital, social capital and climate hazards. The results indicated that female-headed households had higher vulnerability (LVI-0.40) compared to male -headed households (LVI-0.37) and suggest the need for gender inclusive approach in the national, state and local level action plans on climate change adaptation and disaster-risk reduction programme.

KEYWORDS: Climate hazards, gender, livelihood vulnerability, small scale fishers

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1. INTRODUCTION

Coastal states of India have been affected by frequent climate-induced natural disasters such as cyclones, floods, droughts and other related hazards in the recent decades (Kantamaneni et al., 2022). Kerala state located in the south west coast of India has been identified as one of the climate vulnerable hotspots in the country. The intensity of tropical cyclones has been exacerbated by climate change and the state witnessed several catastrophic disasters induced by climate change related extreme weather events causing severe disruptions to the lives and livelihoods of the people. The cyclone *Okhi* in 2017, flash floods in 2018 and cyclone *Tauktae* in 2021 severely affected the livelihoods of coastal people in the state (Punya et al., 2021; Walia and Nusrat, 2020). The Indian Network for Climate Change Assessment (INCCA) projected that one-meter sea level rise could inundate 169 sq. km of the coastal region surrounding Ernakulam district (Anonymous, 2010). Climate change is assumed to cause disproportionate impacts on people dependent on natural resource-based livelihoods particularly on small scale coastal fishers dependent on fishery-based livelihoods (Alig, 2011; Olsson, 2014; Aswathy et al., 2023). Several authors studied the vulnerability of rural livelihoods to climate change and extreme events in different regions using indicator based approach (Hahn et al., 2009); Mainali and Pricope, 2018; Nguyen et al., 2018; Zacarias, 2019; Venus et al., 2020; Shahzad et al., 2021; Suryanto and Rahman, 2019; Das et al., 2020; Mekonen and Berlie, 2021; Qin et al., 2022). Patidar et al. (2018) suggested the suitability of livelihood assessments in addressing actual vulnerabilities and threats faced by marginalised sections of the population such as tribal communities in India. Khan et al. (2022) identified the adaptive capacity indicators that affect the livelihood vulnerability to climate induced disasters in southwest coastal region of Bangladesh. Mengistu (2022) assessed the factors contributing to vulnerability and coping strategies in North Western Ethiopia. However limited research focussed on assessing the impacts and vulnerability of fishermen communities in relation to climate change impacts (Morand et al., 2012; Geetha et al., 2017, Mohammed et al., 2017; Islam et al., 2014; Panpeng and Ahmad, 2017; Gómez et al., 2021; Sreya et al., 2021).

Climate change related environmental stresses and disasters cause differential impacts on men and women depending on the extent of physical, social and human capital they own and women and children are particularly more prone to the adverse effects in view of the differential adaptive capacities, in equality in access to financial capital, productive resources and livelihood options (Goh, 2012). Several studies suggested that vulnerabilities related to climate change and its impacts on communities are gendered. (Bunce and Ford 2015; Morchain et al., 2015; Yadav and Lal, 2018; Basiru et al., 2022; Habib et al., 2022). Women's empowerment and equality still remain as challenges in the fisheries and aquaculture sectors and climate change induced disasters further worsen the gender bias and economic marginalisation of coastal women (Gopal et al., 2017; Defiesta and Badayos-Jover, 2014). Nevertheless, very few studies focussed on the gendered impacts of climate change and disasters of coastal communities and there is dearth of knowledge on differential impacts of climate change on men and women (Nahian et al., 2013). Assessing the gender differences in vulnerability and adaptive capacity will enable in developing effective climate change adaptation and mitigation plans. In this backdrop the present study was undertaken with the aim of assessing the livelihood vulnerability of coastal fisher communities in a gendered perspective in Kerala state in Southern India. The study employed the sustainable livelihood framework for developing a composite livelihood vulnerability index.

2. MATERIALS AND METHODS

The experiment was conducted during January–March, 2021 at Ernakulam district (10.0718° N and 76.5488° E) of Kerala state, India. Field research was conducted to collect data from coastal fisher households in Ernakulam district using a pre- tested interview schedule**.** The respondents consisted of male and female headed households of fishermen communities residing in the marine fishing villages of Ernakulam district (Figure 1). Ernakulam district is an important maritime

Figure 1: Study area (Ernkulam district of Kerala state)

district with a total of 44,352 marine fishermen families and contributing 22% of the marine fish landings in the state (Anonymous, 2022). The small scale fisherfolk in the district predominantly operate inboard and outboard fitted ring seiners and outboard gillnetters. The small scale marine fisherfolk in the district are affected by resource depletion, competition from mechanised fleet and marine pollution in addition to climate change induced sea erosion, coastal flooding and catastrophic cyclonic storms which affect their livelihood sustainability.

One of the most commonly used methods to assess vulnerability and resilience to climate change is the construction of vulnerability index. The livelihood vulnerability index employed in the study is based on the Sustainable Livelihoods Approach (SLA) used by the United Nations. Livelihood comprises the capabilities, assets and activities required for making a living by an individual or a group of people. The Sustainable Livelihood approach uses the five livelihood capital assets such as natural, social, financial, physical, and human capital to design development programmes (Chambers and Conway, 1991; Serrat, 2017). The ability to cope with and recover from external shocks depends on the livelihood assets owned, controlled or accessed by the households (Lal et al., 2009).

The indicators of LVI used to assess the vulnerability of natural resource-based livelihoods varied with regions/sectors. Hahn et al. (2009) estimated climate change vulnerability in Mozambique and the composite vulnerability index developed consisted of socio-demographics, livelihoods, social networks, health, food and water security, natural disasters and climate variability. Numerous studies adopted the five livelihood assets for the construction of livelihood vulnerability index in the farming sector (Mainali and Pricope, 2018; Shah et al., 2013; Nguyen Thi et al., 2018; Shahzad et al., 2021; Venus et al., 2020; Etwire et al., 2013; Madhuri et al., 2014). LVI was employed for vulnerability assessments in the fisheries sector also (Morand et al., 2012; Orencio and Fujiii, 2013; Islam et al., 2014; Daniel, 2019; Etongo and Arrisol, 2021). Some of the recent assessments included financial assets, land tenure and sanitation facilities under the LVI components (Huynh and Stringer, 2018; Daniel, 2019). The Intergovernmental Panel on Climate Change (IPCC) method developed in 2007 assessed the livelihood vulnerability in terms of exposure, sensitivity and adaptive capacity (Shyam et al., 2018; Sahana et al., 2019). The Anonymous (2014) framework defined vulnerability as a pre-existing characteristic property of a system and used sensitivity and adaptive capacity indicators which are hazard specific to assess the vulnerability (Anonymous, 2014). Index based assessments on gendered vulnerability to climate change are very limited (Alhassan et al., 2018).

The present study adopted the methodology developed by Hahn et al. (2009) for gendered vulnerability assessment and modifications to the methodology was done by including physical and financial capital under the major components. Few sub components such as access to toilets at home, toilets non-usable during climate hazards, access to medical insurance/ health cards, insurance to houses and fishing equipments, and poor-quality water during climatic hazards were also included (Table 1). The eight major components used were socio-demographic particulars, social capital, health, access to food, access to water, natural and physical capital, financial capital and exposure to climate hazards these major components were derived from 39 sub components.

Table 1: Major and sub-components of the livelihood vulnerability index

Sl. No.	Major components/ Sub components	Description	Unit
I.	Socio-demographic		
1.	Education of the household head	Percentage of households in which household head had below primary level education or illiterate	%
2.	Dependency ratio	Ratio of the number of household members in the age group <15 and >65 years to the number of members between 16 and 64 years	Ratio
3.	Knowledge on climate change	Percentage of households where the head does not have any knowledge on climate change	%
4.	Employed members	Inverse of number of employed members in the household	Ratio
II. Health			
5.	Distance to the primary health centre	Average distance to the primary health centre	km
6.	Chronic illness	Percentage of households having members with chronic illness	%
7.	Climate change related illness	Percentage of households having members with climate change related illness	%

Table 1: Continue...

Sl. No.	Major components/ Sub components	Description	Unit
8.	Leave due to illness	Percentage of households where members took leave due to illness	%
9.	Medical insurance	Percentage of households without medical insurance or health card	%
10.	Access to toilets	Percentage of household without toilets	%
11.	Toilets non-usable during climatic hazards	Percentage of household in which toilets become non-usable during floods or other disasters	%
III. Access to water			
12.	Source of water	Percentage of households without piped water for household use	%
13.	Adequate supply of water	Percentage of households without adequate supply of water	%
14.	Poor quality water during floods or other climatic hazards	Percentage of households receiving poor quality water during floods	%
IV. Access to food			
15.	Food sufficiency	Percentage households which are food insufficient	%
16.	Number of months food insecure	Average number of months households are food insecure	Count
17.	Households don't process fish	Percentage of households not processing fish for future use	%
18.	Availability of fish for consumption	Percentage of households not getting enough fish for consumption	%
19.	Households do not undertake farming	Percentage households do not undertake any farming activity	%
V. Natural and physical capital			
20.	Land tenure	Percentage of households without ownership of land	%
21.	Housing	Percentage of households without concrete houses resistant to disasters	%
22.	Electricity	Percentage of households which are not electrified	%
23.	Cooking gas	Percentage of households without cooking gas	%
24.	Consumer durables	Percentage of households not possessing at least 3 items of consumer durables	%
25.	Insurance to house / fishing equipments	Percentage of households without insurance to house / fishing equipments	%
VI. Financial capital			
26.	Household income below poverty line	Percentage of households with annual income less than 27,000 (Amount fixed based on poverty line values for household income in India)	%
27.	Access to credit	Percentage of households without access to credit	%
28.	Access to formal credit	Percentage of households without access to formal credit (banks, cooperatives or other institutional sources)	%
29.	Savings	Percentage of households without savings	%
30.	Social security measures	Percentage of households not receiving any social security pension	%
31.	Households without non-fishery-based income	Percentage of households without any non-fishery-based income source	%
VII. Social capital			
32.	Average receive-give ratio	Ratio of the number of types of help received by the household in the past month +1 to the number of types of help given by the household in the past month+1	Ratio

Table 1: Continue...

Sl. No.	Major components/ Sub components	Description	Unit
33.	Households didn't approach local institutions/ leaders for assistance in the last 12 months	Percentage of households reported they haven't approached local institutions/ leaders for assistance in the past 12 months	%
34.	Membership in societies	Percentages of households without membership in cooperatives, fishermen societies, Self-help groups (SHGs) etc.	%
VIII.	Exposure to climate hazards		
35.	Number of climatic hazards reported by the households	Average number of climatic hazard events reported by the households in last three years	Average
36.	Households suffered accidents to members due to climatic hazards	Percentage of households suffered accidents due to climatic hazards	%
37.	Households not receiving hazard warnings	Percentage of households didn't receive hazard warnings	%
38.	Proximity of houses to shoreline	Percentage of households located within 100 m from the shoreline	%
39.	Households suffered loss of physical assets	Percentage of households suffered loss of physical assets due to climatic hazards	%

The livelihood vulnerability was assessed in a gendered perspective and data were collected from 400 small scale coastal fisher households consisting of 340 males headed and 60 female headed households. The villages selected for the study were dominated by coastal fisher communities, small scale fish workers in the fishing allied sector and daily wage workers. The small-scale fisher households in the fishing villages of Ernakulam district were purposively selected as these fishing villages were severely affected by climatic hazards. Female-headed households are those households wherein the household head is female, who are either widows, divorced or separated, those who have never married, and those who are married but husband stays away from the house for more than 6 months.

Each subcomponent in the LVI was measured in different scales and hence standardisation of the index was done (Hahn et al., 2009).

$$\text{Standardized value } (\text{Index}_{sc}) = (S_a - S_{min})/(S_{max} - S_{min}) \quad \ldots\ldots\ldots(1)$$

Where Index_{sc} is the index for each sub component S_a the actual value of the component in the sample Category, S_{max} is the maximum value of the component in the total sample and S_{min} is the minimum value of the component in the total sample. Through this method, all indicators were standardized to values between 0 and 1. After each subcomponent was standardized, the sub-components were averaged using (2) to calculate the value of each major component.

$$M_{sd} = \sum^{n}_{i=1} \text{index}_{sdi} \quad \ldots\ldots\ldots(2)$$

Where M_{sd} is the major component (eg.socio-demographic particulars) consisting of n subcomponents

The LVI was then calculated from the average of the eight major components

$$\text{LVI} = (\sum^{n}_{i=1} W_{Mi} M_{ci})/(\sum^{n}_{i=1} W_{Mi}) \quad \ldots\ldots\ldots(3)$$

Where W_{Mi} is the weight of each major component n is number of major components which constitute LVI, and M_{ci} is the index for each major component. The weight for each major component is the number of subcomponents which constitute the major component. Vulnerability index developed ranged between 0 and 1, with 0 representing low vulnerability and 1 for high vulnerability.

3. RESULTS AND DISCUSSION

The vulnerability with respect to different subcomponents were assessed based on the results of the analysis. The vulnerability of small-scale fisher households to climatic hazards were assessed with respect to the eight indicators consisting of socio-demographic, health status, access to water, access to food, access to natural and physical capital, financial capital, social capital and climatic hazards and discussed in the subsequent sections. Both male headed and female headed households in the study area showed higher vulnerability with respect to access to water (0.51 for MHH and 0.61 for FHH) and social capital (0.4 for MHH and 0.54 for FHH) (Figure 2). Among the major indicators contributing to livelihood vulnerability, health status had the least score for both MHH and FHH (0.23 and 0.22). Among the various sub indicators, households do not undertake farming or processing of fish under access to food component and insurance to houses/fishing equipments received the highest score for both categories of households.

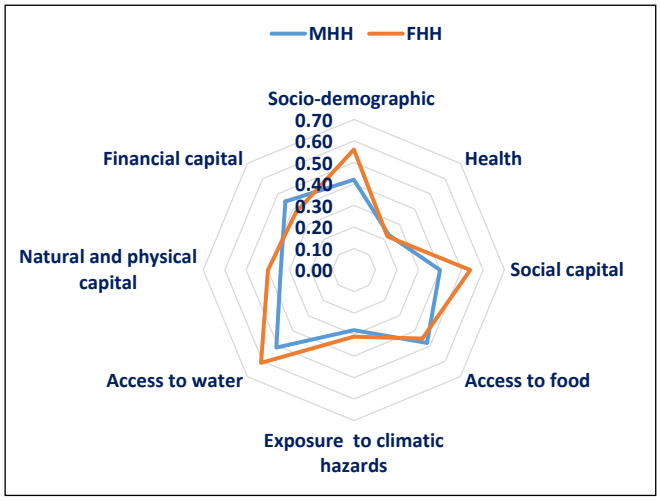

Figure 2: Livelihood vulnerability radar diagram of male headed and female headed households

3.1. Socio-demographic particulars

The marine fisheries in the state is open access and regulations exists in the form of seasonal fishing ban, control of juvenile fishing and mesh size regulations. The marine fish landings in the state showed a consistent decline after 2014 with drastic decline in the catch of small pelagic fish such as Indian oil sardine which was a prominent resource in the marine fisheries of the state. The decline in oil sardine catches adversely affected the livelihood security of small scale fisherfolk depended on this fishery for livelihood. The marine fish production in Ernakulam district showed a decline from 145,395 t in 2011 to 79,819 t in 2020. Fishing was the primary occupation of the male headed household respondents and opportunities for livelihood diversification was limited. Majority of the female headed household respondents were involved in fishing allied activities such as fish marketing, fish drying or shrimp peeling. Few of them worked as housemaids or in the services sector.

The average age of the household head of male headed households was 51 years compared to 56 years in the case of female headed households. Though the family size of female headed households was smaller than male headed households, the number of dependent members were more in the case of FHH. Fifty seven percent of the female heads of the female headed households were widows whereas 35% were either separated or divorced and 8% had their husbands staying away from the house for more than 6 months. The female headed category had 3.3% of the respondents illiterate, 53.3% with primary level education, 21.67% with upper primary and 13.33% with high school level education compared to 0.88%, 37.45%, 34.41% and 21.47% respectively in the case of MHH.

The fisherfolk communities in the study area mostly comprised Latin Catholics (Christian) and Araya (Hindu) communities coming under socially and educationally backward communities (SEBC) of the state. The small-scale marine fishers in the state were among the most marginalized sections of the population. Though the state performs well in terms of percapita gross domestic product and human development index, the development indicators for small scale fisherfolk in the state were low compared to other sections of the society (Sheeja et al., 2023).

Education of the household head, dependency ratio and knowledge on climate change and number of employed members were included under the socio-demographic components for construction of the vulnerability index and female headed households showed more vulnerability to this component. Since the fisher communities live very close to the sea and primarily dependent on fisheries for livelihood, they are more prone to climate change hazards such cyclones, sea erosion, coastal flooding etc. which affect their lives and livelihoods. More than 70 percent of the respondent households were located 100 m within the shoreline. The male fisher respondents in the study area due to their continuous interaction with the sea were well aware of the climate change impacts and reported warming of the sea, erratic rainfall, sea level rise, strong winds, high waves, coastal flooding, reduction in the availability of certain species of fishes and changes in ocean currents in the recent past as climate change related phenomena. The fishing days also reduced due to erratic monsoon and frequent warnings put restrictions for venturing into the sea. The knowledge on climate change received a score of 0.75 for FHH. Seventy five percent of female headed households were reported to have no knowledge on climate change (Table 2).

Table 2: Demographic particulars

Demographic particulars	Standardised score	
	MHH	FHH
Dependency ratio	0.20	0.23
Education of the household head	0.38	0.57
Knowledge on climate change	0.30	0.75
Employed members	0.60	0.69
Index	0.42	0.56

3.2. Health status

Health status scored the least for both categories of households among the major indicators contributing to livelihood vulnerability. Similar finding was reported in the case of community vulnerability to climate change at a coastal municipality in southern Mozambique (Daniel 2019). The female headed households were less vulnerable in the case of health status as chronic illness and climate

change related illnesses were less (Table 3). Availability of toilets and toilets becoming non-usable during floods or other natural disasters was also included as sub components under health status as these components had impact on the health of the household members. Although most of the MHH and FHH possessed toilets, these tend to be non- usable during floods or sea water intrusion caused by frequent cyclones in the study area. The women members of both categories of households faced several issues related to personal hygiene including poor quality water, toilets non-usable during floods and difficulties with respect to changing sanitary napkins during floods or other natural disasters.

Table 3: Health status

Health status	Standardised score	
	MHH	FHH
Distance to the primary health centre	0.39	0.37
Chronic illness	0.17	0.05
Household members took leave due to illness	0.18	0.05
Climate change related illness	0.05	0.02
Medical insurance	0.48	0.57
Access to toilets	0.06	0.07
Toilets non-usable during climatic hazards	0.30	0.40
Index	0.23	0.22

3.3. Access to food

The access to food component in the study was calculated based on food sufficiency, number of months in a year the households were food insecure, households getting enough fish for consumption, households processing fish and households undertaking any farming activity. Food insufficiency in this study is determined based on the number of households in which the family members didn't get at least three meals day^{-1}. The food insecurity was measured by the number of months the households couldn't consume different varieties of nutritious foods which they actually wanted to consume during the year preceding the survey. The marine fisher households rarely undertook farming activity as the coastal areas where they reside were not suitable for cultivating many of the crops.

Female headed households in the study area showed less vulnerability with respect to access to food as the number of months with food insecurity was less (Table 4). With consistent decline in fish catch the MHH with limited livelihood opportunities tend to be more food insecure, whereas livelihood diversification opportunities made female headed households to be more food sufficient. There is evidence based on studies across the world that women empowerment and gender equality has contributed to improving household food and nutrition security and reducing child malnutrition. Women are more capable than men in terms of the ability to use and allocate the available resources to ensure food security for their families (Ibnouf , 2009; Anonymous, 2011). Most of the male headed households in the study area largely rely on fisheries for subsistence and consistent decline in fishery resources and income might have affected the food security of the households.

Table 4: Access to food

Access to food	Standardised score	
	MHH	FHH
Percentage households which are food insufficient	0.11	0.15
Number of months food insecure	0.21	0.06
Households don't process fish	0.93	0.95
Availability of fish for consumption	0.23	0.10
Households do not undertake farming	0.92	0.97
Index	0.48	0.45

3.4. Access to water

Vulnerability with respect to water access was more for the FHH. Eighty three percent of male headed households had access to piped water supply compared to 73% in the case of FHH. Sixty seven percent of MHH reported insufficient water supply in contrast to 77% FHH reporting water scarcity. Sixty nine percent of male headed households reported poor water quality during floods or seawater incursion whereas 78% FHH reported deterioration in water quality during floods (Table 5). There is acute water scarcity in several parts of Ernakulam district during the summer months and coastal fishing villages are the worst affected. The water scarcity also triggers waterborne diseases in the district.

Coastal states in India will be impacted by sea water

Table 5: Access to water

Access to water	Standardised score	
	MHH	FHH
Households without adequate supply of water	0.68	0.77
Households not having access to piped water	0.17	0.27
Poor quality drinking water during floods	0.69	0.78
Index	0.51	0.61

intrusions along with increasing salinity in groundwater systems. Since many of the coastal districts in the Kerala state are already below the mean sea-level, sea water intrusion due to climate change events lead to salinity in coastal ground water. Rising temperature, increased salinity of grounder water due to seawater incursions and flooding due to climate change has affected the water security and quality of water in many regions which may be aggravated with the future climate change events. Measures are necessary for ensuring water security through rain water harvesting systems, water efficient crops and cost-effective technologies for water recycling, purification and water conservation measures for addressing the future water security challenges in the context of climate change.

3.5. Natural and physical capital

The physical and financial capital indicators are very important in the case of livelihood vulnerability assessments as the low asset possession make the vulnerable sections of the population with low coping strategies to mitigate climate risks (Cannon, 2002; Sabarwal et al., 2010). Only 37% of the houses of FHH were made of concrete structures and 90% of households had no insurance facility either to houses or fishing equipments which made them more vulnerable in the case of ownership of physical assets. All respondent households in the study area were electrified and had communication facilities such as mobile phones or televisions. However more than 80 percent of the households lacked insurance to either houses or fishing equipments (Table 6). Coastal hazards impact the livelihood of fishers by way of loss of or damage to fishing crafts or gears, decline in fish catch, in addition to causing death and injuries to the fisherfolk. The government of Kerala undertakes several risk mitigation measures by providing sea safety equipments, conducting sea rescue operations and providing life and accident insurance coverage. However, the existing insurance schemes for fishers in the state cover only death, accident and total vessel loss and do not cover losses due to declining catch and damage to equipment, vessels or infrastructure (Shinoj et al., 2017).

Table 6: Natural and physical capital

Natural and physical capital	Standardised score	
	MHH	FHH
Land tenure	0.00	0.02
Housing quality(respondents not having concrete houses)	0.50	0.63
Households without atleast 3 durable assets	0.73	0.85
Households without insurance to house / fishing equipments	0.82	0.90
Households without electricity	0.00	0.00
Households without cooking gas	0.01	0.00
Index	0.34	0.40

3.6. Financial capital

The financial capital component included credit access, access to formal credit, savings, percentages of households below poverty line and access to social security pensions. The vulnerability index values varied from 0.45 for MHH to 0.38 for FHH. The access to institutional credit was limited for the female headed households (Table 7). The major social security and protective schemes in the fisheries sector consists of saving cum relief scheme, group insurance, personal accident insurance and pension schemes. Eventhough these schemes are not directly linked to climatic hazards, they provide protection to the fishers during lean fishing seasons and protection against accidents or deaths. The savings and relief schemes are intended to provide off season relief to fishermen. The scheme is operated through equal contributions from beneficiary fishermen, state and central governments. An amount of ₹ 1800 is released to the fishermen in 3 instalments during lean season (www.fisheries.kerala.gov.in). In the present analysis only the social security pensions were included under the financial capital component. The social security pensions available to fisher households consists of old age pension, pension for widows and unmarried females, and pension for physically challenged persons.

Table 7: Financial capital

Financial capital	Standardised score	
	MHH	FHH
Household income below poverty line	0.01	0.23
Households without credit access	0.23	0.23
Households without access to formal credit	0.58	0.70
Households without savings	0.54	0.32
Households without social security pension	0.80	0.40
Households without non-fishery based income	0.54	0.38
Index	0.45	0.38

3.7. Social capital

The vulnerability index values were 0.40 for MHH and 0.54 for FHH for the major component social capital. Eighty

five percent of FHH didn't approach any local leaders for assistance in the past year compared to 76% in the case of MHH (Table 8). Analysis of economic vulnerability in the context of climate variability in South Africa also reported that access to social networks and social capital are limited in the case of female headed households as female heads refrain from seeking help from others (Flato et al., 2017).

The existing patriarchal social structure among the fisher communities in the state restricts the women access to various resources including ownership of land, housing and possession of physical, financial and social capital assets which enhance their vulnerability. The knowledge on financial resources as well as government schemes are also limited to the women. Most often the access to physical and financial capital through government schemes are influenced by political contacts. Lack of political power and social contacts restrain women to access government schemes. Among the female headed households 88.33% reported difficulties in access to government schemes.

Table 8: Social capital

Social networks	Standardised score	
	MHH	FHH
Average receive-give ratio	0.35	0.34
Households didn't approach local institutions/ leaders for assistance in the last 12 months	0.76	0.85
Households without membership in societies	0.07	0.42
Index	0.40	0.54

3.8. Climate hazards

The climate hazards subcomponent was assessed based on the average number of climatic hazard events such as sea-level rise, cyclones, floods, rise in temperature etc. reported by the households in last three years. The member of households suffered climate hazard related accidents/ deaths, household without hazard warnings and proximity of the houses to shoreline were also included under exposure to climate hazard component (Table 9).

The results of the analysis indicated that the female headed households showed higher vulnerability ((LVI-0.40) compared to male headed households (LVI-0.37). The results also pointed out that, female headed households had limited access to land, water and social capital which had contributed to their higher vulnerability compared to MHH. Similar finding was obtained on the economic vulnerability assessment of small-scale fisher households in Thrissur district of Kerala state where female headed households showed significantly higher vulnerability than MHH (Sreya et al., 2021). Low-income women and female headed households in semi-arid regions of Africa and Asia are also reported to have more vulnerability to climate change impacts (Rao et al., 2019). Similar findings were reported from Africa, Asia, and Latin America (Fuller and Lain, 2017), Uganda, Ghana and Bangladesh (Christine Jost et al., 2016; and Bangaldesh (Garai, 2016; Nahian et al., 2013). Climate change being a serious challenge to most of the nations, the vulnerability of women with limited access to resources will further get worsened if adequate attention is not given for improving their adaptive capacities (Call and Sellers, 2019). Studies also reveal gender differences in preferences for adaptations and coping responses and hence analysing the gendered preferences in adaptation and mitigation programmes are also necessary (Bagsit et al., 2014).

Table 9: Climate hazards

Exposure to climate hazards	Standardised score	
	MHH	FHH
Number of climatic hazards reported by the households	0.32	0.32
Households suffered accidents to members due to climatic hazards	0.02	0
Households not receiving hazard warnings	0.06	0.15
Proximity of houses to shoreline	0.8	0.72
Households suffered loss of physical assets	0.23	0.37
Index	0.28	0.31

4. CONCLUSION

The findings of the study showed that female headed households had higher vulnerability with respect to socio-demographic particulars, water access, social capital, etc. which suggest the need for promotion of social networks and community-based adaptation measures for building the resilience of fisherwomen. Gender inclusive approach in the national, state and local level action plans and integration of gender mainstreaming in the climate change adaptation and disaster risk reduction programmes are suggested for achieving the sustainable development goal of gender equality in the context of climate change.

5. FURTHER RESEARCH

There are regional differences in gender equality and climate related hazards. The future research should focus on assessing the hazard specific vulnerabilities of

marginalised communities in various regions/sectors with a gender lens for developing policies for climate change adaptation and mitigation.

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7. REFERENCES

Alhassan, S.I., Kuwornu, J.K.M., Osei-Asare, Y.B., 2019. Gender dimension of vulnerability to climate change and variability empirical evidence of smallholder farming households in Ghana. International Journal of Climate Change Strategies and Management 11(2), 195–214. Emerald Publishing Limited, 1756–8692. DOI 10.1108/IJCCSM-10-2016-0156.

Alig, R.J., 2011. Effects of climate change on natural resources and communities: A compendium of briefing paper, U.S. Department of Agriculture, Forest Service Pacific Northwest Research Station Portland, Oregon General Technical Report PNW-GTR-837.

Anonymous, 2010. Climate change and India: 4x4 assessment a sectoral and regional analysis for 2030s, Ministry of Environment and Forests, Government of India, 161. Available at: http://www.indiaenvironmentportal.org.in/files/fin-rpt-incca.pdf and Accessed on: 25th November, 2022.

Anonymous, 2011. Women and rural development Via Paolodi Dono 44, 00142 Rome, Italy. Available at: https://www.ifad.org/en/ and Accessed on: 20th June, 2023.

Anonymous, 2014. Summary for policymakers. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate change 2014: impacts, adaptation, and vulnerability. part a: global and sectoral aspects. contribution of working group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1-32. Available at: https://www.ipcc.ch/site/assets/uploads/2018/02/ar5_wgII_spm_en.pdf and Accessed on: 25th November, 2022.

Anonymous, 2022. FRAD, CMFRI. Marine Fish Landings in India 2020. Technical Report, CMFRI Booklet Series No. 25/2022. ICAR-Central Marine Fisheries Research Institute, Kochi. Available at: https://eprints.cmfri.org.in/15781/1/Marine%20Landings%20in%20India%202020.pdf and Accessed on: 20th June, 2023.

Aswathy, N., Najmudeen, T.M., Mini, K.G., Kuriakose, S., Athira, N.R., Shyam, S.S., Sunil, P.V., Narayanakumar, R., Abdussamad, E.M., Jayasankar, J., Gopalakrishnan, A., 2023. Economic and livelihood impacts of the decline in Indian oil sardine landings in Kerala state, India. Regional Studies in Marine Science 62, 102963.

Bagsit, F.U., Suyo, J.G.B., Subade, R.F., Basco, J.T., 2014. Do adaptation and coping mechanisms to extreme climate events differ by gender? The case of flood affected households in Dumangas, Iloilo, Philippines. Gender in Aquaculture and Fisheries: Navigating Change. Asian Fisheries Science Special Issue 27S, 111–118.

Basiru, A.O., Oladoye, A.O., Adekoya, O.O., Akomolede, L.A., Oeba, V.O., Awodutire, O.O., Charity, F., Abodunrin, E.K., 2022. Livelihood vulnerability index: Gender dimension to climate change and variability in REDD + piloted sites, Cross River State, Nigeria. Land 11(8), 1240. https://doi.org/10.3390/land11081240.

Bunce, A., Ford, J., 2015. How is adaptation, resilience, and vulnerability research engaging with gender? Environmental Research Letters 10, 123003.

Call, M., Sellers, S., 2019. How does gendered vulnerability shape the adoption and impact of sustainable livelihood interventions in an era of global climate change? Environmental Research Letters 14, 083005.

Cannon, T., 2002. Gender and climate hazards in Bangladesh. Gender and Development 10(2), 45–50.

Chambers, R., Conway, G., 1991. Sustainable rural livelihoods: Practical concepts for the 21st century. IDS discussion paper 296.

Christine Josta, B., Kyazze, F., Naabd, J., Neelormie, S., Kinyangia, J., Zougmore, R., 2016. Understanding gender dimensions of agriculture and climate change in smallholder farming communities. Climate and Development 3, 8(2).

Das, M., Das, A., Momin, S., Pandey, R., 2020. Mapping the effect of climate change on community livelihood vulnerability in the riparian region of Gangatic Plain, India. Ecological Indicators 119, 106815. DOI: 10.1016/j.ecolind.2020.106815.

Defiesta, G., Badayos-Jover, M.B., 2014. Do catastrophes exacerbate gender bias? An analysis of coastal women's experiences of economic marginalisation in a disaster context. Gender in Aquaculture and Fisheries:

Navigating Change. Asian Fisheries Science Special Issue 27S, 97–109.

Etongo, D., Arrisol, L., 2021. Vulnerability of fishery-based livelihoods to climate variability and change in a tropical island: insights from small-scale fishers in Seychelles. Discover Sustainability 2, 48. https://doi.org/10.1007/s43621-021-00057-4.

Etwire, P.M., Al-Hassan, R.M., Kuwornu, J.K.M., Owusu, Y.O., 2013. Application of vulnerability index in assessing vulnerability to climate change and climate variability in Northern Ghana. Journal of Environmental and Earth Sciences 3(2).

Flatø, M., Muttarak, R., Pelser, A., 2017. Women, weather, and woes: the triangular dynamics of female-headed households, economic vulnerability and climate variability in South Africa. World Development 90, 41–62.

Fuller, R., Lain, J., 2017. Are female-headed households less resilient? Evidence from Oxfam's impact evaluations. Climate and Development, 12(5), 420–435. https://doi.org/10.1080/17565529.2019.1637330.

Garai, J., 2016. Gender specific vulnerability in climate change and possible sustainable livelihoods of coastal people, a case from Bangladesh**.** Journal of Integrated Coastal Zone Management/ Revista de GestãoCosteiraIntegrada 16(1), 79–88.

Geetha, R., Kizhakudan,S.J., Divipala, I., Shyam, S.S., Zacharia P.U., 2017. Vulnerability index and climate change: An analysis in Cuddalore District of Tamil Nadu, India. Indian Journal of Fisheries 64(2), 96–104. DOI: 10.21077/ijf.2017.64.2.61159-15.10.

Goh, A.H.X., 2012. A literature review of the gender-differentiated impacts of climate change on women's and men's assets and well-being in developing countries. CAPRi Working Paper No. 106. Washington, D.C.: International Food Policy Research Institute. http://dx.doi.org/10.2499/CAPRiWP106.

Gómez, M.M., Liu, Y., Unal, V, Sánchez LIzaso, J.L., 2021. Comparative analysis of the social vulnerability assessment to climate change applied to fisheries from Spain and Turkey. Scientific Reports 11, 13949.

Gopal, N., Williams, M.J., Gerrard, S., Siar, S., Kusakabe, K., Lebel, L., Bhujel, R., 2017. Gender in aquaculture and fisheries: Engendering security in fisheries and aquaculture. Asian Fisheries Science 30S, 1–30.

Habib, N., Alauddin, M., Cramb, R., 2022. What defines livelihood vulnerability to climate change in rain-fed, rural regions? A qualitative study of men's and women's vulnerability to climate change in Pakistan's Punjab. Cogent Social Sciences 8(1). https://doi.org/10.1080/23311886.2022.205415.

Hahn M.B., Riederer, A.M., Foster, S.O., 2009. The livelihood vulnerability index: A pragmatic approach to assessing risks from climate variability and change A case study in Mozambique. Global Environmental Change 19, 74–88.

Huynh, L.T.M., Stringer, L.C., 2018. Multi-scale assessment of social vulnerability to climate change: An empirical study in coastal Vietnam. Climate Risk Management 20, 165–180. https://doi.org/10.1016/j.crm.2018.02.003.

Ibnouf, F.O., 2009. The role of women in providing and improving household food security in Sudan: Implications for reducing hunger and malnutrition. Journal of International Women's Studies 10(4), 144–167.

Islam, M.M., Sallu, S., Hubacek, K., Paavola, J., 2014. Vulnerability of fishery-based livelihoods to the impacts of climate variability and change: insights from coastal Bangladesh. Regional Environmental Change, 281–294. DOI 10.1007/s10113-013-0487-6.

Kantamaneni, K., Panneer, S., Krishnan, A., Shekhar, S., Bhat, L., Aswathi, K.R., Rice, L., 2022. Appraisal of climate change and cyclone trends in Indian coastal states: a systematic approach towards climate action. Arabian Journal of Geosciences 15, 814.

Khan, M.A., Hasan, K., Kabir, K.H., 2022. Determinants of households' livelihood vulnerability due to climate induced disaster in southwest coastal region of Bangladesh. Progress in Disaster Science 15, 100243. ISSN 2590-0617. https://doi.org/10.1016/j.pdisas.2022.100243.

Lal, P., Kinch, J., Wickham, F., 2009. Review of economic and livelihood impact assessments and adaptation to climate change in Melanesia**.** ISBN: 978-982-04-0393-2 Secretariat of the Pacific Regional Environment Programme PO Box 240, Apia, Samoa.

Madhuri, Tewari, H.R., Bhowmick, P.K., 2015. Livelihood vulnerability index analysis: An approach to study vulnerability in the context of Bihar. Jamba: Jounal of Disaster Risk Studies 6(1), 1–13. DOI: 10.4102/jamba.v6i1.127.

Mainali, J., Pricope, N.G., 2018. Mapping the need for adaptation: assessing drought vulnerability using the livelihood vulnerability index approach in a mid-hill region of Nepal. Climate and Development 11, 607–622. https://doi.org/10.1080/17565529.2018.1521329.

Mekonen, A.A., Berlie, A.B, 2021. Rural households' livelihood vulnerability to climate variability and extremes: a livelihood zone-based approach in the Northeastern Highlands of Ethiopia. Ecological Processes 10, 55. https://doi.org/10.1186/s13717-021-00313-5.

Mengistu N.A., 2022. Rural livelihood vulnerabilities, contributing factors and coping strategies in Takusa Woreda, North Western Ethiopia. Cogent Social Sciences 8, 2095746. https://doi.org/10.1080/23311886.2022.2095746.

Mohammed, K.K., Dash, G., Kumari, S., Sreenath, K.R, Makwana, N., Dash, S.S., Ambrose, T.V., Shyam, S.S., Kripa, V., Zacharia, P.U., 2017. Vulnerability of coastal fisher households to climate change: A case study from Gujarat, India. Turkish Journal of Fisheries and Aquatic Science 17, 93–203. DOI: 10.4194/1303-2712-v17_1_21.

Morand, P., Kodio, A., Andrew, N., Sinaba, F., Lemoalle, J., Béné, C., 2012. Vulnerability and adaptation of African rural populations to hydro-climate change: Experience from fishing communities in the Inner Niger Delta (Mali). Climate Change 115, 463–483. DOI 10.1007/s10584-012-0492-7.

Morchain, D., Prati, G., Kelsey, F., Ravon, L., 2015. What if gender became an essential, standard element of vulnerability assessments? Gender and Development 23(3), 481–496. http://dx.doi.org/10.1080/13552074.2015.1096620.

Nahian, M.A., Islam, T., Bala, S.K., 2013. A new approach in gender vulnerability assessment using matrix framework. 4th International Conference on Water and Flood Management, 1–9. https://www.researchgate.net/publication/303666930.

Nguyen T.H., Yao, S., Fahad, S., 2018. Assessing household livelihood Vulnerability to climate change: The case of Northwest Vietnam. Human and Ecological Risk Assessment: An International Journal, DOI: 10.1080/10807039.2018.1460801.

Olsson, L., Opondo, M., Tschakert, P., Agrawal, A., Eriksen, S.H., Ma, S., Perch, L.N., Zakieldeen, S.A., 2014. Livelihoods and poverty. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate change 2014: Impacts, adaptation, and vulnerability. part a: global and sectoral aspects. contribution of working group ii to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 793–832.

Orencio, P.M, Fujii, M., 2013. An index to determine vulnerability of communities in a coastal zone: A case study of Baler, Aurora, Philippines. The Royal Swedish Academy of Sciences AMBIO 42, 61–71. DOI 10.1007/s13280-012-0331-0.

Panpeng, J., Ahmad, M.M., 2017. Vulnerability of fishing communities from sea-level change: A study of Laemsing District in Chanthaburi Province, Thailand. Sustainability 9, 1388. doi:10.3390/su9081388.

Patidar, J., Kumhar, B., Mhaske, S., Jat, S., 2018. Importance of sustainable agriculture in tribal community of India. International Journal of Bio-resource and Stress Management 9(2), 253–256.

Punya, P., Kripa, V., Padua S., Mohamed, K.S., Narayanakumar, R., Nameer, P.O., 2021. Socio-economic impact of cyclone Ockhi on fishers along the Kerala and Tamil Nadu coasts, India. Journal of Marine Biological Association of India 63 (1), 89–96.

Qin, Z., Haili, X., Xiao, L., Luwei, D., Bojie, W., Fengqi, C., Haiping, T., 2022. Livelihood vulnerability of pastoral households in the semiarid grasslands of northern China: Measurement and determinants. Ecological Indicators 140, 109020.

Rao, N., Lawson, E.T., Raditloaneng, W.N., Solomon, D., Angula, M.N., 2019. Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia. Climate and Development 11(1), 14–26. DOI: 10.1080/17565529.2017.1372266.

Sabarwal, S., Sinha, N., Buvinic, M., 2010. How do women weather economic shocks? A review of the evidence. World Bank Policy Research Working Paper No. 5496. The World Bank Poverty Reduction and Economic Management Network Gender and Development Unit.

Sahana, M., Rehman, S., Paul, A.K., Sajjad, H., 2019. Assessing socioeconomic vulnerability to climate change-induced disasters: evidence from Sundarban Biosphere Reserve, India, Geology, Ecology, and Landscapes 5(1), 40–52. https://doi.org/10.1080/24749508.2019.1700670.

Serrat, O., 2017. The Sustainable Livelihoods Approach. In: Knowledge Solutions. Springer, Singapore. https://doi.org/10.1007/978-981-10-0983-9_5.

Shah, K.U., Dulal, H.B., Johnson, C., Baptiste, A., 2013. Understanding livelihood vulnerability to climate change: Applying the livelihood vulnerability index in Trinidad and Tobago. Geoforum 47, 125–137. https://doi.org/10.1016/j.geoforum.2013.04.004.

Shahzad, L., Shah, M., Saleem, M., Asma, M., Faiza, S., Arifa, T., Umar, H., Muhammad, F., Gulzareen, G., 2021. Livelihood vulnerability index: a pragmatic assessment of climatic changes in flood affected community of Jhok Reserve Forest, Punjab, Pakistan. Environmental Earth Sciences 80, 252. https://doi.org/10.1007/s12665-021-09562-1.

Sheeja S.R., Rahi, T.B., Athira, A., 2023. State led social security and inclusion of marine fisherfolk: Analyzing the case of Kerala, India. Marine Policy 147, 105392.

Shinoj, P., Ramachandran, C., Gopalakrishnan, A.,

Mohammed, K.K., Narayanakumar, R., Salini, K.P., Sunil, P.V., 2017. Marine fisheries insurance in India: status and prospects. Marine Fisheries Information Service Technical & Extension Series 233, 3–6.

Shyam, S.S., Narayanakumar, R., Remya, R., Safeena, P.K., Ramees R.M., Harsha E.J., 2018. Climate change impacts on livelihood vulnerability assessment-Adaptation and mitigation options in marine hot Spots in Kerala, India. International Journal of Environment and Climate Change 8(3), 180–199. http://www.sciencedomain.org/abstract/26110.

Sreya, P.S., Chitra, P., Aswathy, N., Bonny, B.P., Aiswarya, T.P., Nameer, P.O., 2021. Economic vulnerability of small-scale coastal households to extreme weather events in Southern India. Marine Policy 131, 104608.

Suryanto, S., Rahman, A., 2019. Application of livelihood vulnerability index to assess risks for farmers in the Sukoharjo Regency and Klaten Regency, Indonesia', Jàmbá: Journal of Disaster Risk Studies 11(1), a739. https://doi.org/10.4102/ jamba.v11i1.739.

Venus, T.E., Bilgram, S., Sauer, J., Chettri, A.K., 2022. Livelihood vulnerability and climate change: a comparative analysis of smallholders in the Indo Gangetic plains. Environment, Development and Sustainability 24, 1981–2009. https://doi.org/10.1007/s10668-021-01516-8.

Walia, A., Nusrat, N., 2020. Kerala floods 2018. National Institute of Disaster Management, New Delhi, 106.

Yadav, S.S., Lal, R., 2018. Vulnerability of women to climate change in arid and semi-arid regions: The case of India and South Asia. Journal of Arid Environments 149, 4–17.

Zacarias, D.A., 2019. Understanding community vulnerability to climate change and variability at a coastal municipality in southern Mozambique. International Journal of Climate Change Strategies and Management 11(1), 154–176. DOI 10.1108/IJCCSM-07-2017-0145.