



Regular Article

Sustainable Livelihoods under Flood Stress of Displaced Households in the Brahmaputra Valley of Assam

Deeksha Hazarika¹, Mrinal Saikia^{2*}, and Nayanmoni Borgohain Baruah¹

Received: 12/03/2026 / Accepted: 27/05/2026 / Published online: 15/09/2026

Abstract Flood-induced displacement represents one of the most pressing challenges for vulnerable communities in developing countries, particularly in regions where livelihoods are closely tied to climate-sensitive agriculture. Assam, located in the Brahmaputra Valley, experiences recurrent high-magnitude floods that disrupt livelihoods, erode riverbanks, and force repeated displacement. This study applies the Sustainable Livelihood Framework (SLF) to examine the vulnerability of displaced households across five flood-prone districts—Morigaon, Dhemaji, Lakhimpur, Nalbari, and Barpeta. Using a mixed-methods approach, primary data were collected through household surveys and focus group discussions, complemented by secondary sources including government reports and scholarly literature. The SLF asset pentagon was operationalized through context-specific indicators covering human, social, natural, physical, and financial capital. Composite scores reveal significant inter-district variation in livelihood resilience. Nalbari recorded the highest composite score (2.06), reflecting relatively stronger access to social and physical capital, while Barpeta exhibited the lowest (1.417), marked by fragile human and financial capital. Across districts, households reported recurrent loss of cultivable land, crop damage, poor housing quality, and limited disaster preparedness training. Social capital, supported by kinship ties and relief aid, emerged as a partial buffer, though institutional support remained inadequate. The findings highlight that displacement is not merely a physical relocation but a multidimensional livelihood crisis, reinforcing cycles of vulnerability. By situating household experiences within the SLF, this study underscores the need for integrated resilience-building strategies that strengthen capital assets, reduce exposure, and enhance adaptive capacity in flood-prone regions of Assam.

Keywords: flood-induced displacement, Sustainable Livelihood Framework (SLF), asset pentagon, vulnerability assessment, Assam, climate resilience

¹ Department of Economics, Dibrugarh University, Dibrugarh, Assam, India

² Department of Economics, Cotton University, Guwahati, Assam, India

* Corresponding author email: mrinalsaikia872@gmail.com

1. INTRODUCTION

Natural disasters represent an escalating global challenge with profound consequences for societies, economies, and ecosystems. Their impacts on humanity have been catastrophic, undermining multiple dimensions of human security (Ndlovu & Maviza, 2026). In 2017 alone, an estimated 96 million people worldwide were affected by natural disasters, with floods accounting for more than 60% of those impacts. This reinforces the perception that floods are among the most destructive forms of disaster (Ahmad & Afzal, 2022; Akram et al., 2025). Rural communities in developing countries are disproportionately vulnerable to flood events. Their dependence on climate-sensitive agriculture, coupled with limited access to resources, weak institutional support, and inadequate infrastructure, exacerbates their exposure and vulnerability (Huong et al., 2019; Afzal et al., 2026).

Floods also accelerate riverbank erosion in the GBM Delta, a lower basin alluvial region where homes, properties, and livelihoods are repeatedly threatened (Rahman et al., 2022). Each year, thousands of households lose their homes due to devastating floods and erosion (Akter et al., 2026). Since 2008, more than 195 million people worldwide have been displaced by floods, more than by any other type of disaster, and exceeding displacement caused by conflicts and violence (Internal Displacement Monitoring Centre (IDMC), 2024). Disaster displacement refers to situations in which individuals are “*forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of [...] natural or human-made disasters*” (UN OCHA, 2004; Mester et al., 2025). While displacement often prevents fatalities, it disrupts livelihoods, undermines well-being, and imposes high costs on communities and nations (Desai et al., 2021).

Displacement risk is shaped by three interrelated factors: the physical properties of flooding (hazard), the exposure of people, assets, and livelihoods to flood events, and vulnerability, defined as susceptibility and lack of resilience (Cardona et al., 2012; Change, 2015; Kaiser, 2023). Flood hazards have evolved over the past five decades (Berghuijs et al., 2017; Blöschl et al., 2019; Fowler et al., 2021; Gudmundsson et al., 2021), and rare, large-scale events are projected to increase under continued climate change (Hirabayashi et al., 2013; Lange et al., 2020). Currently, more than 20% of the global population is exposed to high flood risk (Rentschler et al., 2022). Displacement rates tend to be lower in countries with a gross national income above \$13,000 (2020 international \$) per capita, whereas both low and high displacement rates are observed across lower-income countries (Kakinuma et al., 2020). India ranks sixth among the other ten countries in the world on the Global Climate Risk Index 2025 (Adil et al., 2025) and has been affected by extreme weather events from 1998 to 2022. India experiences a large number of displacements every year, and one of the most prominent causes is environmentally induced displacement, such as floods, droughts, landslides, and riverbank erosion. India experiences significant population displacement in the Ganges, Brahmaputra, and Yamuna river basins in the North and Northeast, as well as along its east coast, where towns are vulnerable to tropical cyclones from the Bay of Bengal. The Global Report on Internal Displacement Monitoring (GRID) 2025 by Internal Displacement Monitoring Cell

revealed that India experienced the highest displacement count in 2024 among other countries in South Asia, with 5.4 million movements, nearly two-thirds attributable to flooding.

Riverbank erosion, a hazard occurring year-round but intensifying during monsoon and post-monsoon seasons, further compounds vulnerability (Saikia & Mahanta, 2024a; Akter et al., 2026). A DFID study revealed that river degradation is among the most damaging disasters, affecting approximately 1 million people annually and submerging 9,000 hectares of land (Deely et al., 2010). Many affected individuals remain homeless for extended periods, with only a fraction able to secure new shelters (MSWRR, 2018).

The Sustainable Livelihood Framework (SLF), developed by the UK Department for International Development, provides a valuable lens for understanding how households sustain and improve their livelihoods under stress (Afzal et al., 2026). It emphasizes five forms of capital, human, social, natural, physical, and financial, that collectively shape households' adaptive capacity (Morse & McNamara, 2013). By illustrating how these assets interact to reduce vulnerability to disasters and climate variability, the SLF highlights pathways for resilience. For instance, the ability of vulnerable communities to cope with or adapt to natural disasters is strongly influenced by their access to these capital assets (Hahn et al., 2009; Prayitno et al., 2025).

Floods are amongst the most prevalent and devastating natural disasters in Assam, particularly during the monsoon season from June to September (Sachdeva & Kumar, 2022). The Brahmaputra and Barak river systems, along with their myriad tributaries, continue to be the primary conduits of these floods, often becoming turbulent due to continuous and intense rainfall (Mahanta & Das, 2017; Chetia & Paul, 2024). According to the report of the Assam State Disaster Management Authority (ASDMA) (2022a), about 3.9 million people in Assam are affected by massive floods, and Assam is ranked 2nd in the flood risk index. ASDMA (2017) identified that out of 34 districts of Assam in 2016, 17 of them were the worst flood-affected. During peak monsoon periods, the majority of surface runoff is funnelled into rivers and tributaries, carrying large volumes of water and sediment, resulting in high stage-discharge levels across Assam's rivers (Bhuyan et al., 2023; Das & Das, 2022). These floods are projected to cause widespread destruction, including damage to homes, roads, and other infrastructure, the destruction of crops, erosion, and the breaching of embankments, leading to severe disruptions in daily life (Dikshit & Dikshit, 2014). Recurring floods in Assam have led to four different forms of internal displacement- Temporary displacement resulting from water logging or the partial or complete destruction of home, voluntary or forced displacement resulting from the implementation of flood control measures, permanent displacement as result of erosion and outmigration of one or more household members, often leaving women, children and the elderly behind in the place of origin (Krishnan, 2022). Floods in Assam affected almost 55 lakh people, leading to immediate displacement and homelessness in 2022 itself (Juned, 2022). People in Assam are frequently displaced many times a year and several more times throughout the course of their lives (Gogoi & Siddique, 2023). Villages frequently disappear overnight as a result of riverbank erosion. Thousands of people have been displaced by the state's frequent riverbank erosion, and the number is still rising. Landlessness is the most difficult situation for

the marginalized people who depend on agriculture, even when all the hazards associated with displacement are annoying (Gogoi & Siddique, 2023).

With the growing concern of the impacts of disasters on the livelihoods of the people, it is important to make sure that the livelihoods of the vulnerable population is sustainable. Sustainable livelihoods are those that can withstand shocks and stressors from the outside world, do not rely on external assistance, preserve the long-term productivity of natural resources, and don't negatively impact the livelihoods of others or jeopardize their ability to make a living (DFID, 1999). The Sustainable Livelihood Framework has been used by many nations to assess livelihood vulnerability and climate vulnerability in their respective flood-prone areas. But there have been very limited studies at the national, state, and regional level framing the asset pentagon to understand the livelihood structure, and very few have specifically applied this approach to understand the livelihood conditions of displaced households. However, this study attempts to understand the way displaced households deal with the shocks and stresses of the catastrophe and identifies the reasons for displacement. The study employs the Sustainable Livelihood Framework (SLF) - The Asset Pentagon to analyze and understand the livelihoods of vulnerable (displaced) populations, focusing on their assets, strategies, and the broader context that shapes their ability to cope with shocks and stresses.

The Sustainable Livelihood Framework (SLF)

Robert Chambers played a pivotal role in shaping the Sustainable Livelihoods (SL) discourse. Alongside Gordon Conway, he co-authored *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century* (Chambers & Conway, 1992), which provided the first comprehensive definition of livelihoods. They argued that a livelihood is sustainable if it can withstand shocks, preserve or enhance assets, provide opportunities for future generations, and contribute positively to other livelihoods locally and globally. This built upon earlier references in the Brundtland Report (United Nations, 1987) and the UNDP Human Development Report (1990), both of which used the term "sustainable livelihood" without defining it (Solesbury, 2005).

Ian Scoones (1998) advanced the concept by reframing Sustainable Livelihoods from an approach (SLA) to a framework (SLF). He emphasized sustainability as linked to vulnerability, noting that those unable to adapt (long-term changes) or cope (short-term adjustments) face inevitable livelihood insecurity. DFID subsequently simplified Scoones' framework into a practical technique (Carney, 1999). Kollmair et al. (2002) further clarified that sustainable livelihoods must ensure long-term natural resource use, resilience to shocks, independence from external aid, and non-jeopardization of others' livelihoods. Central to this is the *vulnerability context*—shocks, seasonality, and trends that affect assets and strategies, often beyond people's control (DFID, 1999). Shocks such as floods or conflicts can directly erode assets or force coping strategies like migration or asset liquidation.

More recently, Natarajan et al. (2022) reformulated the SLF for the 21st century. They critiqued the original framework's tendency to depoliticize vulnerability by isolating causes and overlooking structural conditions. Their reformulation introduced the concept of a *livelihood context*, embedding livelihoods within broader socioeconomic, political, and

environmental structures. They highlighted transforming structures and processes as cross-cutting elements necessary to understand vulnerability and structural change. The traditional asset pentagon was reconceptualised as permeable and dynamic, symbolizing assets and relations that evolve. Importantly, they argued that livelihoods cannot be reduced to capital alone; instead, capital must be understood as reproduced and reshaped through human agency within wider contexts.

2. MATERIALS AND METHODS

2.1 Floods in Brahmaputra Valley in Assam: A Background

The Brahmaputra Valley in Assam experiences recurrent high-magnitude floods due to the extensive and dynamic geophysical and hydrological characteristics of the Brahmaputra river system. Millions of people depend on the river and its tributaries for livelihoods, with over 3 million—about 10% of the state’s population—residing on fertile but highly vulnerable riverine islands (chars). Approximately 40% of Assam’s land is flood-prone, and the increasing frequency and severity of floods have forced repeated and prolonged displacement (Internal Displacement Monitoring Centre, 2025). Assam ranks highest among Indian states on the Climate Vulnerability Index, with a score of 0.616 (Mohanty et al., 2021). More than 20 districts are severely flood-prone (Mohanty et al., 2021). Since the 1950 earthquake, floods have become a recurrent disaster, with 31.05 lakh hectares—39.58% of the state’s area—susceptible, four times the national average (Water Resources Department, Government of Assam). Flood-induced displacement has been significant in the past 15 years, notably in 2012 and 2022. In 2024, Assam witnessed its worst floods in over a decade, displacing 2.5 million people. This accounted for nearly half of India’s 5.4 million disaster displacements that year, the highest in 12 years (Internal Displacement Monitoring Centre, 2025).

2.2 Data Sources

Both primary and secondary data have been used in this study to achieve its objectives. Secondary data is sourced from yearly government reports on floods, including the Flood Hazard Atlas, the Assam Disaster Management Plan, and the Assam Flood Memorandum Report. Along with the reports, we have also gathered information from several scholarly articles on the topic from sources including EPW, JSTOR, Springer Nature, Google Scholar, Shodhganga, and others. However, for the primary data, both quantitative and qualitative information have been gathered through household surveys using a structured questionnaire. Focus group discussions with the village headman are arranged to gain a deeper understanding of the issues and verify the information provided by the households. The data collection process began in January 2024, and it concluded in the middle weeks of May 2024. The respondent to the household level questionnaire is the head of the household of the displaced family, and if the head is not present, the oldest person on hand at the time of the survey is interviewed. The reference year for gathering data is 2023.

2.3 Study Area and Sampling Design

The selection of districts for this study was guided by the *Assam Disaster Management Plan* (2014) and the *Flood Hazard Atlas* (2016). The 2014 Plan, prepared by the Assam State Disaster Management Authority (ASDMA, 2014), served as the primary source. In 2022, ASDMA published two revised volumes (ASDMA, 2022a; 2022b), which, unlike the comprehensive data provided in 2015, offered only limited information on the proportion of flood hazard areas and the extent of flood damage across districts. To ensure the continued relevance and validity of the chosen districts, the *Assam Flood Memorandum Reports* (2023, 2024) were also consulted, which confirmed the persistent vulnerability of these regions.

The district-level flood hazard profile is presented in the Disaster Management Plan, which employs the Flood Hazard Index (FHI) formula: $\sum \text{Hazard Category (H)} \times \text{Hazard Area (A)}$. A higher FHI score indicates greater flood risk, frequent inundation, and wider spatial impact. Districts with 40–80% flood-affected regions were prioritized, with selection further validated by FHI scores. Within the 40–50% category, five districts were identified; Dhemaji and Nalbari were chosen due to their relatively higher affected area (47%) and elevated FHI scores. Lakhimpur, with 53% flood-sensitive area and an FHI score of 22, represents the 50–60% range. Barpeta, with 69% affected area and an FHI score of 20, represents the 60–70% range. In the 70–80% category, Morigaon (72% affected, FHI 22) was selected over Darrang due to its higher index score.

Thus, the study incorporates Morigaon (Central Assam), Dhemaji and Lakhimpur (Upper Assam), and Nalbari and Barpeta (Lower Assam). This selection ensures a representative spatial profile of flood susceptibility across the Brahmaputra Valley, reflecting the regional variance in flood vulnerability and enabling a comprehensive analysis of flood risk patterns. The location of the study area is depicted in Figure 1.

The study adopted a multistage sampling technique to capture household-level experiences of flood displacement. Based on the *Flood Reporting and Information Management System (FRIMS) Cumulative Report 2023*, provided by the District Project Officer of the respective District Disaster Management Authority (DDMA), the two most severely flood-affected revenue circles were identified in each district. From these circles, 5% of flood-affected villages were selected, as such areas typically exhibit a higher concentration of displaced households due to recurrent and severe flooding.

Within each selected village, 15% of flood-displaced households were randomly chosen, yielding a total sample of 141 households. The distribution comprised 59 households from Morigaon, 27 from Dhemaji, 22 from Lakhimpur, 16 from Nalbari, and 17 from Barpeta. This stratified approach ensured proportional representation across districts with varying degrees of flood vulnerability.

The study further observed intra-village displacement as a dominant pattern. Most households relocate to relatively elevated areas within the same village, which, while temporarily safer, remain exposed to subsequent floods. Due to marginalized socio-economic conditions and the loss of limited assets, relocation to safer, entirely new locations is financially

unfeasible. Consequently, households experience repeated, localized displacement, reinforcing cycles of vulnerability and precarious living conditions. Figure 2 presents the sampling design of the study.

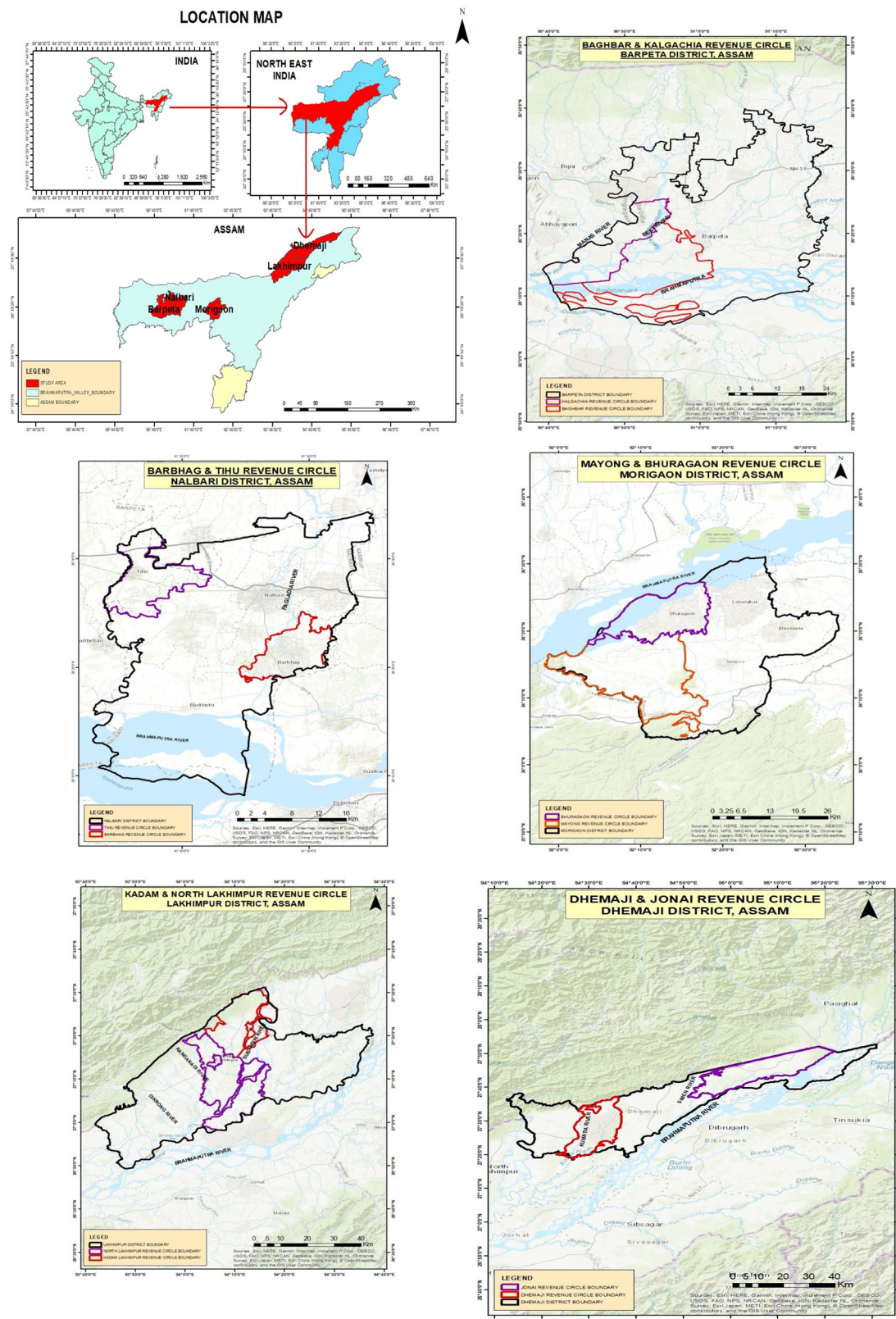


Figure 1. Location maps of the study area
Source: Authors' creation using GIS

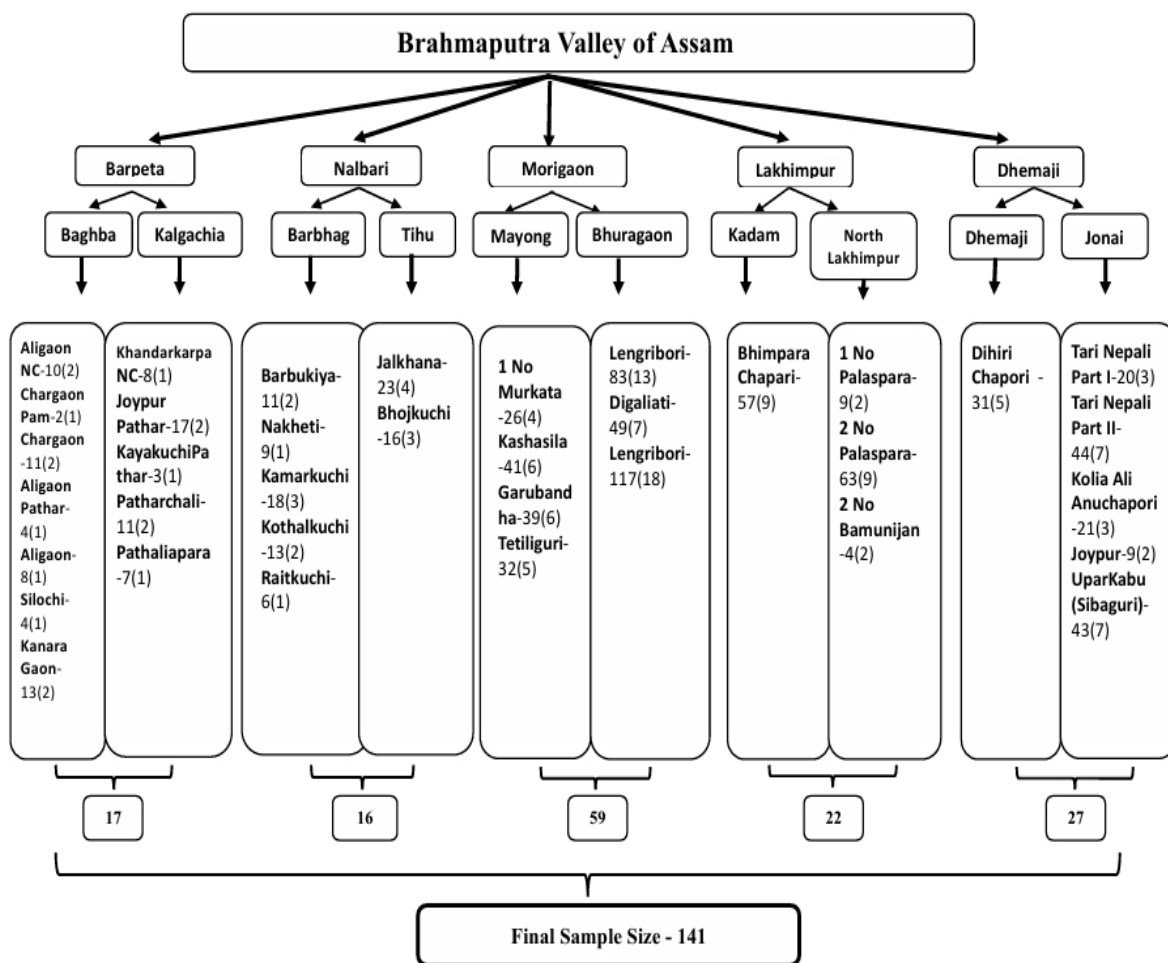


Figure 2. Sampling design of the study area
Source: Author's own compilation

2.4 Methodology

This study utilizes the Sustainable Livelihood Framework (SLF) in the vulnerability context to explain the shocks and stresses faced by the people, and the asset pentagon tries to explain the problems and situations faced by people in the study areas by examining their access to livelihood assets from the time of flooding till the people are displaced. The asset pentagon reflects the loss or reduction in access to assets that significantly impact people's ability to sustain their livelihoods and identifies which specific access to capital shortfalls among the access to capital that compels people to adopt alternative strategies, including displacement to cope with the resulting vulnerabilities.

2.4.1 Framing Sustainable Livelihood Framework – The Asset Pentagon

The livelihoods framework's central component, "within" the vulnerability context, is the asset pentagon. The pentagon (Figure 3) was created to make it possible to visually demonstrate information about people's assets, highlighting the significant relationship between the different assets.

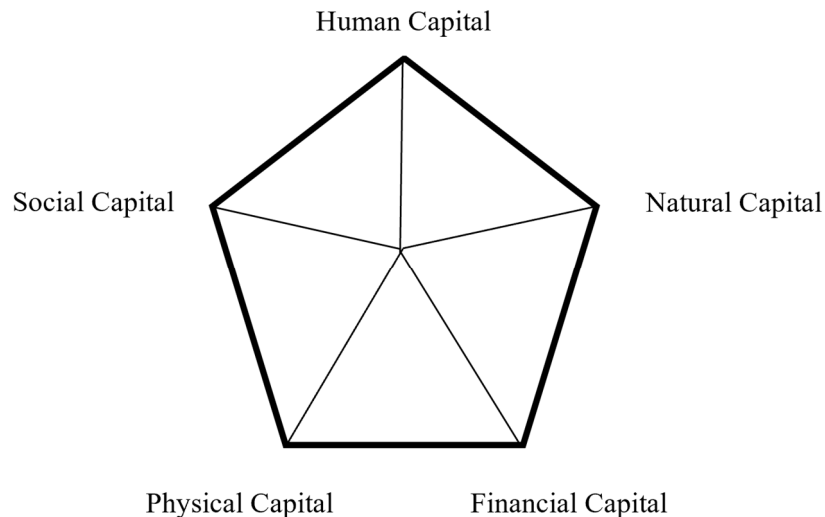


Figure 3. Asset pentagon of SLF

Source: Sustainable Livelihood Guidance Sheets, Department for International Development (DFID)

The Pentagon grid can be used as a schematic demonstration of variations that exist regarding capital access (DFID, 1999). According to the concept, the pentagon's outer perimeter denotes greater access to assets, while the centre, where the lines converge, indicates zero access (DFID, 1999). DFID (1999) used the following definitions to describe all the capitals.

- i. **Human Capital** – The ability, experience, work skills, and health circumstances that enable populations to use various techniques and achieve their own livelihood goals are referred to here.
- ii. **Social Capital** – It refers to the social resources that people use to accomplish certain goals related to their livelihoods. These could include membership in more organized groups and developing relationships of trust, reciprocity, and exchanges that promote collaboration, as well as networks and connections that boost people's trust and capacity to collaborate and extend their access to wider institutions.
- iii. **Natural Capital** – This refers to the natural resource stocks that people can draw on for their livelihood, such as land, forests, waters, air, etc. Natural Capital and the Vulnerability context have a particularly strong interaction within the scope of sustainable livelihoods. Several natural calamities that ruin the livelihoods of the impoverished are also processes that damage natural capital, such as floods and earthquakes that destroy the agricultural and homestead land, and fires that burn forests.
- iv. **Physical Capital** – This refers to the basic production and factor inputs needed to support the livelihoods. The essential components of infrastructure for sustainable livelihood are affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean and affordable energy and access to information.
- v. **Financial Capital** – It refers to the financial resources that communities use to achieve their goals regarding livelihoods.

A universally accepted or standardized approach for assigning indicator scores to the components of the Sustainable Livelihood Framework (SLF) does not exist (DFID, 1999). The SLF is purposefully adaptable to fit a variety of materials, goals, and data availability. It was developed by institutions such as the UK's Department for International Development (DFID) and modified by others such as the United Nations Development Programme (UNDP), Cooperative for Assistance and Relief Everywhere (CARE). The framework offers guiding concepts and encourages practitioners to create indicators and scoring systems that are specific to their particular study or project, rather than establishing scoring standards (DFID, 1999). The framework incorporates five major capitals to construct livelihoods: human, social, physical, financial, and natural capital. Each of these capitals is operationalized through context-specific indicators, chosen based on the objectives of this study and the availability of data. The context-specific indicators are presented in Table 1.

Table 1. List of Indicators used for each capital

Access to Capital	Indicators	Source
Human Capital	No Prevalence of illness during or post-flood	Primary
	Access to knowledge and training on flood awareness given by DDMA	UNDP Discussion Paper, 2017b
Social Capital	Presence of Sources of Warning of Flood	Primary
	Effectiveness of Flood Warning	Primary
	Access to Social or Community Asset	UNDP Discussion Paper, 2017b
	Access to Relief Aid	Primary
	The organization provided help	UNDP Discussion Paper, 2017b
	Proper Implementation of DDMP	Primary
Natural Capital	No Homestead land lost during the flood	Primary
	No Homestead and Cultivable land was lost together during the flood	Primary
	No Crop Damage	Primary
	No Land use Proximity to river	Primary
	No livestock proximity to the river	Primary
Physical Asset	No Kutcha House type	Primary
	No Physical Asset lost	Primary
	Adequate Water Supply	UNDP Discussion Paper, 2017b
	Access to Sanitation Facility	UNDP Discussion Paper, 2017b
	Access to Electricity	UNDP Discussion Paper, 2017b
	Access to LPG as a cooking source	UNDP Discussion Paper, 2017b
	Access to Transportation for Evacuation provided by institutional and non-institutional sources	UNDP Discussion Paper, 2017b
Financial Capital	Unchanged household income after the flood	Primary
	Engagement in non-flood-sensitive occupations	Primary
	No loss of livestock assets during or after the flood	Primary
	Access to Financial Resources	UNDP Discussion Paper, 2017b
	Confidence in Savings to deal with Flood Damage	Primary

Source: Author's own compilation based on the data collected for the study

Structured questionnaires are used to gather primary data, which are then methodically coded and combined into percentage distributions for each indicator. For this study, we have followed the indicator-based scoring system of DFID Sustainable Livelihoods Guidance Sheets (1999), and additionally, this scoring system is also referenced in the UNDP's (2017a) Guidance Note on the Application of the Sustainable Livelihoods Framework in Development Projects. Indicators' scores are assigned using a three-point scale based on percentage thresholds ($>70\%$ =3, $40\%-70\%$ =2, and $<40\%$ =1), thereby standardizing heterogeneous variables into a comparable metric. A composite indicator score was calculated by averaging values for indicators that included several response types. Each livelihood asset's capital score was then calculated by taking the arithmetic mean of its corresponding indicator scores. Using the SLF, UNDP conducted a desk analysis of environmental and climate change projects in 2015 (UNDP, 2017a). The capital scores are ranked using a rating system ranging from 1 to 3, where 1 depicts low, 2 and 3 denote medium and high, respectively. Therefore, the present study adopts this ranking system to classify and interpret the final computed capital scores for each livelihood asset of the displaced households in the study areas.

In scoring systems, the choice of threshold values is fundamentally context specific. The Department for International Development (DFID) Sustainable Livelihoods Guidance Sheets (1999), which support the use of straightforward, comprehensible scoring systems for evaluating livelihood assets, served as the basis for the indicator-based scoring approach used in this study. The United Nations Development Programme (UNDP, 2017a) Guidance Note on the Application of the Sustainable Livelihood Framework, which suggests using categorized or threshold-based scoring to improve policy relevance and enable comparison across various indicators, further supports this strategy. With a focus on clarity, comparability, and practical applicability, the thresholds used in this study are therefore based on accepted methodological methods within livelihood analysis rather than being arbitrary. The specific thresholds of 70% and 40% were not selected arbitrarily but reflect two substantive considerations grounded in the data, such as livelihood indicators. First, these cut-points correspond to recognized proportional benchmarks in welfare and vulnerability research: a majority threshold (above 70%) signals that a condition is sufficiently widespread to characterise the population as having meaningful access to that capital, while a minority threshold (below 40%) denotes that access is so limited as to constitute a structural deficit. The intermediate band (40–70%) captures heterogeneous or transitional states. Second, inspection of the indicator distributions in this dataset reveals that these thresholds produce meaningful discrimination: the great majority of indicators cluster within the 1–2 range, with very few crossing into the highest score of 3, which is consistent with the documented deprivation of flood-displaced households in the Brahmaputra Valley. Had a narrower band (e.g., 60/30) been applied, the scoring distributions would have been artificially compressed toward the upper end and would have overstated capital access in districts where conditions are materially poor. Had a wider band been used, near-identical scores across districts would have obscured the variation the SLF analysis seeks to illuminate. The 70/40 thresholds reflect a deliberate calibration to the empirical range of this dataset, consistent with the SLF's intent to capture relative differences in capital access across comparable units. It is acknowledged that the absence of a formal sensitivity analysis remains

a limitation, and future studies using similar designs would benefit from testing alternative threshold values to verify the stability of district-level rankings.

Theoretically, considering the nature of the underlying indicators used for each capital in this study, the adoption of ordinal scaling is appropriate. Cardinal precision is intrinsically limited for qualitative and semi-quantitative traits, which characterize several of the variables operationalized within the Sustainable Livelihood Framework. The conversion to a three-point scale prevents over-interpretation of small variations in raw percentages, thereby reducing sensitivity to measurement imprecision inherent in household survey data. It is further acknowledged that a formal sensitivity analysis of threshold effects was not conducted; however, the robustness of the scale lies in its structural insensitivity to marginal boundary shifts — a change at the threshold boundary applies uniformly across all districts and all capitals, meaning the comparative patterns of capital configuration across districts remain stable. The ordinal nature of the scale also means that decimal composite scores, while arithmetically derived from indicator averages, should be interpreted as reflecting overall capital configurations rather than cardinal precision. This limitation is further acknowledged in the study's conclusions

2.4.2. Statistical Testing

To statistically assess whether composite SLF scores differ significantly across districts, a one-way ANOVA was performed. Since district-level analysis yields only five composite scores, one per district, which is insufficient for a robust statistical test, block-level composite SLF scores were additionally computed for this purpose. As two revenue circles were identified and surveyed within each of the five study districts, this yielded ten block-level composite SLF values (two per district), which served as the unit of analysis for the ANOVA. It is important to note that this block-level computation was undertaken solely to enable statistical testing; all other assessments in this study, including the pentagon figures, capital score comparisons, and discussion, are based on district-level composite scores.

The null hypothesis (H_0) assumed no significant difference in mean composite SLF scores across districts; the alternative hypothesis (H_1) posited a significant difference in at least one pair of districts. The results presented in Table 2 yield an F-value of 5.498 ($p = 0.045$), leading to rejection of the null hypothesis at the 5% significance level. This confirms that the districts differ significantly in their composite SLF scores, providing statistical support for the comparative findings presented in this study. Given the small number of observations, post-hoc pairwise comparisons were not conducted; district-level differences are instead interpreted through the capital configuration patterns and qualitative evidence presented in the Results and Discussion sections.

Table 2. Result of One-Way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.404	4	.101	5.498	.045
Within Groups	.092	5	.018		
Total	.496	9			

Source: Author's own finding

3. RESULTS

The Sustainable Livelihood Framework (SLF) was applied to assess the vulnerability of displaced households across five flood-prone districts of Assam. Table 3 presents the composite scores of livelihood capitals, while Figure 4 illustrates the pentagon assets for each district. These visual and numerical outputs provide a comparative picture of household access to human, social, natural, physical, and financial capital during flooding and displacement.

Table 3. Scores of access to capital of SLF- Pentagon Asset

Districts	Human Capital	Social Capital	Natural Capital	Physical Capital	Financial Capital	Composite SLF Score
Barpeta	1	2	1.6	1.285	1.2	1.417
Dhemaji	1.5	1.83	1.6	1.142	1.4	1.4944
Lakhimpur	1.5	1.66	1.8	1.285	1.2	1.489
Morigaon	1.5	1.5	1.6	1.571	1.4	1.5142
Nalbari	2	2.5	1.8	2	2	2.06

Source: Author's own calculation

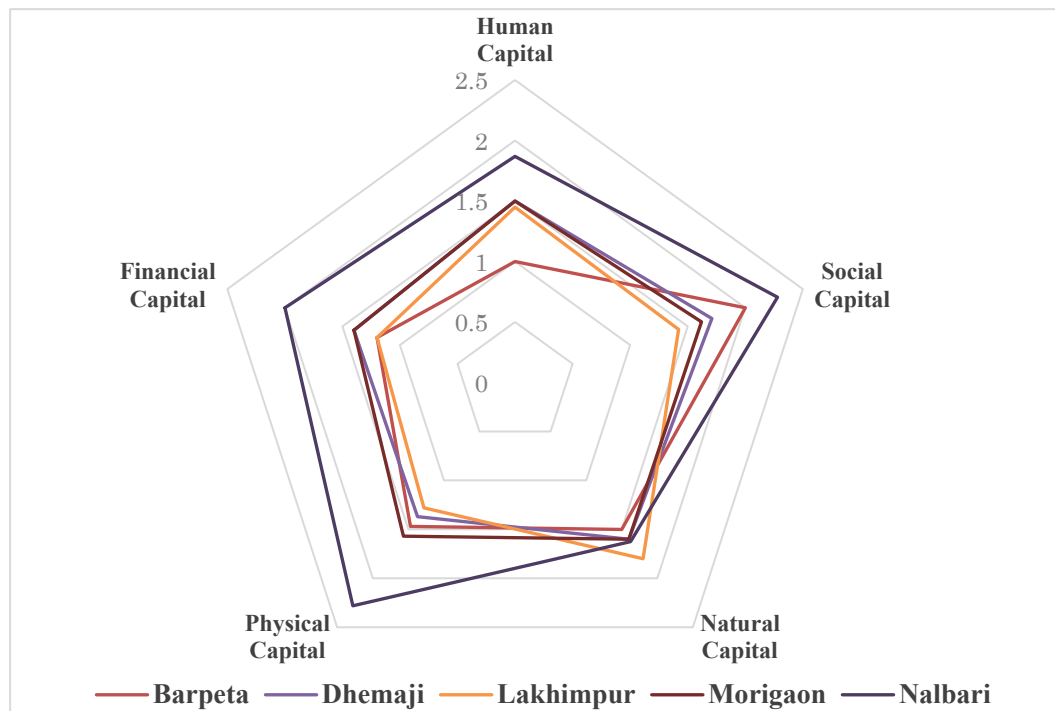


Figure 4. SLF asset pentagon of the study area

Source: Authors' creation

Barpeta recorded the lowest composite SLF score, reflecting the weakest livelihood base among the districts studied. Human capital was particularly fragile, with households lacking flood preparedness knowledge and training. Subsistence agriculture dominated household occupations, and a large proportion of families lost both homestead and cultivable land. Financial capital was also weak, constrained by unstable land tenure and limited access to credit. Social capital, however, scored relatively higher, supported by kinship ties and relief aid. Physical capital showed poor access to sanitation and electricity, though drinking water and LPG availability were moderately better.

Lakhimpur, with a composite score of 1.489, displayed a distinct pattern of vulnerability across its capital assets. Financial capital was the weakest dimension, with households reporting significant livestock losses and very limited access to financial services and credit, leaving them highly exposed to income shocks during and after flooding. Human capital was similarly constrained, as households largely lacked training in flood awareness and disaster preparedness. Agriculture remained the dominant livelihood, supplemented by livestock and poultry, but widespread crop damage severely disrupted household income and food security. Physical capital was also poor, with kutcha housing offering minimal resilience to flood impacts, though transportation access for evacuation was relatively moderate compared to other districts. Natural capital was moderately exposed — while some households retained portions of their land, crop damage was extensive and recurrent. Social capital, though the second lowest among all districts, showed relative strength within Lakhimpur's own capital profile, with households reporting access to community networks and reliable flood warning sources that provided some preparation time and helped minimize livelihood disruptions.

Dhemaji scored 1.49 overall. Human capital was weak, with households reporting poor health conditions and limited evacuation training. Agriculture was the dominant occupation, heavily disrupted by floods. Social ties were present, though households reported inadequate implementation of disaster management plans. Physical capital was poor, with limited amenities such as sanitation, electricity, and safe drinking water. Financial capital was weak, though livestock ownership and minimal livestock losses contributed positively. Most households lost both homestead and cultivable land, with complete crop damage reported. Natural capital was highly exposed to recurrent floods and erosion, making livelihoods precarious.

Morigaon, with a composite score of 1.51, showed financial capital as the weakest dimension. Households reported minimal access to financial resources, poor financial literacy, and significant livestock losses. Human capital was weak, with poor health and limited disaster training. Agriculture was the primary livelihood, with extensive crop damage. Social and natural capitals scored equally, reflecting ineffective flood warnings, poor disaster management, and widespread land losses. Despite these vulnerabilities, some households retained livestock assets and financial resources, contributing to moderate resilience.

Nalbari stood out with the highest composite score (2.06). Livelihoods were more diversified, with households engaged in business, wage labour, and cultivation. Household amenities and health facilities were comparatively better, reducing illness during and after floods. Social capital was strengthened by effective flood warnings and relief aid. Financial capital was stronger, with households confident in mitigating flood damage. Income levels remained relatively stable after flooding, and crop damage was minimal. Livestock sheds were not located near rivers, reducing exposure. Organizational support reduced evacuation stress, positioning households in Nalbari more favourably than those in other districts.

4. DISCUSSION

The application of the Sustainable Livelihood Framework (SLF) to displaced households in Assam demonstrates that livelihood sustainability is shaped not only by exposure to flooding but by the balance and interaction of livelihood capitals. The asset pentagon serves as a diagnostic lens, revealing how displacement emerges when certain capitals collapse under stress. This approach shifts the emphasis from hazard-centric explanations to asset-based interpretations, underscoring that resilience is built through the simultaneous reinforcement of multiple capitals.

Across the districts studied, significant contrasts emerge in the configuration of livelihood assets. In areas such as Barpeta, Dhemaji, and Morigaon, the pentagons are visibly skewed, reflecting fragile human capital, weak financial resources, and inadequate physical infrastructure. Barpeta's lowest composite score illustrates the consequences of limited preparedness training, unstable land tenure, and restricted access to credit, which collectively undermined household capacity to sustain livelihoods. Subsistence agriculture, the dominant occupation, left families highly exposed to shocks, and the loss of homestead and cultivable land further eroded natural capital. *"Because floods and erosion compel us to relocate annually, we have not been lucky enough to experience the benefits of electrification, access to good restrooms, or LPG as a primary cooking source. As a result, investing in such permanent amenities is futile."* — Male 39, Kayakuchi Pathar Gaon, Kalgachia revenue circle, Barpeta.

The majority of Char dwellers in the Barpeta district are immigrants who continue to lack access to basic domestic facilities. They rarely ask for government assistance because they are used to the minimal facilities. Open defecation is prevalent in interior settlements, and focus group conversations show that the upkeep of utilities is not given priority since the yearly displacement caused by riverbank erosion makes such investment expensive and unsustainable. Although kinship ties and relief aid contributed to social capital, the imbalance across the Pentagon meant that households lacked the adaptive capacity to remain in place, making displacement the primary coping strategy (Chandel & Kumar, 2026; Islam et al., 2025).

A similar pattern is evident in Dhemaji, where poor health and inadequate amenities weakened human capital, while recurrent erosion and crop losses destabilized natural capital. Agriculture's dominance increased displacement risks (Saikia & Mahanta, 2023), as households lacked diversification to buffer against shocks. *"We have not visited institutional hospitals in nearly ten years due to challenging access to the district headquarters. The mighty Brahmaputra is the edge of our world but to others it is a river of grandeur. The only way to get to the other side, which is frequently unreachable, is by ferry. Last year, I lost my grandchild due to the lack of access to appropriate medical care. We are born here, live here and die here."* — Female, 54 years, Koila Ali Anuchapori Gaon, Jonai Revenue Circle, Dhemaji.

This illustrates the failure of institutional healthcare to reach interior communities, leaving households without medical support precisely when flood-related health conditions deteriorate. During floods, the majority of households reported difficulty obtaining treatment for family

members. Flood-related health concerns have increased due to a lack of basic amenities, such as inadequate water supplies, poor sanitation facilities, lack of electrification, and restricted access to clean fuel. Financial capital was fragile, though livestock ownership provided limited protection. The pentagon here reveals how weaknesses in human and physical capital cascade into other dimensions, leaving households unable to sustain livelihoods. This case underscores the need for integrated interventions that strengthen health infrastructure, improve amenities, and diversify livelihoods to rebalance the pentagon (World Health Organization, 2023).

Morigaon further highlights the centrality of financial capital in sustaining livelihoods. Households deprived of savings, financial literacy, and livestock assets were unable to recover effectively, making displacement inevitable. The simultaneous loss of homestead and cultivable land created extreme vulnerability, depriving households of both income and residence. *"For the seventh consecutive time, we have been displaced. We won't be living here next. Our lives have been taken by floods, and we are currently counting down the seconds before we pass away."* — Male, 63 years, Lengeribori Gaon, Bhuragaon Revenue Circle, Morigaon.

This account reflects the chronic and compounding nature of displacement in Morigaon, where repeated flooding leaves households with no viable path to stable resettlement. Numerous displaced households have constructed shelters that remain susceptible to subsequent flooding, with the majority located on embankment fringes or unnamed land with no legal tenure. Some households that resettled on government-approved land have been served eviction notices, leaving them caught between flood risk and institutional displacement. The breakdown in communication between government agencies and affected households has created space for middlemen to exploit the situation, with landless and poorly informed families frequently losing what little they retained to fraudulent transactions. These conditions directly explain Morigaon's weak financial and physical capital scores — the simultaneous loss of homestead land, cultivable land, and income-generating assets strips households of any base from which to recover, making repeated displacement the only available response. This dual loss signifies a tipping point in livelihood insecurity, where displacement becomes the only viable option (Mallik, 2019; Saikia & Mahanta, 2024b). The Pentagon demonstrates how financial capital interacts with natural and physical capital, showing that weaknesses in one dimension magnify losses in others (Habib et al., 2023). Strengthening financial inclusion and literacy is therefore essential to enhance resilience within the SLF framework (National Strategy for Financial Inclusion, 2019).

Field evidence from the study districts visually corroborates the capital deficiencies identified through the SLF scoring. Figure 5 presents four field photographs documenting the lived realities of displaced households across the Brahmaputra Valley. The ferry-dependent access in Dhemaji (Figure 5(a)) illustrates the physical and institutional isolation that drives human capital deterioration, particularly in healthcare access. The flood-inundated kutchra interior in Barpeta (Figure 5(b)) captures the near-total collapse of physical capital, where fragile housing provides no protection against rising water. The seventh-displacement shelter in Morigaon (Figure 5(c)) reflects the compounding erosion of physical assets with each successive relocation. The riverbank-proximate household in Lakhimpur (Figure 5(d))

underscores the intersection of natural capital loss and structural landlessness that traps households in perpetual flood exposure. Together, these images affirm that displacement is not an isolated event but a multidimensional livelihood crisis.



(a) Ferry transport as the sole means of access to interior revenue circles across the Brahmaputra, Dhemaji. The river, while a source of livelihood, simultaneously acts as a barrier to institutional services, including healthcare and disaster relief.



(b) Interior of a flood-inundated household in Barpeta, Assam. A testament to the fragility of kutchha housing and the complete absence of flood-resilient physical infrastructure among households.



(c) The shelter of a household displaced for the seventh consecutive time, Morigaon, Assam. The structure reflects the compounding erosion of physical capital with each successive displacement, leaving households with progressively fewer resources to rebuild.



(d) Riverbank proximity of a household structure in Lakhimpur. The precarious location reflects the compulsion of landless households to settle on flood-exposed land, underlining the intersection of natural capital loss and structural landlessness.

Figure 5. Field Evidence of Livelihood Capital Erosion among Flood-Displaced Households in the Brahmaputra Valley, Assam

Source: Field photographs, 1st Author, 2024

Lakhimpur presents a distinct dimension of livelihood vulnerability, where recurrent flooding — occurring twice annually — systematically erodes vegetation and livestock assets, posing a chronic threat to household food security and subsistence livelihoods. Unlike other districts where physical displacement dominates, Lakhimpur's vulnerability is compounded by informal financial dependency structures that trap households in exploitative relationships when institutional support is absent.

“At times, the Mahajan acts as both a protector and an exploiter, providing jobs in the dry or post-flood seasons and rescue during floods, but exploiting our reliance when the government’s institutional support is lacking.” — Male, 37 years, 2 No. Bamunijan, North Lakhimpur revenue circle, Lakhimpur.

Mahajan happens to be a contradictory person who stands in for the unofficial system of control and assistance in the impacted areas. The majority of households’ primary activity is agriculture, whether they are working in their own fields or renting land for farming. However, most fields are either swept away or left uncultivable after the negative impacts of flooding, and even in cases where the agricultural field is unaffected, the farmers lack the necessary inputs for cultivation. Mahajan intervenes in these situations by finding an appropriate market to sell the agricultural produce and providing all the capital, fertilizer, and raw supplies required to continue agriculture. He takes advantage of the farmers’ reliance by claiming more than half of the profits in exchange. Additionally, Mahajan contributes to the total amount owed to him by lending money to impacted families during emergencies involving medical, educational, and other such requirements. It appears that he occasionally permits the cultivation of his agricultural area as leased land, and he keeps more than half of the final produce without having to pay for it.

In contrast, districts such as Nalbari present a more balanced pentagon, where diversified livelihoods, stronger social networks, and better access to health and financial services reinforce resilience. Reduced dependence on agriculture minimized exposure to land-related risks, while effective flood warnings and organizational support strengthened human and social capital. Financial confidence and institutional assistance further stabilized household strategies, enabling families to withstand flooding without severe disruption (Agnew & Sotardi, 2025; Gaisie et al., 2021). The more symmetrical pentagon observed here reflects a balanced distribution of assets that collectively sustain livelihoods, offering a model of resilience in flood-prone contexts.

Comparisons across districts highlight that sustainable livelihoods depend on the simultaneous strengthening of all five capitals. Weakness in one dimension often cascades into others, amplifying vulnerability and accelerating displacement. Conversely, balanced pentagons provide households with adaptive capacity, allowing them to absorb shocks and rebuild livelihoods (Singh & Singh, 2021). The SLF thus offers a valuable framework for understanding displacement not merely as a humanitarian crisis but as a livelihood sustainability challenge. By situating displacement within the asset pentagon, the study demonstrates that resilience is achieved through the balanced development of human, social, natural, physical, and financial capital, and that policy interventions must address these dimensions in an integrated manner.

It is important to situate this study within the evolving theoretical landscape of the SLF. Natarajan et al. (2022) reformulated the framework for the 21st century, critiquing the original asset-inventory approach for depoliticizing vulnerability by treating capital assets as isolated stocks, thereby abstracting livelihoods from the structural conditions, power relations, and historical processes that shape them. Their revision introduced the concept of a livelihood

context that embeds assets within broader socioeconomic and political structures, recasting the asset pentagon as permeable and dynamic rather than fixed. This study acknowledges this critique. By operationalizing the SLF primarily through the asset pentagon, the present analysis works within the original DFID framework and does not fully capture the structural and political dimensions that Natarajan et al. (2022) foreground. However, this choice is justified because the study's primary objective is diagnostic and comparative: to systematically assess household capital configurations across five districts using primary data, a task for which the original pentagon offers operational clarity and cross-district comparability. Crucially, the political economy dimensions that Natarajan et al. (2022) highlight are not entirely absent from this analysis. The qualitative data reveal precisely such structural vulnerabilities — the exploitative role of the Mahajan in Lakhimpur, the inequitable distribution of rehabilitation packages in Morigaon, and the institutional failure to deliver health services to interior Dhemaji all reflect the transforming structures and power asymmetries that the revised SLF foregrounds. Future research applying the Natarajan et al. (2022) reconceptualization to flood-prone contexts in Assam could further illuminate how political processes and structural inequalities reproduce livelihood insecurity beyond what capital scores alone can capture.

5. CONCLUSION

This study employed the Sustainable Livelihood Framework to analyze the asset pentagon of flood-affected households displaced across five districts of Assam. By mapping household access to human, social, natural, physical, and financial capital, the research demonstrates that displacement is not simply a direct reaction to flooding but a consequence of imbalances across livelihood assets. Districts such as Barpeta, Dhemaji, and Morigaon exhibited skewed pentagons, where weak human capital, fragile financial resources, and inadequate physical infrastructure combined to erode resilience and compel households to adopt displacement as a coping strategy. In contrast, Nalbari presented a more balanced pentagon, where diversified livelihoods, stronger social networks, and better access to health and financial services enabled households to withstand shocks with greater stability.

The comparative scores highlight that sustainable livelihoods depend on the simultaneous strengthening of all five capitals. Weakness in one dimension often cascades into others, amplifying vulnerability and accelerating displacement. Conversely, balanced pentagons provide households with adaptive capacity, allowing them to absorb shocks and rebuild livelihoods. The SLF thus offers a valuable lens for understanding displacement not merely as a humanitarian crisis but as a livelihood sustainability challenge. By situating displacement within the asset pentagon, the study emphasizes that resilience is achieved through the balanced development of human, social, natural, physical, and financial capital rather than reliance on hazard management alone.

The findings carry important implications for both policy and practice. Strengthening human capital through training and health services, expanding financial inclusion and literacy, improving physical infrastructure, and reinforcing social and institutional support are critical

pathways to resilience. These implications must, however, be grounded in the specific disaster governance architecture of Assam rather than applied generically. The Assam State Disaster Management Authority (ASDMA) DRR Roadmap 2030 provides a strategic framework that explicitly targets livelihood resilience, infrastructure strengthening, and community-based early warning systems — all of which align directly with the capital deficiencies identified in this study. Yet implementation remains uneven. In Dhemaji, where human and physical capital scores were among the lowest, the District Disaster Management Plan (DDMP) mandates mobile health units and periodic physician visits to interior revenue circles, but households reported no access to such services in nearly a decade. This gap demands district-level accountability mechanisms under ASDMA's monitoring framework. In Morigaon, the inequitable distribution of rehabilitation packages — a concern repeatedly raised in FGDs — points to failures in the grievance redress systems stipulated under the Assam State Disaster Management Plan (2022a & 2022b). Strengthening ward-level implementation of the DDMP and introducing community verification of relief delivery would address this. In Barpeta, where char-dwelling migrants are systematically excluded from electrification, sanitation, and LPG schemes, policy must recognize the tenure-insecurity of char residents and extend infrastructure provisioning under flood-adaptive, mobile delivery models rather than fixed-asset investments. Across all districts, the findings suggest that the ASDMA framework, while structurally sound, requires decentralized, need-based operationalization with robust monitoring, community participation, and inter-departmental coordination to translate policy intent into livelihood outcomes for displaced households. Interventions must be integrated and multi-dimensional, addressing structural inequalities while reducing immediate disaster risks. For regions like Assam, where recurrent flooding is a defining feature of the socio-ecological landscape, such strategies are essential to enable displaced households to transition from vulnerability to resilience and to secure sustainable livelihoods in the long term.

This research contributes to broader scholarship by framing displacement as a livelihood sustainability challenge within the SLF. The asset pentagon highlights how imbalances across capitals compel households toward displacement, while more symmetrical distributions strengthen adaptive capacity. Extending this approach to comparative contexts across South Asia, where similar patterns of livelihood erosion and forced mobility are observed, offers opportunities to enrich both theoretical understanding and practical responses to climate-induced displacement.

This study is not without limitations. The district-level sample sizes, particularly for Nalbari ($n = 16$) and Barpeta ($n = 17$), reflect the 15% random sampling applied within flood-affected villages identified through official *FRIMS Cumulative Reports* (2023), which inherently yields smaller samples in areas where fewer households were affected. While the sampling strategy was systematic and proportional, the small sample sizes constrain the precision of comparative inferences. Accordingly, composite scores should be interpreted as indicative patterns of capital configuration rather than precise quantitative measures, and near-identical scores across districts do not constitute meaningfully distinct findings. The one-way ANOVA ($F = 5.498$, $p = 0.045$) confirms that differences across districts are statistically significant as a group, but district-level comparisons should be read in conjunction with the qualitative evidence and the

broader structural context rather than based on decimal-level score differences alone. There are specific ways in which the smaller samples in Nalbari and Barpeta may have shaped the findings reported here. Nalbari's notably high composite score (2.06), the only district to exceed 2.0, rests on a sample of 16 households. If even a small number of those households were disproportionately drawn from relatively better-off settlements within the selected revenue circles, the capital scores for human, social, financial, and physical capital could be upwardly biased, overstating the district's comparative advantage. Conversely, Barpeta's lowest composite score (1.417) is derived from 17 households concentrated in two revenue circles identified as the most severely flood-affected; this selection criterion likely captures the most deprived segment of the district population, meaning the score may understate conditions in less-affected parts of Barpeta. The practical implication is that the contrast between Nalbari and the remaining districts, which is the study's most substantive comparative claim, should be treated as indicative rather than definitive. The qualitative evidence from focus group discussions corroborates the broad directionality of this contrast, which lends some confidence to the pattern, but the magnitude of the difference should not be over-interpreted. For the three mid-range districts (Dhemaji: 1.494, Lakhimpur: 1.489, Morigaon: 1.514), whose composite scores are separated by less than 0.03 units, the small sample constraint is most consequential: given this degree of proximity, no meaningful rank-ordering among these three districts can be inferred from the scores alone, and their similarities are more analytically important than their differences. Additionally, this study operationalizes the SLF primarily through the asset pentagon and does not fully engage with the structural and political dimensions highlighted by Natarajan et al. (2022). Future studies with larger, more disaggregated samples and a reconceptualized framework that embeds assets within transforming structures and power relations would further strengthen the analytical depth of livelihood assessments in flood-prone regions of Assam.

ACKNOWLEDGEMENT

The first author would acknowledge the Indian Council of Social Science Research (ICSSR), New Delhi, for providing financial support in the form of an ICSSR Doctoral Fellowship to carry out the research work. We are also grateful to all respondents for sharing their crucial information during the time of the field survey.

FINANCIAL INTEREST

The authors have no financial interest to disclose.

DATA AVAILABILITY STATEMENT

The authors do not want to share the data publicly. However, the data can be shared based on the request.

CLINICAL TRIAL NUMBER

not applicable

ETHICS DECLARATION

This study was conducted in accordance with the ethical standards of Dibrugarh University, and it is approved by “Dibrugarh University Ethical Committee for Social Science and Humanities”. No personal identifiers were disclosed, and data were used strictly for academic purposes.

CONSENT TO PUBLISH DECLARATION

Informed consent to publish the information has been obtained from the individuals interviewed in the research.

CONSENT TO PARTICIPATE DECLARATION

Informed consent to participate has been obtained from the individuals interviewed in the research.

REFERENCES

- Adil, L., Eckstein, E., Künzel, V., Schäfer, L. (2025). Climate risk index 2025: Who suffers most from extreme weather events? Weather-related loss events in 2022 and 2000 to 2022. Germanwatch.
- Afzal, M., Mai, T., Mushtaq, S., Reardon-Smith, K., & An-Vo, D.-A. (2026). Assessing livelihood vulnerability in flood-prone communities through systems thinking and the sustainable livelihood framework: A case study of Rajanpur district, Pakistan. *Weather and Climate Extremes*, 51, 100850.
- Agnew, S., Sotardi, V.A. (2025). Family Financial Socialisation and its Impact on Financial Confidence, Intentions, and Behaviours among New Zealand Adolescents. *Journal of Family and Economic*, 46, 246–258.
- Ahmad, D., & Afzal, M., (2022). Flood hazards and livelihood vulnerability of flood-prone farm-dependent Bait households in Punjab, Pakistan. *Environmental Science. and Pollution. Research*, 29(8), 11553–11573.
- Akram, A., Tahir, A., Alam, A., Waheed, A. (2025). Livelihood vulnerability index: assessment of climatic changes in flood-affected areas of Mianwali district, Punjab, Pakistan. *PLoS One*, 20(3), e0315398.
- Akter, M.T., Islam, M.R. & Ali, M.Y. (2026). River bank erosion induced settlement displacement and livelihood impacts in Saghata Upazila of Gaibandha District. *Natural Hazards*, 122, 171.
- Assam State Disaster Management Authority (ASDMA). (2017). Flood hazard atlas for Assam state (1998-2015). Indian Space Research Organisation (ISRO), National Remote Sensing Centre (NRSC).
- Assam State Disaster Management Authority (ASDMA). (2014). *Assam State Disaster Management Plan*.
- Assam State Disaster Management Authority (ASDMA). (2022a). *Assam State Disaster Management Plan 2022: Volume -I (Perspective Plan)*. Retrieved April 21, 2023, from https://asdma.assam.gov.in/sites/default/files/swf_utility_folder/departments/asdma_revenue_uneec_opscloud_com_oid_70/this_comm/asdmp_vol-i.pdf

- Assam State Disaster Management Authority (ASDMA). (2022b). Assam Floods 2022: Flood Memorandum to the Government of India. Retrieved April 21, 2023, from: https://asdma.assam.gov.in/sites/default/files/swf_utility_folder/departments/asdma_revenue_unecopscloud_com_oid_70/menu/document/assam_flood_memorandum_2022.pdf
- Assam State Disaster Management Authority (ASDMA). (2023). Assam Floods 2023: Flood Memorandum to the Government of India. https://asdma.assam.gov.in/sites/default/files/swf_utility_folder/departments/asdma_revenue_unecopscloud_com_oid_70/menu/document/assam_flood_memorandum_2023.pdf
- Assam State Disaster Management Authority (ASDMA). (2024). Assam Floods 2024: Flood Memorandum to the Government of India. https://asdma.assam.gov.in/sites/default/files/swf_utility_folder/departments/asdma_revenue_unecopscloud_com_oid_70/menu/document/assam_flood_memorandum_2024.pdf
- Berghuijs, W. R., Aalbers, E. E., Larsen, J. R., Trancoso, R. & Woods, R. A. (2017). Recent changes in extreme floods across multiple continents. *Environmental Research Letters*, 12, 114035.
- Bhuyan, N., Sharma, Y., Sajjad, H., Ahmed, R. (2023). Estimating bank-line migration of the Brahmaputra River in the Middle Brahmaputra floodplains of Assam, India using Digital Shoreline Analysis System. *Environmental Earth Sciences*, 82(16).
- Blöschl, G., Hall, J., Viglione, A., Perdigão, R. a. P., Parajka, J., Merz, B., Lun, D., Arheimer, B., Aronica, G. T., Bilibashi, A., Boháč, M., Bonacci, O., Borga, M., Čanjevac, I., Castellarin, A., Chirico, G. B., Claps, P., Frolova, N., Ganora, D., . . . Živković, N. (2019). Changing climate both increases and decreases European river floods. *Nature*, 573(7772), 108–111.
- Cardona, O., Van Aalst, M. K., Birkmann, J., Fordham, M., McGregor, G., Perez, R., Pulwarty, R. S., Schipper, E. L. F., Sinh, B. T., Décamps, H., Keim, M., Davis, I., Ebi, K. L., Lavell, A., Mechler, R., Murray, V., Pelling, M., Pohl, J., Smith, A., & Thomalla, F. (2012). Determinants of risk: exposure and vulnerability. In C. B. Field, V. Barros, T. F. Stocker, & Q. Dahe (Eds.), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change* (pp. 65–108). chapter, Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9781139177245.005>
- Carney, D. (1999). Livelihoods approaches compared: A brief comparison of the livelihoods approaches of the UK Department for International Development (DFID). CARE, Oxfam and the United Nations Development Programme (UNDP). London, Department for International Development.
- Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. IDS Discussion Paper no 296, Institute of Development Studies, Sussex, UK.
- Chandel, A. S., & Kumar, R. (2026). Spatial politics of displacement: ethnic conflict, governance fragility, and livelihood resilience in Southern Ethiopia. *Cogent Social Sciences*, 12(1).
- Change, I. P. O. C. (2015). Emergent risks and key vulnerabilities. In *Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects: Working Group II Contribution to the IPCC Fifth Assessment Report* (pp. 1039–1100). chapter, Cambridge: Cambridge University Press.

- Chetia, L., & Paul, S.K. (2024). Spatial Assessment of Flood Susceptibility in Assam, India: A Comparative Study of Frequency Ratio and Shannon's Entropy Models. *Journal of the Indian Society of Remote Sensing*, 52(2), 343–358.
- Das, S., & Das, T. (2022). Flood, Livelihood, and Community Resilience: A Study from Barak Valley Region of Assam in Northeast India. In A. Singh (Ed.), *International Handbook of Disaster Research* (pp. 1-14). Springer, Singapore.
- Deely, S., Dodman, D., Hardoy, J., Johnson, C., Satterthwaite, D., Serafin, A., Waddington, R., & International Federation of Red Cross and Red Crescent Societies. (2010). *World Disasters Report 2010 – Focus on urban risk* (By International Federation of Red Cross and Red Crescent Societies; D. McClean, Ed.).
- Desai, B., Bresch, D. N., Cazabat, C., Hochrainer-Stigler, S., Mechler, R., Ponserre, S., & Schewe, J. (2021). Addressing the human cost in a changing climate. *Science*, 372(6548), 1284–1287. <https://doi.org/10.1126/science.abh4283>
- DFID. (1999). Sustainable Livelihoods Guidance Sheets. London: Department for International Development.
- Dikshit, K. R., & Dikshit, J. K. (2014). North-East India: Land, people and economy. Springer.
- Fowler, H. J., Lenderink, G., Prein, A. F., Westra, S., Allan, R. P., Ban, N., Barbero, R., Berg, P., Blenkinsop, S., X, H., DO, Guerreiro, S., Haerter, J. O., Kendon, E. J., Lewis, E., Schaer, C., Sharma, A., Villarini, G., Wasko, C., & Zhang, X. (2021). Anthropogenic intensification of short-duration rainfall extremes. *Nature Reviews Earth & Environment*, 2(2), 107–122.
- Gaisie, E., Han, S. S., & Kim, H. M. (2021). Complexity of resilience capacities: Household capitals and resilience outcomes on the disaster cycle in informal settlements. *International Journal of Disaster Risk Reduction*, 61, 102292.
- Gogoi, J., & Siddique, N. (2023). Flood, Displacement and Politics: The Assam Chapter. In Economic and Political Weekly (Engage), *Economic and Political Weekly (Engage)*, 58 (01).
- Gudmundsson, L., Boulange, J., X, H., DO, Gosling, S. N., Grillakis, M. G., Koutroulis, A. G., Leonard, M., Liu, J., Schmied, H. M., Papadimitriou, L., Pokhrel, Y., Seneviratne, S. I., Satoh, Y., Thiery, W., Westra, S., Zhang, X., & Zhao, F. (2021). Globally observed trends in mean and extreme river flow attributed to climate change. *Science*, 371(6534), 1159–1162.
- Habib, N., Ariyawardana, A. & Aziz, A.A. (2023). The influence and impact of livelihood capitals on livelihood diversification strategies in developing countries: a systematic literature review. *Environmental Science Pollution Research*, 30 (27), 69882–69898.
- Hahn, M. B., Riederer, A. M., & Foster, S. O. (2009). The livelihood vulnerability index: A pragmatic approach to assessing risks from climate variability and change - a case study in Mozambique. *Global Environmental Change*, 19(1), 74–88. <https://doi.org/10.1016/j.gloenvcha.2008.11.002>
- Hirabayashi, Y., Mahendran, R., Koirala, S., Konoshima, L., Yamazaki, D., Watanabe, S., Kim, H., & Kanae, S. (2013). Global flood risk under climate change. *Nature Climate Change*, 3(9), 816–821.

- Huong, N.T.L., Yao, S., & Fahad, S. (2019). Assessing household livelihood vulnerability to climate change: the case of Northwest Vietnam. *Human and Ecological Risk Assessment an International Journal*, 25 (5), 1157–1175.
- Internal Displacement Monitoring Centre (IDMC). (2024). *Global Report on Internal Displacement*.
- Internal Displacement Monitoring Centre. (IDMC) (2025). *Global Report on Internal Displacement 2025*.
- Islam, A., Ghosh, S. & Sarkar, M. (2025). Assessing livelihood vulnerability of rural communities in the wake of recurrent tropical flood hazards in India. *Natural Hazards*, 121 (1), 677–704.
- Juned, F. (2022). Natural - Disaster and Displacement in Assam: The Case of Floods and Impact on Marginalised Communities. Social and Political Research Foundation.
- Kaiser, Z.R.M.A. (2023). Analysis of the livelihood and health of internally displaced persons due to riverbank erosion in Bangladesh. *Journal of Migration and Health*, 7, 100157.
- Kakinuma, K., Puma, M. J., Hirabayashi, Y., Tanoue, M., Baptista, E. A., & Kanae, S. (2020). Flood-induced population displacements in the world. *Environmental Research Letters*, 15(12), 124029.
- Kollmair, M., Jr., Gamper, St., & Development Study Group, University of Zurich. (2002). The sustainable livelihoods approach. In *Integrated Training Course of NCCR North-South*.
- Krishnan, S. (2022). Gender, disasters and climate: Case of internal displacement in Assam, India. *Jindal Global Law Review*, 13(1), 87–101.
- Lange, S., Volkholz, J., Geiger, T., Zhao, F., Vega, I., Veldkamp, T., Reyer, C. P. O., Warszawski, L., Huber, V., Jägermeyr, J., Schewe, J., Bresch, D. N., Büchner, M., Chang, J., Ciais, P., Dury, M., Emanuel, K., Folberth, C., Gerten, D., . . . Frieler, K. (2020). Projecting exposure to extreme climate impact events across six event categories and three spatial scales. *Earth S Future*, 8(12).
- Mahanta, R., & Das, D. (2017). Flood induced vulnerability to poverty: Evidence from Brahmaputra Valley, Assam, India. *International Journal of Disaster Risk Reduction*, 24, 451–461.
- Mallik, S. (2019). Land Alienation and Threats to Livelihoods of Indigenous Populations. In M. Sekher, R. Carciumaru (Eds.), *Including the Excluded in South Asia*. Springer, Singapore.
- Mester, B., Frieler, K., Korup, O., Desai, B., & Schewe, J. (2025). Socioeconomic predictors of vulnerability to flood-induced displacement. *Nature Communications*, 16(1), 8296.
- Mohanty, A. (2021). Preparing India for Extreme Climate Events: Mapping Hotspots and Response Mechanisms. CEEW.
- Morse, S., & McNamara, N. (2013). *Sustainable Livelihood Approach*. Springer Dordrecht.
- MSWRR. (2018) Department of Disaster Management. Ministry of Social Welfare, Relief and Resettlement, p 1
- Natarajan, N., Newsham, A., Rigg, J., & Suhardiman, D. (2022). A sustainable livelihoods framework for the 21st century. *World Development*, 155, 105898.

- National Strategy for Financial Inclusion. (2019). Reserve Bank of India. https://www.rbi.org.in/commonman/upload/english/content/pdfs/english_16042021.pdf
- Ndlovu, S., & Maviza, G. (2026). A systematic review of the impact of climate-related displacements on food and water security in Mozambique and Zimbabwe, *Jàmbá: Journal of Disaster Risk Studies*, 18(1), a1965.
- Prayitno, G., Fikriyah, Nugraha, A. T., Siankwilimba, E., Wicaksono, A. D., Dinanti, D., Subagiyo, A., Hoque, M. E., & Hiddlestone-Mumford, J. (2025). The role of social and human capital on climate change adaptation in agricultural activities in Indonesia. *Environmental Challenges*, 21, 101353.
- Rahman, M., Popke, J., & Crawford, T. W. (2022). Resident perceptions of riverbank erosion and shoreline protection: a mixed-methods case study from Bangladesh. *Natural Hazards*, 114(3), 2767–2786.
- Rentschler, J., Salhab, M. & Jafino, B. A. (2022). Flood exposure and poverty in 188 countries. *Nature Communications*, 13, 3527.
- Sachdeva, S., & Kumar, B. (2022). Flood susceptibility mapping using extremely randomized trees for Assam 2020 floods. *Ecological Informatics*, 67, 101498.
- Saikia, M., & Mahanta, R. (2023). Does livestock loss affect livelihood? An investigation on char residing mishing community of Assam. *International Journal of Community Well-Being*, 6(4), 327–351.
- Saikia, M., & Mahanta, R. (2024a). Riverbank erosion and vulnerability—a study on the char dwellers of Assam. India. *Natural Hazards Research*, 4(2), 274–287.
- Saikia, M., & Mahanta, R. (2024b). Why do people live in disaster-prone *char* regions? Perspectives from Assam, India. *Discover Global Society*, 2(1), 99.
- Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. IDS Working Paper no 72, Institute of Development Studies, Sussex, UK.
- Singh, S., Singh, R. B. (2021). Investigation of Livelihoods Asset Pentagon: The SLF Core. In *Simulating Climate Change and Livelihood Security. Advances in Geographical and Environmental Sciences*. (pp. 177–193). Springer, Singapore.
- Solesbury, W. (2005). Sustainable livelihoods: A case study of the evolution of DFID Policy. In *Practical Action Publishing eBooks* (pp. 133–154).
- United Nations. (1987). *Our common future*.
- UN OCHA. (2004). Guiding Principles on Internal Displacement.
- United Nations Development Programme. (2017a). *Application of the sustainable livelihoods framework in development projects: Guidance note*. United Nations Development Programme.
- United Nations Development Programme. (2017b). *Strengthening livelihoods in environmental action: Sustainable livelihoods approach – A contribution to Agenda 2030* (Discussion Paper). United Nations Development Programme.
- World Health Organization. (2023). *Strategic health infrastructure investments to support universal health coverage: WHO UHL technical brief*. World Health Organization. Retrieved February, 2026, from <https://cdn.who.int/media/docs/default-source/universal-health-coverage/who-uhl-technical-brief-infrastructure.pdf>

Yang, Y., Huang, Y., Huang, J. & Nie, F. (2024). The role of social capital in the impact of multiple shocks on households' coping strategies in underdeveloped rural areas. *Scientific Reports*, 14(1), 14218.