

Flood Vulnerability and social resilience of residents along river Ravi in Lahore

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ABSTRACT

This paper investigates growing flood risk faced by the people settled near the River Ravi in Lahore-induces unplanned constructions, urban sprawl and alongside shifting weather patterns. To reveal key physical, socio-economic and institutional vulnerabilities, researchers relied on primary data collected from the fifty homes situated in the danger prone riverside locations. The results show that there are few structural flood protection measures, poor early warning systems, drainage systems, and weak housing constructions. Risk is increased by low household incomes and in adequate readiness there are a few still few organized communities-based mechanisms and coordinated institutional responses, even though some houses exhibit fundamental individual coping skills. Long-term exposure and recovery difficulties are exacerbated by the lack of integrated flood governance and efficient local level disaster risk management. This report suggests investing in structural meeting communication infrastructure enforcing land use restrictions along riverbanks improving early warning communication systems and institutionalizing community-based disaster risk management CBD RM frameworks reducing flood well vulnerability and improving such stable urban resilience in the river Ravi corridor require evidence based, multi stakeholder coordination.

KEYWORDS: Flood vulnerability, Flood risk governance, Community-based disaster risk management, Urban flood management, Disaster risk reduction, Climate resilience.

1. INTRODUCTION

Floods are the most frequent and damaging natural disasters in the world, especially in developing nations with fast expanding populations and poor infrastructure (Shah et al.,2020). Pakistan which is situated in the Indus basin and is affected by monsoon patterns frequently experiences floods that put communities at serious danger (UNISDR,2015).thousands of residences are at risk of flooding, structural damage ,displacement and disruption of their livelihoods due to river Ravi which flows along the eastern edge of Lahore(Khan & Adams,2019).exposure and vulnerability are increased by unplanned urban growth and encroachment or natural flood plains and ineffective drainage systems(Ali & Bajwa,2021). Physical, social and economic factors that affect our household's ability to prepare for, respond to, and recover from disasters influence flood risk (Cutter et al., 2003). Risk of property destruction, relocation and interruption of

livelihood are increased because many residents along the riverside in low-income settlements with inadequate housing and inadequate protective infrastructure (Nazeer et al., 2022). sensitivity to flood shocks is further increased by reliance on daily wage labor or agriculture (Ahmed & Mustafa, 2020).

With these challenges riverine population have conventional coping mechanism and unofficial social network that strengthened resilience. Preparedness and responses depend heavily on social resilience or a community capacity to absorb and recover from disasters while continue to perform vital functions (Folke et al., 2010). households are assisted during evacuation, relief distribution and recovery through community collaboration, resource sharing, leadership support and voluntarism (Khalid & Iqbal, 2021). however inadequate early warning system, poor institutional coordination and lack of community-based disaster risk management (CBDRM) efforts all contribute to varying levels of resilience (Shafiq & Malik, 2022).

Punjab's agricultural inhabitants have long benefited from the Ravi river, a significant tributary of the Indus. The river's ability to control monsoon flow has been diminished in recent decades due to land use changes riverbank, encroachment and rapid unplanned urbanization (Khan & Ali, 2022). Rainfall variability has increased due to climate change resulting in increasingly frequently and severe flood events (Piracha, 2025). The 2023 and 2025 disasters that affected places like Parkview city demonstrate how urban growth, ecological degradation and complicated transboundary water management with India have increased flood risk (Ahmed et al., 2023; Khawaja, 2024).

This study employee standardize questionnaires within emphasizes on social economic and physical aspects to assess residence near the river Ravi social Brazilian and flirt ability. The results are intended to help development groups, disaster management, authorities and government improve community resilience and reduce the likelihood of future floods. To assess the household-level vulnerability to floods in selected Ravi River localities based on physical, economic, and social factors. To analyze community-level resilience and preparedness, with focus on the availability of access to early warning systems, evacuation resources, and social support networks. To assess and visualize the flood impact patterns and trends using collected data and graphical representations to inform targeted mitigation and disaster management strategies.

2. LITERATURE REVIEW

Flooding is one of the most damaging environmental risks in the world, especially in South Asia where monsoon driven river systems regularly

overflow and impact heavily populated floodplains. Pakistan's Geomorphology, climate variability, rapid urban growth and inadequate planning framework make it extremely vulnerable to flood disasters (Shah et al.,2020). the complex environment of Lahore, which is located along the river Ravi, exacerbates flood susceptibility due to the interaction of hydrological processes, socio-economic inequality and changes in land use. the ability of communities to anticipate, absorb, adapt to and recover from the effects of flooding is highlighted in recent research on social resilience (Folke et al.,2010). This paper summarizes significant issues related to the rivers Ravi resistance and susceptibility to flooding.

2.1 Physical and Infrastructural Vulnerability in Riverside Settlements

Physical vulnerabilities in riverbank settlements are major role in determining by house quality, elevation and proximity to the river. Traditional towns like Chung, Purani Bhaini, and Sehjowal, which are situated in an active floodplain, often flood during monsoon floods. due to the prevalence of *kutchra* and semi-pucca structures, there is little defense against flooding which caused significant structural damage and relocations (Ullah et al.,2021). vulnerability is further increased by a weak embankment, poor drainage and a lack of evacuation services. on the other hand, developed communities like Parkview city and a theme park area have Pucca infrastructure but they are situated on low lying or reclaim floodplain land, which increases the risk of flooding. Even contemporary infrastructure can be overtaken by extreme flood occur occurrence resulting in significant financial damages (Ali & Hassan, 2016).

2.2. Flood Vulnerability in Riverine and Urban Environments

The term flood vulnerability describes how vulnerable infrastructure, people and property are to the effects of flooding (Cutter et al.,2003). Vulnerability in riverine environment is influenced by social economic factors housing quality, landform and river proximity (Wisner et al., 2004). The research continuously demonstrates that the most vulnerable and least able to cope are low income, households and informal settlements close to rivers (Mustafa et al.,2018). due to poor housing, inadequate infrastructure and reliance on livelihoods that are susceptible to climate change, riverine floodplains in Pakistan continue to be extremely vulnerable (Nazeer et al.,2022). according to the research from Punjab the river Ravi frequently floods due to sedimentation, monsoon rain and insufficient embankments (Rehman et al.,2019). due to reduction of natural flood retention areas are caused by rapid urban expansion flood risk has increased (Khan & Ali,2022). Together, this body of literature

supports the view that vulnerability in study area (Theme Park / Park View Society) is shaped by a combination of hazard (river-flood potential), exposure (proximity to the Ravi River, low elevation, high density housing), and vulnerability (household income, awareness, settlement type, age of buildings).

2.3. Socio-Economic And Household Vulnerability Factors

Social economic factors have a big impact on how vulnerable and resilient a household is. during flood occurrence low income, families daily wage earners and household with few assets experience disproportionate losses and must end your protracted recovery times (Ahmed & Mustafa,2020). Katcha and semi-pucca building sustained the most damage, and housing style is a significant factor (Nazeer et al.,2022). vulnerability is further shaped by household characteristics as education level, family size risk awareness and access to essential services (Rehman et al.,2019). marginalized groups suffer more when they have limited assessed to emergency transportation clean water and healthcare (Atta-ur-Rahman, & Shaw,2015).

2.4. Urbanization, Land-Use Change, and Floodplain Encroachment

Along the river Ravi rapid and frequently unplanned urbanization has just drastically change the dynamics of the floodplain. wetlands and agricultural area that once served as natural flood buffers have been invaded by housing projects, Road networks and commercial developments (Khan & Ali,2022). the invasion raises flood dangers for nearby areas decreases flood storage capacity and increases run-off (Ali & Bajwa,2021). The construction of infrastructure close to the river in Lahore has also increased the risk of flooding and drain issues (Ahmed & Mustafa,2020).

2.5. Flood Vulnerability And Community Resilience Along River Ravi

Community resilience plays an important role in shaping how riverine population prepare for manage and recover from the effects of flood. It describes the ability of communities to absorb, disruption, adjust to shifting circumstances and preserve vital social activities both during and after disasters (Folke et al.,2010). Social cohesion, local knowledge and unofficial support network frequently make up for the lack of institutional support in flood prone areas of Pakistan, specially near major rivers (Mustafa et al.,2018).

There are significant geographical differences between the Ravi river eastern and Western corridors. Western side communities are more

vulnerable overall because to their greater physical exposure, reliance on daily wage, labor and agriculture and restricted access to planned infrastructure (Mustafa & Wrathall,2021). on the other hand, planned layouts and pucca infrastructure are advantageous for eastern side developments like Parkview city; however, their location on reclaimed or low-lying floodplains land creates latent flood risk, especially in extreme events where high value assets are exposed to significant damages (Ali & Hassan, 2016).

These desperate patterns demonstrate how vulnerability along the Ravi river is spatially diverse rather than consistent. driven by the interplay of physical location, social economic circumstances and community resilience levels. To design effective and sustainable flood mitigation strategies in Lahore, organizers must have prioritized the localized approach that know the city's complex spatial variations. Establishing true community resilience is only possible when we address the specific geographic imbalances or gaps and socio-economic variations that exist across the urban landscapes.

3. MATERIAL AND METHODS

3.1. Study area

The study area is located in Lahore District, Punjab, Pakistan along the Western floodplain of river Ravi, seasonal flooding has a significant effect on community vulnerability, infrastructure stability and land use patterns (Cutter et al.,2003).Hydrologically, the area is a part of the larger Ravi-Chenab system ,which is important for agriculture ,the distribution of settlements and social economic activities in Lahore and neighboring areas (CPCB,2020).Chung, Purani Bhaini, Sehjowal, Lurkey Nemat, Madar Sharif, Rajian Raiyan, Saharaqpur City, Park View City, and the Theme Park vicinity among the potential urban development and ruler villages chosen for the study.

Urban developments like Parkview city and the theme park area, on the other hand, are innovative privately planned residential zones that span about 11,000 canal and include housing blocks, recreational facilities, commercial areas mosque, community centers and gated infrastructure (Parkviewcity.org, 2023). because they are situated on the reclaim floodplains, these places are still vulnerable to flooding despite improve infrastructure. overall, the area is ideal for evaluating flood vulnerability and community resilience because to its flats alluvial and monsoon drive and climate and social economic profile which includes both middle class, urban household and low-income rural population.

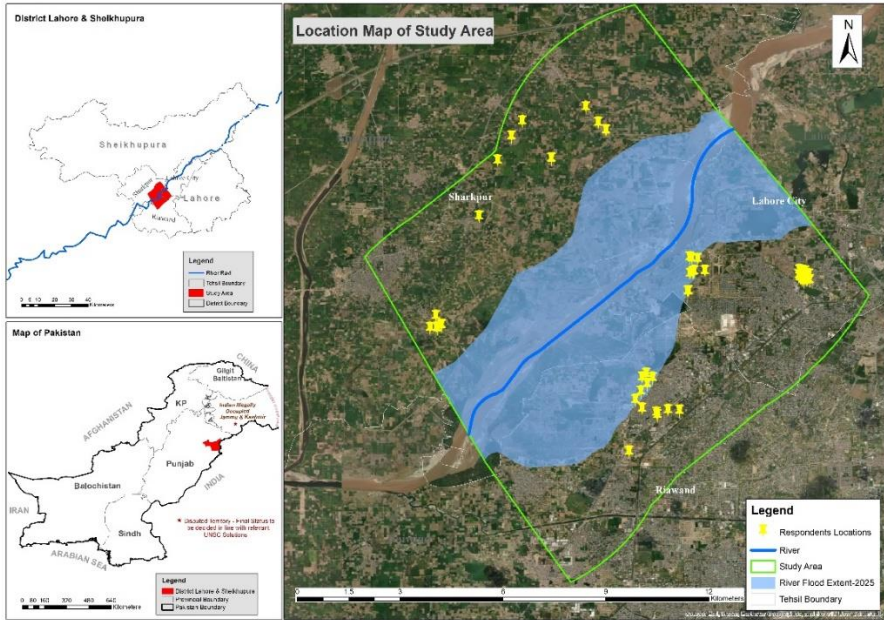


Figure 1: Study area Map

3.2. Data and its Sources

This study employs a descriptive and cross-sectional research design to examine the flood vulnerability and resilience of households along Lahore’s Ravi River.

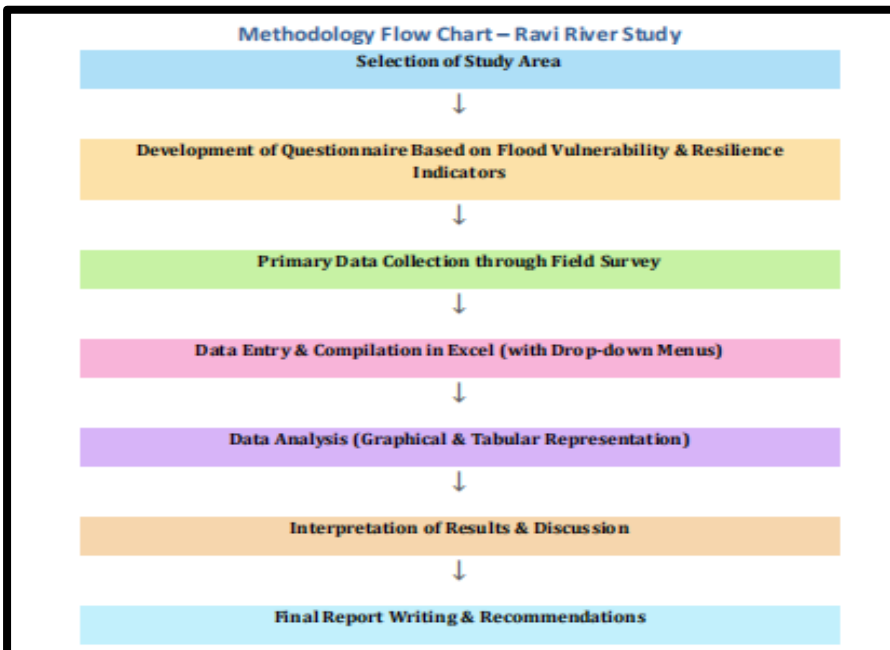


Figure 2: Flowchart of Methodology

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Fifty people from place like Chung and Purani Bhaini – known as flood prone area –took part in this survey. Those locations also include the neighborhood close to theme park. Information came through fixed format survey that ask about physical and economic vulnerability, financial strain, resource accessibility, emergency planning and access to support. Each form was completed during face-to-face interview, because many residents struggle with reading. These verbal interactions enhanced the data accuracy while ensuring the involvement of people frequently oppressed by written methodologies.

The study employs descriptive and thematic techniques to identify trends and difference in community-level resilience strategies. This methodological framework ensures a detailed assessment of flood-related risks, providing a detailed understanding of the physical and financial dimensions of disaster exposure in the study region.

3.3. Sampling and Sample Size

The study utilizes the purposive sampling to target 50 residents living near the River Ravi high risk plains. This sample was designed to represent the socio economic and spatial diversity to capture the representative range or perspectives. Although organizational and time restrictions, this sample size was considered adequate to provide significant preliminary awareness into household level susceptibility and local resilience strategies.

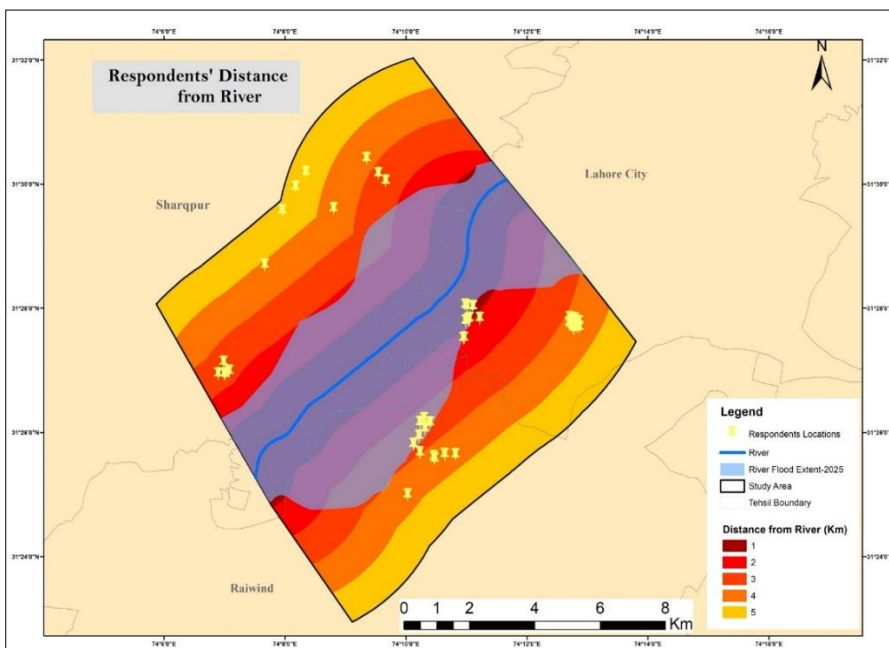


Figure 3: Respondent Distance Map

3.4. Data Collection Tool

Primary data was gathered and utilizes a structured questionnaire titled “Ravi River Flood Vulnerability and Community Resilience Assessment Questionnaire”. The questionnaire was divided into five main sections, utilizing both open ended and close ended questions to grasp detailed insights into community resilience and flood risks.

- I. Household Information – demographic and socio-economic profile of respondents.
- II. Physical Vulnerability – housing type, flood exposure, and structural protection.
- III. Economic Vulnerability – income, livelihood losses, and access to financial aid.

3.5. Data Collection Procedure

Structured face to face interviews serves as a primary data mode of data collection, targeting household heads and adult members. Participants were informed that their participation is for study and voluntary purposes. The timing of survey aligned with dry season, ensuring maximum accessibility to high-risk prone zones and minimizing the risk of disturbances caused by ongoing flood Related Activities.

3.6. Data Analysis Approach

The study utilizes the purely qualitative approach, bypassing statistical modeling in favor of descriptive interpretation. By linking field data with established research, the analysis categorized results into social, economic and physical context. This framework provides a clear view of community level struggles and coping mechanism present at community level.

4. RESULTS

The survey conducted across flood-prone localities of the Ravi River—Chung, Purani Bhaini, Saharaqpur City, Sehjowal, Lurkey Nemat, Madar Sharif, Rajian Raiyan, Park View City, and the Theme Park vicinity provides an overview of the community’s vulnerability and resilience.

4.1. Socio-Demographic Profile of Respondents

The community is overall characterized by high social and economic sensitivity to flooding. Most respondents belonged to the economically active age group (25–45 years), mostly married-males with average 3 to 4 persons in family, implying that flood impacts directly affect productive livelihoods and household income, with increased dependency and recovery responsibilities. Educational attainment was generally low, with a

substantial proportion of respondents either illiterate or educated only up to primary level, limiting access to flood preparedness information and adaptive practices. Economic vulnerability was pronounced, as more than half of households reported low monthly incomes, constraining their capacity for pre-flood investment and post-disaster recovery. Livelihoods were largely dependent on informal and climate-sensitive sectors, particularly agriculture, further increasing exposure to flood-induced disruptions. Collectively, these characteristics reflect limited adaptive capacity and heightened susceptibility to flood hazards within the study area.

4.2. Physical Vulnerability of Households

Table 1: Physical vulnerability of households

Dimension	Indicator	Dominant / Critical Condition	%
Structural & Exposure	Housing damage	Minor–Moderate damage	74
	Housing type	Pucca & Semi-pucca	84
	Floodwater entry	Sometimes–Always	40
Asset Protection	Structural mitigation	No	74
	Safe storage for belongings	No	78
	Ability to shift assets	No	52
	Transport assets damaged	Yes	30
Displacement & Services	Experienced displacement	Yes	60
	Shelter shortage	Yes	48
	Health access during floods	Difficult / None	86

4.2. Structural and Exposure Vulnerability

Structural indicators reveal recurrent physical exposure of households to flooding. Despite the dominance of pucca and semi-pucca housing, most dwellings experienced repeated minor to moderate damage, indicating cumulative degradation rather than one-time impacts. Floodwater entered homes frequently in a substantial proportion of households, reflecting persistent locational exposure. The limited adoption of structural mitigation measures further suggests inadequate long-term adaptation,

reinforcing physical vulnerability despite relatively stronger housing Materials.

4.3. Asset Protection And Preparedness Capacity

Household asset protection capacity was generally low, with most respondents lacking safe and elevated storage and resources to relocate essential belongings during floods. Damage to transport assets further constrained mobility and recovery potential. Flood-induced displacement was widespread, and nearly half of households faced shelter shortages, indicating pressure on temporary housing arrangements. These factors collectively amplify physical vulnerability by increasing asset loss and reducing post-flood recovery efficiency.

4.4. Physical Access Constraints During Flood Events

Access to essential services during flood periods remained problematic. While drinking water access was relatively high, healthcare access was difficult or unavailable for most households, increasing exposure to secondary health risks. The synergy between limited access and direct physical impacts serves to strengthen the overall severity of flood events, resulting in gradual degradation and lengthen socioeconomic recovery.

4.5. Economic Vulnerability

Table 2: Economic vulnerability

Dimension	Indicator	Any Loss / Constraint	%
Income & Livelihood Loss	Household income loss	Yes	30
	Agricultural land loss	Yes	24
Production & Stock Loss	Stored crop loss	Yes	48
	Food stock loss	Yes	50
Financial Buffer Capacity	Savings affected	Yes	8
	Post-flood savings/income	No	98
Inflation Pressure	Food price increase (>10%)	Yes	34
External Financial Support	No aid received	72	
	No access to loans/insurance	94	

4.6. Livelihood And Income-Related Vulnerability

Economic vulnerability was evident through widespread livelihood and income disruptions caused by flooding. The reported losses in household income and agricultural assets represents the severe exposures of local livelihood to flood. This correlation highlights the necessity of target interventions to protect agriculturally based economies from the intensifying frequency of flood hazard in region. Loss of stored crops and

food stocks was particularly common, directly affecting household food security and income continuity.

4.7. Financial Coping Capacity And Recovery Constraints

The findings reveal that household acquire minimal economic stability characterized by lack of institutionalized fiscal protections such as insurance or formal aid mechanism. The lack of ability to access credit, coupled with the loss of primary income sources creates a severe restrains induced market variability and rising inflation in food prices significantly compromise the socioeconomic stability of the community. collectively, these factors highlight a high degree of economic vulnerability, leaving households inadequate to manage the financial effects of repeated floods.

4.8. Community Based Disaster Risk Management

Table 3: Community Based Disaster Risk Management

Dimension	Indicator	%ages
CBDRM Role in Community	Ineffective	6
	Not Present	94
Type of help from Government or NGOs	Early warning systems and timely flood alerts	66
	Rescue and evacuation support	50
	Emergency relief supplies	24
	Financial or livelihood assistance after floods	72
	Infrastructure improvements	34
	Long-term rehabilitation and housing assistance	4
Long-term measures to reduce flood risk	Awareness and training programs for disaster preparedness	16
	Strengthening of embankments, levees, and floodwalls	66
	Improvement of drainage and sewerage systems	72
	Relocation or zoning of houses	42
	Community awareness and education programs	40
	Installation of early warning systems	48
Household Measures Taken	Support for livelihood diversification	46
	Raised the foundation or floor level	28
	Built barriers to prevent water entry	18
	Moved valuables and furniture to higher places during flood season	34
	Strengthened house structure	12
	No specific measures taken yet	30

4.9. CBDRM Role In Community

The finding demonstrates the significant scarcity in Community based disaster risk management (CBDRM) in the framework of surveyed region. Most respondents reported that CBDRM mechanisms were not present, with only a very small number perceiving existing efforts as ineffective. This suggests that disaster risk management at the community level remains largely informal and uncoordinated.

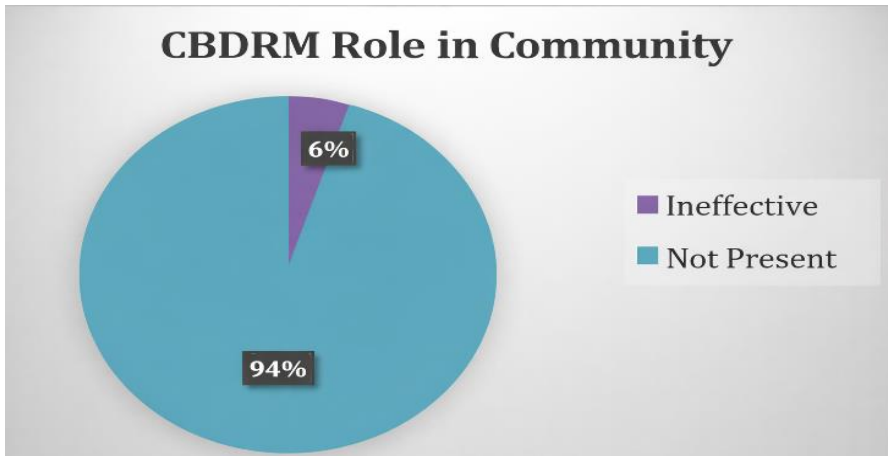


Figure 4: CBDRM role in community

4.10. Type of Help From Government Or NGOS

Types of support people receiving during floods. The most common forms of help include financial assistance and early warning alerts, followed by rescue support and emergency relief supplies, some respondents also reported support in infrastructure improvement and awareness program.

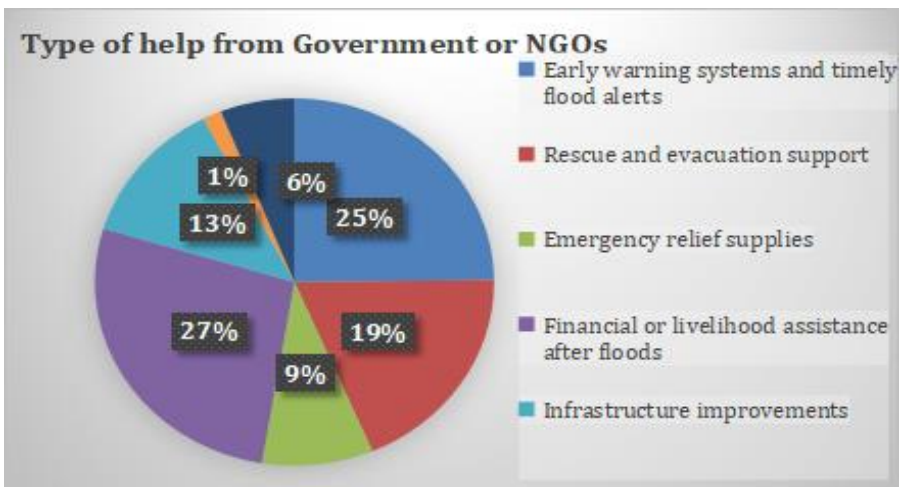


Figure 5: help from NGOs

4.11. Long-Term Measure Suggestions to Reduce Flood Risk

Perceptions of long-term flood risk reduction measures highlight strong demand for improved drainage systems and strengthened embankments, reflecting persistent exposure to flood hazards. Measures related to relocation, early warning installation, and livelihood diversification were moderately recognized, suggesting partial awareness of non-structural risk reduction strategies.

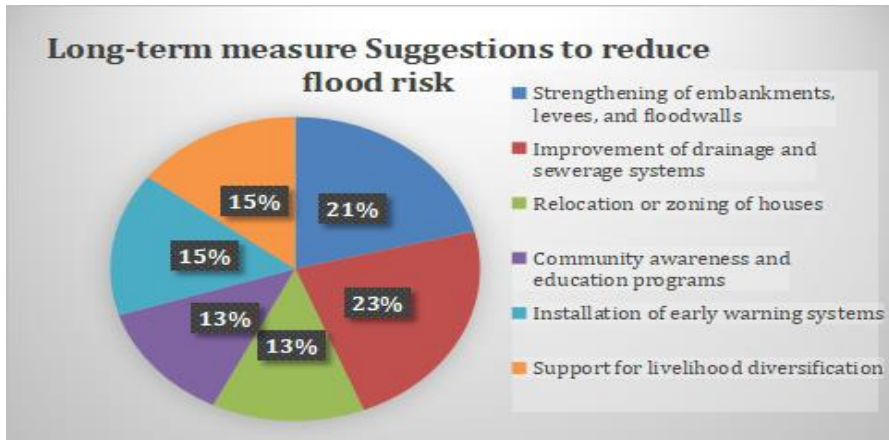


Figure 6: Suggestions to reduce flood risk

4.12. Household Measures Taken

Common measures include moving valuable to higher places, raising floor levels, and building barriers to prevent water entry, some households strengthened their structure, while many reported making no specific measure yet.

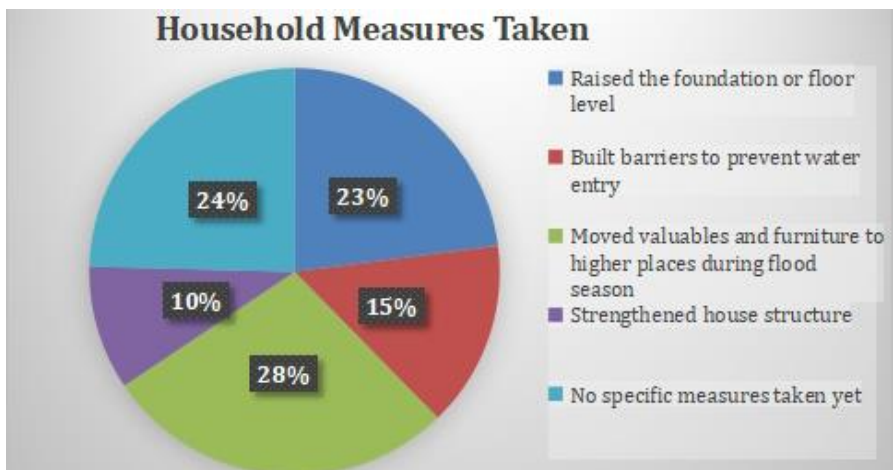


Figure 7: Household measure taken

5. DISCUSSION

The findings of this study highlight that flood vulnerability in the study area is shaped by the interaction of physical exposure, economic fragility, and limited community-based disaster risk management (CBDRM), with notable spatial and socio-economic differences between communities along the riverbanks. Residents of the eastern bank, particularly in urban areas near Lahore, typically lived in newer houses and were engaged in business or formal employment. Despite higher income and relatively stronger housing, these households experienced greater damage to assets, reflecting higher exposure due to proximity to the river. In contrast, western bank communities were predominantly rural, with lower education levels, older houses, and agriculture-based livelihoods. While located farther from the river, these households were more economically and structurally vulnerable in terms of livelihood security, though physical damage to housing was comparatively lower. This demonstrates that flood vulnerability is influenced not only by proximity to hazard but also by socio-economic and demographic characteristics.

Houses built with materials resistant to water damage, such as elevated foundations or water-resistant materials, are more likely to endure the impact of floods without significant structural damage (Raza & Abu Hatab, 2025). Physical vulnerability results indicate that most households experienced minor to moderate housing damage and repeated floodwater entry, with limited structural mitigation measures adopted, which prolongs recovery. Economic vulnerability was evident in losses to household income, agricultural land, and stored crops, compounded by limited savings, absence of insurance, and minimal access to financial support. CBDRM capacity was largely informal and reactive; few communities had organized committees, preparedness training, or structured early warning systems. While some external support and evacuation resources were available, long-term capacity-building initiatives and coordinated community planning were mostly absent.

These findings underscore the importance of incorporating social vulnerability assessments into flood risk management planning, as socio-economic and demographic differences clearly affect exposure and recovery (Fatima et al., 2025). Furthermore, the results emphasize that active participation of vulnerable communities in planning and implementing flood risk management programs enhances decision-making and produces favorable outcomes for at-risk households (Fatima et al., 2025). Together, the patterns observed in this study suggest that effective flood risk reduction requires a holistic approach that integrates physical, economic, and social dimensions, strengthens household preparedness,

and institutionalizes community-based interventions tailored to the specific needs of diverse communities along the river.

6. CONCLUSION AND RECOMMENDATIONS

Flood vulnerability in the study area is shaped by the interaction of physical exposure, economic fragility, and limited community-based disaster risk management, with clear spatial and socio-economic differences between riverbank communities. The residents of Eastern bank lived in more modern house and had higher incomes yet lost more property because they were closer to river, while residents on western bank relies heavily on farming or agriculture dependent, stayed poorer over time even though their assets suffered less harm. Persistent home destructions, socio-economic instability characterized by insufficient domestic reediness and significant losses in income, savings and harvested crops diminish the long-term resilience.

These findings reveal that the need for multi-dimensional approach to flood management that bridge the gap between structural interventions and social vulnerability. Through educational campaigns, trainings and mitigation measures are vital for enhancing the preparedness at house hold level. Furthermore, transforming the Community based disaster risk management (CBDRM) into institutionalized system is vital to build long term regional resilience. Social vulnerability assessments must be incorporated into planning to prioritize the most at-risk households. Livelihood resilience can be strengthened through crop insurance, income diversification, and timely post-flood financial support. Finally, long-term flood risk reduction requires structural and non-structural measures, including embankment construction, drainage improvements, and relocation or zoning of vulnerable communities.

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