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Climate Vulnerability, Riverbank Erosion and Rural Livelihood Insecurity in Assam: A Review

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Abstract

Assam is highly vulnerable to recurring floods, riverbank erosion and other environmental hazards owing to its geographical location, river systems and climatic conditions. These hazards have considerable implications for rural livelihoods, particularly among communities dependent on agriculture, fisheries, livestock and other natural resources. Riverbank erosion is especially consequential because it results in the loss of agricultural land, homesteads, infrastructure and productive assets, thereby increasing socio-economic insecurity and displacement. This paper examines the interrelationship between climate vulnerability, riverbank erosion and rural livelihood insecurity in Assam through a review and documentary analysis of secondary sources. It draws upon published research articles, government reports, meteorological records, disaster-management documents and demographic and agricultural publications. The analysis is organised around the dimensions of environmental exposure, socio-economic sensitivity and adaptive capacity. The reviewed evidence indicates that environmental hazards do not affect all rural communities equally; their consequences are shaped by landholding patterns, agricultural dependency, poverty, infrastructure, livelihood diversification and institutional support. The paper argues that climate vulnerability and riverbank erosion should be understood not merely as environmental concerns but also as interconnected rural development challenges. It recommends integrated river management, climate-resilient agriculture, livelihood diversification, rehabilitation support, improved disaster preparedness and systematic district-level vulnerability monitoring. The study also identifies the need for further empirical research using comparable district-level secondary datasets.

Keywords: Climate Vulnerability; Riverbank Erosion; Rural Livelihood Insecurity; Floods; Char Areas; Agricultural Vulnerability; Displacement; Assam.

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1. Introduction

Climate change and environmental degradation have emerged as significant challenges to sustainable development, particularly in regions where rural communities depend heavily on natural resources for their livelihoods. Changes in rainfall patterns, recurrent floods, riverbank erosion, land degradation and other environmental uncertainties affect agricultural production, household income, food security and the overall socio-economic well-being of rural populations. These challenges are particularly pronounced in developing regions, where agriculture, fisheries, livestock rearing and other nature-dependent activities constitute important sources of livelihood.

Assam, situated in the north-eastern region of India, is characterised by an extensive river network, fertile floodplains, wetlands, hills and numerous tributaries. The Brahmaputra and Barak river systems have shaped the state's geographical, economic and socio-cultural development. These rivers provide water resources, fertile agricultural land, fisheries, transportation opportunities and other livelihood benefits. At the same time, their hydrological and geomorphological characteristics expose surrounding settlements to recurrent floods, riverbank erosion and displacement.

The Brahmaputra River is particularly significant because of its braided channel system, high sediment load, extensive floodplain and changing river courses. Flooding and bank erosion are recurring environmental processes in the Brahmaputra Valley, affecting agricultural land, residential settlements, public infrastructure and livelihood resources. According to the Water Resources Department, Government of Assam, approximately 4.27 lakh hectares of land have been eroded by rivers since 1950, with an estimated average annual erosion rate of nearly 8,000 hectares. The department also identifies approximately 31,500 square kilometres of the state as flood-prone (Government of Assam, Water Resources Department, n.d.). These figures indicate the considerable geographical and developmental significance of flood and erosion-related hazards in Assam.

The consequences of riverbank erosion extend beyond the physical loss of land. For rural households, agricultural land is not simply an economic asset; it is also a source of food security, employment, social identity and continuity of settlement. The loss of agricultural land and homesteads can undermine household income, disrupt traditional occupations, increase dependence on wage employment and contribute to temporary or permanent displacement. Such consequences may be particularly severe among small and marginal farmers and households with limited financial resources or alternative livelihood opportunities.

Previous studies have examined different dimensions of these challenges. Borah et al. (2022) discussed the impacts of climate change on the socio-hydrological spaces of the Brahmaputra floodplain and highlighted the relationship between climatic processes, hydrology, agriculture and rural livelihoods. Dekaraja and Mahanta (2021) examined the relationship between riverbank erosion and migration in Assam through secondary demographic and socio-economic information. Kumar and Das (2019) investigated the livelihood conditions of char dwellers in Western Assam, particularly their income and seasonal migration patterns.

More recent studies have provided further empirical evidence concerning the vulnerability of riverine communities. Saikia and Mahanta (2024a) examined the effects of riverbank erosion on the livelihood and vulnerability of char dwellers. Their subsequent research applied an adjusted Livelihood Vulnerability Index to assess climate vulnerability in the char areas of Assam (Saikia & Mahanta, 2024b). Similarly, Bhuyan et al. (2024) assessed socio-economic vulnerability to riverbank erosion in the Middle Brahmaputra floodplains using the exposure, sensitivity and adaptive capacity framework.

Although these studies have contributed significantly to understanding environmental and livelihood vulnerability in Assam, there remains a need to examine the broader relationship between environmental exposure and rural socio-economic development through an integrated perspective. The present paper therefore synthesises available secondary evidence to understand climate vulnerability, riverbank erosion and livelihood insecurity as interconnected dimensions of rural development in Assam.

2. Review of Related Literature

2.1 Climate Change and the Brahmaputra Floodplain

Borah et al. (2022) examined climate change impacts on the socio-hydrological spaces of the Brahmaputra floodplain in Assam. Their review highlighted the interaction between climatic conditions, hydrological processes, agricultural systems and human activities. Changes in precipitation and hydrological conditions may influence the frequency and intensity of environmental hazards and consequently affect the livelihoods of communities residing in floodplain areas.

The study is relevant because it considers the Brahmaputra floodplain as a socio-hydrological system in which environmental processes and human activities are closely interconnected. It provides a conceptual foundation for understanding the vulnerability of rural communities whose livelihoods depend on floodplain resources.

2.2 Riverbank Erosion and Population Migration

Dekaraja and Mahanta (2021) investigated the interrelationship between riverbank erosion and migration in Assam using secondary information from government publications, including the Census of India and the Statistical Handbook of Assam. The researchers developed indicators from demographic, agricultural and socio-economic variables and applied factor analysis to examine the relationship between erosion and migration.

Their findings demonstrate the importance of considering migration within the broader socio-economic consequences of riverbank erosion. The loss of agricultural land and residential property may influence occupational mobility and encourage affected households to seek alternative livelihood opportunities. The study also illustrates the usefulness of secondary statistical sources for examining environmental and demographic relationships.

2.3 Riverbank Erosion and the Socio-Economic Vulnerability of Char Dwellers

Saikia and Mahanta (2024a) examined riverbank erosion and the vulnerability of char dwellers in Assam through quantitative and qualitative approaches. Their research involved household-

level information and participatory rural appraisal techniques. The study highlighted the adverse consequences of erosion for livelihood resources and the economic well-being of riverine communities.

The findings indicate that riverbank erosion is not merely a physical or geographical process. It also affects the socio-economic conditions of households through the loss of productive resources, residential insecurity and reduced livelihood opportunities.

In another study, Saikia and Mahanta (2024b) applied an adjusted Livelihood Vulnerability Index to assess climate vulnerability in the char areas of Assam. Based on a survey of 394 households conducted between May and September 2022, the study identified access to food and housing as important dimensions of household vulnerability. This research demonstrates the importance of examining environmental exposure alongside household resources and socio-economic conditions.

2.4 Socio-Economic Vulnerability in the Middle Brahmaputra Floodplains

Bhuyan et al. (2024) assessed socio-economic vulnerability to riverbank erosion in the Middle Brahmaputra floodplains of Assam. Their study used the IPCC-based framework of exposure, sensitivity and adaptive capacity and collected primary information from 508 households across 18 villages. The researchers constructed a socio-economic vulnerability index and identified considerable differences in vulnerability among the selected villages.

The study reported that eight villages were highly vulnerable, seven were moderately vulnerable and three had comparatively low vulnerability. Its findings underline the importance of considering environmental exposure together with socio-economic conditions, infrastructure, health, education and agricultural resources. The study also demonstrates that vulnerability varies across locations and cannot be understood through environmental exposure alone.

2.5 Livelihood Conditions of Char Dwellers in Western Assam

Kumar and Das (2019) examined the livelihood conditions of char dwellers in Western Assam, focusing particularly on household income and seasonal migration. Their research was based on primary household-level information and statistical analysis. The study highlighted the economic difficulties experienced by char communities and examined factors influencing income and migration decisions.

The research is important for understanding how recurrent floods, soil erosion, limited livelihood opportunities and socio-economic disadvantages influence the economic conditions of riverine populations. It also establishes the relationship between environmental insecurity and livelihood diversification.

2.6 Factors Influencing Residence in Disaster-Prone Char Areas

Saikia and Mahanta (2024c) examined why people continue to reside in disaster-prone char regions of Assam. Their research provides an additional perspective on the relationship between environmental hazards, settlement decisions and the socio-economic circumstances of riverine communities.

The continued settlement of vulnerable populations in char areas cannot be explained exclusively through environmental exposure. Access to land, employment, social networks, livelihood resources and alternative settlement opportunities may influence household decisions. This perspective is important for developing policies that recognise the socio-economic realities of communities residing in environmentally vulnerable locations.

2.7 Climate Vulnerability and Household Adaptation

Saikia and Mahanta (2025) further investigated factors affecting the climate vulnerability of char-dwelling households in Assam. Their empirical research contributes to understanding the factors associated with household vulnerability and the importance of adaptation and coping mechanisms.

Taken together, the reviewed studies demonstrate that climate vulnerability, riverbank erosion, migration, agricultural dependency and household livelihood insecurity are closely interconnected. They also reveal that environmental risks have differentiated consequences depending on the availability of economic resources, infrastructure, livelihood alternatives and institutional support.

3. Research Gap and Statement of the Problem

3.1 Research Gap

The existing literature provides considerable insight into the environmental and socio-economic consequences of floods, riverbank erosion and climate-related hazards in Assam. Several studies have examined the vulnerability of char dwellers, the relationship between erosion and migration, household livelihood conditions and the application of vulnerability indices.

However, the available literature also indicates certain areas requiring further examination.

First, several empirical studies focus on selected villages, households or specific geographical locations, particularly char areas and the Middle Brahmaputra floodplains. Although such studies provide detailed local evidence, their geographical coverage does not necessarily represent the diversity of rural communities across the Brahmaputra and Barak valleys.

Second, environmental exposure and socio-economic vulnerability are frequently examined through separate dimensions. There is a need to interpret their interrelationships within a broader rural development perspective, particularly concerning agricultural dependency, livelihood diversification, infrastructure and institutional support.

Third, the availability of government statistics and administrative records provides opportunities for further district-level comparative research. However, differences in geographical coverage, reference periods and data-collection methods require careful examination before such datasets can be integrated.

The present paper addresses these issues through a documentary analysis of published research and government information. It brings together environmental, agricultural, demographic and livelihood-related evidence to develop an integrated understanding of rural vulnerability in

Assam. It does not claim to provide a new district-level statistical index or original household-level findings.

3.2 Statement of the Problem

Rural communities in Assam face recurring environmental challenges associated with floods, riverbank erosion, rainfall variability and other hydrological processes. These hazards are particularly consequential for populations residing in riverine and char areas, where livelihoods are often dependent on agriculture, fisheries, livestock and other natural resources.

The loss of agricultural land, residential property and productive assets can weaken the economic foundation of rural households. Repeated environmental disturbances may also increase employment insecurity, food insecurity, displacement, migration and dependence on institutional assistance.

Although government departments and research institutions publish information on rainfall, floods, erosion, agriculture, population and rural development, these sources have different geographical and temporal coverage. Their combined implications for rural livelihood insecurity require further examination.

Accordingly, the central problem addressed in this paper is to understand how climate-related environmental hazards and riverbank erosion interact with socio-economic conditions to influence the livelihood security and development prospects of rural communities in Assam.

4. Objectives of the Study

The paper is guided by the following objectives:

1. To examine the major environmental and climatic challenges affecting rural communities in Assam, with particular reference to recurrent floods and riverbank erosion.
2. To analyse the socio-economic implications of riverbank erosion and climate-related hazards for rural livelihoods.
3. To understand the relationship between environmental exposure, agricultural dependency, population displacement and livelihood insecurity.
4. To examine the role of infrastructure, livelihood diversification and institutional support in strengthening the adaptive capacity of vulnerable rural communities.
5. To identify policy measures for promoting sustainable and climate-resilient rural development in Assam.

5. Research Questions

The paper seeks to address the following research questions:

1. What are the major environmental and climatic factors contributing to rural vulnerability in Assam?

2. How does riverbank erosion affect agricultural land, household assets and rural livelihood opportunities?
3. How are environmental vulnerability, agricultural dependency, migration and socio-economic insecurity interconnected?
4. What role do infrastructure, education, livelihood diversification and institutional support play in strengthening adaptive capacity?
5. What policy measures can contribute to reducing the vulnerability of rural and riverine communities in Assam?

6. Research Methodology

6.1 Research Design

The paper adopts a descriptive and analytical research design based entirely on secondary sources of information. It follows a documentary approach to examine the interrelationship between climate vulnerability, riverbank erosion and rural livelihood insecurity in Assam.

The study draws upon published research articles, government reports, official statistical publications, meteorological information, disaster-management documents and relevant policy materials. The evidence is interpreted through the conceptual dimensions of environmental exposure, socio-economic sensitivity and adaptive capacity.

The research does not involve primary household surveys, interviews, field observations or the construction of a new statistical vulnerability index. Accordingly, the discussion represents a synthesis and interpretation of available published evidence rather than the results of an original district-level econometric investigation.

6.2 Sources of Data

The paper draws upon the following categories of secondary information:

A. Directorate of Economics and Statistics, Government of Assam

The Statistical Handbook of Assam and related statistical publications provide information on population, agriculture, land utilisation, economic activities, infrastructure and other development indicators. These publications are relevant for understanding the socio-economic conditions of different districts.

B. Assam State Disaster Management Authority (ASDMA)

Disaster-management reports and flood-related documents provide information on affected districts, affected populations, agricultural damage, infrastructure losses and disaster-management interventions. These records help establish the broader context of environmental exposure and disaster-related consequences.

C. India Meteorological Department (IMD)

The IMD provides gridded rainfall datasets and other meteorological information that can be used to examine rainfall variability and long-term climatic patterns. Its 0.25° × 0.25° daily

gridded rainfall product is currently listed for 1901–2024. The original dataset methodology was documented by Pai et al. (2014). The period covered by a particular downloaded dataset should be verified before conducting statistical analysis.

D. Census of India

Census publications provide information on population distribution, rural population, literacy, occupational structure, workers and other demographic characteristics. These indicators are useful for understanding the socio-economic profile of rural communities.

E. Central Water Commission (CWC)

Hydrological and flood-related publications provide information on river discharge, water levels and flood-related processes. Such information is useful for interpreting the hydrological context of environmental vulnerability.

F. Water Resources Department, Government of Assam

The department provides information on river systems, flood-prone areas, riverbank erosion, land loss and related river-management challenges. Its published records provide important contextual evidence regarding the scale of erosion in Assam.

G. Agricultural Statistics and Related Publications

Agricultural Statistics at a Glance, Agriculture Census publications and state-level agricultural reports provide information on cropping patterns, agricultural landholdings, production and farming conditions.

H. Research Publications and Academic Literature

Peer-reviewed journal articles and scholarly publications provide the conceptual and empirical foundation for examining climate vulnerability, riverbank erosion, migration and rural livelihood insecurity.

6.3 Geographical Scope

The geographical focus of the paper is rural Assam, with particular reference to the Brahmaputra and Barak river systems. The Brahmaputra floodplain receives special attention because of its extensive riverine settlements, recurrent flooding, erosion-related land loss and dependence on natural-resource-based livelihoods.

The Barak Valley is also considered within the broader geographical context of the state. However, the availability and comparability of evidence may differ between the two river systems. Findings from studies conducted in selected char areas or the Middle Brahmaputra floodplains are therefore interpreted within their actual geographical scope and are not assumed to represent every rural district of Assam.

6.4 Period of Study

The documentary discussion primarily considers relevant research publications and government information available up to 2026. The reference periods of individual datasets

differ according to their institutional sources.

For example, the IMD daily gridded rainfall dataset has a much longer historical coverage, while demographic and socio-economic information may be available only for particular census years or administrative reporting periods. Therefore, the period of a source should not be confused with the period covered by every variable discussed in this paper.

6.5 Analytical Approach

The following analytical approaches guide the interpretation of the secondary evidence:

1. **Descriptive analysis:** To understand the major environmental and socio-economic characteristics of rural vulnerability.
2. **Comparative interpretation:** To examine differences in the conditions of riverine, char and other rural communities discussed in the reviewed studies.
3. **Thematic analysis:** To organise the evidence under environmental exposure, socio-economic sensitivity, adaptive capacity and livelihood insecurity.
4. **Documentary analysis:** To interpret government publications, statistical reports and policy documents in relation to the research objectives.
5. **Evidence synthesis:** To identify common findings, differences and research gaps across the selected empirical studies.

No new correlation coefficients, regression estimates, district rankings or composite vulnerability scores are claimed in this paper because the underlying district-level datasets have not been compiled and statistically analysed.

7. Conceptual Framework

The paper adopts the vulnerability framework associated with the Intergovernmental Panel on Climate Change (IPCC), which considers exposure, sensitivity and adaptive capacity as important dimensions of vulnerability (IPCC, 2014).

The framework is applied to the environmental and socio-economic circumstances of rural Assam.

7.1 Environmental Exposure

Environmental exposure refers to the extent to which rural communities and their livelihood resources are affected by climatic, hydrological and geomorphological hazards.

Important indicators include:

- Rainfall variability and extreme rainfall events.
- Frequency and extent of floods.
- Riverbank erosion and channel migration.
- Loss of agricultural and residential land.

- Flood-affected geographical areas.
- Damage to roads, embankments and other infrastructure.

The degree of exposure may vary according to geographical location, settlement patterns and proximity to rivers and flood-prone areas.

7.2 Socio-Economic Sensitivity

Socio-economic sensitivity refers to the extent to which the social and economic characteristics of communities influence the consequences of environmental hazards.

Relevant dimensions include:

- Dependence on agriculture and natural resources.
- Rural poverty and household economic conditions.
- Landholding patterns and access to productive assets.
- Occupational structure and employment opportunities.
- Population characteristics and household dependency.
- Access to basic services and infrastructure.

Households with limited land, low income and few alternative employment opportunities may experience greater difficulty in recovering from environmental disturbances.

7.3 Adaptive Capacity

Adaptive capacity refers to the ability of individuals, households and communities to respond to environmental stress, minimise losses and sustain their livelihood resources.

Important dimensions include:

- Educational attainment and awareness.
- Access to infrastructure and public services.
- Availability of alternative employment.
- Agricultural and occupational diversification.
- Access to financial services and institutional assistance.
- Disaster preparedness and early-warning systems.
- Access to social protection and rehabilitation programmes.

The availability of these resources may influence the ability of rural communities to cope with floods, erosion and other environmental challenges.

7.4 Rural Livelihood Insecurity

Livelihood insecurity represents the economic and social consequences arising from the

interaction between environmental exposure, socio-economic sensitivity and adaptive capacity.

It may be reflected in:

1. Instability in agricultural production and household income.
2. Loss or depletion of productive assets.
3. Displacement and residential insecurity.
4. Migration and occupational mobility.
5. Employment insecurity.
6. Food and housing insecurity.
7. Increased dependence on external assistance.

The framework recognises that environmental exposure alone does not determine vulnerability. Similar environmental hazards may produce different consequences depending on household resources, socio-economic conditions and institutional support.

8. Analytical Discussion

8.1 Climate Vulnerability and Environmental Challenges in Assam

The geographical and hydrological characteristics of Assam expose rural communities to recurring environmental hazards. The Brahmaputra and Barak river systems, along with their tributaries, influence settlement patterns, agricultural activities and the distribution of natural resources. Seasonal changes in river discharge, sediment transport and channel morphology contribute to the recurring occurrence of floods and riverbank erosion.

The Water Resources Department, Government of Assam, identifies flood and erosion as major challenges affecting the state's riverine environment. Its published information records substantial historical land loss due to erosion and indicates that the average annual area affected by floods is also considerable (Government of Assam, Water Resources Department, n.d.).

Borah et al. (2022) explain the Brahmaputra floodplain through a socio-hydrological perspective, emphasising the interaction between environmental processes and human activities. Fertile floodplain land and access to natural resources have historically supported rural settlements and agricultural livelihoods. However, the same geographical characteristics also expose these communities to environmental hazards.

Climate vulnerability in Assam should therefore be understood through the combined influence of climatic conditions, hydrological processes, river morphology, settlement patterns and dependence on natural resources. It is important, however, to distinguish between climate variability, hydrological hazards and riverbank erosion. Although these processes may interact, riverbank erosion is also influenced by geomorphological, sedimentary and channel-dynamic factors and should not automatically be attributed solely to climate change.

8.2 Riverbank Erosion and Agricultural Livelihoods

Agriculture remains an important source of livelihood for rural communities in Assam. Agricultural land provides food, income and employment and supports associated economic activities. Riverbank erosion can directly undermine this livelihood system by reducing cultivable land, destroying standing crops and affecting access to productive resources.

For small and marginal farmers, the loss of agricultural land may have particularly serious consequences because their economic security is often closely associated with limited landholdings. Repeated erosion can also reduce the capacity of affected households to maintain their previous agricultural activities.

Kumar and Das (2019) highlighted the economic difficulties experienced by char dwellers in Western Assam, particularly in relation to household income and seasonal migration. Similarly, Saikia and Mahanta (2024a) documented the adverse effects of char land erosion on livelihood resources and the economic well-being of affected households.

These studies indicate that riverbank erosion is not merely a physical-geographical phenomenon. It is also a rural development concern that affects agricultural productivity, household income, productive assets and economic stability.

8.3 Riverbank Erosion, Displacement and Migration

One of the important socio-economic consequences of riverbank erosion is population displacement. The loss of agricultural land and residential settlements may compel households to relocate to safer areas or seek alternative livelihood opportunities.

Dekaraja and Mahanta (2021) examined the relationship between riverbank erosion and migration in Assam using secondary demographic and socio-economic information. Their research demonstrates the importance of examining environmental change alongside agricultural and occupational characteristics when interpreting population movement.

Migration may provide affected households with access to alternative employment and income sources. Seasonal or temporary migration can therefore become a livelihood diversification strategy. However, displacement may also disrupt traditional occupational networks, reduce access to productive resources and create difficulties in securing housing, employment and public services.

The consequences of migration are not uniform. Its effects depend on employment opportunities, social networks, financial resources, skills and institutional assistance. Therefore, migration should be understood as both a possible livelihood response and a potential consequence of environmental insecurity.

8.4 Climate Vulnerability and Rural Poverty

Environmental vulnerability and rural poverty are closely interconnected. Households with limited economic resources may face greater difficulties in recovering from floods, erosion and other environmental disturbances. Restricted access to land, employment, credit and basic services can further increase their vulnerability.

Saikia and Mahanta (2024b) identified access to food and housing as important dimensions of vulnerability among char households in Assam. Their findings indicate that environmental risks may intensify existing household disadvantages.

The relationship between poverty and environmental vulnerability is therefore multidimensional. The loss of productive resources may reduce household income, while low income and limited access to services may restrict the ability to recover from environmental shocks.

An integrated understanding of rural vulnerability should consequently consider poverty, housing, sanitation, education, employment and access to public services alongside environmental exposure.

8.5 Agricultural Adaptation and Livelihood Diversification

The ability of rural communities to respond to environmental hazards is influenced by their access to alternative livelihood opportunities and productive resources. Communities in the Brahmaputra floodplain have historically developed different practices to cope with seasonal environmental uncertainty.

Borah et al. (2022) discussed the relationship between traditional agricultural practices, environmental changes and adaptation in the Brahmaputra floodplain. Such practices demonstrate the importance of local knowledge and context-specific adaptation strategies.

Livelihood diversification may also reduce excessive dependence on a single source of income. Activities such as livestock rearing, fisheries, small enterprises, wage employment and non-farm work can provide alternative economic opportunities.

However, these opportunities are not equally accessible to all households. Vulnerable rural communities may face limitations arising from inadequate infrastructure, limited financial resources, low educational attainment and geographical isolation.

Consequently, livelihood diversification should be supported through appropriate institutional interventions, skill development, financial inclusion and access to rural markets.

8.6 Regional Disparities in Environmental and Livelihood Vulnerability

Environmental and livelihood vulnerability varies across geographical locations. Differences in river morphology, flood exposure, settlement patterns, agricultural dependency and access to public services influence the conditions of rural communities.

Char areas represent a particularly important geographical context because their inhabitants may experience recurring floods, erosion and land instability. Studies by Kumar and Das (2019), Dekaraja and Mahanta (2021), Saikia and Mahanta (2024a, 2024b) and Bhuyan et al. (2024) demonstrate the importance of examining the environmental and socio-economic circumstances of riverine populations.

Nevertheless, the vulnerability of char dwellers should not be treated as representative of all rural communities in Assam. Other rural areas may experience different combinations of flood exposure, erosion, infrastructure constraints and livelihood dependence.

A broader assessment of regional disparities should therefore consider the distinct conditions of the Brahmaputra and Barak valleys, as well as differences among riverine, agricultural and other rural settlements. District-level comparative research using consistent indicators would be useful for identifying geographical concentrations of vulnerability.

8.7 Institutional Support and Climate-Resilient Rural Development

Government intervention plays an important role in reducing the socio-economic consequences of environmental hazards. Disaster management, agricultural assistance, rural employment programmes, housing support, infrastructure development and social protection can strengthen the resilience of affected communities.

Information published by ASDMA can help identify disaster-affected areas and understand the nature of reported damage. Similarly, the statistical publications of DES Assam provide information on the socio-economic and developmental conditions of different regions.

Effective rural development planning should integrate environmental risk assessment with livelihood security. Riverbank protection, scientific river management, flood forecasting, climate-resilient agricultural practices and rehabilitation support should be considered complementary components of a comprehensive development strategy.

Institutional coordination is particularly important because environmental vulnerability is connected with several sectors, including water resources, agriculture, rural development, disaster management, education and social welfare.

9. Major Observations Emerging from the Reviewed Evidence

The reviewed research articles and government documents indicate several important observations:

1. Environmental vulnerability is multidimensional. Climate variability, floods and riverbank erosion interact with geographical and socio-economic conditions to influence rural livelihoods.

2. Riverbank erosion threatens productive resources. The loss of agricultural land, homesteads and other assets can weaken the economic security of rural households.

3. Migration is an important livelihood response. Environmental displacement may influence occupational mobility and encourage households to seek alternative sources of employment and income.

4. Agricultural dependency increases livelihood sensitivity. Households that rely heavily on agriculture may face greater economic difficulties when environmental hazards damage their productive land and agricultural activities.

5. Adaptive capacity is unevenly distributed. Education, infrastructure, financial resources, employment opportunities and institutional support influence the ability of communities to respond to environmental stress.

6. Char communities experience distinct forms of vulnerability. The reviewed household-level studies demonstrate the importance of considering the specific geographical and socio-economic circumstances of char dwellers.

7. Regional differences require greater attention. Rural communities across Assam do not experience identical environmental conditions or development constraints. Comparative research should therefore account for geographical and socio-economic variations.

These observations represent a synthesis of existing published evidence and official documentation. They should not be interpreted as the results of a newly conducted statistical analysis or a district-level vulnerability index.

10. Policy Implications and Recommendations

The reviewed evidence highlights the need for an integrated approach to environmental risk reduction and rural livelihood development in Assam. The following recommendations are proposed:

10.1 Integrated River Management

The Brahmaputra and Barak river systems require long-term and scientifically informed management strategies. Riverbank protection, sediment monitoring, channel assessment, land-use planning and appropriate flood-management measures should be integrated into regional development planning.

River management interventions should consider local geomorphological conditions and the livelihood requirements of communities residing along riverbanks.

10.2 Promotion of Climate-Resilient Agriculture

Agricultural communities should receive appropriate support for adopting climate-resilient farming practices, diversifying cropping systems and improving agricultural infrastructure.

Access to agricultural extension services, relevant crop insurance schemes, improved seeds, irrigation facilities and climate information should be strengthened, particularly for small and marginal farmers.

10.3 Livelihood Diversification and Skill Development

Alternative livelihood opportunities should be promoted to reduce excessive dependence on agriculture and other environmentally sensitive occupations.

Livestock rearing, fisheries, rural entrepreneurship, vocational training, small enterprises and non-farm employment may provide additional income opportunities. Such initiatives should be supported through financial inclusion, market access and appropriate skill-development programmes.

10.4 Rehabilitation and Social Protection

Households affected by riverbank erosion require appropriate rehabilitation and resettlement support. Such interventions should address housing, access to public services, livelihood

restoration and protection of basic entitlements.

Special attention should be given to displaced households, small and marginal farmers and communities that have repeatedly experienced the loss of land and residential property.

10.5 Strengthening Disaster Preparedness

Flood forecasting, early-warning systems and community-level disaster preparedness should be strengthened. Local institutions and communities should be involved in disaster-management planning, evacuation preparedness and post-disaster recovery.

Improved coordination among relevant government departments would support more effective disaster response and rehabilitation.

10.6 District-Level Vulnerability Monitoring

A systematic vulnerability-monitoring mechanism should be developed using environmental, demographic, agricultural and socio-economic indicators.

Such a database should include information on flood exposure, erosion-related land loss, rural population, agricultural dependency, infrastructure, education and access to institutional support.

The data should be updated regularly, with clear definitions, geographical boundaries and reference periods. District-level monitoring could help policymakers identify vulnerable areas and prioritise development interventions.

10.7 Protection of Vulnerable Riverine Communities

Special emphasis should be placed on protecting char dwellers, small and marginal farmers and households lacking access to basic infrastructure and essential public services.

Development interventions should recognise the specific circumstances of riverine settlements and ensure that environmental risk reduction is accompanied by livelihood protection and social inclusion.

11. Limitations of the Study

The present paper is based entirely on secondary sources and therefore depends on the availability, reliability and comparability of published information.

First, the statistical information released by different government institutions is collected for different reference periods and geographical units. Differences in reporting methods and administrative coverage may create difficulties in comparing indicators across districts and years.

Second, demographic and socio-economic information from the Census of India is not available annually. Consequently, census-based indicators cannot automatically be treated as continuous annual observations.

Third, administrative records may not fully capture informal displacement, household-level livelihood losses and the longer-term economic consequences of riverbank erosion.

Fourth, district-level information may conceal substantial differences among villages and households within the same district. The findings of studies conducted in selected char areas or villages should therefore be interpreted within their respective geographical and methodological limitations.

Finally, this paper does not present original household survey findings, a newly constructed composite vulnerability index or original statistical estimates. It also does not establish causal relationships between climate change, riverbank erosion and livelihood insecurity. Such conclusions would require systematically compiled datasets, appropriate statistical modelling and, where necessary, additional primary research.

12. Conclusion

Climate vulnerability, riverbank erosion and rural livelihood insecurity represent interconnected challenges to sustainable development in Assam. The geographical and hydrological characteristics of the Brahmaputra and Barak river systems, together with recurring floods and erosion, create significant pressures on rural settlements and natural-resource-dependent livelihoods.

The reviewed literature demonstrates that riverbank erosion can result in agricultural land loss, displacement, migration and reduced livelihood security. These consequences are particularly significant for households that depend heavily on agriculture and possess limited economic resources or alternative employment opportunities. The evidence also indicates that access to food, housing, infrastructure, education and institutional support influences the ability of rural communities to cope with environmental hazards.

An important implication of the review is that livelihood vulnerability cannot be understood solely in terms of environmental exposure. The consequences of environmental hazards are shaped by the interaction of geographical conditions, agricultural dependency, household resources, livelihood diversification and adaptive capacity.

Addressing these challenges requires a comprehensive rural development approach that combines scientific river management, climate-resilient agriculture, livelihood diversification, disaster preparedness, rehabilitation and social protection. Particular attention should be directed towards char dwellers, small and marginal farmers and other vulnerable riverine communities.

The paper further highlights the importance of systematically integrating environmental and socio-economic information for district-level vulnerability monitoring. Future empirical research should compile comparable datasets on rainfall, flood exposure, erosion, agriculture, demographic characteristics and rural development indicators. Such research could provide a stronger statistical basis for identifying regional disparities and evaluating the relationship between environmental vulnerability and livelihood insecurity.

Ultimately, sustainable rural development in Assam requires moving beyond a narrowly reactive approach to disaster management towards an integrated strategy that protects productive resources, strengthens adaptive capacity and improves the long-term livelihood security of vulnerable communities.

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