LIVELIHOOD VULNERABILITY AND ADAPTIVE STRATEGIES DUE TO FLASH FLOOD FOR AN AGRICULTURAL COMMUNITY IN DHARMAPUR UNION OF FATIKCHHARI, CHATTOGRAM

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ABSTRACT

Agricultural communities in flood-risk zones of Bangladesh, such as the Dharmapur Union of Fatikchhari, face ongoing threats to livelihood due to recurring flash floods that undermine agricultural production, income stability, food security, and access to essential services. This study investigates how recurrent flash floods affect livelihood vulnerability and adaptive capacity in an agricultural community through three primary objectives: (1) assessing effects and long-term impacts of flash floods over the past 20 years, (2) analyzing local adaptive strategies and coping mechanisms, and (3) developing a community-based adaptation plan. A participatory approach was employed using Participatory Rural Appraisal (PRA) tools including social and resource mapping, trend analysis, cause-effect diagrams, pairwise ranking, and action plan matrices. Data were collected from 91 households in low-lying areas adjacent to Katakhali Khal over three consecutive days of field sessions. This method enabled active engagement with non-literate and less articulate participants, ensuring that local perceptions, experiences, and knowledge were accurately represented in the analysis. Results reveal significant livelihood transformations: day labor increased from 15% to 39% of household income post-2014, while livestock farming declined from 20% to 2%. Flash flood frequency and intensity showed marked escalation, expanding from July-only events (2004-2008) to June-September occurrences (2022-2024). Housing vulnerability remains high, with 50.5% (n=46) living in katcha houses and 53% (26 of 49 critical infrastructure elements) located in high-risk flood zones. Pairwise ranking identified relocation to higher ground as the most preferred adaptation strategy (selected 4 times), followed by moving livestock and establishing village emergency funds (3 times each). Current adaptive strategies include crop diversification, seasonal migration (non-migrant population decreased from 82% to 55% post-2014), livestock rearing on elevated platforms, and reliance on social capital and NGO interventions. However, the effectiveness of these measures is constrained by financial limitations, inadequate institutional support, and lack of long-term planning resources. The research emphasizes the necessity to integrate local knowledge into policy frameworks and strengthen institutional support mechanisms for enhancing resilience of vulnerable farming communities. By documenting grassroots knowledge and coping mechanisms, this research contributes to the discourse on climate resilience and rural sustainability planning in Bangladesh.

Keywords: *Flash flood, Participatory, Livelihood, Vulnerability, Agriculture*

1. INTRODUCTION

Floods are widely recognized as one of the most destructive and economically damaging natural disasters in the world. Bangladesh, which is among the most climate-vulnerable nations globally, experiences significant social and economic losses from flooding in several regions (Hoque, 2023). While crops often benefit from seasonal floods that make the soil fertile and have shorter durations, prolonged inundation period damages irrigation (Hoq et al., 2021). Flash floods negatively affect agriculture, especially for people living in Bangladesh's Haor region. During the Monsoon period in Bangladesh 10–100% of Aman rice at various cultivation stages was damaged by the flash flood (Arif et al., 2019). Along with agriculture, floods have a devastating effect on the life of livestock in rural Bangladesh since the rate of death increases before and after floods (Biswas et al., 2019; Kabir & Hossen, 2019). Although the overall effect of flash floods on agriculture is well documented, relatively less attention has been given to farmers' adaptive measures in these regions to reduce such effects (Younus & Harvey, 2013). Traditional knowledge transferred from generation to generation is crucial to such adaptive measures, but still remains mostly untapped in formal disaster management policies (Ahmed et al., 2019). Implementation of Participatory Rural Appraisal (PRA) techniques provides a valuable opportunity to evaluate how communities forecast and manage flash floods, thereby contributing to the overall resilience of agricultural practices. Although some studies of Bangladesh address the effects of flash flood on livelihoods, there is still limited research based on disaster theory that focuses on underlying factors which reduces communities' capacity to cope with risks (Ahmed et al., 2019). Farmers in flood-prone areas have traditionally adopted some strategies to resist the impacts of this natural phenomenon. But these measures are often informal due to lack of proper planning. This study aims to address the gap by identifying the specific adaptive measures which are adopted by the farmers of Dharmapur Union of Fatikchhari through Participatory Rural Appraisal (PRA) techniques.

2. METHODOLOGY

2.1 Overview of the study area

Fatikchhari is an upazila of Chattogram District in the Chattogram Division of Bangladesh. Dharmapur is one of the 18 unions within Fatikchhari upazila. Dharmapur union is located at 22°36′10.09″ N latitude and 91°51′55.50″ E longitude, covering an area of 5.81 square miles. According to the Bangladesh Bureau of Statistics (BBS 2011) the union has a population of 27,326, comprising 14,136 males and 13,190 females, distributed across 5,008 households. The union is served by several educational institutions including one girls' high school, two co-educational high schools, four primary schools, and two kindergartens. Dharmapur also contains four marketplaces and essential facilities such as one hospital, one animal hospital, three community clinics, and a family welfare center. Despite the presence of these facilities, the region remains underdeveloped in communication and infrastructure. It's agricultural dependence and exposure to flash floods make Dharmapur suitable for the research.

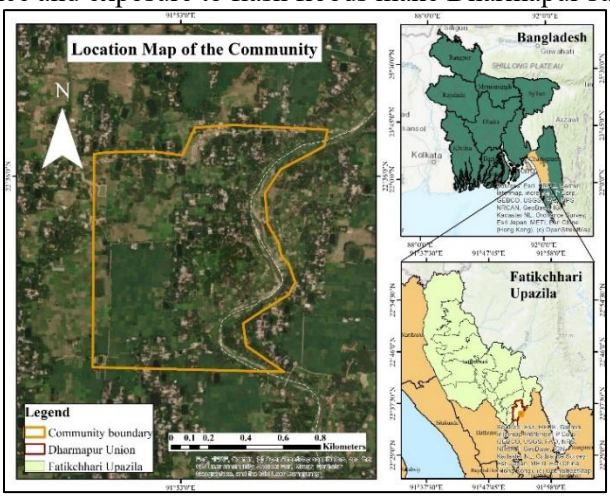

Figure 1: Study area map

2.2 Sample size determination

The sample size was determined following a reconnaissance survey, which revealed that residents living in the low-lying areas adjacent to the Katakhali Khal are the most vulnerable. Consequently, a total of 91 households located in these low-lying areas were selected for the survey.

2.3 Participatory Approach

The research was conducted using Participatory Rural Appraisal (PRA) technique to ensure that non-literate and less articulate community members could actively and meaningfully participate by illustrating their situations through maps and diagrams. The PRA exercises were organized in consultation with local people to decide the appropriate location and time. Participants were informed about the purpose of the activity and were asked to draw the main physical features of their area using pen, pencil and papers provided by the researchers. The researcher's role was mainly to guide the process, observe discussions, and ensure that everyone could participate. After completing the maps, participants identified and numbered their households and added necessary socio-economic information. The collected information was subsequently verified with community members to ensure accuracy. The participatory sessions were conducted over three consecutive days. The methodology was structured around three main objectives. The first objective focused on assessing flash flood effects and long-term impacts through various PRA tools, including social and resource mapping, trend analysis, and livelihood assessment. The second objective involved analyzing local adaptive strategies using pair-wise ranking and Venn diagrams to identify key institutions, organizations, and effective adaptation measures. The third objective emphasized the development of a community-based adaptation plan through SWOT analysis, stakeholder mapping, and participatory problem-solving workshop.

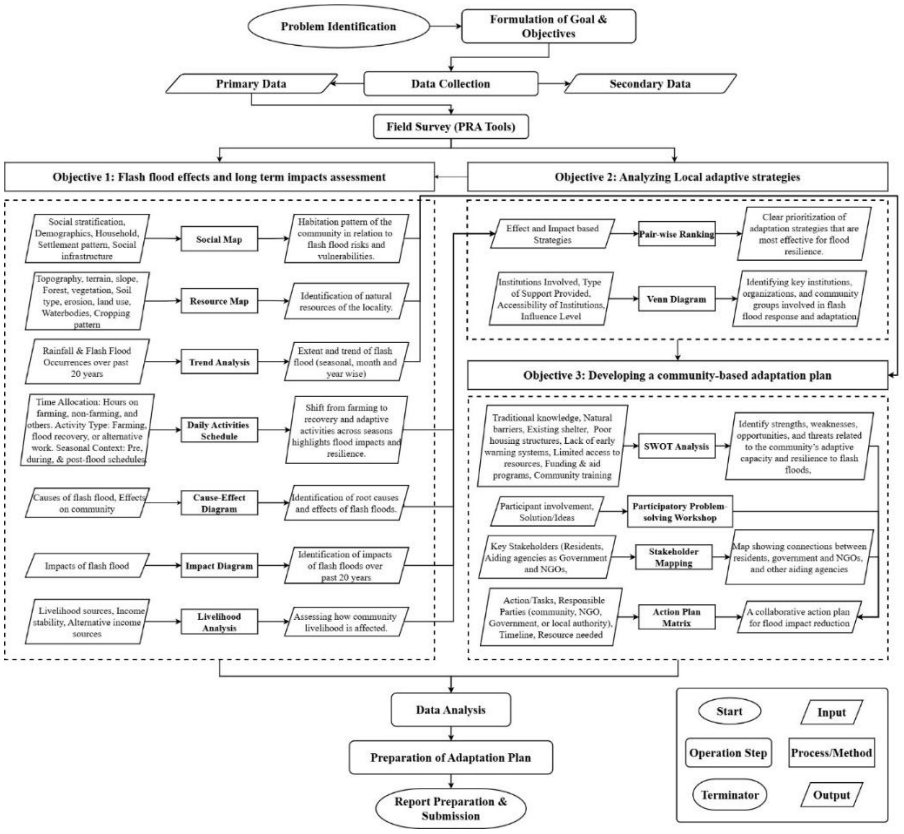

Figure 2: Methodology flowchart

3. RESULT AND DISCUSSION

3.1 Effects and long-term impacts of flash floods on livelihoods of the agricultural community

The social map presented in Figure 1 illustrated various aspects of land use, housing, and infrastructure based on data from 91 surveyed households. Among the total households surveyed, 46 were katcha houses, while 27 and 18 were semi-pucca and pucca houses respectively which indicated that the majority of residents live in vulnerable housing structures with relatively few well-built houses. Katcha and semi-pucca houses were located close to pucca or HBB roads, whereas katcha houses along developed roads were less scattered compared to those along other roads reflecting disparities in infrastructural development. The map also identified 2 mosques, 2 mazars, a few roadside shops along the pucca roads, and a relatively even distribution of tube wells and latrines ensuring basic access to water and sanitation.

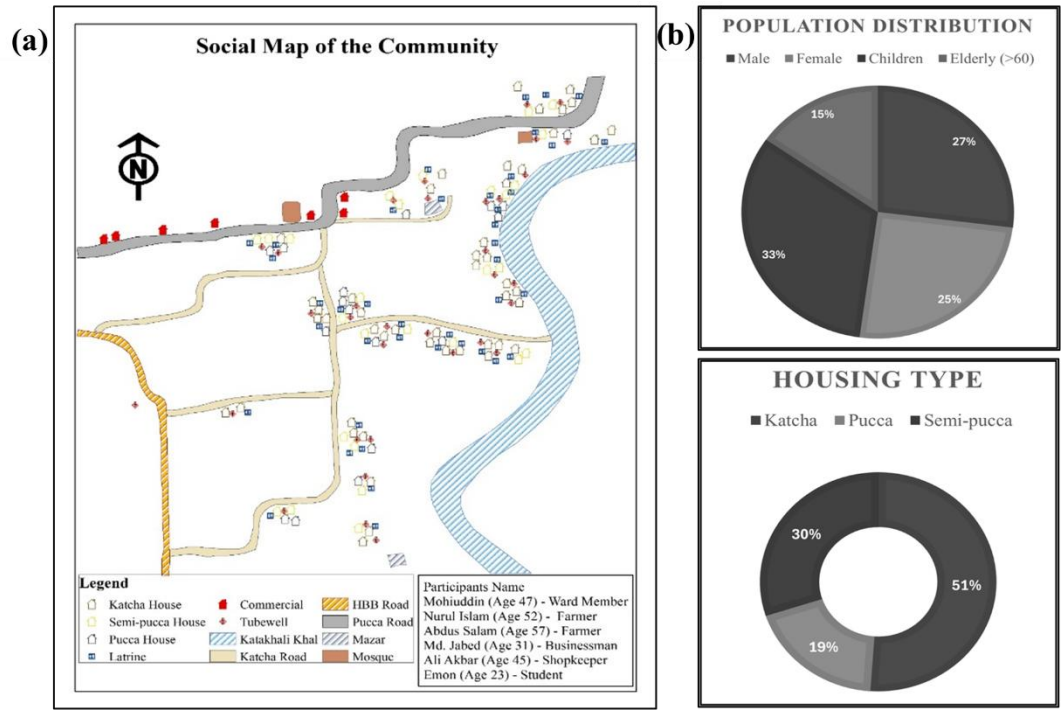

Figure 3: (a) Social map of the community, (b) Housing and population distribution pattern of the community

The resource map showcased the primary natural and physical resources of the area. Agriculture was identified as the most important source of income, with limited vegetable cultivation contributing to livelihood diversification. The presence of water bodies and tube wells provided adequate support for both irrigation and domestic water supply. Animal husbandry was a key livelihood activity as evidenced by cattle farms and haystacks whereas mosques and shrines gave an idea of the community's social and cultural life. The distribution of pucca, HBB, and katcha roads indicated different levels of accessibility, and the presence of roadside trees indicated a concern for environmental conservation.

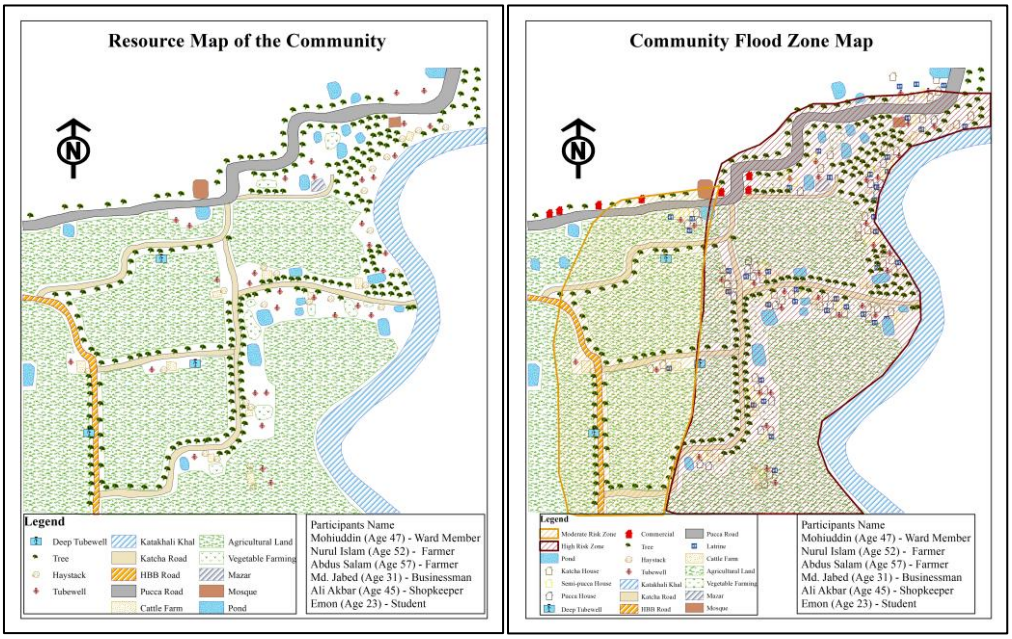

Figure 4: Resource map and flood zone map of the community

The area with the highest flood risk contained 26 tubewells, 16 ponds, 7 cattle farms, a mosque, and one mazar, all of which were located in areas highly susceptible to flooding. As a result, water quality, livestock, and community activities were exposed to significant risk. Besides, extensive agricultural field, vegetable cultivation areas, haymaking places, and tree plantations were also situated within flood-prone zones, placing both their production and even the farmers' livelihood at risk. In the moderate flood risk zone, 4 tube wells, 2 deep tube wells, 5 ponds, 2 cattle farms, and a mosque were also exposed. he widespread distribution of cultivated land and vegetation cover indicated that even moderate-intensity floods could substantially affect local livelihoods and resources.

According to the trend analysis, flash floods had become more frequent, more intense, and less predictable over the past two decades. Between 2004 and 2008, flash floods occurred sporadically, primarily in July, and caused minimal damage. However, the period from 2014 to 2018 marked a substantial increase in both the frequency and severity of floods events. The situation began to deteriorate from 2019 and reached a peak during 2022–2024 when floods shifted from occasional events to regular annual or multi-annual occurrences. Flood events which were previously confined to July, were observed from June to September encompassing the pre-monsoon to post-monsoon period. Overall, the analysis indicated a transition from isolated flood events to continuous climatic stress, with July remaining the month of highest flood occurrence and intensity.

Table 1: Trend Analysis of Flash Flood Occurrence in Dharmapur Union

Criteria	2004–2008	2009–2013	2014–2018	2019–2021	2022–2024
Frequency of Flash Floods	○○	○○○	○○○○	○○○○○	○○○○○
Intensity of Flash Floods	○	○○	○○○	○○○○	○○○○○
Monthly Occurrence Pattern	July	July-August	June, July, September	June-August	June-September

Seasonal Severity	Monsoon	Monsoon	Pre-Monsoon & Post-Monsoon	Pre-Monsoon & Monsoon	Pre-Monsoon, Monsoon & Post-Monsoon

○○○○○ = Very High
○○○○ = High
○○○ = Moderate
○○ = Low
○ = Very Low

Participants Name

Mohiuddin (Age 47) - Ward Member,
Nurul Islam (Age 52) - Farmer,
Ali Akbar (Age 45) - Shopkeeper,
Emon (Age 23) - Student

Table 2 outlined the disruption of the community's routine caused by flash floods. During flood events, villagers' daily activities previously centered on farming and household work, shifted toward survival-oriented actions such as relocating livestock to safer areas, rationing food, and securing essential items. Conditions in overcrowded shelters were characterized by limited food availability and inadequate sleeping arrangements. The post-flood period involved extensive recovery activities including cleaning, repairing damaged structures, and reseeding agricultural land. These disruptions resulted in work stoppages for farm laborers, loss of productive assets, and interruptions in income, thereby exacerbating the community's economic vulnerability.

Table 2: Daily activities schedule of the community

Time	Pre-Flood Activities	During Flood Activities	Post-Flood Activities
5:00 AM	Prayers, personal hygiene	Prayers, monitoring floodwater	Prayers
6:00 AM	Feeding cattle, fetching water	Relocating cattle, collecting water from accessible and safe sources	Fetching water, drying wet essentials
7:00 AM	Preparing and eating breakfast	Stored/dry food, food rationing	Cooking basic meals with limited firewood
8:00 AM	Agricultural work, household chores	Monitoring flood, helping children/elderly	Cleaning homes, minor field/farm inspections
10:00 AM	Washing clothes, preparing lunch	Shifting essentials to elevated places, cleaning rising water	Rebuilding damaged areas, continuing cleaning
12:00 PM	Lunch and short rest	Limited lunch sharing, using stored food and safe water	Lunch, brief rest
2:00 PM	Rest, light chores, social interactions with neighbors	Waiting for updates, assessing water levels, fixing leaks	Repair work, coordinating with others for recovery
4:00 PM	Visiting neighbors, social interactions	Receiving or collecting aid, checking livestock	Recovery related information gathering and rebuilding
5:00 PM	Feeding cattle, preparing dinner	Feeding cattle if accessible, cooking simple meals	Feeding cattle, assessing agricultural losses
7:00 PM	Dinner and family gathering	Minimal dinner, crowding in shelters, disrupted family routines	Dinner, preparing for next day
8:00 PM	Sleeping	Disturbed sleep due to water, noise, crowding in shelters	Sleeping with discomfort (wet bedding, limited space)

The change in the economy of the Dharmapur Union due to flash floods over the past 20 years were depicted in Figure 4. Before 2014, agriculture had been the main source of income for 35% of the population, followed by livestock farming (20%), small businesses (8%), day labor (15%), and remittances (6%). In 2014, the share of day labor increased to 39%, while livestock farming declined to 2% which reflected the long-term impact of recurrent flooding on livelihoods. Crop diversification was also evident. Areas under mixed vegetables and leafy vegetables expanded, whereas rice and ginger cultivation decreased. It indicated a shift in farming practices in response to flood-prone conditions. Migration patterns further reflected these changes, with only 55% of the population remaining non-migrants after 2014 compared to 82% before. Overall, the decline in traditional staple crop yields alongside increased vegetable production highlighted the community's adaptation strategies to cope with continuous flooding.

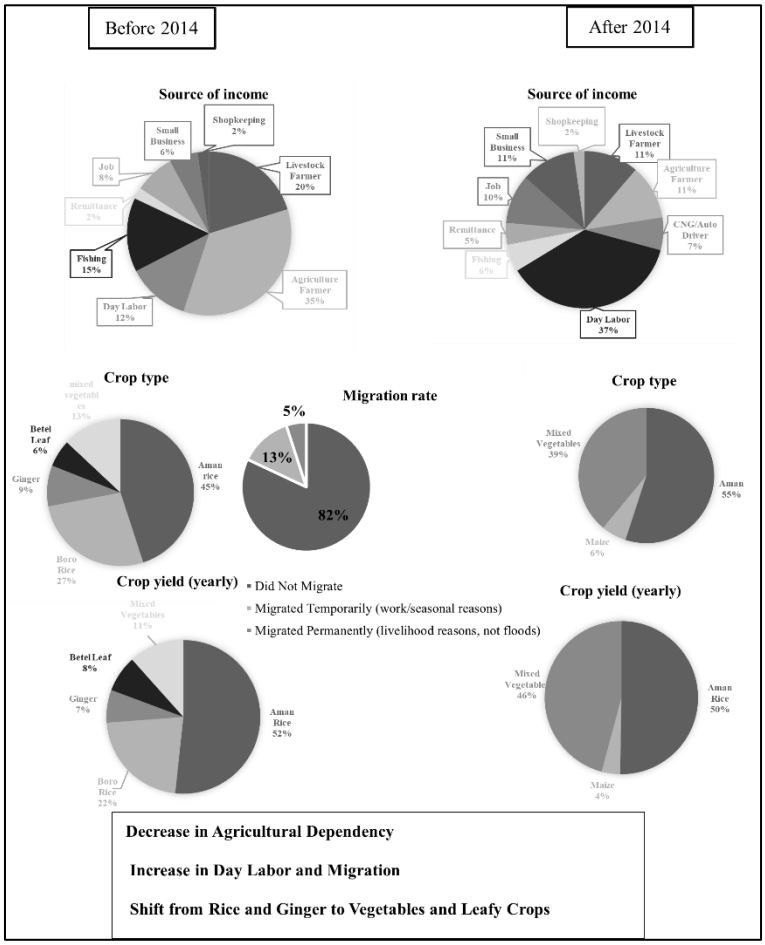

Figure 5: Livelihood analysis of the community

As per the cause-effect diagram, heavy rainfall brought about the floods in Dharmapur Union which then resulted in the most immediate impacts such as crop loss, land flooding, damage to houses and roads, water contamination, and increased disease risk. The diagram also showed that long-term consequences included soil erosion, reductions in agricultural output, changes in cropping patterns, increased poverty, and higher rates of migration.

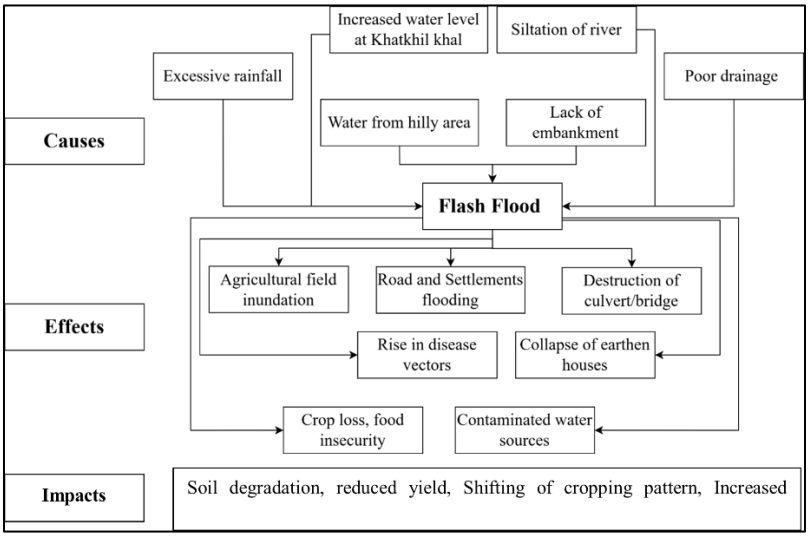

Figure 6: Cause-effect and Impact Diagram

3.2 Local adaptive strategies and coping mechanisms

Pairwise ranking identified the most effective flash flood adaptation strategies among farmers in Dharmapur based on local knowledge. Six strategies were identified, which are- relocation to higher ground, sand-filled tarpaulin barriers, livestock evacuation, food and water storage, mud and bamboo walls, and a village emergency fund. Relocation to higher ground ranked highest, followed by food and water storage and tarpaulin barriers, due to their immediate impact on safety. In contrast, mud and bamboo barriers and the village emergency fund ranked lower, as they were more suitable for preparedness or post-flood recovery.

Table 4: Pair-Wise Ranking matrix

Strategies	**1**	**2**	**3**	**4**	**5**	**6**
1. Shifting to higher place	X	1	1	4	1	1
2. Using sand filled terpal barriers	-	X	3	2	2	6
3. Moving livestock	-	-	X	3	5	3
4. Store food/water	-	-	-	X	4	6
5. Mud/bamboo barriers	-	-	-	-	X	6
6. Village level emergency fund	-	-	-	-	-	X

Strategies	**Times Preferred**
Shifting to higher place	**4**
Using sand filled terpal barriers	**2**
Moving livestock	**3**
Store food/water	**2**
Mud/bamboo barriers	**1**
Village level emergency fund	**3**

The Venn Diagram delineated the institutional roles in flash flood response and adaptation derived from community consultations on support received during and post-inundation events. Circle magnitude denotes influence with intersections indicating collaboration. The outermost circle encompasses the village perimeter encapsulating localized activities. A concentric community circle represents the hub

of decision-making and preparedness. Local leaders occupied the core directing mobilization and adaptive actions. The Union Parishad overlaps community and village domains balancing administrative obligations with practical disaster engagement. Community clubs were situated within the community nucleus and consisted of volunteers who disseminated early warnings and coordinated resources. Schools were positioned on the periphery, contributing mainly through awareness activities and announcements rather than direct intervention. NGOs positioned externally exerted less influence yet provide financial support, technical expertise, and capacity development.

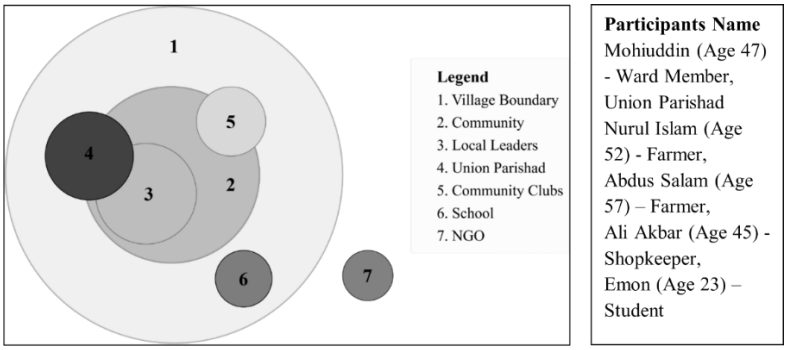

Figure 7: Venn diagram

3.3 Development of a community-based adaptation plan to reduce flash flood impacts

The agricultural sector exhibited intrinsic resilience to flash floods through intergenerational knowledge, topographic safeguards, shelter availability, and strong social ties, yet vulnerabilities persisted in the form of substandard housing, the absence of early warning systems, resource scarcity, and infrastructural deficiencies. External opportunities for adaptation included governmental and NGO aid, educational initiatives, the integration of scientific and indigenous knowledge, and ecological measures such as reforestation. Conversely, threats included crop-induced food shortages, irregular financing, out-migration that reduced labor availability and social cohesion, and the degradation of natural defenses, all of which intensified the impacts of flooding.

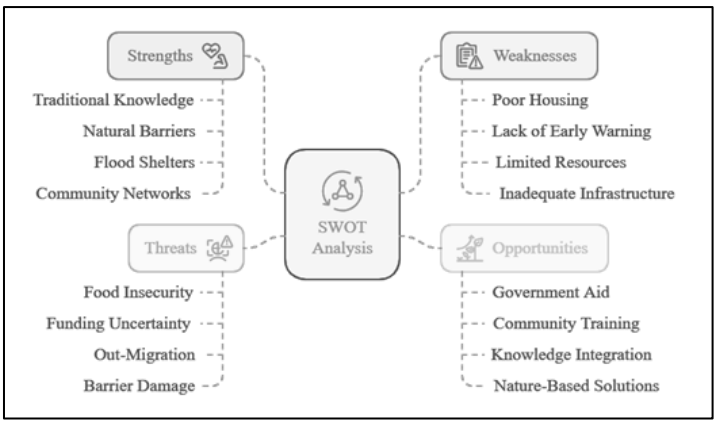

Figure 8: SWOT analysis of community adaptation to flash floods

During the participatory workshop, agricultural groups proposed targeted measures against flash floods. Farmers advocated floating and raised-bed cultivation, seed banks, and collective resource oversight. Women emphasized household preparedness, child-secure refuges, and improved hygiene. Youth pushed for SMS alerts and village loudspeaker networks. Elders mapped flood-prone pathways. Union Parishad representatives emphasized monitoring and financing. NGOs and CBOs pledged livelihood aid and psychosocial care, while extension officers recommended revised planting schedules and flood-resilient crop varieties.

Table 5: Participants involvement in generating solutions to reduce flood impacts

Participant Involvement	Solutions / Ideas Generated
Farmers	➢ Promotion of floating and raised-bed cultivation ➢ Seed banks at community level ➢ Community agricultural resource management ➢ Barrier near khal
Women's groups	➢ Family-level disaster preparedness training ➢ Child-safe shelter planning ➢ Sanitary facility improvement at shelter
Youth groups / Local students	➢ Early warning dissemination via mobile and megaphones ➢ Volunteer task forces
Elderly residents	➢ Mapping traditional flood routes and indigenous coping strategies
Local government representatives (Union Parishad)	➢ Allocation of funds for shelter maintenance Coordination for relief logistics
NGOs and CBOs (e.g., BRAC, GUK)	➢ Livelihood support training Psycho-social support post-flood
Agricultural extension officials	➢ Crop calendar shifting guidance Promotion of short-duration and flood-tolerant crops

Participants Name
Md. Selim Uddin (Age 52) – Administrative Officer, Dharmapur Union Parishad
Mohiuddin (Age 47) - Ward Member, Union Parishad
Nurul Islam (Age 52) - Farmer,
Ali Akbar (Age 45) - Shopkeeper,
Emon (Age 23) – Student
Amena Begum (32) - Housewife

Residents maintained direct linkages with the Union Parishad, NGOs, and CPP volunteers for prompt assistance. NGOs function as intermediaries, facilitating aid delivery and policy advocacy between locals and state entities. The Union Parishad collaborates with LGED and the District Disaster Management Committee to implement structural upgrades and regulatory reforms. Youth organizations and educational institutions constituted grassroots networks that enhance stakeholder coordination. A reciprocal feedback mechanism operated from inhabitants to NGOs and authorities, primarily via participatory workshops and task force deliberations.

Table 6: Stakeholders mapping along with their roles

Key Stakeholder	Role/Contribution
Local Residents	Primary flood-affected group; provide local knowledge and manpower
Union Parishad	Coordinates local development and disaster response activities
NGOs	Aid distribution, training, post-flood rehabilitation support
LGED	Infrastructure and drainage development
Health Department & Clinics	Emergency medical support and public health awareness
Schools & Teachers	Act as knowledge hubs and temporary shelters during emergencies

The Action Plan Matrix integrated flood causes, effects, and impacts with community-led adaptations, prioritizing farmer-driven resilience through risk mapping, natural barrier reinforcement, housing improvements, and awareness enhancement. Key measures included local early-warning systems, flood-resistant crops, elevated storage structures, and routine drills. Community resilience committees would be established alongside documentation of traditional coping practices to strengthen sustained preparedness.

Table 7: Action plan matrix

Action/Tasks	Responsible Parties	Resources Needed
1. Community mapping of flood-prone areas	Agricultural Community members, local youth, Union Parishad personnel	Maps, GPS devices, local facilitators
2.Strengthening and maintenance of natural barriers (Khal, vegetation belts)	Agricultural Community volunteers, LGED, Forest Dept., NGOs	Tree saplings, tools, technical support
3. Upgrading flood shelters with basic services	Local government, Disaster Management Committee, NGOs	Funds, construction materials, sanitation kits, dry food resources
4. Awareness campaigns and school-level training on flood preparedness	NGOs, Schools, Community	Posters, megaphones, trainers, leaflets in local language
5. Installation of flag and megaphone-based local early warning systems	Union Parishad, community task forces	Flags, poles, megaphones, warning protocols
6. Promotion of flood-resilient farming (e.g., raised beds, floating gardens)	Dept. of Agriculture, NGOs, Farmer groups, Union parishad personnel	Seeds, training, resources, monitoring
7. Establishment of elevated community grain and seed storage units	Farmers' cooperatives, Union Parishad	Raised platforms, storage bins, community coordination
8. Regular community drills and emergency evacuation simulations	Local Disaster Committees, community leaders, NGOs	First aid kits, boats (if available), simulation guides

9. Formation of a Community Resilience Committee in each ward	Community representatives, UP members	Meeting spaces, coordination support
10. Documentation and dissemination of traditional flood coping practices	Research teams, Elders, NGOs	Interview guides, printing support, visual documentation

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4. CONCLUSION

This study on the impacts of flash floods in the agricultural community of Dharmapur Union, Fatikchhari, Chattogram, conducted through Participatory Rural Appraisal (PRA) methods reveals significant livelihood vulnerabilities caused by recurrent flooding. Frequent flash floods have disrupted agricultural cycles, reduced crop productivity, and heightened livelihood insecurity, often prompting seasonal migration. While traditional coping mechanisms such as relocation to elevated areas and constructing temporary embankments provide short-term relief, they remain insufficient for long-term resilience. The findings emphasize the urgent need for integrated and sustainable adaptation measures including improved early warning systems, flood-resilient agricultural practices, strengthened infrastructure, and enhanced local disaster preparedness. Overall, the study underscores the importance of combining indigenous knowledge with modern disaster management approaches to build enduring community resilience and secure rural livelihoods in flood-prone regions..

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