ECONOMY POLITY ENVIRONMENT
An International Peer-reviewed Journal of Social Studies

Livelihood Vulnerability among Tribal Communities in West Bengal

Sourav Kumar Das, Assistant Professor, Department of Economics, Women's College, Calcutta

Sanghita Bhattacharjee*[1] Associate Professor, Department of Economics, Women's College, Calcutta

ARTICLE INFO

Received:
Nov 11, 2025

Accepted:
June 12, 2026

ABSTRACT

In West Bengal, Tribal communities depend heavily on natural and forest-based resources for their livelihoods. However, socio-economic disadvantages, environmental degradation, and dependence on climate-sensitive livelihoods increase their overall vulnerability and limit their adaptive capacity. This study assesses the livelihood vulnerability of Tribal households by constructing a modified Livelihood Vulnerability Index (LVI) using household-level data collected from 348 households in the underdeveloped districts of Purulia, Bankura, and Jhargram during 2023 through a stratified sampling approach. The modified LVI, evaluates vulnerability across five indicators: socio-economic status, livelihood, social security, forest dependency, and health. These dimensions capture the socio-economic pathways through which climate variability and environmental change influence household livelihoods. The findings reveal that Tribal households in Purulia exhibit the highest level of livelihood vulnerability, followed by Jhargram and Bankura. The study recommends strengthening livelihood diversification, sustainable forest management, social protection, healthcare, and educational opportunities to reduce Tribal vulnerability and enhance resilience in climate-sensitive regions.

Keywords: *Livelihood vulnerability, Tribal community, Climate change, Forest dependency*
JEL Code: Q54, Q56, Q23, I32, Q15

[1]*Dr. Sanghita Bhattacharjee, Associate Professor, Department of Economics, Women's College, Calcutta Email: sanghita.bhattacharjee@womenscollegekolkata.ac.in*

1. Introduction

The concept of vulnerability has evolved considerably in recent years. The IPCC Sixth Assessment Report (AR6) defines vulnerability as the propensity or predisposition to be adversely affected by climate change. Vulnerability encompasses sensitivity or susceptibility to harm and the lack of capacity to cope with and adapt to changing climatic conditions (IPCC, 2022). Unlike earlier conceptualizations that treated vulnerability as a function of exposure, sensitivity, and adaptive capacity, AR6 identifies exposure as a distinct dimension of climate risk. Accordingly, climate risk is understood to arise from the interaction of climate hazards, exposure, and vulnerability, where vulnerability itself reflects the susceptibility of individuals, communities, and ecosystems to harm and their limited ability to anticipate, cope with, recover from, and adapt to adverse climatic events.

This understanding closely aligns with the United Nations Office for Disaster Risk Reduction (UNDRR) under the Sendai Framework for Disaster Risk Reduction (2015–2030). UNDRR defines vulnerability as the conditions determined by physical, social, economic, and environmental factors or processes that increase the susceptibility of an individual, community, assets, or systems to the impacts of hazards (UNDRR, 2017). The Sendai Framework emphasizes that vulnerability is multidimensional and socially constructed, arising from inequalities, poverty, inadequate governance, environmental degradation, and limited access to resources and services. Consequently, reducing disaster risk requires not only mitigating hazard exposure but also strengthening resilience through improved adaptive capacity, social protection, inclusive governance, sustainable livelihoods, and ecosystem conservation.

In the context of climate-sensitive regions such as the Indian Sundarbans, this integrated perspective is particularly relevant. Households are exposed to recurrent cyclones, sea-level rise, salinity intrusion, and changing rainfall patterns, while vulnerability is shaped by socio-economic disadvantages such as dependence on climate-sensitive livelihoods, poverty, inadequate infrastructure, limited healthcare access, gender inequalities, and restricted livelihood diversification. Enhancing adaptive capacity through livelihood diversification, improved public services, disaster preparedness, social safety nets, and ecosystem-based adaptation can therefore substantially reduce climate vulnerability and strengthen long-term resilience.

While the Sundarbans exemplify the interaction between climatic hazards and socio-economic vulnerability, other ecologically fragile and socio-economically marginalized regions of West Bengal also experience similar livelihood challenges arising from their distinct environmental and socio-economic contexts. Across many developing countries, Tribal populations depend heavily on forests and other common property resources for their livelihoods. Forest products—including food, fuelwood, fodder, timber, and medicinal plants—serve not only as essential sources of subsistence but also as important contributors to household income (Angelsen et al., 2014; Mukul et al., 2016). In West Bengal, Tribal communities inhabiting the districts of Purulia, Bankura, and Jhargram rely extensively on forest-based and other natural resource-dependent livelihoods. However, increasing climate variability, recurrent droughts, rising temperatures, erratic rainfall, and environmental degradation have reduced the

productivity and reliability of these resources, thereby undermining livelihood security and weakening household adaptive capacity. As a result, these communities face heightened vulnerability to both immediate climatic shocks and long-term socio-economic stresses, highlighting the need for place-based assessments that can inform targeted adaptation and resilience-building strategies.

Against this backdrop, the present study assesses the livelihood vulnerability of Tribal households in the climate-sensitive districts of Purulia, Bankura, and Jhargram, where recurrent droughts, rainfall variability, declining forest productivity, and environmental degradation increasingly influence livelihood opportunities. Rather than measuring climatic hazards directly, the study examines how these stresses are manifested through household socio-economic conditions, livelihood dependence, forest dependency, social security, and health, which together determine the adaptive capacity of Tribal communities.

2. Literature Survey

Climate change has emerged as a major driver of livelihood insecurity, particularly among marginalized communities that depend heavily on natural resources. Recent literature conceptualizes vulnerability as a function of climate hazards, exposure, sensitivity, and adaptive capacity rather than climatic events alone (IPCC, 2022). The IPCC Sixth Assessment Report emphasizes that climate risks are closely linked with poverty, inequality, weak governance, and limited access to livelihood assets. This makes socially disadvantaged groups disproportionately vulnerable because of their lower adaptive capacity (IPCC, 2022; Pandey et al., 2022). Similarly, recent reviews advocate multidimensional approaches that integrate socio-economic conditions, institutional capacity, livelihood diversification, and ecosystem dependence to better understand livelihood vulnerability in developing countries (Zainab & Shah, 2024).

District-level studies further demonstrate that vulnerability extends beyond environmental exposure to include socio-economic deprivation and institutional exclusion. The Council on Energy, Environment and Water (CEEW, 2021) identifies low income, poor infrastructure, inadequate healthcare, and dependence on climate-sensitive occupations as major determinants of vulnerability, highlighting the importance of localized assessments that combine socio-economic and environmental dimensions.

Forest ecosystems remain central to rural livelihoods, particularly among Tribal and indigenous communities. Forests provide food, fuelwood, fodder, medicinal plants, and supplementary income. However, climate variability, biodiversity loss, and environmental degradation have reduced the reliability of these resources (FAO, 2022). Consequently, Tribal communities that rely heavily on forests and rain-fed agriculture face greater livelihood insecurity despite possessing valuable indigenous knowledge for climate adaptation (Kumar et al., 2025).

Social protection and health are increasingly recognized as key determinants of adaptive capacity. Employment guarantee programmes, food security schemes, pensions, and health insurance reduce households' sensitivity to climate shocks and strengthen long-term resilience (ILO, 2021). Likewise, inadequate sanitation, unsafe drinking water, poor nutrition, and limited

access to healthcare increase livelihood vulnerability by reducing labour productivity and imposing additional financial burdens on households (WHO, 2023). Evidence from the Indo-Gangetic Plains further suggests that livelihood diversification, education, institutional support, and access to extension services substantially enhance resilience to climate change (Venus et al., 2022). In addition, multidimensional poverty assessments reveal that simultaneous deprivations in health, education, housing, sanitation, and living standards create persistent cycles of vulnerability that cannot be adequately captured through income-based measures alone (UNDP, 2024).

Methodologically, the Livelihood Vulnerability Index (LVI) developed by Hahn et al. (2009) has become one of the most widely applied tools for assessing household vulnerability. Recent studies have adapted the framework by incorporating context-specific indicators related to socio-economic conditions, adaptive capacity, livelihood diversification, forest dependence, and institutional support, making it suitable for diverse ecological and socio-economic settings (Kumar et al., 2024; Kumar et al., 2025).

Despite these advances, empirical evidence on the livelihood vulnerability of Tribal communities in West Bengal remains limited. Existing studies have largely focused on climate vulnerability, poverty, or forest dependence separately, with relatively few attempts to integrate socio-economic status, livelihood characteristics, social security, forest dependency, and health into a comprehensive household-level vulnerability assessment. To address this gap, the present study develops a modified Livelihood Vulnerability Index for Tribal households in Purulia, Bankura, and Jhargram districts. By comparing inter-district variations across multiple dimensions of vulnerability, the study contributes to the growing literature on climate resilience and provides policy-relevant evidence for strengthening the adaptive capacity of marginalized Tribal communities.

In the three districts selected for this study, Tribal populations form a significant portion of the local demographic: 10.25 % in Bankura**,** 14.88 % in Paschim Medinipur**,** and 18.45 % in Purulia**,** as per the 2011 Census. These figures highlight the relevance of focusing on these communities, as their socio-economic vulnerabilities are compounded by their numerical significance in these regions. This demographic concentration makes these areas critical for understanding and addressing the specific vulnerabilities of Tribal communities in the context of climate change and environmental degradation.

3. Methodology

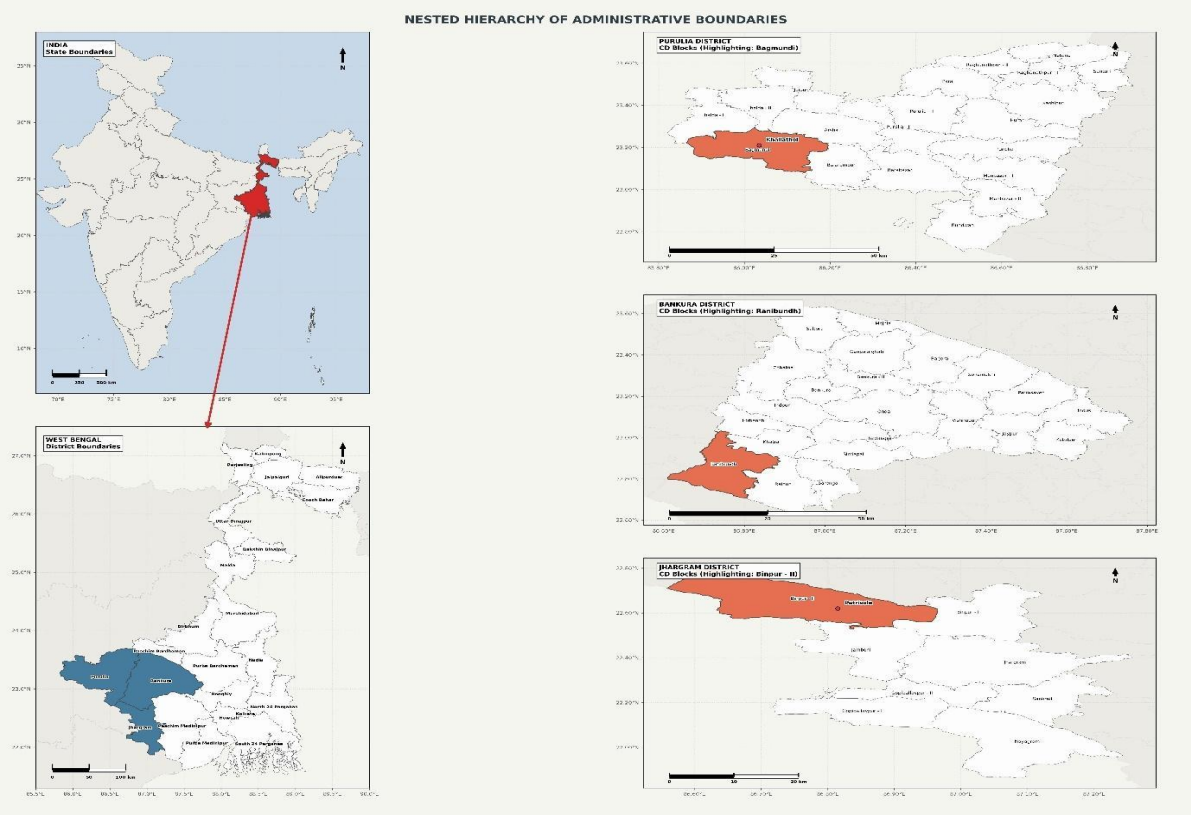
3.1 Study Area

The study was conducted in three predominantly Tribal districts of the western plateau region of West Bengal—Purulia, Bankura, and Jhargram. These districts form part of the Chota Nagpur Plateau fringe and are characterized by undulating topography, lateritic soils, dry deciduous forests, and a tropical monsoon climate. The region experiences relatively low and erratic rainfall, frequent droughts, and high dependence on rain-fed agriculture, making rural livelihoods particularly sensitive to climatic variability.

The selected districts have a high concentration of Scheduled Tribe populations and are among the relatively less developed regions of the state. Livelihoods are primarily based on agriculture, wage labour, and the collection of non-timber forest products (NTFPs), rendering households highly dependent on natural resources. Environmental degradation, declining forest productivity, and climate variability have further increased livelihood insecurity.

The study was carried out in three villages: Khaliathol in Bagmundi Block (Purulia), Kamo in Ranibandh Block (Bankura), and Patrisole in Binpur II Block (Jhargram), as illustrated in Figure 1. These villages were purposively selected because they represent Tribal-dominated settlements with substantial dependence on forest resources and climate-sensitive livelihoods.

Figure 1



Source: Google Maps; figure compiled by the authors using AI-assisted tools

3.2 Data Collection Procedure

Primary data were collected between January and December 2023 through a structured household survey. Prior to data collection, preliminary field visits were conducted to familiarize the investigators with the study villages and to establish rapport with local communities. A pre-tested interview schedule was administered through face-to-face interviews with the household head or another knowledgeable adult member.

The questionnaire collected information on household demographic characteristics, education, occupation, income, landholding, livelihood diversification, forest dependency, access to social security programmes, housing and sanitation, drinking water, healthcare utilization, and other variables relevant to livelihood vulnerability. Secondary information on socio-economic conditions, Tribal population, and district characteristics was obtained from the Census of India, Government of West Bengal publications, NITI Aayog reports, and other published literature. Ethical considerations were maintained throughout the survey. Participation was voluntary, informed consent was obtained from all respondents prior to the interview, and the confidentiality and anonymity of respondents were ensured.

3.3 Sample

A stratified sampling technique was adopted. The three districts constituted the primary strata. Within each district, one Tribal-dominated village was purposively selected based on the concentration of Tribal households and dependence on forest-based livelihoods. Subsequently, households were selected using systematic random sampling from village household lists. A total of 348 households were surveyed, comprising 123 households from Purulia, 118 from Bankura, and 107 from Jhargram.

Table 1 presents the distribution of the sample, which was drawn from three villages across selected districts. Khaliathol is from the Bagmundi block in Purulia district, Patrisole is from the Binpur II block in Jhargram district, and Kamo is from the Ranibandh block in Bankura district. The total sample size is 348.

Table 1: Sample size of the selected districts

Sample Size (in numbers)				
Year	District			
	Purulia	Bankura	Jhargam	Total
2023	123	118	107	348

Source: Field Survey, 2023

3.4 Analytical Technique

This study adopts the Livelihood Vulnerability Index (LVI) proposed by Hahn et al. (2009) as the analytical framework to assess household livelihood vulnerability. To reflect the socio-economic and ecological characteristics of Tribal communities in western West Bengal, the original framework was modified by selecting indicators relevant to the study context. The modified LVI comprises five indicators—Socio-economic Status, Livelihood, Social Security, Forest Dependency, and Health—represented by fifteen sub-indicators (Table 2).

Table 2: Livelihood Vulnerability Index

Main Indicators	**Sub-Indicators**	**Description**
Socio-economic Index	Dependent People	In Percentage
	Female Headed Households	If Yes=1, No=0
	Education	Mean Education
	Land Holding	In Acre
Livelihood Index	Type of Livelihood Activity	In Numbers
	Occupation of Head	Collection of NTFP=1, Agriculture=2, Wage Labour=3, Service=4, Others=5
	Monthly Per Capita Income	In Rupees
Social Security Index	Income from MGNREGA	In Percentage
	Benefit in PDS	If Yes=1, No=0
	Social Security Schemes	In Number
Forest Dependency Index	Income from Forest	In Percentage
	Household dependent on Forest	If Yes=1, No=0
	Number of Product Collected from Forest	In Numbers
Health Index	HHs do not have toilets	
	HHs do not receive treatment	
	HHs do not have Drinking Water Facility	

Source: Adapted from Hahn et al. (2009) and modified by the authors

3.5 Livelihood Vulnerability Index

The original Livelihood Vulnerability Index proposed by Hahn et al. (2009) consists of seven major components: socio-demographic profile, livelihood strategies, social networks, health, food, water, and natural disasters and climate variability. In the present study, this framework was modified to suit the objectives of the household survey and the local context. Consequently, the natural disasters and climate variability component was not incorporated as a separate dimension.

Instead, the influence of climate variability is captured indirectly through indicators of livelihood conditions, forest dependency, health, and access to social security, which influence household sensitivity and adaptive capacity.

The modified LVI therefore comprises five major indicators and fifteen sub-indicators (Table 2), providing a context-specific measure of livelihood vulnerability among Tribal households in western West Bengal. As the sub-indicators were measured on different scales- including binary variables (0/1), percentages, counts, and continuous variables such as monthly per capita income and landholding—they were first transformed into dimensionless values using the min–max normalization method proposed by Hahn et al. (2009). This standardization ensures comparability across indicators.

$$\text{Index}_{SV} = \frac{Xv - Xmin}{Xmax - Xmin} \quad \ldots\ldots\ldots\ldots\ldots\text{Eq. (1)}$$

Where,

Xv = Original sub-component or indicator value

$Xmax$ = the maximum observed value of the sub-indicator

$Xmin$ = the minimum observed value of the sub-indicator

Binary variables (e.g., female-headed household, receipt of PDS benefits, household dependence on forests) were coded as 1 for the presence of the attribute and 0 otherwise. Percentage variables (e.g., dependency ratio, income from forests, income from MGNREGA) were entered in their observed percentage values, while continuous variables such as monthly per capita income, mean years of education, landholding, and the number of forest products collected were normalized using Equation (1).

For indicators positively associated with vulnerability (e.g., dependency ratio, forest dependence, lack of sanitation), higher normalized values indicate greater vulnerability. Conversely, for indicators that enhance adaptive capacity (e.g., education, landholding, monthly per capita income, access to social security programmes, and healthcare), reverse normalization was applied so that higher values correspond to lower vulnerability. This ensured that all normalized sub-indicators ranged from 0 (least vulnerable) to 1 (most vulnerable) and were comparable prior to aggregation. The normalized sub-indicators were then averaged with equal weights to obtain each of the five main indices, and the overall Livelihood Vulnerability Index (LVI) was computed as the arithmetic mean of these five component indices.

$$LVI_j = \frac{1}{n}\sum_{i=1}^{n} Iij \quad \ldots\ldots\ldots\ldots\ldots\text{Eq. (2)}$$

LVI_j = Livelihood Vulnerability Index for district j

Iij = normalized value of the i-th dimension

n = 5 (the five major indicators)

Following normalization, the composite Livelihood Vulnerability Index was calculated as the arithmetic mean of the five equally weighted indicators. Equal weighting was adopted to avoid introducing subjective bias in the absence of evidence supporting differential weights.

4. Results and Discussion

4.1 Livelihood Vulnerability Index Score:

Table 3 presents the composite Livelihood Vulnerability index (LVI) and its five component indices for each district. Higher index values indicate greater livelihood vulnerability.

Table 3: Livelihood Vulnerability Index Score across Study Districts

Main Indicators	Purulia	Bankura	Jhargram
Socio-economic Index	0.365	0.198	0.343
Livelihood Index	0.574	0.354	0.499
Social Security Index	0.301	0.211	0.152
Forest Dependency Index	0.141	0.098	0.121
Health Index	0.695	0.521	0.541
Livelihood Vulnerability Index	**0.415**	**0.276**	**0.331**

Source: Field Survey, 2023

The results indicate spatial variations in livelihood vulnerability across the three districts studied. Purulia records the highest vulnerability (0.415), followed by Jhargram (0.331) and Bankura (0.276). This higher vulnerability observed in Purulia is attributed to lower socio-economic conditions, limited livelihood opportunities, weaker social security and greater health-related vulnerability. Bankura exhibits the lowest overall vulnerability, reflecting comparatively favourable socio-economic conditions and better livelihood security. Jhargram occupies an intermediate position, with moderate levels of vulnerability across most indicators.

Additionally, as observed in Table 3, the Health Index records the highest value across all three districts, indicating that health-related factors constitute the most significant source of livelihood vulnerability among Tribal households. This suggests that inadequate health status, poor nutritional outcomes, and limited access to healthcare services continue to constrain household well-being and resilience. Health serves a dual role: as a consumption good, it provides direct satisfaction and utility, and as an investment good, it enhances productivity, reduces absenteeism, and improves earning capacity (Grossman, 1972). Consequently, investments in healthcare and nutrition can strengthen household resilience and reduce overall livelihood vulnerability.

Poor households are especially vulnerable to health risks due to factors such as crowded living conditions, unhygienic environments, and insufficient access to essential amenities like clean water, sanitation facilities, waste disposal systems, and primary health care services (Montgomery and Hewett, 2005). Poor health not only diminishes an individual's earning

capacity but also leads to significant expenditures on medical treatment. These expenses can rapidly deplete savings, forcing households to seek loans from informal sources to cover their healthcare costs.

The findings underscore the severe livelihood vulnerability faced by Tribal communities in Purulia. The district's low socio-economic status, high reliance on forest resources, and limited access to social security and healthcare services collectively contribute to its elevated vulnerability level. In contrast, Jhargram and Bankura exhibit relatively better conditions, though challenges persist across all three districts.

5. Policy Implications

The findings highlight the need for integrated, place-specific interventions to reduce the livelihood vulnerability of Tribal communities in the western districts of West Bengal. Since vulnerability arises from the interaction of socio-economic deprivation, forest dependence, inadequate healthcare, and limited livelihood opportunities, policy responses should simultaneously strengthen adaptive capacity and reduce sensitivity to climate-related shocks.

First, livelihood diversification should be prioritized by promoting skill development, entrepreneurship, agroforestry, horticulture, livestock rearing, and small-scale forest-based enterprises to reduce excessive dependence on declining forest resources. Capacity-building programmes under the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) and the National Rural Livelihood Mission (NRLM) can be tailored to the needs of Tribal households.

Second, sustainable forest management should be strengthened through community participation under the Forest Rights Act, 2006, and Joint Forest Management (JFM). Promoting value addition and marketing of non-timber forest products (NTFPs) through the Minimum Support Price (MSP) Scheme for Minor Forest Produce and TRIFED can enhance household incomes while conserving forest resources.

Third, social protection programmes should be expanded to improve livelihood security. Greater access to MGNREGA, the Public Distribution System (PDS), old-age pensions, health insurance under Ayushman Bharat–PM-JAY, and other welfare schemes can reduce household vulnerability by providing income support and improving food and health security.

Fourth, strengthening rural healthcare infrastructure, safe drinking water, sanitation facilities, and nutrition services through the National Health Mission (NHM) and Jal Jeevan Mission would substantially reduce health-related vulnerability, which emerged as the most vulnerable dimension across the study districts.

Finally, climate-resilient development strategies should focus on improving irrigation facilities, drought-resilient agriculture, watershed management, and climate information services. Such interventions would strengthen the adaptive capacity of Tribal households and contribute to achieving the Sustainable Development Goals relating to poverty reduction, food security, health, and climate action.

6. Conclusion

This study assessed the livelihood vulnerability of Tribal households in the districts of Purulia, Bankura, and Jhargram by developing a modified Livelihood Vulnerability Index (LVI) comprising five indicators: socio-economic status, livelihood, social security, forest dependency, and health. The multidimensional framework enabled a comprehensive assessment of the factors influencing household vulnerability beyond conventional income-based measures.

The findings reveal considerable inter-district variation in livelihood vulnerability. Among the three districts, Purulia exhibited the highest overall vulnerability, followed by Jhargram and Bankura. Poor socio-economic conditions, limited livelihood diversification, dependence on forest resources, inadequate access to social security, and poor health outcomes were identified as the principal drivers of vulnerability. Notably, the health dimension recorded the highest vulnerability scores across all districts, underscoring the importance of healthcare, sanitation, safe drinking water, and nutrition in shaping household resilience. The results also demonstrate that households with greater dependence on climate-sensitive and forest-based livelihoods are more vulnerable to environmental and economic shocks.

The study contributes to the literature by extending the Livelihood Vulnerability Index framework to the context of Tribal communities in western West Bengal. Unlike previous studies that primarily focused on single dimensions of vulnerability, this research integrates socio-economic status, livelihood characteristics, social security, forest dependency, and health into a unified household-level assessment. The modified index provides a context-specific tool for identifying vulnerable households and supports evidence-based planning for climate adaptation and rural development.

From a policy perspective, the findings suggest that reducing Tribal vulnerability requires coordinated interventions that combine livelihood diversification, sustainable forest management, improved healthcare, expanded social protection, and climate-resilient rural infrastructure. Strengthening the implementation of programmes such as MGNREGA, the Public Distribution System (PDS), Ayushman Bharat–PM-JAY, the Forest Rights Act, TRIFED, and the National Rural Livelihood Mission (NRLM) can substantially enhance the adaptive capacity and resilience of Tribal households. Integrating these programmes with locally tailored climate adaptation strategies would further support sustainable livelihood development in the region.

The study has certain limitations. It is based on cross-sectional household data collected from three villages in three districts and therefore captures vulnerability at a single point in time. The selected indicators, although comprehensive, may not fully represent all social, cultural, institutional, and environmental dimensions of vulnerability. Furthermore, equal weighting of indicators, following the conventional LVI approach, may not reflect the relative importance of individual components.

Future research may employ longitudinal or panel data to examine changes in household vulnerability over time and assess the long-term impacts of climate change and policy interventions. Comparative studies across different ecological regions of India, the

incorporation of geospatial and climatic datasets, and the application of advanced weighting techniques such as Principal Component Analysis (PCA), the Analytic Hierarchy Process (AHP), or machine-learning approaches could further improve vulnerability assessment and provide stronger guidance for policy formulation.

Declarations

Funding: No funding was received for the preparation of this manuscript.

Conflicts of interest/Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Availability of data and material: Field survey

References

[1] Angelsen, A., et al. (2014). Environmental income and rural livelihoods: A global-comparative analysis. World Development, 64 (Suppl. 1), S12–S28. https://doi.org/10.1016/j.worlddev.2014.03.006

[2] Council on Energy, Environment and Water. (2021). Mapping India's climate vulnerability: A district-level assessment. Council on Energy, Environment and Water.

[3] Food and Agriculture Organization of the United Nations. (2022). The State of the World's Forests 2022: Forest pathways for green recovery and building inclusive, resilient and sustainable economies. FAO.

[4] Grossman, M. (1972). On the concept of health capital and the demand for health. Journal of Political Economy, 80(2), 223–255. https://doi.org/10.1086/259880

[5] 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

[6] International Labour Organization. (2021). World social protection report 2020–22: Social protection at the crossroads—In pursuit of a better future. International Labour Office.

[7] Intergovernmental Panel on Climate Change. (2022). Climate change 2022: Impacts, adaptation and vulnerability. In H.-O. Pörtner, et al. (Eds.), Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[8] Kumar, A., Devi, J. P., & Mohanasundari, T. (2025). Climate change impact assessment on livelihood vulnerability of tribal communities: A systematic review. Mitigation and Adaptation Strategies for Global Change, 30, Article 56. https://doi.org/10.1007/s11027-025-10226-9

[9] Kumar, P., Ashwani, Mishra, S., et al. (2024). Vulnerability of tribal communities to climate variability in Lahaul and Spiti, Himachal Pradesh, India. İstanbul University Journal of Geography, (48), 65–84.

[10] Mukul, S. A., et al. (2016). Role of non-timber forest products in sustaining forest-based livelihoods and rural households' resilience capacity in and around protected areas: A Bangladesh study. Journal of Environmental Planning and Management, 59(4), 628–642. https://doi.org/10.1080/09640568.2015.1035774

[11] Pandey, R., et al. (2022). Poverty, livelihoods and sustainable development. In H.-O. Pörtner, et al (Eds.), Climate change 2022: Impacts, adaptation and vulnerability (pp. 1171–1274). Cambridge University Press.

[12] United Nations Development Programme. (2024). Global multidimensional poverty index 2024: Poverty amid conflict. UNDP.

[13] Venus, T. E., et al. (2022). Livelihood vulnerability and climate change: A comparative analysis of smallholders in the Indo-Gangetic Plains. Environment, Development and Sustainability, 24 (2), 1981-2009. https://doi/10.1007/s10668-021-01516-8

[14] World Health Organization. (2023). World health statistics 2023: Monitoring health for the SDGs. World Health Organization.

[15] Zainab, A., & Shah, K. U. (2024). Taking stock of recent progress in livelihood vulnerability assessments to climate change in the developing world. Climate, 12(7), Article 100. https://doi.org/10.3390/cli12070100