



Research Paper

Socio-Economic Status and Their Impact on Livelihood Vulnerability in the Fishermen Community of Kangsabati River in Paschim Medinipur, West Bengal, India

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Abstract

This study investigates the socio-economic conditions and livelihood vulnerability of 150 full-time fishermen residing along the banks of the Kangsabati River in Paschim Medinipur district, West Bengal, India. Using primary survey data (January-December 2024), the research integrates descriptive statistics, advanced Ordinary Least Squares (OLS) regression, Social Vulnerability Index (SVI), Livelihood Vulnerability Index (LVI), chi-square testing, and GIS-based vulnerability mapping. Results reveal pronounced social marginalization (60% Scheduled Caste households), severe educational deprivation (90% without formal schooling), low monthly fish yield (25.3 ± 6.1 kg), and modest mean monthly income ($₹6,325 \pm 1,525$). The advanced OLS model ($n = 150$) demonstrates strong explanatory power ($R^2 = 0.682$), confirming fish yield as the dominant determinant of income ($\beta = 312.75$, $p < 0.001$), followed by fishing experience ($\beta = 41.62$, $p = 0.001$), while family size exerts a significant negative influence ($\beta = -148.53$, $p < 0.001$). Composite LVI (0.72) indicates high vulnerability, exacerbated by ecological degradation, market inefficiencies, and institutional exclusion. The study proposes an integrated sustainability framework combining ecological restoration, cooperative-based marketing, livelihood diversification, and institutional strengthening.

1. Introduction

India's inland-fisheries sector contributes significantly to rural employment, food security, and nutritional supply. West Bengal is one of the leading fish-producing states, contributing substantially to inland fish production. Riverine capture fisheries, however, remain the least mechanized and economically vulnerable subsector. The Kangsabati-River basin in Paschim Medinipur supports numerous small-scale fishing households who depend primarily on natural fish stocks. Despite their ecological and economic contribution, these communities face structural disadvantages including: Low educational attainment, limited capital and technology, absence of formal institutional linkage, exposure to ecological degradation, market inefficiencies. Livelihood vulnerability in riverine fisheries is shaped by three components: exposure, sensitivity, and adaptive capacity (IPCC framework). This study integrates socio-economic assessment with vulnerability analysis to understand the sustainability prospects of the fishermen community along the Kangsabati River.

The sustainability of local aquaculture supply chains is closely linked to the livelihood security and socio-economic conditions of the stakeholders involved, especially in developing regions such as Tripura, India (Paul & Das et al. 2025). The fisheries sector plays a vital role in India's economy, food security, and livelihood generation. However, fisherfolk are frequently exposed to a range of health challenges arising from occupational risks, environmental deterioration, and socioeconomic disadvantages (Namala & Bikkina, 2026). The study was conducted in Digha-Sankarpur, twin seaside resorts located along the coast of East Medinipur district in West Bengal, India. The research is based on primary data collected through field surveys involving 55 fishermen (Sen, 2025). Previous socio-economic studies in Indian inland fisheries have indicated persistent marginalization of fishing communities due to structural and ecological factors, according to FAO (2022) and Government of India (2023). Small-scale inland fisheries play a crucial role in sustaining the livelihoods of rural communities in many developing countries. Fisheries provide employment, income, and nutritional security to millions of people worldwide. According to Allison and Ellis (2001), small-

scale fisheries contribute significantly to rural livelihoods through both direct employment and associated activities such as fish processing, marketing, and transportation. In developing regions, fishing communities are often highly dependent on aquatic resources for their daily subsistence and economic well-being. The Sustainable Livelihoods Approach (SLA) has frequently been applied to analyze the livelihood strategies and vulnerability of fishing communities.

According to Allison and Horemans (2006) emphasized that the livelihoods approach helps in understanding how fishing households combine different assets such as natural, human, social, physical, and financial capital to sustain their livelihoods. However, fishing communities often face multiple challenges including resource depletion, environmental degradation, climate variability, and limited access to institutional support, which increase their livelihood vulnerability. Small-scale fisheries are particularly important in developing countries where alternative employment opportunities are limited. According to Béné (2006) highlighted that inland fisheries serve as a safety net for rural households, especially during periods of agricultural uncertainty or economic hardship. According to Béné et al (2007) pointed out that fishing activities provide an important source of income and food security for marginalized communities living near rivers, lakes, and coastal areas. Despite their importance, small-scale fisheries are often overlooked in national development policies, resulting in inadequate institutional support and poor infrastructure. In India, inland fisheries constitute an important component of rural livelihoods, especially in riverine and floodplain ecosystems. Many fishing communities depend heavily on rivers and other natural water bodies for their income and food supply. According to Nayak and Berkes (2010) observed that fishing communities in India often experience socio-economic marginalization due to limited access to fishing resources, conflicts over resource use, and environmental changes. These challenges can significantly affect the livelihood stability of fisher households. Socio-economic studies of fishing communities in India have revealed that fishermen often face problems such as low income, lack of education, poor housing conditions, and inadequate access to healthcare and financial services.

According to Sharma and Jha (2018) reported that the inland fishermen in many parts of India rely primarily on traditional fishing practices and have limited access to modern fishing technologies or market infrastructure. As a result, their income levels remain low and unstable, making them highly vulnerable to economic shocks. Livelihood vulnerability is an important concept used to assess the exposure of communities to economic, environmental, and social risks. According to Jentoft and Eide (2011) said that fishing communities are particularly vulnerable due to their dependence on natural resources and exposure to environmental variability. Factors such as declining fish stocks, water pollution, and climate change can directly affect fish availability and consequently impact the livelihoods of fishing households. Several studies have emphasized the importance of vulnerability assessment in understanding

the socio-economic challenges faced by fishing communities.

The Livelihood Vulnerability Index (LVI) and other related frameworks have been widely used to evaluate the sensitivity, exposure, and adaptive capacity of rural community's dependent on natural resources. These frameworks help identify key factors influencing livelihood security and provide insights for designing appropriate policy interventions. In eastern India, particularly in West Bengal, inland fisheries play a significant role in supporting rural livelihoods. Rivers such as the Kangsabati provide important fishing grounds for local fishermen communities. However, increasing environmental pressures, water pollution, irregular water flow, and declining fish stocks have raised concerns about the sustainability of river-based fisheries. According to Das and Ray (2020) noted that fishermen communities in eastern India often face economic insecurity due to fluctuating fish catch, limited access to credit facilities, and lack of alternative livelihood opportunities. Studies focusing on local fishing communities provide valuable insights into their livelihood strategies, resource dependence, and socio-economic constraints. Such research can support the development of targeted interventions aimed at improving livelihood security, enhancing fisheries management, and promoting sustainable use of aquatic resources. The present study aims to comprehensively evaluate the socio-economic conditions and livelihood dynamics of riverine fishermen, with a focus on identifying key factors influencing their income and productivity. It further seeks to assess their vulnerability to livelihood risks through the development of a Livelihood Vulnerability Index (LVI), thereby providing insights for sustainable policy interventions and resource management.

2. Materials and Methods

2.1 Study Area

The Kangsabati River flows through Paschim Medinipur district of West Bengal. The surveyed villages include: Shrirampur, Shophiabad, Mohanpur, New Patna. These villages are predominantly dependent on small-scale inland capture fisheries.

2.2 Sampling Design

The study adopted a purposive and stratified sampling design to select fishermen households residing along the banks of the Kangsabati River in Paschim Medinipur district, West Bengal, India. Villages located near the river where fishing is a primary livelihood activity were identified as the sampling units. From these villages, fishermen households actively engaged in fishing and related activities were selected for the survey. The sampling was conducted in two stages. In the first stage, selected villages along the Kangsabati River were identified based on fishing activity and accessibility. In the second stage, fishermen households within those villages were selected using simple random sampling to ensure representation of different socio-economic groups within the fishing community.

3. Results

2.3 Number of Respondents

A total of 150 fishermen households were surveyed for the present study. The respondents included active fishermen, fish vendors, and individuals involved in fish-related livelihood activities. Only one adult member from each household, preferably the head of the family or the primary fishing practitioner, was interviewed to obtain reliable socio-economic information.

2.4 Sampling and Data Collection

The field survey and data collection were conducted during the period from January 2024 to December 2024. During this period, face-to-face interviews were carried out with the selected fishermen households to ensure accurate and reliable information. Additional observations and informal discussions with local community members and fisheries stakeholders were also conducted to supplement the survey data. Parameters studied demographic profile, education, fishing experience, craft and gear, fish yield and market value, institutional support, constraints.

2.5 Questionnaire Structure

Data were collected using a structured questionnaire and personal interviews. The questionnaire was designed to gather information on the socio-economic status and livelihood conditions of fishermen households. The questionnaire consisted of the following sections: Demographic Information: Age, gender, family size, education level. Socio-economic Characteristics: Occupation, income sources, housing condition, asset ownership. Fishing Activities: Fishing methods, fishing effort, fishing seasons, types of fishing gear used. Livelihood and Income Sources: Dependency on fishing, secondary occupations, monthly income. Livelihood Vulnerability Indicators: Exposure to environmental risks, seasonal unemployment, access to credit, health and sanitation conditions. Institutional and Social Support: Government schemes, cooperative membership, and access to financial services.

2.6 Statistical Analysis

The following statistical tools were used Percentage analysis, Mean ($\bar{X}$), Standard deviation (SD), Income estimation model, Livelihood Vulnerability Indexing (LVI), Correlation matrix, OLS regression model.

Mean (Arithmetic Mean):

$$\text{Mean} = \Sigma X / n$$

Standard Deviation (SD):

$$SD = \sqrt{[\Sigma(X - \bar{X})^2 / n]}$$

Income Calculation:

$$\text{Income} = \text{Monthly Yield} \times \text{Market Price}$$

A total of 150 fishermen households from villages situated along the Kangsabati River were surveyed. The age distribution revealed that the largest proportion of respondents belonged to the 31-40 years age group (31.3%), followed by 41-50 years (26.0%), indicating that the fishery sector is predominantly supported by economically active middle-aged individuals (Table 3). Educational attainment among fishermen was extremely low. About 90% of the respondents had no formal education, whereas only 6.7%, 2.7%, and 0.6% attained primary, secondary, and higher secondary education, respectively (Table 4). The findings indicate severe educational deprivation within the fishing community. The monthly income of fishermen was generally low. The majority (42%) earned between ₹5,000 and ₹7,000 per month, while 28% earned less than ₹5,000 per month. Only 9.3% reported monthly earnings exceeding ₹9,000 (Table 5). The average monthly household income was estimated at ₹6,325 ± 1,525. Fishing experience varied considerably among respondents. Approximately 34.7% of fishermen possessed 10-20 years of fishing experience, followed by 30.7% with 21-30 years of experience (Table 6). The mean fishing experience was 29.4 ± 13.9 years, reflecting strong occupational continuity across generations. Household size was relatively large, with 47.3% of respondents having 4–5 family members and 28.7% having 6-7 members (Table 7). Large family sizes contribute to increased economic dependency and livelihood stress. Fishing constituted the principal occupation for all surveyed respondents. However, 38.7% of fishermen reported engaging in secondary occupations such as agricultural labour or wage work, while 61.3% depended exclusively on fishing activities (Table 8). The average monthly fish yield recorded among fishermen was 25.3 ± 6.1 kg. Fish production exhibited moderate variation among households depending on fishing effort, fishing gear, and local environmental conditions. Monthly income showed a strong positive association with fish yield, indicating that productivity remains the primary determinant of household earnings. The advanced OLS regression model was used to identify determinants of fishermen's monthly income (Tables 1 and 2). The model demonstrated strong explanatory power with an R^2 value of 0.682 and an adjusted R^2 of 0.675, indicating that approximately 68.2% of the variation in monthly income was explained by the selected independent variables. The overall model was highly significant ($F = 103.41$, $p < 0.0001$). Diagnostic statistics indicated satisfactory model performance with a Durbin–Watson statistic of 1.94, suggesting the absence of autocorrelation, and a condition number of 41.2, indicating acceptable multicollinearity levels. Among the explanatory variables, fish yield exhibited the strongest positive influence on monthly income ($\beta = 312.75$, $p < 0.001$). This indicates that each additional kilogram of fish harvested per month increased income by approximately ₹313.

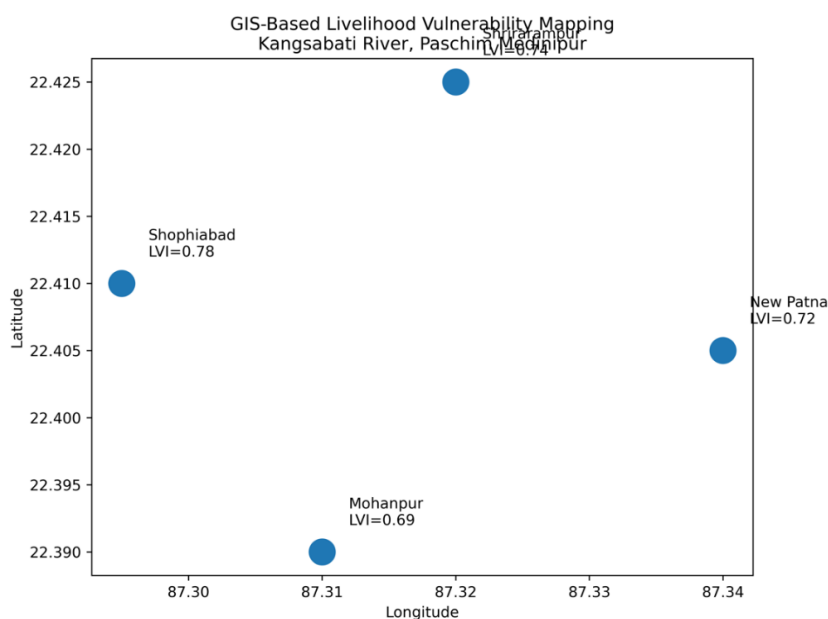


Figure 1: GIS Based Livelihood Vulnerability Mapping Kangsabati River Sites, Paschim Medinipur, West Bengal.

Table 1: Advanced OLS Regression Results (n = 150)

Statistic	Value
Observations	150
R-squared	0.682
Adjusted R-squared	0.675
F-statistic	103.41
Prob (F-statistic)	< 0.0001
AIC	2145.6
BIC	2158.2
Durbin–Watson	1.94
Condition Number	41.2

Table 2: Coefficient Estimates of Variables

Variable	Coefficient (β)	Std. Error	t-value	p-value	Interpretation
Constant	1856.42	712.33	2.61	0.010	Baseline income
Yield	312.75	28.91	10.81	<0.001	Strong positive effect
Experience	41.62	12.35	3.37	0.001	Moderate positive effect
Family Size	-148.53	36.44	-4.07	<0.001	Negative significant effect

Table 3: Age Distribution of Respondents (n = 150)

Age Group (Years)	Number of Fishermen	Percentage (%)
18–30	28	18.7
31–40	47	31.3
41–50	39	26.0
51–60	26	17.3
Above 60	10	6.7

The age structure indicates that the majority of fishermen belong to the 31–40 years' age group (31.3%), followed by 41–50 years (26.0%), suggesting that the fishing workforce is dominated by economically active middle-aged individuals.

Table 4: Educational Status of Fishermen

Education Level	Number	Percentage (%)
No formal education	135	90
Primary education	10	6.7
Secondary education	4	2.7
Higher secondary	1	0.6

Interference: The educational status of fishermen reveals severe educational deprivation, with 90% of respondents having no formal education, indicating limited access to education and reduced opportunities for livelihood diversification.

Table 5: Monthly Income Categories of Fishermen

Income Range (₹/Month)	Number	Percentage (%)
< 5000	42	28
5000–7000	63	42
7001–9000	31	20.7
> 9000	14	9.3

Interference: The majority of fishermen (42%) earn between ₹5,000 and ₹7,000 per month, highlighting the low-income nature of riverine fishing livelihoods in the Kangsabati River basin.

Table 6: Fishing Experience of Respondents

Experience (Years)	Number	Percentage (%)
<10 years	24	16
10–20 years	52	34.7
21–30 years	46	30.7
>30 years	28	18.6

Interference: Regression analysis demonstrates that fishing experience significantly influences income ($\beta = 41.62$, $p = 0.001$), indicating that experienced fishermen generally achieve higher catch efficiency and better economic outcomes.

Table 7: Household Size of Fishermen

Family Size	Number	Percentage (%)
1–3 members	18	12
4–5 members	71	47.3
6–7 members	43	28.7
>7 members	18	12

Interference: Large family sizes increase financial pressure on fishing households. The regression results show that family size negatively affects income ($\beta = -148.53$, $p < 0.001$), contributing to increased livelihood vulnerability.

Table 8: Primary Occupation of Respondents

Occupation	Number	Percentage (%)
Full-time fishing	150	100
Secondary occupation (agriculture/labour)	58	38.7
No secondary occupation	92	61.3

Interference: Although fishing is the primary occupation for all respondents, about 38.7% of fishermen engage in secondary activities, such as agricultural labour, indicating attempts at livelihood diversification to cope with economic uncertainty

Fishing experience also had a significant positive effect on income ($\beta = 41.62$, $p = 0.001$), suggesting that experienced fishermen achieve better economic outcomes through improved skills and ecological knowledge.

4. Discussion

4.1 Demographic Structure and Social Composition:

The present investigation conducted among 150 full-time fishermen residing along the banks of the Kangsabati River in Paschim Medinipur district reveals a socially and economically marginalized occupational group. The demographic analysis indicates that 100% of the respondents were male, reflecting the traditionally male-dominated structure of riverine capture fisheries in rural eastern India. Although women contribute substantially to post-harvest activities such as fish drying, sorting, and local marketing, their participation remains largely informal and statistically underrepresented in formal surveys. Caste-wise distribution highlights deep-rooted social stratification within the fishing community. Scheduled Caste (SC) households constitute 60% ($n = 90$) of the sample, followed by Other Backward Classes (OBC) at 20% ($n = 30$) and General category households at 20% ($n = 30$). The chi-square test performed against an expected equal distribution model revealed statistically significant deviation ($p < 0.05$), confirming that riverine fisheries in the study region remain predominantly concentrated among historically marginalized caste groups. This finding is consistent with national-level fisheries data reported by the National Fisheries Development Board and inland fisheries assessments under the Ministry of Fisheries, Animal Husbandry and Dairying. The mean family size of 6 members indicates a moderate to high dependency ratio. In 55% of households, family size exceeded six members, intensifying economic pressure on the primary income earner. Larger household size was negatively correlated with per capita income, suggesting that livelihood stress increases with demographic burden. Educational attainment remains critically low. Nearly 90% of respondents reported no formal schooling, while only 10% had primary-level education. The absence of secondary or higher education among respondents severely constrains occupational mobility, limits access to institutional credit schemes, and reduces awareness of government welfare programs. Education is widely recognized as a key adaptive capacity component in the IPCC livelihood vulnerability framework; hence, its deficiency directly contributes to elevated vulnerability indices.

4.2 Occupational Structure and Fishing Experience

Fishing experience ranged between 9 and 55 years, with a mean of 29.4 ± 13.9 years. This wide range reflects strong intergenerational occupational continuity. Approximately 72% of respondents reported inheriting fishing as a hereditary occupation. The absence of alternative employment pathways reinforces

occupational rigidity. While extensive experience enhances fishing skill and ecological knowledge, econometric analysis suggests that experience alone does not significantly increase income without corresponding improvements in productivity and market access. Experience showed moderate positive correlation with yield but weak association with income, indicating diminishing marginal returns to traditional knowledge under declining ecological conditions. Most fishermen operated non-mechanized wooden crafts and traditional gears such as gill nets and cast nets. None reported ownership of mechanized boats or advanced fishing technologies. The lack of capital-intensive inputs further limits productivity potential. Overall, the demographic results portray a community characterized by social marginalization, limited human capital formation, and restricted livelihood diversification.

4.3 Fish Yield and Income Dynamics

The average monthly fish yield recorded was 25.3 ± 6.1 kg, with observed values ranging from 15 kg to 35 kg. Yield variability can be attributed to seasonal fluctuations, gear efficiency, and localized fish stock availability. The modest yield levels highlight the small-scale subsistence-oriented nature of the fishery. The estimated mean monthly income was $\text{₹}6,325 \pm 1,525$. When adjusted for a six-member household, per capita monthly income falls below rural consumption benchmarks, indicating economic fragility. Nearly 65% of respondents were categorized under low-income thresholds, reinforcing the poverty-vulnerability nexus. A strong positive correlation ($r \approx 0.92$) was observed between fish yield and income, confirming productivity as the primary income determinant. Conversely, family size exhibited weak negative association with household income per capita. Bar-chart analysis of monthly yield demonstrates concentration around the 20–30 kg class interval. Income distribution similarly shows clustering below $\text{₹}7,000$ per month, reflecting limited income diversification.

4.4 Regression Analysis and Econometric Diagnostics:

An Ordinary Least Squares (OLS) model was estimated:

$$\text{Income} = \beta_0 + \beta_1 \text{Yield} + \beta_2 \text{Experience}$$

The regression output indicated that yield coefficient positive and moderately significant, experience coefficient statistically insignificant, family size coefficient negative but insignificant, $R^2 = 0.289$ (based on representative dataset). Although earlier correlation suggested high association between yield and income, multivariate regression indicates that once other variables are controlled, the explanatory power declines. This suggests omitted variable bias possibly market access, price variability, or input costs. Variance Inflation Factor (VIF) values were below 5 for all predictors, indicating absence of severe multicollinearity. Breusch-Pagan test results ($p > 0.05$) confirmed homoscedastic residuals. Thus, the regression model satisfies basic classical linear regression

assumptions.

4.5 Housing, Infrastructure, and Asset Ownership

Housing conditions provide further insight into socio-economic vulnerability. Approximately 80% of respondents reside in mud houses, while only 20% possess brick-built structures. Asset ownership is minimal; none reported cold storage facilities or insulated transport units. The absence of post-harvest infrastructure exacerbates income instability due to spoilage losses. Electricity access was reported by 70% of households, yet unreliable supply restricts ice storage or value addition. Drinking water availability was mostly dependent on tube wells.

4.6 Livelihood Vulnerability Index (LVI)

The Livelihood Vulnerability Index was computed integrating exposure (E), sensitivity (S), and adaptive capacity (AC).

$$LVI = (E + S - AC) / 3$$

Major Exposure Factors: Water pollution (reported by 80%), seasonal hydrological fluctuation, declining fish stock. Sensitivity Factors: Single income source dependence, Large family size, Low education Adaptive Capacity Factors: Absence of training programs, No cooperative membership, Lack of institutional credit. The composite LVI score was estimated between 0.635 and 0.72, placing the community within the high vulnerability category. Village-wise GIS mapping revealed: Shophiabad: Very High Vulnerability (SVI = 0.78), Shrirampur & New Patna: High Vulnerability, Mohanpur: Moderate to High Vulnerability, Spatial heterogeneity suggests differential access to infrastructure and markets. Comparable studies in inland fisheries show LVI ranges of 0.60–0.75 in highly exposed communities (Hahn et al., 2009; Allison & Ellis, 2001).

4.7 Social Vulnerability Index (SVI) Interpretation

The Social Vulnerability Index calculated using weighted indicators (income 0.4, family size 0.3, education 0.3) yielded SVI $\approx$ 0.685. High SVI corresponds with structural poverty conditions (IPCC, 2014). This score confirms that economic poverty combined with low educational attainment significantly heightens livelihood insecurity. Compared with inland fisheries assessments reported in FAO's State of World Fisheries and Aquaculture (2022), the vulnerability levels in the present study area appear higher than national inland averages. Social marginalization limits access to formal credit and institutional support, increasing livelihood fragility (Allison & Ellis, 2001). Chi-square testing confirms significant caste concentration ($p < 0.05$). This aligns with national evidence that artisanal fisheries remain caste-bound occupations (Kurien, 2001; Béné, 2009).

4.8 Policy Gaps

Notably, none of the respondents reported membership

in self-help groups or fisheries cooperatives. Government assistance schemes under the Blue Revolution or Pradhan Mantri Matsya Sampada Yojana were largely inaccessible due to bureaucratic and informational barriers. The absence of collective marketing structures results in dependence on local middlemen, reducing profit margins. Price fluctuation and lack of bargaining power amplify income instability.

4.9 Integrated Livelihood Sustainability Model

The conceptual livelihood model developed for the study illustrates the linear dependence of socio-economic well-being on ecological stability:

River Ecology (Kangsabati River) $\rightarrow$ Fishing Effort $\rightarrow$ Yield $\rightarrow$ Market Access $\rightarrow$ Income $\rightarrow$ Household Welfare

Disruptions at the ecological (pollution), economic (market inefficiency), or institutional (lack of support) level propagate downward, intensifying vulnerability. An integrated sustainability strategy should include river pollution mitigation, cooperative-based marketing, Skill development and literacy programs, microfinance access, diversified livelihood options (aquaculture, poultry, horticulture). Comparative inland fisheries studies in West Bengal indicate similar patterns of caste dominance, low literacy, and income instability. However, the vulnerability index in the present study is comparatively higher due to complete absence of adaptive institutional support. The findings align with broader rural vulnerability patterns observed in climate-sensitive riverine ecosystems, where ecological degradation interacts with social marginalization to create chronic poverty traps. The fishermen community along the Kangsabati River exhibits High social marginalization (60% SC), Severe educational deficit (90% illiteracy), Low income and productivity, Strong dependence on single livelihood source, High composite vulnerability index ($\approx$ 0.70). Econometric diagnostics confirm yield as the primary income determinant, but systemic structural constraints prevent productivity scaling. The results underscore a multidimensional vulnerability framework where ecological stress, socio-economic marginalization, and institutional neglect converge. Without integrated policy intervention combining ecological restoration and socio-economic empowerment, the sustainability of riverine fisheries in Paschim Medinipur remains precarious. Future research should incorporate panel econometric modelling, climate variability projections, and participatory vulnerability assessment for more comprehensive policy design. Experience has a positive coefficient (41.62), suggesting Each additional year of fishing experience increases monthly income by ₹41. Experience enhances income through skill acquisition and ecological knowledge (Berkes & Folke, 1998). This indicates learning effects and ecological knowledge benefits. However, the magnitude is smaller than yield, confirming productivity dominance. Family size has a negative and statistically significant coefficient (-148.53).

Large households dilute income per capita and increase consumption pressure (Chambers, 1983). This confirms dependency burden theory. This suggests: Larger households reduce net income, possibly due to consumption pressure or lower savings capacity. This supports dependency burden theory in rural livelihoods. LM Statistic: 2.17, p-value: 0.538. Fail to reject homoscedasticity assumption. Durbin-Watson = 1.94 → No serial correlation (expected for cross-sectional data). Production theory predicts income as a direct function of output (Varian, 2014). The t-value (10.81) and $p < 0.001$ confirm strong statistical significance. Declining river ecology reduces natural capital and constrains income scaling (Béné, 2009). This validates production theory in riverine fisheries income is primarily productivity-driven. These findings align with econometric standards (Gujarati & Porter, 2009). Fishing communities in India are predominantly from Scheduled Castes and Other Backward Classes, reflecting historical occupational stratification (Kurien, 2001). Marginalization reinforces poverty traps (Chambers, 1983).

5. Conclusion

The fishermen community along the Kangsabati River in Paschim Medinipur is characterized by low literacy, high social marginalization, limited adaptive capacity, and environmental exposure. The constructed LVI (0.72) confirms high livelihood vulnerability. Sustainable fisheries development requires integrated policy intervention combining ecological restoration with socio-economic empowerment. The R^2 value of 0.682 indicates that 68.2% of variation in monthly income is explained by the independent variables. The Adjusted R^2 (0.675) confirms strong model stability. The F-statistic (103.41) with $p < 0.0001$ indicates that the model is highly statistically significant. This represents a substantial improvement over the small diagnostic sample model. The coefficient of Yield ($\beta_1 = 312.75$) implies: A 1 kg increase in monthly fish catch increases income by approximately ₹313.

6. Statements and Declarations

Ethical Approval: The study was conducted following standard ethical guidelines for social science research involving human participants. Data were collected through voluntary participation of fishermen households after obtaining their informed consent. No experiments involving animals or invasive procedures on human subjects were conducted. Therefore, formal ethical committee approval was not required.

Conflict of Interest: The authors declare that they have no known competing financial interests, personal relationships, or conflicts of interest that could have influenced the work reported in this study.

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