An Assessment of Vulnerability to Extreme Rainfall and Livelihood Resilience in Hillslope Geography: A Case Study of Malappuram, Kerala, India

Haani and Kamal Kumar Murari

Abstract Extreme rainfall events and hazards may rise as a result of climate change, which is already known to intensify the global water cycle. Disasters like floods and landslides are also becoming more common in India. Located in the state of Kerala, the district of Malappuram is prone to both landslides and floods. People become vulnerable as a result of disasters because they are initially deprived of their support systems and have few options for recovery. Rural poor communities lose jobs and their income is reduced as a result of such events, limiting their capacity to prepare for, respond to, and recover from future floods. In order to retain livelihood resilience, livelihoods must respond to global and local changes. For this research study, 127 quantitative household surveys were carried out throughout the Chaliyar Panchayat of the Nilambur block in the Malappuram District. Respondents were categorized into different groups based on their caste category (General/OBC (Other Backward Classes) and SC(Scheduled Caste)/ST(Scheduled Tribes)) to compare their overall household livelihood resilience by index method. The results show that the overall livelihood resilience of general/OBC (0.619) household is higher than SC/ST household (0.330). Better access to five livelihood capitals (Natural, Physical, Human, Financial, and Social) by General/OBC households helped them to build better livelihood resilience compared to SC/ST households. The study additionally looks at how extreme rainfall events affect people's livelihood, including losses and damages.

Keywords Extreme rainfall events · Livelihood resilience · Loss and damages · Adaptation · Vulnerability

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1 Introduction

Climate change has affected the social and ecological systems on the earth with changes in weather patterns which result in increased magnitude and number of extreme events like floods, drought, and cyclones [1]. This can bring a significant risk to the livelihood, health, and culture of communities as more frequent climatic disasters have a huge impact on the poor section of society who are forced to live in a vulnerable environment [2, 3]. [4] expressed vulnerability as "a function of exposure, sensitivity, and adaptive capacity" to such hazards. Therefore, the degree to which people are dependent on natural resources and ecosystems, as well as how sensitive those resources are to changing climate and how well they are able to adapt to it, determines how vulnerable they are to disaster [5].

Vulnerabilities of many communities, especially poor communities, are enhanced by the effects of disasters caused by extreme events [6]. Poor communities experience a disproportionate share of loss during a disaster since they are typically less resilient to loss and rarely have access to social protection or insurance [7]. Their welfare is negatively affected over the long term as the impacts of disasters lead to income and consumption shortfalls. Low-income groups always struggle for a better livelihood due to lack of access to resources [8]. When a disaster strikes, they are the ones that suffer the biggest loss of their livelihood resources, which makes it challenging to mitigate the effects that make many people sensitive to better livelihoods due to disasters [9].

Between 2003 and 2013, more than 1.3 billion people were affected by natural hazards and disasters in developing countries and caused an estimated damage of over US $494 billion [10]. Disasters cause loss in crop production and livestock and destroy agricultural assets [11]. Millions of small-scale farmers and people in developing countries that depend on forests are directly impacted by disasters in terms of their livelihood and food security [12]. Livelihood security of developing countries is concerned with the effort to cope with climate change at community level as it is always poor and marginalized communities that are susceptible to the negative effects of climate change due to their habitat and livelihood activities [5].

Resilience is the process to tackle shocks and vulnerability [13] and livelihood resilience is the capacity of a person or community to rebound after facing challenges with their livelihood to reduce susceptibility, recover from the past and present impacts of vulnerabilities, and may endure in a challenging livelihood environment [14]. There is a need to focus on the assessment and identification of vulnerability instead of only focusing on hazards or extreme events in order to promote resilience and adaptive capacities of communities [15]. A community's livelihood system is solely dependent on the socio-ecological system, as livelihood consists of financial, natural, human, physical, and social capital and is dependent on the community's complex system of financial, biophysical, political, and institutional conditions [14].

The livelihood of individuals who have few resources is impacted by natural disasters, and environmental conditions are responsible for impeding their support system [16]. Access to and control over resources are crucial factors in determining a

household's capacity, and that household's vulnerability to disaster is determined by its ability to handle, absorb, and manage with a disaster. Due to differences in how different households respond to shock or stress caused on by disasters and how they adjust and sustain their way of life through their adaptive capacity, households with differential potential are relatively more often at risks and vulnerable to disasters. This can worsen the livelihood conditions of households with poor capacity [17].

Extreme rainfall events like floods and landslides are the most frequent natural disasters that can have an impact on livelihoods, and India has seen some of the most extreme rainfall events that have resulted in flooding and loss of lives [18]. Anthropogenic activities including deforestation, the cultivation of plants incapable of adding root cohesiveness to steep slopes, mining, and quarrying all contribute to the increasing occurrence of several forms of landslides on hill slopes in Kerala's western ghats [19]. Exposure to landslide hazard and preparedness to face the hazard are essential to assessing the vulnerability to landslides [20]. It is very important to learn about such impacts on the livelihood and to understand their coping mechanism for effective adaptation that can build the resilience of the communities. It will help them to enhance the ability of the community or people to sustain livelihood opportunities [21]. Thus, there is a need to reduce the adverse impacts on the livelihood and to find proper coping mechanisms that will reduce the vulnerability.

This research is an attempt to understand the resilience of the rural livelihood of households in Chaliyar Panchayat of Nilambur, Kerala, to extreme rainfall events like floods and landslides. The major focus of the research project is to find out changes in the livelihood resilience among different social groups such as General, Other Backward Class (OBC), and Scheduled Caste/Scheduled Tribes (SC/ST), along with a focus on the impacts and losses incurred by them. In this context, this study has put forth the following research questions:

1. What are the differences in level of livelihood resilience between General/OBC and SC/ST households?
2. What are the losses and damages that households have suffered?

2 Study Area

Chaliyar is a panchayat in Nilambur Taluk of the Malappuram district of Kerala, India. Chaliyar panchayat covers a total of 14 wards in an area of 125 km^2 with a population of 20,834 people and 4614 households with a population density of 166.67 people per sq.km. Nilambur taluk has a total of 6 grama panchayats. Western Ghats hills surround Chaliyar Panchayat on one side, and the Chaliyar River on the other. Chaliyar is the fourth largest river in Kerala at 169 km in length, also known as the Chulika River or Beypore River [22]. Malappuram is one of the four major districts, including Idukki, Palakkad, and Wayanad, that experienced heavy rainfall from August 8 to 9, 2018, and was severely affected in the form of numerous landslides. However, in 2019, another heavy rain resulted in catastrophic landslides and floods and made a devastating impact across 14 districts of Kerala. Malappuram

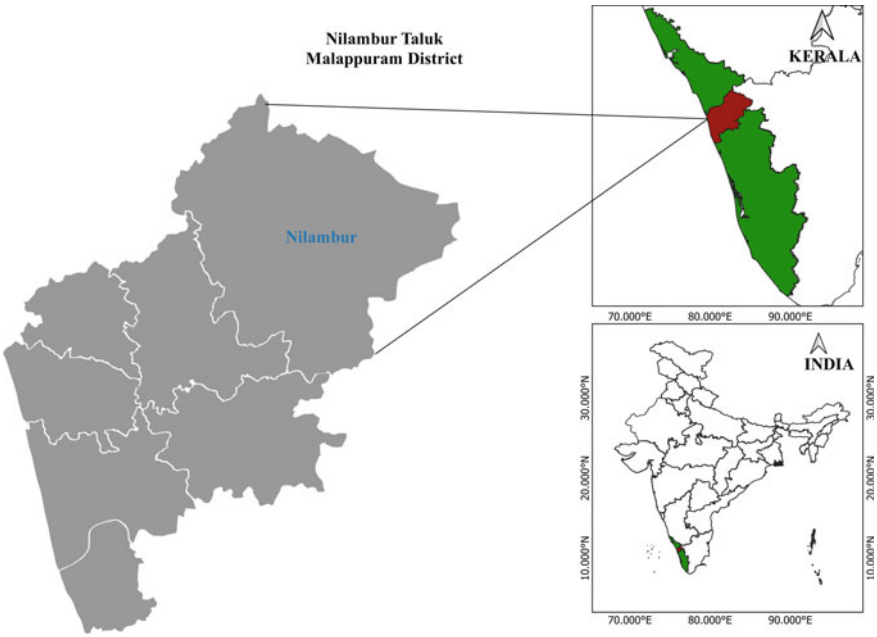

Fig.1 Map of study area

district, with the Chaliyar river region, is one of the worst hit regions in Kerala due to massive landslides.

Due to its steep slopes and frequent flooding caused by the presence of the river Chaliyar, Nilambur Taluk is among the most vulnerable places in the region. Chaliyar panchayat has three villages: Akampadam, Kurumbilangode, and Pullipadam. The study was conducted in Akampadam and Kurumbilangode villages of Chaliyar Panchayat (Fig. 1). The households of these villages fall into various social categories, including general, OBC (Other Backward Class), SC (Scheduled Caste), and ST (Scheduled Tribe). The general and OBC respondents were located mainly along the Chaliyar River, whereas the SC/ST respondents were located on the hillsides. Most of the ST communities live in the settlement near to the forest.

3 Methodology

3.1 Data Collection

The study has adopted a mixed method approach that includes both qualitative and quantitative methods of collecting primary as well as secondary sets. Quantitative data was collected to get baseline information about the village, various forms of

losses and damage, and the impact on the livelihoods of people living in flood and landslide-prone areas. Secondary data was collected from the panchayat on loss and damage. A household survey was conducted at the village level with the help of panchayat officials, to select the wards and areas that were worst affected. A random sampling technique was adopted and the surveyed households were spread all throughout the panchayat, based on the extent of extreme events and damage incurred. 127 households in the panchayat (Akampadam and Kurumbilangode villages) were surveyed. Households were selected with the help of local ward members so that the researcher would be able to survey respondents to meet the research objectives. Within this sampling, variation sampling was undertaken to make sure that the surveyed samples include households belonging to different social categories, such as general/OBC/SC/ST. A structured questionnaire was used to conduct household surveys, and the data was analysed statistically based on their basic demographic details such as occupation, gender, education, income, and age.

3.2 Livelihood Resilience Index

A household livelihood resilience index was developed in order to compare and evaluate the households' livelihood resilience, as outlined by [23]. A two-sample mean z-test was used to compare the differences in livelihood resilience between different social groups. A p value of <0.05 was used as a statistically significant cutoff point. Indicators of livelihood resilience were developed based on the livelihood capitals of the sustainable livelihood framework. Household surveys with quantitative questions based on the indicators presented in Table 1 were conducted with 127 respondents. To create the composite index for each household, survey results were converted in such a way that answers to questions were on a scale of 0 to 1 for each indicator. The most desirable response was assigned as 1 and the least desirable response as 0. For example, a question about any household member with a salaried job is assigned a result of 1 if the answer is yes, and 0 for a response of no. Any question with more than one choice was given values within the range of 0 to 1 (for example, 0, 0.25, 0.5, 0.75, 1). It was assumed that a higher level of livelihood capital should be indicated by higher scores and thus greater livelihood resilience. The main reason for converting responses from 0 to 1 is that it enables us to average them all together and simplifies analysis. Equal weightage was given for each indicator.

The composite asset index for each livelihood asset was created by taking an average of the individual indicator scores for all selected households. This is done by calculating the average of all the results for each livelihood asset for each household. For instance, the total financial capital score for that a household was calculated by averaging all the responses to the financial capital questions for that household. This process is done at the household level, and now these scores are aggregated to represent general/OBC and SC/ST households. For each survey respondent, the average scores for five capitals were used to create an overall livelihood composite asset index. From this overall index, the livelihood resilience between general/OBC

Table 1 Household survey livelihood resilience indicators

Capitals	Indicators
Financial capital	• Main source of fuel (Firewood, LPG, Both) • Own vehicle (Yes or No) • Own TV, radio, or smartphone (Yes or No) • Remittances (Yes or No) • Salaried job (Yes or No) • Own farm equipment (Yes or No)
Human capital	• Highest level of education (Below 5, 5 to 10, 10 to 12, above 12) • Health issues impact on capacity to practice livelihoods (Scale of no to very much) • Chronic ailments in family (Yes or No) • Health problem as a result of flood (Yes or No) • Labour availability (number of household members between 18 and 60) • Skilled work (Yes or No) • Education of head of household
Natural capital	• Size of land (in acres) • Own farmland (Yes or No) • Collect forest produce or bee hives (Yes or No) • Livestock (Yes or No) • Face soil erosion (Yes or No)
Social capital	• Participation in self-help groups (Yes or No) • Participation in local politics (Yes or No) • Family living nearby (Yes or No) • Seek advice from Krishi Bhavan (Yes or No) • Received financial help from government (Yes or No) • Social/Insurance schemes (Yes or No)
Physical capital	• Distance from market • Source of water (well or Springwater) • Distance from hospital • Distance from school • Condition of road • Condition of road during rainy season

and SC/ST households can be compared and analysed. The overall composite asset index and the composite asset index were used to compare general, OBC, and SC/ST respondents. The intention of this process is to determine which groups are more resilient and the reason for the same (which group's capital is higher for a particular group). This is done using a spider chart, which helps to compare the five capital assets between general/OBC and SC/ST households.

4 Results and Discussion

4.1 Livelihood Asset Analysis

Financial Capital

The livelihoods of surveyed respondents largely depend on the daily wage. Majority of them (around 62%) depend on wage earnings as their primary occupation. Only a small percentage of them are farmers, and a few of them had salaried jobs or had their own businesses. But all these account for only 27% of the total households. Disasters like floods and landslides had a significant impact on their livelihoods, especially on their financial capital, because these areas were completely affected by flooding and destroyed their properties, which affected their work and, thereby, their income. Most people were compelled to spend many days in shelter camps as a result of loss, damage, and destruction of their homes. This had a severe impact on their economic condition as people were unemployed for several weeks.

Physical Capital

Natural disasters and climate change can cause extensive damage to physical commodities and infrastructure, as well as a significant number of casualties. Compared to other communities, the physical environment surrounding ST households is relatively poor because of the remoteness of their place. ST settlements do not have access to proper metalled roads, and the condition of their roads is more worse during the monsoon season. This can have an impact on their accessibility to markets, schools, and hospitals. During the monsoon, the roads near the river flood, forcing many people to relocate to shelter camps. In a few settlements, the electricity connection was destroyed in the 2018 flood and landslide. Most of the households in ST communities did not have access to electricity and had to walk 2–3 km to charge their phones. Villagers emphasized how severely the devastating landslides and floods affected physical capital, including infrastructures such as roads and houses. Community roads are easily affected by flooding and landslides if such climate risks occur. Of the total economic loss, 59.7% of the loss and damage are houses and related infrastructure loss (Table 3).

Natural Capital

Agriculture was not their primary occupation, and just eight of them are farmers; nonetheless, those with land holdings of more than 30 cents practiced farming for their household requirements. Animals pose a threat to agriculture in this area and many of them experience crop raiding. The main crops cultivated in these areas are vegetables and fruits which include bananas, pineapples, and coconuts. These crops are attacked and destroyed by animals such as elephants, wild boar, and monkeys. So, in order to prevent such a situation, people have shifted their land to rubber plantation. Farmers lose their crops every year due to heavy rain and high winds during the monsoon season. Coconut and areca nut trees have been damaged in

recent years by certain diseases that destroy the trees and render them unproductive, making it difficult for farmers to improve their production. During the 2018 and 2019 floods and landslides, many households lost farmland and crops. Some of their lands had become sand-filled or barren, rendering them uncultivable. People in this region also have extremely limited livestock holdings. They raise hens and cows for eggs and milk, primarily for their own consumption. Data on livestock loss can be seen in the section loss and damage.

Human Capital

Climate change may endanger health conditions. Extreme floods, for example, can cause epidemics in the aftermath. Extreme events can also result in the death or injury of humans. Access to health-care facilities is critical for those living in disaster-prone and vulnerable areas. The health of the head of the household and any earning members of the household has a significant impact on the household's livelihood. Because of their remote location and limited financial resources, ST communities have reduced access to medical care, which may jeopardize their ability to sustain their livelihoods. While comparing the ST households to others, we can observe the impact of properly metalled roads on the day-to-day life of a household. People from ST settlements had difficulties travelling to the hospital and schools, and transport services are severely constrained. Education is another crucial component influencing the human capital. Lower education among ST communities limits them from alternative jobs except for manual labour. All general/OBC households have wells for drinking water and domestic purpose whereas ST households depended on spring water and river stream for water supply. These sources of drinking water have been depleted throughout the summer and muddied during the winter. On the other side, ST communities lack decent sanitary facilities.

Social Capital

There are distinctions between general/OBC households and SC/ST households in terms of the perception of social cohesion within communities. This was because the ST communities live in a place that is secluded and remote from the other households. Moreover, the lack of a better or more convenient mode of transportation and appropriate roads to their places makes their accessibility to towns or cities more difficult. Kudumbashree's (an initiative by State Poverty Eradication Mission (SPEM) of the Government of Kerala to eradicate poverty and empower women.) advocacy of self-help groups (SHGs) was not active in these areas. However, until 2019, either region's social cohesion is adequate for disaster preparedness. During flooding occurrences in their areas, the people hardly ever prepare to put their belongings and important documents in a secure place. Thus, the communities may experience a loss of livelihood as a result of the lack of mutual support and disaster awareness. Based on the experiences of the 2018 and 2019 floods in the area, different political parties, NGOs, and government agencies reportedly offered support to respondents in order to facilitate their coping mechanisms and to make their lives amid flooding easier.

4.2 Livelihood Resilience

A livelihood resilience index was calculated to compare the livelihood capitals between SC/ST and General/OBC households. For assessing each livelihood capital, different indicators and factors were selected. From Table 2, we can see and compare each livelihood capital between General/OBC and SC/ST households. Z-tests (two samples for mean) found that all livelihoods were statistically different between the two groups. The Z-test for all five livelihood capitals showed a significant difference between both social groups. The resilience index for each livelihood capital was calculated for both general/OBC and SC/ST households. It has been observed that there is a significant difference between all capitals with only a very slight difference in natural capital (Table 2). However, the resilience index for each livelihood capital is explained below.

Financial Capital

From Table 2, it has been observed that the value for General/OBC is 0.63 and the value for SC/ST is 0.30. The reason for the lower value among SC/ST households is mostly due to their lesser asset holding. Majority of SC/ST households primarily depended on fuelwood as a source of energy and had no Liquified Petroleum Gas (LPG) connection. They rely on manual labour as a primary source of income and none of them had a salaried job. Also, the proportion of people who possess any kind of vehicle is larger in general/OBC families compared to others, while most SC/ST households do not own any kind of vehicle.

Physical Capital

A significant difference in physical capital was observed, with a value of 0.27 for SC/ST households and 0.76 for general/OBC households (Table 2). ST communities do not have access to decent roads since they dwell in hilly places where the topography makes road construction difficult. Furthermore, due to their remoteness, these regions receive comparatively less development, limiting their access to government programmes and developmental activities. The road's condition makes it difficult to commute to many locations, such as markets, schools, and hospitals. The issue worsens during the monsoon, when most roads become muddy and inundated.

Table 2 Livelihood resilience index for each capital asset

Livelihood capitals	General/OBC	SC/ST
Social capital	0.544	0.351
Financial capital	0.633	0.301
Human capital	0.608	0.455
Natural capital	0.463	0.402
Physical capital	0.760	0.273
Overall	0.619	0.330

Natural Capital

The value of natural capital does not significantly differ between both social groups (Table 2). This is due to the fact that there's not much of a difference between the two in terms of land holding. The ST communities had a large amount of land, which they also used for farming. Some ST households collect forest produce, and the distribution of livestock holdings is nearly identical among these households.

Human Capital

A significant difference in the resilience of human capital between both social groups can be noticed in this category (Table 2). However, there is a gap between these groups in their education, health, and skills. In particular, there are many uneducated members in SC/ST households compared to other groups. ST households also have very poor health conditions. The primary reason for these groups' poor education and health is the remoteness of their region and lack of access to schools and hospitals.

Social Capital

The main indicators used to measure the social capital among the households were their involvement in SHGs and politics, the number of family members living nearby, social insurance schemes, and financial support from the government. The value of general/OBC is 0.54 and that of SC/ST is 0.35 (Table 2). ST communities have very little interaction with the outside world, and this restricts them from active participation in politics and weak SHG formation.

Overall Livelihood Resilience

An overall household livelihood resilience index was calculated for all respondents. A spider diagram is constructed (Fig. 2) to compare the individual livelihood capital between both social groups. While calculating overall livelihood resilience, weightage was given to each livelihood capital. In order to give weights to capital, key informants were asked to rank different livelihood capitals. Based on their response, 50% of the weight is given to financial capital, 15% to social capital, 15% to physical capital, 10% to human capital, and 10% to natural capital. After calculating the livelihood resilience index value for each household, a weighted average was calculated as described above for all livelihood capitals to find the overall resilience at the household level. In order to compare the overall livelihood resilience between General/OBC and SC/ST households, an average of both groups was calculated. A value of 0.619 was obtained for the general/OBC household, and a value of 0.330 was obtained for the SC/ST household.

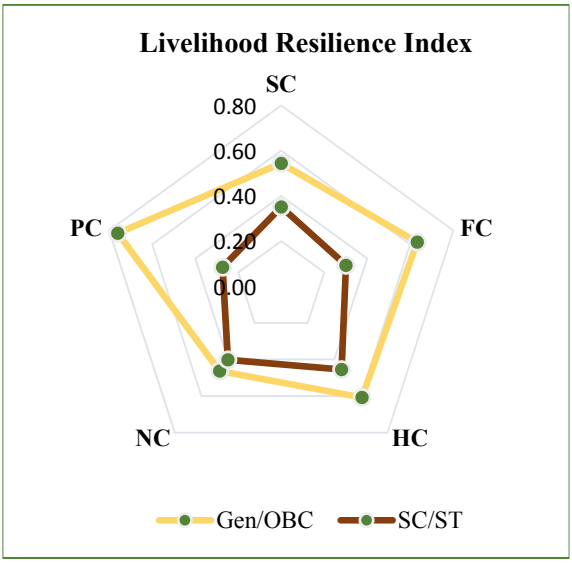

Fig. 2 Spider diagram comparing the five livelihood capitals between General/ OBC and SC/ST households

4.3 Loss and Damages

The villages of Akampadam and Kurumbilangode were damaged by the floods of 2018 and 2019. However, the floods' effects were not evenly dispersed among the settlements. In 2018, ST communities were the most affected group compared to low-lying places along the river. This was mostly due to a number of landslides that happened in various regions. Riverside locations are the most impacted in 2019 due to river overflow induced by heavy rains and debris flow at several sites throughout the Nilambur taluk, notably at Kavalappara in the Pothukal panchayat. However, each of these catastrophes resulted in significant loss and damage across the settlements.

Table 3 shows data from the 2018 and 2019 floods on overall agricultural losses, house losses, vehicle damage, medical losses, lost wages, and livestock losses. The total economic losses of respondents due to the flood and landslides amounted to Rs. 2,99,77,500 and the average economic loss to be borne by each household is Rs. 2,36,043.31. We can observe that the average economic loss of general/OBC households (Rs. 4,04,306.45) is more than the total average economic loss (Rs. 2,36,043.31) and that of SC/ST households (Rs. 75,546.15) is lower than the total average economic loss (Fig. 3).

In comparison to 2018, agriculture losses are predicted to increase in 2019. This is because floods in 2019 impacted low-lying areas where many people practiced agriculture. During the 2018 and 2019 floods, we can see that floods damaged several houses and caused significant damage. Floods have had a significant influence on many people's sources of income and livelihoods. People have been unable to work for several days since cleaning their homes from the mud, stones, and sand dumped inside took several days. For some households, it took a few months for them to

Table 3 Total loss and damages incurred by households (in Rs)

Types of lose	Household		
	Gen/OBC (n = 62)	SC/ST (n = 65)	Total (n = 127)
Agriculture	23,96,500	6,35,000	30,31,500
Vehicle damage	71,88,500	33,000	72,21,500
Medical cost	48,000	6,500	54,500
Earnings lost	16,77,000	2,72,500	19,49,500
House and other infrastructure	1,35,30,000	38,40,000	1,73,70,000
Livestock	2,27,000	1,23,500	3,50,500
Total economic loss	**2,50,67,000**	**49,10,500**	**2,99,77,500**

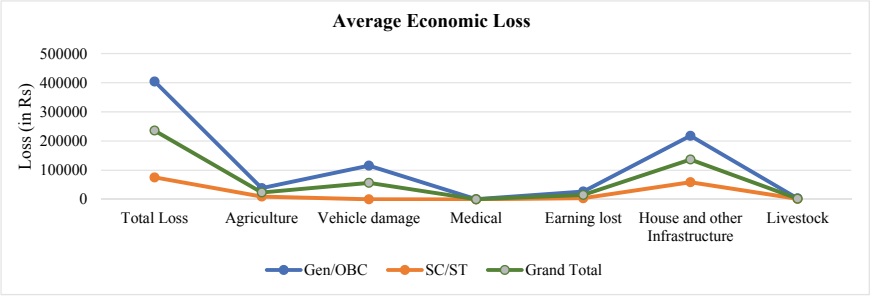

Fig. 3 Average value of different types of loss incurred by households

return to normal. Farmers were unable to cultivate their land since all crops had been destroyed and the land had been deposited with mud and sand.

Only around 30% of the total surveyed households (41 households) owned livestock. Most of them owned livestock for domestic use solely, not as a source of income. Only a very small percentage of the surveyed households relied on agriculture as their primary source of income, but many of them continued to do small-scale farming on their land. The major agricultural products in these areas include rubber, pepper, bananas, coconut, Areca nuts, nutmeg, and turmeric. In comparison to 2018, the 2019 floods had a higher impact on agriculture in these locations. The majority of the land that was impacted was in low-lying areas near the river.

5 Conclusion

The study attempted to capture general livelihood resilience between general/OBC and SC/ST households to a variety of shocks, including climate change-related shocks including floods and landslides. General/OBC households had 29 percent higher average scores for all five livelihood capitals, as well as 33 percent higher scores for financial capital, 19 percent for social capital, 15 percent for human capital, 6 percent for natural capital, and 49 percent for physical capital than SC/ST households. Flood resistance is more likely to be found in households with more stable sources of income (higher livelihood capital scores) [23]. The major livelihood shocks studied in this study contribute to localized economic instability by reducing agricultural yields, disrupting people's daily lives and livelihood activities, and affecting access to local markets [24]. As a result, the findings directly and implicitly explore how different livelihood capitals contribute to livelihood resilience in the face of economic uncertainty. The findings of this study emphasize the value of each livelihood capital during periods of economic uncertainty caused by severe events in the study area.

A balance of these five capitals is thought to be essential for a household to maintain overall well-being and sustain their adaptive capacity [25]. The development of various types of livelihood assets can be facilitated by the accumulation of one type of livelihood asset. A better financial capital can reduce the vulnerability and enhance resilience in the time of shock [26]. Dealing with economic insecurity by a household depends on the balanced accumulation of their livelihood capital assets [27]. The findings of this study show that there is a difference in livelihood resilience between SC/ST and general/OBC households, as well as an increase in livelihood resilience among general/OBC households. There were also substantial differences between SC/ST and General/OBC households in terms of overall livelihood resilience. Casual labour was the most common source of income for SC/ST households, while some General/OBC households had businesses, salaried employment, and other stable sources of income. The availability of livelihood opportunities may differ greatly among various communities due to the ecological, social, and political conditions of each community.

This study adds to our understanding of the impact of floods and landslides on household livelihood in addition to presenting empirical evidence on livelihood resilience. This was primarily determined by examining the losses and damages suffered by the households surveyed. Since some of the households affected in 2019 were not affected in the 2018 floods, the data on loss and losses was focused on both 2018 and 2019 flood events. Floods cause havoc on agriculture, food distribution networks [28], infrastructure, and employment, as well as other aspects of daily life [29]. Since 2018, residents have had to contend with floods and landslides in their daily lives.

This study only offers a "snapshot" of livelihood resilience rather than a complex indicator of how resilience is evolving. The same questions about resilience measures would need to be asked of households twice if the goal was to determine how resilience has changed over time. Furthermore, the methodology used here does

not prioritize measures of resilience. This method might not take some indicators into account, even though those indicators might be more crucial than others in developing resilience. Various surrogates could be given different weights during the analysis using the same techniques. It is possible to weigh various surrogates; however, this study will not do so.

Another drawback is that large-scale variables such as macroeconomics, national politics, and international trade, which can directly impact livelihoods and their adaptation practices, can be challenging to integrate into resilience calculation. This is a criticism of sustainable livelihoods in general [30], but it also applies to the approaches discussed in this article. In addition, resilience measurement is frequently highly contextualized, which makes it difficult to incorporate into policy [31].

6 Future Scope of the Study

Despite studies and theories that focus on the implication of extreme events on the resilience of local livelihood and their day-to-day activities, there is still a lack of literature on livelihood resilience mainly focusing on their five livelihood capitals. Most of the existing studies are on the concept of vulnerability, adaptation, and resilience with respect to climate change and extreme events. These studies, however, lack in analysing the direct implication of climate change and related extreme events and disasters on livelihood of local people at household level. Also, most of the studies are only region specific and not focusing on socioeconomic and cultural background of the region especially the various social groups. This study is an attempt to unravel the impact of extreme events on livelihood of local people and to measure their livelihood resilience. This study tries to address certain gaps in existing literature as only a few studies have been conducted at household level on livelihood resilience in India.

The findings of this study are intended to be beneficial to both development organizations and policymakers. These findings can be applied to development programmes as well as wider policies aimed at increasing livelihood resilience. A wide range of international development and humanitarian organizations use the concept of resilience. At a number of scales, resilience has also gained popularity in policy-making. This study has the possibility to provide policy recommendations on how to increase livelihood resilience to losses and damage brought on by climate change.

The research's second future path is to broaden the scope of the analysis to include more locations. To further understand livelihood resilience to extreme rainfall events, conducting a study similar to this in a few different locations with various social, economic, and environmental settings would be beneficial. Many of the findings in this study were context-dependent, and changing the context may influence the main types of disturbances or their characteristics. Additionally, the capacity of households in diverse locations to absorb shocks and respond to disturbances may

vary. The availability of livelihood options and a household's capacity to withstand shocks may be influenced by local politics, educational options, land tenure policies, and climate patterns.

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