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ORIGINAL ARTICLE

Adaptive Strategies and Livelihood Resilience among Riverine Communities Facing Flood and Erosion Hazards in Assam, India

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Abstract

Objectives: This study explores flood and erosion vulnerabilities and examines the adaptive strategies and livelihood resilience of riverine communities near Laokhowa–Burhachapori Wildlife Sanctuary, Assam in India. **Methods**: A mixed-method approach was used, combining long-term data on floods and erosion (2000–2024) with household surveys (n=453), focus group discussions, and interviews with key informants. Villages were selected through stratified sampling across three hazard zones. Spatial tools and comparative tables helped analyze the nature of hazards, social and economic vulnerabilities, local adaptation efforts, and how communities recover. Special attention was given to the differences in resilience strategies from one village to another. **Findings**: Results indicate notable geographic variations in hazard severity and adaptability potential. Villages vulnerable to erosion such as Jhaoni and Sishuhati experienced a loss of up to 2.15 sq. km of land in 2024, with yearly erosion rates averaging 5–15 meters. Over 70% of households in these regions are marginal landowners with limited access to welfare services. Structural methods such as raised platforms, bamboo fences, and geo-textile barriers are frequently employed, while non-structural tactics include temporary relocation, cultivating quick-maturing crops, livestock farming, and depending on self-help organizations and informal support systems. Access to PMAY, MGNREGA, and early warnings differs between villages and affects recovery duration—spanning from 3 months to more than a year. The research highlights the ways in which micro-level socio-economic, environmental, and institutional factors combine to influence livelihood resilience. These results enhance regional vulnerability indices and underscore the necessity for tailored planning in hazardous regions of Assam **Novelty**: This study uniquely combines spatial hazard assessment with grassroots adaptation data to offer micro-scale insights into resilience patterns near Assam's Laokhowa–Burhachapori sanctuary complex.

Keywords: Flood; erosion; Adaptive Strategies; Resilience; Recovery

1 Introduction

As major worldwide issues, natural disasters—especially erosion and flooding—have the potential to change ecosystems, uproot communities, and jeopardize the stability of livelihoods in a variety of ecological domains[1]. The world's most frequent disaster from 2000 to 2019 was flooding; in 2020, 389 natural catastrophes killed 15,080 people, affected 98.4 million, and cost the economy more than USD 171.3 billion[2],[3]. Hydrological variations and human activities, such as deforestation, land encroachment, and land use changes, combine to cause these disasters[4].

In this regard, Assam, located in northeastern India, is particularly vulnerable because of the vast river ecosystems that the Brahmaputra River and its tributaries have produced[5]. The region often experiences disastrous floods, which are closely linked to significant erosion of the riverbanks. As per the Rashtriya Barh Ayog (RBA), Assam represents 9.4% of the overall flood-prone regions in India[6]. Moreover, the state's landscape, significant precipitation, and rivers filled with sediment render it especially vulnerable to periodic flooding and erosion of the land[7]. In order to develop successful disaster risk reduction and resilience measures, it is essential to comprehend the particular vulnerabilities and adaptation mechanisms of Assamese communities affected by flooding. Riverine communities in the Brahmaputra Valley of Assam are the ones who are severely impacted by the constant risks of erosion and floods[8].These populations, which are mostly found in low-lying, environmentally delicate places close to riverbanks, experience annual trends of flooding, land degradation, and forced displacement. Because of this, their primary sources of income, primarily being farming, fishing, animal husbandry, and forest resources, continue to be significantly susceptible to environmental changes and severe weather occurrences[9]. The risks are further increased by, erosion of riverbanks and changes in river paths often leading to the destruction of arable land, homes, and essential infrastructure, increasing the dangers faced by these communities.[10] With a motive to sustain their livelihoods and reduce these persistent threats, multiple livelihood strategies have been adopted by families and communities. This encompasses changes in agricultural practices, seasonal movement for employment, increased housing development, and dependence on indigenous ecological wisdom to predict flooding (Fieldwork 2024). Moreover, social networks, family connections, and collaborative community practices frequently act as unofficial safety nets during times of crisis, enabling resource distribution and group efforts[11]. Yet, despite the fact that these techniques promote both immediate survival and long-term resilience, their efficacy is increasingly threatened by the growing intensity and unpredictability of erosion and flooding events.

Although there is an increasing amount of study on the risks of erosion and flooding in Assam and other riverine regions, the majority of the literature until now has concentrated on the physical and hydrological components of these risks, such as patterns of land degradation, river dynamics, and flood frequency[12]. Additionally, a number of studies have focused on infrastructure-based mitigation strategies or widespread displacement patterns, frequently ignoring the everyday, local reality of impacted communities[13]. On the other hand, there are still not enough community-level studies that examine how families view, react to, and recover from recurrent hazards, especially through livelihood-based adaptation and indigenous knowledge systems. Furthermore, the diversity of community responses is not given enough consideration, particularly when it comes to caste, ethnicity, gender, land tenure, and unequal access to institutional resources[13]. Accordingly, whereas recent studies provide insight into the broader impacts of erosion and floods, they fall short in elucidating how local adaptation strategies might maintain livelihood resilience in frequently impacted locations.

A notable research gap results from this, especially in the Brahmaputra Valley, where socio-ecological problems interact with institutional and cultural complexity. The aim of this research is to examine the resilience strategies and sustainable lifestyles employed by Assam's riverine communities who are always at risk from flooding and erosion. Based on actual data from particular riparian villages along the Brahmaputra River, the research investigates how locals respond to environmental stress, the value of social networks and indigenous knowledge in adapting, and the limitations of these tactics in the face of escalating ecological problems. By focusing on community viewpoints and human experiences, the research provides a more comprehensive and contextually aware understanding of resilience in disaster-affected areas. It also provides policy-relevant suggestions for developing sustainable, localized, and inclusive adaptation plans.

2 Methodology

2.1 Study area

2.1.1. Location, extent and boundary

The present study has been conducted in selected flood and erosion prone fringe villages situated along the southern banks of the Brahmaputra River, within the central part of Assam, India (Figure 1). These settlements are near the Laokhowa-Burhachapori Wildlife Sanctuary (LBWLS), a major biological area that includes portions of the districts of Sonitpur and Nagaon[14]. Due to its dynamic riverine topography, which is influenced by sedimentation, seasonal flooding, and fluvial processes; the region

is especially vulnerable to erosion and flood threats [15]. From an administrative point of view, the selected study villages are included in the Rupahi and Samaguri Revenue Circles as well as the Tezpur Revenue circle of the Nagaon and Sonitpur district respectively. Several administrative and physiographic divisions encircle these districts which are primarily situated in the northern and central regions of the Brahmaputra Valley. The district of Sonitpur, is bordered to the north by Arunachal Pradesh, to the south by Nagaon, and to the northeast by Biswanath. [16], [17]

Together, the chosen village clusters cover an area of around 1756.4 hectares, which includes low-lying riparian tracts, char lands (river islands), and riverine floodplains. Human settlement is both supported and challenged by the region's physically unstable and ecologically sensitive environment, which is defined by sediment-laden waterways, fluctuating riverbanks, and periodic overbank flooding [18]. The region's distinctive environment gives it a perfect place to study the dynamics of livelihood resilience, vulnerability, and community adaptation to recurrent hydro meteorological catastrophes.

2.1.2. Hydro-geomorphologic Features and Hazard Profile

The chosen fringe villages are located along the active and environmentally unstable floodplains of the Brahmaputra River, among the largest braided rivers globally. Marked by changing channels, variable sediments, and significant seasonal flow, the Brahmaputra's River dynamics greatly influence the hydro-geomorphologic features of the area [12].

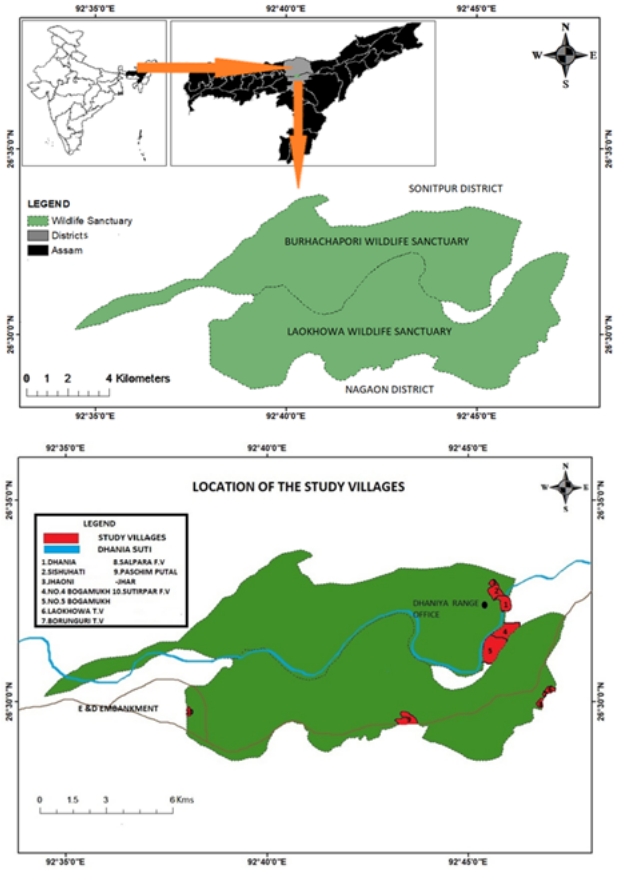

Fig 1. Location of the study area

This area exhibits a low-lying alluvial plain with sandy and silt deposits that are highly susceptible to erosion and seasonal submergence. The terrain is interspersed with chars (temporary sandbars), cut banks, point bars, and abandoned channels. These features continually evolve due to the river's strong lateral migration tendencies. Figure 2 illustrates maps generated using GIS software, derived from the extracted Google Earth time-series imagery, depicting the land eroded by bank line shift of Brahmaputra in the Burhachapori region from 1976 to 2024.

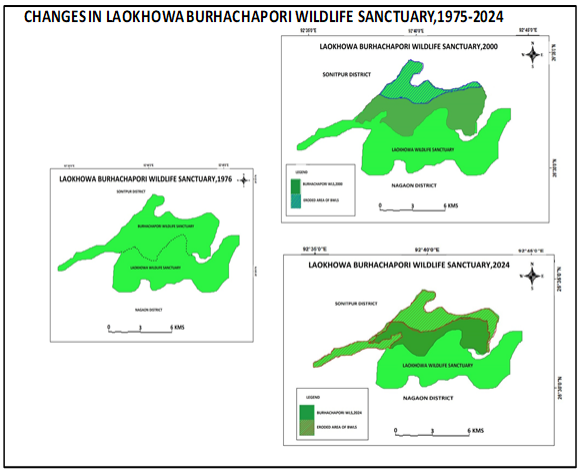

Fig 2. Land eroded in the Burhachapori region, 1976-2024

According to rainfall data from the Center for Hydrometeorology and Remote Sensing Data Portal (CHRS) extracted in2024, the region receives an annual average rainfall of over 1200 mm as presented in Table 1 which causes the peak discharge of the Brahmaputra to exceed its normal range resulting in flood. These conditions aggravate erosion, particularly in banks composed of loose alluvium.

Soil samples collected from Sishuhati and Dhania village indicate a dominance of fine sand and silt, with weak cohesive properties that enhance the erosion (Field work, 2023). This interplay between geomorphology and hydrology makes the region highly vulnerable to hazard-related impacts, particularly among agrarian communities dependent on natural resources. Understanding this hydro-geomorphologic context is thus essential for interpreting the patterns of risk, displacement, and adaptation strategies observed in the selected villages.

Table 1. Rainfall data in the study area

Year	Rainfall (in mm)
2014	970.01
2015	1468.57
2016	1209.77
2107	1209.31
2018	747.36
2019	934.4
2020	817.96
2021	659.02
2022	815.36
2023	989.4

2.1.3. Socio-economic Profile and Livelihood Characteristics

The socio-economic landscape of the selected fringe villages is defined by a vulnerable agrarian base, heavily influenced by the Brahmaputra's fluvial dynamics. Most households derive their primary income from subsistence farming, seasonal fishing, livestock rearing, and wage labor, which are highly sensitive to recurrent flood and erosion hazards (Field work, 2023). The majority of farmers are either landless or own marginal plots along riverbanks and embankments, which are frequently eroded or submerged.

It can be seen from the Table 2 that villages situated along the bank of the Brahmaputra namely Dhania, Jhaoni and Sishuhati have highest numbers of households owing 1 hectare of land. Housing structures in the area are predominantly ***kutcha*****,** made

from bamboo, thatch, and mud, offering minimal protection against water damage and displacement during flood events (Figure 3).

Access to basic services is uneven. While some villages are equipped with primary schools or public distribution centers, access to healthcare, markets, and flood shelters remains limited. During peak flood months, road connectivity is often lost, isolating entire communities. Residents in Dhania reported walking3–5 km through submerged paddy fields to reach medical help during the 2022 flood season (Field Interview Data, 2023).

Social capital also plays an important role. Traditional institution, local cooperatives, and community-based resource sharing mechanisms are active in some areas but weakened in others due to repeated displacement and fragmentation caused by erosion.

Taken together, these socio-economic attributes; combined with hydro-geomorphologic instability; underscore the chronic vulnerability of these fringe communities and frame the need for examining their adaptive strategies and resilience-building mechanisms in subsequent sections.

Fig 3. Photograph of a typical flood-prone *kutcha* house in Dhania village (Source: Field work, August 2024)

2.2 Database and methods

The research utilized a mixed-methods strategy, incorporating both primary and secondary data to thoroughly examine the adaptive tactics and livelihood resilience of riverine communities in Assam affected by floods and erosion. Primary data were gathered by various means like structured household surveys, key informant interviews, Focus Group Discussions (FGDs), and field observations which were carried out in selected fringe villages. In order to collect the opinions of communities and information regarding various adaptation strategies related to flood and erosion hazards, the Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) techniques were used.

In each village, a purposively chosen sample of families was given a semi-structured questionnaire that focused on socioeconomic traits, landholding size, vulnerability to erosion and flooding, livelihood strategies, and adaptive responses. Oral histories were also collected from elderly residents and community leaders to supplement the quantitative data with experiential insights on environmental change and displacement trends.

Qualitative data were thematically analyzed to identify local adaptation mechanisms, while quantitative data were processed using descriptive statistics. In cases where erosion or flood vulnerability mapping was required, remote sensing and GIS-based spatial overlays were employed to visualize hazard intensity and exposure levels. Community perspectives were central to the research design to ensure contextually relevant and accurate documentation of vulnerability and resilience.

2.2.1. Rational behind selecting the villages

From hydrological point of view, these villages are ecologically significant and sensitive, where frequent overbank flooding and lateral channel migration result in land loss, displacement, and livelihood disruption. For instance, villages like Dhania,

Table 2. Household wise average land holding size in study villages, 2023

Household Wise Average Land Holding (Hectares)								
Villages	**Total HHS**	**Sampled HHS**	**Up to 1 HA**	**1 HA to 3 HA**	**3 HA to 5 HA**	**5 HA to 7 HA**	**7 HA to 9 HA**	**Above 9 HA**
1. Dhania	153	46	22	8	4	5	3	4
2. Sishuhati	60	18	12	3	2	1	0	0
3. Jhaoni	37	12	7	4	1	0	0	0
4. No.4 Bogamukh	227	68	25	10	15	7	5	6
5. No.5 Bogamukh	181	54	17	6	13	7	6	5
6. Laokhowa T.V	74	23	4	6	7	3	2	1
7. Borunguri T.V	46	14	5	3	3	2	1	0
8. Salpara F.V	176	53	21	12	7	5	5	3
9. Paschim Putaljhar	467	140	53	34	24	14	9	6
10. Sutirpar F.V	83	25	3	4	8	5	3	2

N (sample size) =30% of the total size Source: Field study, 2024

Sishuhati and Jhaoni, have experienced riverbank erosion multiple times in the past decade, leading to the relocation of households and farmland loss. However, Bogamukh Nos. 4 and 5 are important transitional areas between cultivated fields and forest-edge villages, which make them essential for comprehending how humans and the environment interact in fringe ecologies.

A thorough lens to examine adaptation strategies and resilience patterns is provided by the selection, which also represents differences in livelihood activities, from seasonal migration and wage work to subsistence farming and fishing. These villages were also given priority because they were administratively accessible (in the Tezpur, Rupahi, and Samaguri Revenue Circles) and had historical records of erosion, floods, and demographics, which allowed for efficient data source triangulation.

By providing a microcosmic sample of Assam's flood-prone riparian environments, the selected villages are perfect for investigating the effects of recurrent hazards as well as the locally developed coping strategies that influence community resilience.

3 Result and Discussion

3.1 Nature and Extent of Flood and Erosion Hazards

The degree of exposure to flood and erosion dangers varies significantly among the periphery settlements chosen for this study. The distinct physical environment these places owe and proximity to the Brahmaputra River are the main causes of such variations. The data related to landmass lost to erosion obtained from Assam State Disaster Management Authority for the year 2000 to 2023 shows a clear picture of increase in the frequency and severity of flood disasters over time. Villages that are directly along the banks of rivers, such Dhania, Jhaoni, and Sishuhati, are most affected by this tendency. While in some of these places, riverbanks are retreating by five to fifteen meters per year, resulting in the destruction of houses, farms, and other important assets.

Community perceptions gathered through focus group discussions revealed a fact that the increasing unpredictability and severity of flood and erosion incidents over the past decade, corresponds with the secondary data trends. It has been also found that villages with higher rates of erosion reported more socioeconomic disturbances, such as decreased landholdings, crop losses, and increased migration as coping mechanisms. These trends show a close relationship between hydro-geomorphologic factors and level of hazard exposure, which in turn affects the adaptability and vulnerability of communities. The village-wise differences regarding the impacts of hazards, highlights the need for some location-specific adaptation strategies, which are explored in subsequent sections.

In contrast to the regional-scale hazard maps produced using MCDA-AHP[19]; our work offers detailed erosion data at the village level accompanied by primary field mapping, enabling micro-level study and instances directly taken from field. In contrast to broader flood zoning studies where areas are categorized based on discharge return periods, our study integrates both

Table 3. Landmass lost to erosion, 2000 to 2023

	Landmass lost to erosion (in sq. km)		
	Villages		
Years	Dhania	Sishuhati	Jhaoni
2000	0.213	0.441	0.543
2008	0.712	0.783	0.832
2012	0.313	0.412	0.614
2015	3.426	4.219	6.137
2018	2.119	3.664	4.310
2021	1.201	1.410	1.748
2024	1.418	1.730	2.149

Source: ASDMA reports, 2000-2023

hydro-geomorphologic data and community perceptions, giving a picture of how severity of an incident influences mobility and land-use changes at the household level.

3.2 Socio-Economic Vulnerability of Riverine Communities

The riverine communities residing in the selected flood prone fringe villages have a varying socio-economic structure, which has a likewise impact on their exposure and adaptive capacity to recurring flood and erosion hazards. Factors which shape the differential vulnerabilities across villages include landholding size, primary occupation, household income sources, and caste/community composition.

Landholding and Livelihood Dependence:

In villages like Dhania, Jhaoni and Sishuhatia large number of households fall under the marginal landholding category (less than 1 hectare), that makes them vulnerable to loss induced due to flood and erosion. However, households in Forest villages and Taungiya village have a comparatively higher percentage of small to semi-medium holdings, which helps to improve resilience through diversified cropping systems and livestock-based income.

Occupational Structure and Income Diversity: The occupational pattern reflects a heavy dependence on agriculture and daily wage labor, with limited non-farm employment options. For instance, in Bogamukh no.4 and Bogamukh no.5, over 70% of households rely solely on agriculture, while Paschim Putaljhar shows a modest increase in wage-based and service-related income due to its relative proximity to administrative centers.

Caste and Community Composition: Several fringe villages (notably No.4 Bogamukh and No.5 Bogamukh) are inhabited by marginalized communities such as Bengali speaking Muslims who were brought during British period for plantation works. Other marginalized group also includes Nepali speaking Hindus who were traditionally grazers and these groups historically occupied erosion-prone lowlands and char areas, heightening their risk exposure. Additionally, caste-based differences often translate into unequal access to government schemes, land titles, and emergency relief.

These socio-economic factors intersect to shape adaptive potential. Households with multiple income sources, formal education, or secure land tenure tend to respond better to disruptions caused by flood and erosion. In contrast, marginalized communities residing in high-risk zones with limited state support remain trapped in cycles of vulnerability.

Various socio-economic dimensions of vulnerability; such as marginal landholding, caste-based disparity, and occupational dependence reciprocates with findings from Sharma et al. (2020) who analyzed LVI components in Assam. However, our work distinctly adds value by highlighting intra-village variations across 10 flood-prone belts where socio-demographic profiles with specific patterns of flood and erosion can be well correlated.

3.3 Adaptive Strategies against Flood and Erosion

To deal with the problems of flood and riverbank erosion, communities residing in the riverine and flood-prone villages of Assam have developed a range of adaptive strategies; both structural and non-structural. These responses in the form of adaptive strategies are influenced by traditional ecological knowledge passed down through the generations, socioeconomic capability, institutional support, and the frequency and severity of dangers.

Structural Measures

Structural adaptations refer to physical interventions adopted at the household or community level to minimize flood damage. One of the most common measures observed in the surveyed villages is the elevation of homestead plinths using earth and sandbags (Figure 4). These raised plinths serve to keep houses and livestock sheds above typical flood levels. Additionally, villagers in areas like Dhania and Sishuhati temporary bamboo bunds acting as rudimentary embankments to deflect water away from agricultural fields.

Fig 4. Photograph of raised homestead plinths houses in Dhania village (Source: Field work, August, 2024)

Non-Structural Strategies

Non-structural adaptations include behavioral and livelihood-based responses. A significant proportion of the households in Jhaoni and Sishuhati villages resort to seasonal migration to nearby villages during the flood season, seeking employment in unskilled labor or construction to offset agricultural losses. Many farmers also reported switching to short-duration or flood-resilient crop varieties, while others shifted entirely to livestock rearing or weaving to diversify income sources. These adjustments reflect an evolving understanding of flood risk and a need to maintain a minimum livelihood threshold. Moreover, there is increasing dependence on early warning information disseminated through mobile networks, radio, or local administration. Although still limited in rural stretches, such early alerts allow families to move valuables and livestock to safer grounds.

Community-Initiated Coping Mechanisms

Local solidarity networks play a critical role in coping with flood emergencies. Community members frequently share elevated storage spaces, organize collective embankment repairs, and pool labor and resources to protect vulnerable families. Women's self-help groups (SHGs) have also emerged as key agents in organizing post-flood relief and in disseminating adaptation knowledge—especially regarding government schemes such as PMAY (housing) and MGNREGA (employment). These community-led responses demonstrate an intrinsic resilience despite infrastructural and institutional gaps. Nevertheless, the effectiveness of adaptation varies significantly between villages depending on their hydro-geomorphologic setting, social capital, and economic assets. All these mechanisms adopted in the study area villages are illustrated in Table 4, Table 5 and Table 6.

What sets this study apart is how we carefully assessed the types of coping strategies used in each village, not just describing them but assigning values that reflect how widely each strategy is actually practiced. This approach helped us compare and understand how well different communities are prepared, offering a clearer picture that connects real experiences with measurable data—something earlier studies often missed.

3.4 Livelihood Resilience and Recovery Mechanisms

The river communities in Assam, often subjected to repeated flooding and riverbank erosion, demonstrate a complicated combination of weaknesses and strengths in terms of maintaining livelihoods and recovering after disasters. Insights from the chosen fringe villages indicate that although flood and erosion risks diminish material resources and disturb everyday activities, they have also influenced various tailored strategies that enhance resilience at both household and community levels

If we consider above mentioned factors, livelihood resilience varies among villages. It depends on various factors like the range of income sources, the robustness of local social networks, and the level of institutional assistance accessible to households.

This part examines how communities manage, adjust, and heal, with an emphasis on livelihood diversification, availability of programs, and perceived recovery duration; each of these factors enhances their overall resilience profile

3.4.1. Livelihood Diversification as a Resilience Strategy

Diversification into non-farm and off-farm livelihoods has emerged as a primary mechanism to reduce dependence on flood-prone agriculture. Households that engage in weaving (notably women), livestock rearing, fishing, petty trade, and daily wage labor tend to report higher resilience. In Laokhowa T.V., Borunguri T.V., and Salpara Forest villages, for example, a large portion of households depend on various such activities like weaving and handloom activities which are less susceptible to interruptions from flooding. Furthermore, during the monsoon period, migration to nearby towns or cities has become a part of seasonal coping mechanism. When agriculture becomes non-viable due to water logging or lands submergence such mobility ensures an alternative income source.

3.4.2. Role of Social Capital and Institutions

Social institutions and group networks; particularly Self-Help Groups (SHGs), youth clubs, and local committees; act as buffers during flood emergencies. In villages like Dhania, Sishuhati and Dhania, SHGs have helped mobilize resources, access government support schemes, and organize community-level recovery efforts.

Moreover, sharing resources between households, like lending food, fodder, or shelter, is common in tightly connected char communities. These unofficial methods frequently offset the absence of prompt formal support.

Table 4. Village-wise Adaptive Strategies to Flood and Erosion (Structural Strategies)

Strategy Type	Adaptive Strategy	Dhania	Sishuhati	Jhaoni	No.4 Bogamukh	No.5 Bogamukh	Laokhowa T.V	Borunguri T.V	Salpara F.V	Paschim Putaljhar	Sutirpar F.V
Structural	Plinth elevation, bamboo bunds	✓	✓	✓	✓			✓		✓	✓
	Sandbag protection, bamboo fencing	✓	✓	✓	✓	✓	✓			✓	✓
	Raised platforms for livestock	✓	✓	✓	X	X	✓	✓	✓		✓
	Elevated houses, makeshift flood shelters	✓	✓	✓			✓	✓			✓
	Earthen embankments (self-built)	✓	✓	✓	X	X	✓	✓		X	✓
	Stilt houses	✓	✓	✓	X	X	✓	✓	✓		✓
	Shelter prepared with easily movable items	✓	✓	✓				✓	✓	✓	✓

4 Conclusion

A thorough assessment of the socioeconomic vulnerability of riverine inhabitants on the outskirts of Laokhowa–Burhachapori Wildlife Sanctuary, Assam, as well as the dangers of erosion and flooding they are living with can be well traced from this study. It was found that few villages, such as Jhaoni, Dhania, and Sishuhati, faced land losses of more than 6 sq. km during 2000 and 2024, which has a significant effect on agriculture and other livelihood perspectives for the communities of this region. The spatial analysis shows that settlements vulnerable to erosion near active riverbanks experience greater effects, with yearly erosion rates between 5 and 15 meters. By combining years of flood and erosion data with what local communities have shared about their everyday struggles and coping methods, this study gives a grounded view of how differently villages experience and respond to hazards. This perspective generally lacks in mere description and interviews.

Socio-economic indicators reveal high vulnerability in marginal landholding communities; over 60% of households own less than 1 hectare of land; and a limited presence of alternative income sources. Adaptive responses, while widespread, show stark inequalities. More than 25 distinct strategies were identified, but adoption varies based on institutional access, caste, land

Table 5. Village-wise Adaptive Strategies to Flood and Erosion (Non-Structural Strategies)

Strategy Type	Adaptive Strategy	Dhania	Sishuhati	Jhaoni	No.4 Bogamukh	No.5 Bogamukh	Laokhowa T.V	Borunguri T.V	Salpara F.V	Paschim Putaljhar	Sutirpar F.V
Non-Structural	Sold out fruit laden trees before the erosion takes places	✓	✓	✓		✓	X	X	X	✓	X
	Early warning reliance	X	x	x					x	x	X
	Wage labor migration, livestock rearing	✓	✓	✓			✓	✓	✓	✓	✓
	Switching to handloom and weaving, govt. scheme usage						✓	✓	✓		✓
	Rain-fed kitchen gardens, shifting harvest periods	✓	✓	✓			✓	✓	✓	✓	✓
	Switching to poultry farming	✓	✓	✓			✓	✓	✓		✓
	Providing access to flood insurances and raising awareness about the same	X	X	x			✓	✓	✓		
	Early harvesting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Seasonal migration, short-duration crops	✓	✓	✓	X	x	✓	x	x	✓	x
	Pig farming adoption under govt. scheme	✓	✓	✓	X	x	✓	✓	✓	x	✓

Table 6. Village-wise Adaptive Strategies to Flood and Erosion (Community led Strategies)

Strategy Type	Adaptive Strategy	Dhania	Sishuhati	Jhaoni	No.4 Bogamukh	No.5 Bogamukh	Laokhowa T.V	Borunguri T.V	Salpara F.V	Paschim Putaljhar	Sutirpar F.V
Community led	Shared storage, SHG involvement	✓	✓	✓	✓				✓	✓	✓
	Collective embankment repair	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Mutual aid during displacement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Giving shelter in village owned open spaces like playgrounds etc	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Community awareness programs regarding floods	✓	✓			✓		✓	✓	✓	✓
	Local volunteer groups assist with evacuation, disaster recovery	✓	✓			✓	✓	✓	✓	✓	
	Approached government for the construction of E and D embankment	X	X	x	✓	✓	✓	✓	✓	x	x

Source: Field survey, 2024 Where, ✓=widely adopted, = partially adopted, x = not adopted Note: It refers to the number of villages adopting each strategy, not the number of households The values reflect how many villages have adopted each strategy. Where, ✓=widely adopted (1 point), = partially adopted (0.5 point), x = not adopted (0 point)

tenure, and proximity to markets. Villages closer to administrative centers, such as Paschim Putaljhar, demonstrate quicker recovery and greater resilience due to diversified livelihoods and better scheme access.

Unlike earlier studies that focus on broader vulnerability indices or flood frequency mapping[19],[20], this study contributes a micro-level, village-wise analysis integrating erosion data, socio-economic profiling, and local adaptation strategies. The inclusion of time-series erosion figures, combined with field narratives and community perceptions, provides a more grounded understanding of how vulnerability unfolds over time. It also sheds light on adaptive inequality, a less explored aspect in regional literature.

In doing so, the research emphasizes the importance of context-specific planning, particularly for high-risk villages where traditional coping mechanisms are increasingly inadequate. Strengthening community resilience will require integrating local strategies with formal support mechanisms and addressing structural inequities in land rights, scheme access, and risk communication. Future research could extend this model to other flood-prone sensitive zones, integrating real-time hazard data and participatory GIS tools to guide micro-level adaptation strategies. In doing so, the framework developed here can serve as a replicable template for livelihood resilience assessments in similar vulnerable landscapes.

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6 Contributory Statement

Inku Devi conducted the research and wrote the original manuscript. Dr. Ashok Kumar Bora critically revised the work, supervised the research process, and approved the final version for publication. Both authors have read and approved the final manuscript.

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