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Research Article

Climate Change, Agricultural Practices and Livelihoods: A Study of Sharsha Upazila, Jashore District

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Abstract

This research investigates household adaptability, livelihood ramifications, and climate exposure in Sharsha Upazila, Jashore District, southwest Bangladesh. In March 2026, a survey of 120 farming families (non-probability purposive and convenience sample) was merged with 20 in-depth interviews and 10 key informant interviews using a convergent mixed-methods cross-sectional methodology. Descriptive statistics with 95% confidence intervals, a composite Climate Impact Index (CII) summarising six exposure indicators, chi square and t tests, correlation, and binary logistic regression were used to analyse survey data; all inferential inferences are exploratory and sample-specific since the sample was not random. The open-ended content was examined using qualitative content analysis, which was then triangulated with the survey results. Climate impacts were almost universal: 73–88% of households reported each of the six unfavourable impact categories, with the typical household reporting five of them. The majority had adapted (89.2%, 95% CI [82.3, 93.6]), and many reported loan access (81.7%) and migration linked to livelihood (76.7%). Nevertheless, the multivariable model for adaptation was not significant (χ^2 (8) = 7.49, p =.49), and none of the socioeconomic or resource characteristics investigated substantially predicted adaptation, migration, or cumulative effect. Weaker everyday coping was indicated by open-ended responses: 57.5% reported little to no community support, 34.2% depended on erosive coping, and 26.7% did not identify any coping strategy. Climate stress and adaptive response are widespread among families in this regularly exposed border upazila rather than concentrated among distinct subgroups. These findings argue that policy should focus on the depth and sufficiency of adaptation rather than its adoption, challenging the notion that adaptation is limited to the resource-rich.

Keywords

Climate Change, Agricultural Livelihoods, Vulnerability, Adaptation Strategies, Rural Bangladesh, Sustainable Livelihoods.

1. Introduction

Bangladesh is repeatedly identified among the countries most exposed to the consequences of climate change, owing to its deltaic geography, high population density, and heavy dependence on climate sensitive agriculture (Intergovernmental Panel on Climate Change (IPCC, 2022; Uddin, 2024). Rising temperatures, increasingly erratic rainfall, recurrent flooding, prolonged dry spells, and creeping salinity intrusion converge on the rural economy, where crop cultivation,

livestock rearing, and inland fisheries remain the principal sources of income and food (Hossain et al., 2012; Amin et al., 2021). For millions of smallholders, climate variability is therefore not an abstract environmental trend but a direct and cumulative pressure on production, income, and household security.

The south western region, which includes Jashore District, is particularly instructive. It sits at the transition between the drought prone north west and the salinity affected coastal belt, and its farming systems span crops, livestock, and aquaculture (Shaibur et al., 2018). Prior work from the wider region documents declining crop yields (Kabir, 2015), shifts toward short duration and stress tolerant varieties (Shaibur et al., 2018), agroforestry as a diversification strategy (Chakraborty et al., 2015), and the growing role of climate related out migration (Uddin, 2024). Yet much of this evidence is national in scale or focused on a single sector, and comparatively little work characterizes the joint profile of exposure, impact, and adaptation across crops, livestock, and fisheries at the scale of a single upazila.

A second gap is conceptual. A large adaptation literature treats the uptake of adaptive practices as a function of household endowments education, land, credit, information, and institutional support — and reports that these factors significantly discriminate adopters from non-adopters (Ahmed & Fatema, 2023; Begum et al., 2023; Bhuyan et al., 2024). This framing implicitly assumes that adaptation is socially differentiated. Whether that assumption holds in a highly and uniformly exposed farming community, where adaptation may already be widespread, is an empirical question that micro level studies are well placed to test.

Against this background, the present study pursues three objectives: (i) to document the extent and types of climate exposure and their impacts on agricultural livelihoods in Sharsha Upazila; (ii) to describe the adaptation, coping, and migration responses that households employ; and (iii) to test whether socio demographic and resource related factors are associated with adaptation, migration, and the cumulative burden of climate impacts. The study reports its inferential findings transparently including null associations and interprets them substantively, contributing an honest, place-based account of how adaptation is distributed in a border upazila of south western Bangladesh.

2. Theoretical Framework and Literature Review

2.1. Climate Change and Agricultural Livelihoods in South Western Bangladesh

A large body of research demonstrates the vulnerability of Bangladeshi agriculture to climate fluctuations. Agriculturalists in the southwestern region mostly recognize changes in precipitation and temperature patterns: Kabir (2015) indicates that 98.91% of farmers polled in Jessore and Satkhira saw a reduction or alteration in rainfall, while Shaibur et al. (2018) explore potential correlations between climatic variability and changing agricultural practices in Jashore District. Flood vulnerability is also widespread; Amin et al. (2021) reveal that 62.08% of farmers experienced flood effects on their crops and cattle, and Karim et al. (2014) document comparable disruption to crop production in the flood plain of Chauhali Upazila, while Hossain et al. (2016) note that 87.8–94.8% of families in drought affected regions used drought mitigation techniques, indicating substantial exposure. The repercussions on livelihoods transcend mere production: Hossain et al. (2012) illustrate extensive disturbances in income, food security, and overall welfare in the southwestern coastal region, while Uddin (2024) notes that migration is becoming a prevalent reaction among families facing ecological stress. Simultaneously, adaptation is limited: Kabir et al. (2022) reveal that around one third of farmers exhibit poor adaptation practices, citing insufficient credit as a major obstacle, while Islam, Biswas, et al. (2023) and Islam, Das, et al. (2024) highlight ongoing discrepancies between adaptation policy frameworks and local service implementation.

2.2. Vulnerability Theory

Vulnerability Theory defines the likelihood of people and societies experiencing damage as a combined result of their exposure to stressors, their sensitivity to those impacts, and their ability to adjust (Adger, 2006). In agricultural settings, susceptibility is socially stratified: families with unstable land rights, little education, minimal resources, and restricted institutional access endure the same climate threats more acutely than their more affluent neighbours. In Sharsha Upazila, vulnerability manifests as erratic precipitation, inundation, aridity, and thermal stress; susceptibility arises from the prevalence of climate reliant occupations; and resilience is influenced by availability of irrigation, financial resources, technological advancements, and institutional assistance. The framework directs analytical attention to the structural determinants of who is most harmed, how severely, and why.

2.3. The Sustainable Livelihoods Approach

The Sustainable Livelihoods Approach (SLA), formulated by Chambers & Conway (1992) and implemented by the UK Department for International Development (DFID, 1999), examines how households utilise five types of capital—natural,

human, social, financial, and physical—to build livelihoods amidst adversity and pressure. In the context of Sharsha Upazila, natural capital encompasses land and water resources; human capital consists of agricultural expertise and education; social capital pertains to community connections and mutual support; financial capital relates to savings and access to credit; and physical capital involves irrigation systems and agricultural machinery. The SLA posits that the results of adaptation are influenced more by the structure and flexibility of family asset allocations than by the hazard itself, hence effectively elucidating the varied adoption of adaptation strategies within a uniformly affected area.

2.4. Human Ecology Theory

Human Ecology Theory explores the mutual adaptation of human societies and their surroundings, highlighting that adaptive actions are influenced by social structures, institutions, and technology rather than only by environmental alterations. This research elucidates how agriculturalists modify planting schedules, water utilization, and income strategies in reaction to environmental cues, as well as the influence of community organizations and institutional entities on the viability of these modifications. Adaptive methodologies like crop diversification, agroforestry, and integrated farming are hence seen as socio ecological reactions integrated within local institutional structures.

3. Conceptual Framework

The conceptual model of the research, integrating these three viewpoints, suggests a four-phase trajectory. First, climate stressors (irregular rainfall, floods, drought, temperature change) destroy natural assets via soil, water, and crop health channels. Secondly, the conversion of exposure into detriment is influenced by household vulnerability and adaptive capability, which are contingent upon livelihood resources and institutional accessibility. Third, families use adaptation techniques such as crop diversification, climate resilient varieties, enhanced irrigation, agroforestry, livelihood diversification, and migration as means of coping. Fourth, livelihood results (income stability, food security, wellbeing) demonstrate the interplay between the severity of stressors and the efficacy of adaptation.

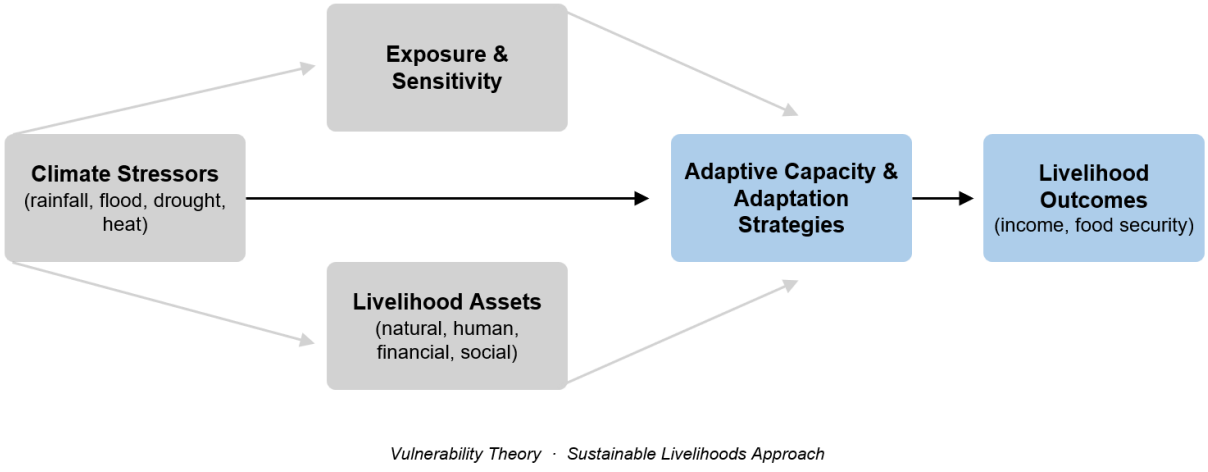


Figure 1: Conceptual framework linking climate stressors, livelihood assets, adaptive capacity, and livelihood outcomes. Source: Author, adapted from Chambers and Conway (1992) and DFID (1999)

4. Methodology

4.1. Study Area

The research was carried out in Sharsha Upazila, the westernmost sub district of Jashore District located in the Khulna Division of southwestern Bangladesh (about 22°55′–23°12′ N and 88°51′–89°01′ E; Fig. 2). Sharsha adjoins India (West Bengal) and houses the Benapole land port, the nation's most significant overland commercial entry point, providing the region with relatively extensive road connectivity and non-agricultural job prospects in addition to its agricultural foundation. Agricultural systems integrate rice and vegetable production with animal husbandry and pond aquaculture,

while families face a combination of unpredictable rainfall, seasonal and sudden floods, water saturation, and intermittent drought. These characteristics provide Sharsha an appropriate location for analyzing the combined aspects of climate exposure, effects, and adaptation within a varied rural economy.

(a) Sharsha Upazila

(b) Jashore District Map

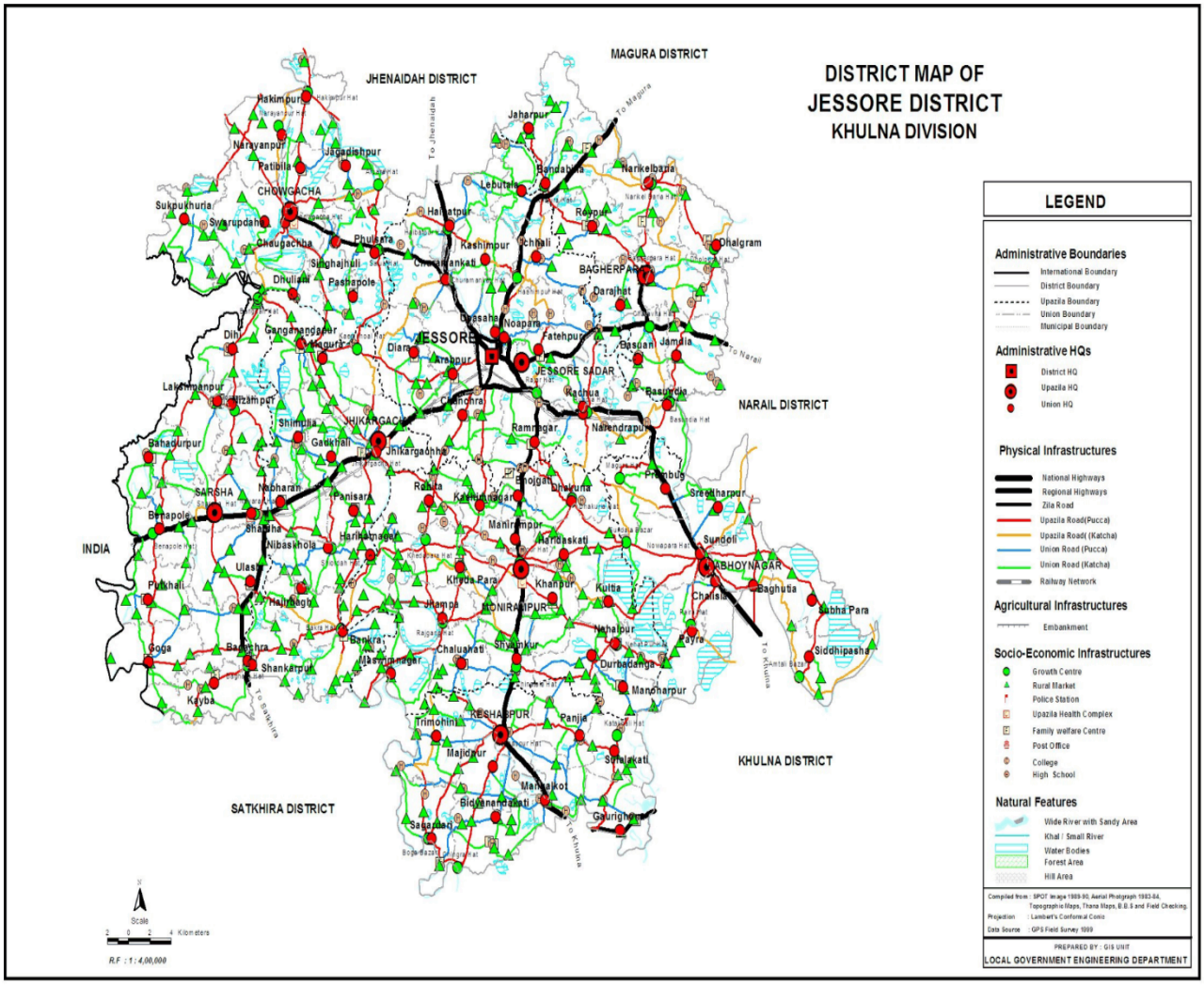


Figure 2: Location of the study area: (a) Sharsha Upazila with its unions and the Benapole border crossing; (b) Jashore District Map. Source: https://oldweb.lged.gov.bd/UploadedDocument/Map/KHULNA/jessore/jessore.pdf

4.2. Research Design and Sampling

A convergent mixed methods approach was used in a cross sectional, descriptive exploratory design. The prevalence and patterning of exposure, impact, and adaptation were determined by quantitative survey data, while a qualitative strand consisting of ten open ended questionnaire items given to all participants in addition to in depth interviews (IDIs) and key informant interviews (KIIs) was analyzed through qualitative content analysis and integrated with the survey results at the interpretation stage so that each strand could support, contextualize, or qualify the other (Fetters et al., 2013).

The heads of farming families were chosen for the survey using non probability sampling, which combined convenience (accessibility based) and purposive selection across the Sharsha Upazila unions. Only households that derived a significant portion of their income from crop, livestock, or fisheries activities were eligible. This approach, which is a recognized method for exploratory, place-based research but does not produce a statistically representative sample, was chosen because there was no current sampling frame of farming families available and field access in this border upazila was limited by time and resources (Etikan et al., 2016). As a result, the descriptive and inferential statistics that follow only describe the achieved sample; they are presented as exploratory, sample internal analyses, and no statistical generalization to the larger farming population of Bangladesh or Sharsha Upazila is claimed (see Limitations). Additionally, 20 IDIs with farmers and 10 KIIs with local agricultural officials, NGO employees, and community leaders were carried out. Participants were purposefully chosen based on their institutional responsibilities in agriculture and rural development or their direct exposure to climate related dangers. Fig. 3 summarizes the whole procedure.

Figure 3: Methodological workflow of the study, from design and sampling through data collection to analysis and interpretation. Source: Author.

4.3. Sample Size Determination

There were 120 homes in the actual survey sample. The sample size suggested by conventional survey formulas is presented as a baseline for openness. Cochran's formula for a big population,

$$n_0 = \frac{z^2 p\,(1-p)}{e^2} \quad (1)$$

with z = 1.96, p = 0.5, and a ±5% margin of error (e = 0.05), yields $n_0 \approx 385$, and the equivalent Yamane (1967) expression,

$$n = \frac{N}{1 + Ne^2} \quad (2)$$

yields a similar number. These formulas are presented just as a transparency benchmark and require probability sampling, which was not used in this case. Because the obtained sample was not picked at random and was smaller than the benchmark, inferential findings are regarded cautiously as exploratory and sample specific (see Limitations).

4.4. Quantitative Data Collection

A structured questionnaire covering sociodemographic traits, perceived climate exposure, effects on crop, livestock, and fisheries production and household income, access to irrigation and credit, adaptation practices, migration related to

livelihood, and institutional support was used to gather primary data in March 2026 through in person interviews conducted in Bengali. The 120 entries in the dataset had no missing values after the responses were coded and placed into a spreadsheet.

4.5. Qualitative Data Collection and Analysis

Two sources were used in the qualitative strand. Ten open ended questions covering observed climatic changes, effects on farming, significant household losses, coping strategies during disasters, community support, challenges in adaptation, gendered impacts, livelihood decision making, institutional and policy needs, and suggestions for future livelihood security were first presented to all 120 respondents as part of the survey instrument. Responses were recorded in the field in Bengali and coded into distinct response categories. Second, using guides created from the study's theoretical framework, 20 semi structured IDIs with farmers and 10 KIIs with agricultural extension officers, local government officials, NGO representatives, and community leaders were conducted during the same fieldwork period (March 2026). Since these interviews were recorded through field notes rather than complete transcripts, they were used to contextualize and interpret the findings rather than as an autonomously analyzed corpus.

In order to maintain transparency and auditability, category frequencies were given after the coded open-ended replies were subjected to qualitative content analysis (Hsieh & Shannon, 2005). Following the logic of thematic analysis (Braun & Clarke, 2006), categories were subsequently organised into four intersecting themes. The themes were then compared with the survey results in a triangulation matrix to evaluate convergence, complementarity (expansion), and divergence between the strands (Fetters et al., 2013); the integrated findings are presented in the Results and used during the Discussion.

4.6. Data Analysis

Python (pandas, SciPy) was used for the analyses, while SPSS was used for cross checking. Categorical answers were summarized as frequencies and percentages, with 95% Wilson confidence intervals for major proportions; age, the solitary continuous variable, was represented by its mean, standard deviation, median, and range. A Climate Impact Index (CII, 0–6) was created by adding the six adverse impact indicators (irregular rainfall, flood, drought, crop decline, livestock/fish decline, and income impact) that were coded as present or absent. Since these parameters represent different hazards rather than manifestations of a single latent trait, the CII is regarded as a formative index, and its internal consistency reliability (Cronbach's α/KR 20) was only for fullness.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} s_i^2}{s_T^2}\right) \quad (3)$$

Associations between categorical variables were tested with the Pearson chi square statistic,

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \quad (4)$$

with Fisher's exact test substituted for 2×2 tables with small expected counts, and Cramér's V reported as the effect size,

$$V = \sqrt{\frac{\chi^2}{n\,(\min(r,c) - 1)}} \quad (5)$$

Group differences in mean age were assessed with independent samples t tests (Levene's test for variances; Cohen's d effect size),

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s_p} \quad (6)$$

bivariate relationships among continuous and ordinal measures were examined using Pearson and Spearman correlation,

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \quad (7)$$

and a binary logistic regression modelled the probability of adopting any adaptation practice,

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k \quad (8)$$

with model adequacy assessed via the likelihood ratio test, McFadden's pseudo-R^2, the Hosmer–Lemeshow test, the area under the ROC curve (AUC), and variance inflation factors. Significance was set at $p < .05$, with effect sizes and 95% CIs reported throughout. Because the sample was not randomly drawn, p values and confidence intervals are interpreted as exploratory, sample internal measures of the strength and precision of associations, not as formal inferences to a wider population.

4.7. Ethical Considerations

Respondents were free to reject or withdraw at any time, and no personally identifiable information was collected. Participation was voluntary and predicated on verbal informed consent given when the aim of the research was explained. One drawback is that formal institutional review board permission was not sought.

5. Results

5.1. Socio Demographic Profile of Respondents

The majority of the 120 respondents (91.7%) were males, which reflects the preponderance of men as principal agricultural decision makers and heads of households; the low participation of women (8.3%) is recognized as a limitation. The age range was 29–63 years (M = 49.2, SD = 9.05, median = 50). Crop farming, livestock raising, fishing, and agricultural and non-farm work were among the vocations, while educational attainment ranged widely from no formal schooling (15.8%) to graduate level or beyond (18.3%). 51.7% of families had unstable land tenure arrangements (landless, sharecropping, or leasing). The profile is summarized in Table 1.

Table 1: Socio-Demographic Profile of Respondents (N = 120)

Characteristic	Category	N	%
Gender	Male	110	91.7
	Female	10	8.3
Education	No formal education	19	15.8
	Primary	27	22.5
	Secondary	28	23.3
	Higher Secondary	24	20.0
	Graduate or above	22	18.3
Primary occupation	Crop farming	19	15.8
	Livestock rearing	19	15.8
	Fisheries	18	15.0
	Day labour	17	14.2
	Vegetable cultivation	14	11.7
	Farmer (general)	13	10.8
	Shrimp farming	12	10.0
	Other	8	6.7
Land tenure	Lease land	27	22.5
	1–3 acres	23	19.2
	Less than 1 acre	19	15.8
	Sharecropping	19	15.8
	Landless	16	13.3
	More than 3 acres	16	13.3

Age (not tabulated): M = 49.2, SD = 9.05, range 29–63 years. Source: (Field Survey, 2026).

5.2. Climate Exposure and Livelihood Impacts

The reported exposure was considerable. A perceived irregularity in rainfall was noted by 73.3% of participants, flooding by 79.2% (mostly flash and seasonal river floods), and drought related issues by 87.5% (predominantly heightened

irrigation expenses and desiccation of ponds and canals). The effects on production exhibited a consistent trend: 79.2% indicated a decrease in agricultural output, 85.0% noted a reduction in livestock or fisheries, and 85.0% saw negative consequences on family income (refer to Fig. 4. for overall data; see Table 2. for category specific information). The synthesis of the six binary indicators reveals that the median household encountered five out of six impact areas, with 70.8% experiencing five or more, highlighting the pervasive nature of exposure (Table 3).

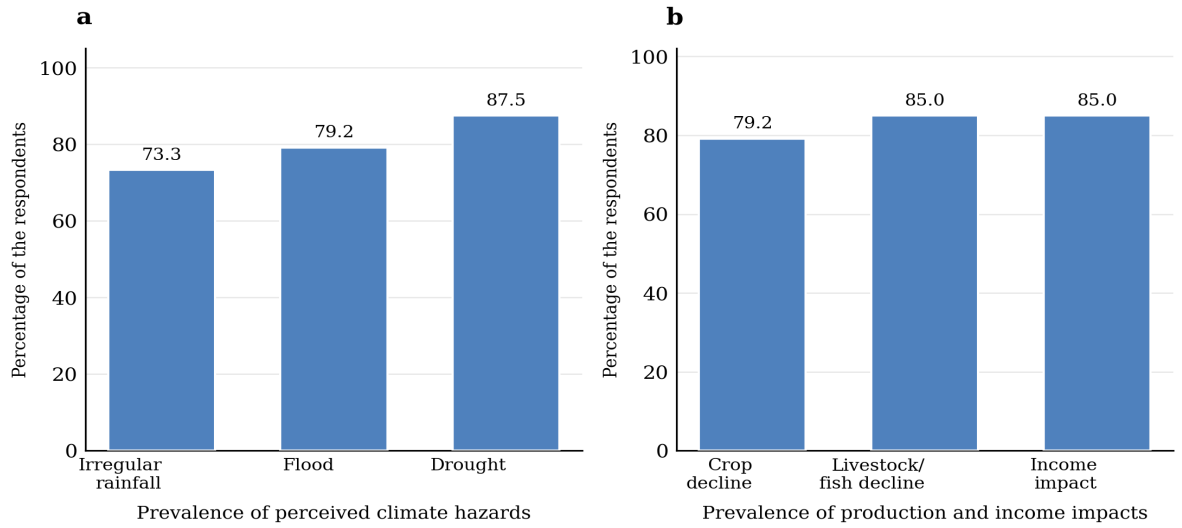


Figure 4: Prevalence of (A) Perceived Climate Hazards and (B) Production and Income Impacts Among Respondents (N = 120). Source: (Field Survey, 2026).

Table 2: Distribution of Perceived Climate Exposure and Livelihood Impacts (N = 120)

Domain	Category	N	%
Irregular rainfall	Later than before	28	23.3
	Prolonged dry periods	22	18.3
	Intensity increased	20	16.7
	Earlier than before	18	15.0
	No change	32	26.7
Flood experience	Flash flood	29	24.2
	Seasonal river flood	29	24.2
	Waterlogging	21	17.5
	Cyclone related	16	13.3
	No flooding	25	20.8
Drought experience	Increased irrigation cost	31	25.8
	Dry ponds/canals	29	24.2
	Crop damage	25	20.8
	Water shortage	20	16.7
	No drought	15	12.5
Crop decline	Crop disease increase	28	23.3
	Fruit decline	24	20.0
	Rice decline	23	19.2
	Vegetable decline	20	16.7
	No decline	25	20.8
Livestock/fish decline	Fish mortality	32	26.7
	Feed/water shortage	25	20.8
	Pond quality change	24	20.0
	Livestock disease	21	17.5

	No decline	18	15.0
Income impact	Reduced income	33	27.5
	Increased cost	31	25.8
	Need loans	23	19.2
	Lost working days	15	12.5
	No impact	18	15.0

Each domain was a single response item; percentages sum to 100 within domain. Source: (Field Survey, 2026).

Table 3: Prevalence of Adverse Impacts and Adaptive Responses, With 95% Wilson Confidence Intervals (N = 120)

Indicator (binary)	N	%	95% CI
Irregular rainfall	88	73.3	[64.8, 80.4]
Flood experience	95	79.2	[71.0, 85.5]
Drought experience	105	87.5	[80.4, 92.3]
Crop production decline	95	79.2	[71.0, 85.5]
Livestock/fish decline	102	85.0	[77.5, 90.3]
Household income impact	102	85.0	[77.5, 90.3]
Adopted ≥1 adaptation practice	107	89.2	[82.3, 93.6]
Livelihood related migration	92	76.7	[68.3, 83.3]
Access to credit	98	81.7	[73.8, 87.6]
Access to irrigation	104	86.7	[79.4, 91.6]
Received institutional support	108	90.0	[83.3, 94.2]

Binary indicators code any adverse experience (or any adaptive response) as present. Source: (Field Survey, 2026).

5.3. Adaptation, Resources, Migration, and Institutional Support

Climate resistant cultivars (25.0%), agroforestry (20.0%), enhanced irrigation (15.8%), crop diversification (15.0%), and integrated farming (13.3%) were the most prevalent adaptive responses, with 89.2% of households reporting at least one practice; only 10.8% reported none (Fig. 5a). Seeds, fertilizer, and agricultural extension were the main sources of institutional assistance (90.0%) (Fig. 5b). The availability of resources was also widespread: 86.7% had access to irrigation, and 81.7% had access to finance, although the latter was controlled by moneylenders (20.8%) and cooperatives (25.8%) rather than traditional banks (Fig. 6b). 76.7% of families reported migration due to livelihood, which included both seasonal and permanent relocation to towns and cities (Fig. 6a).

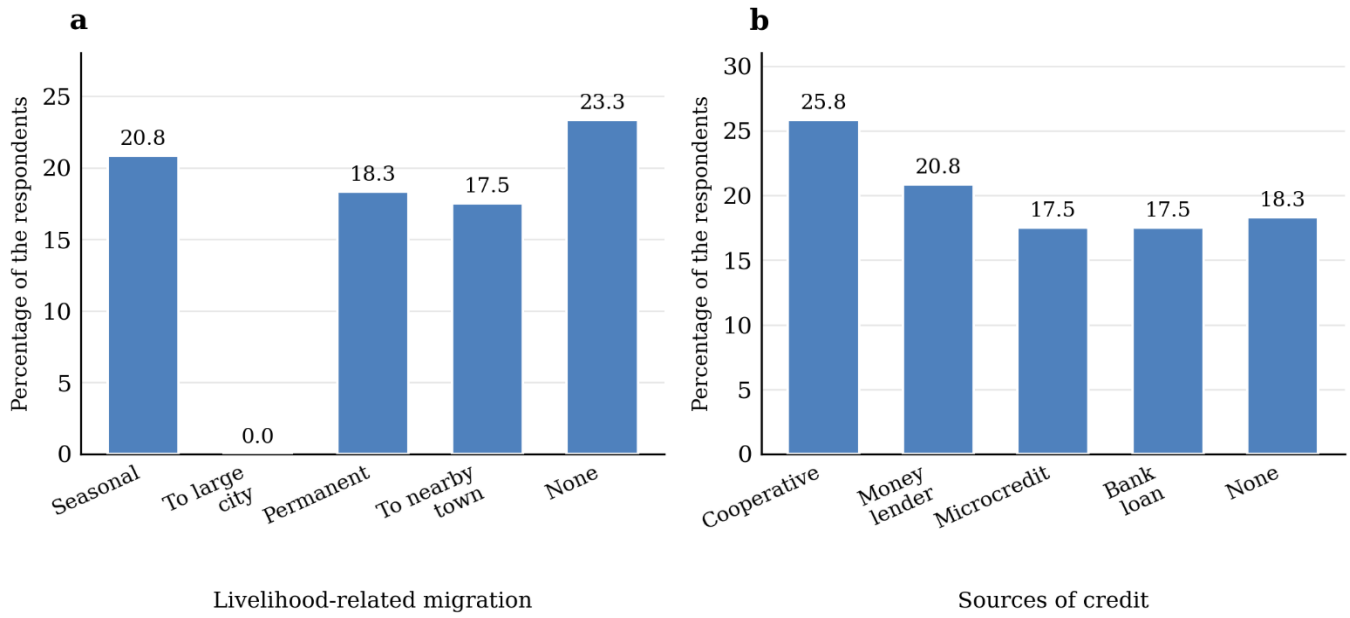
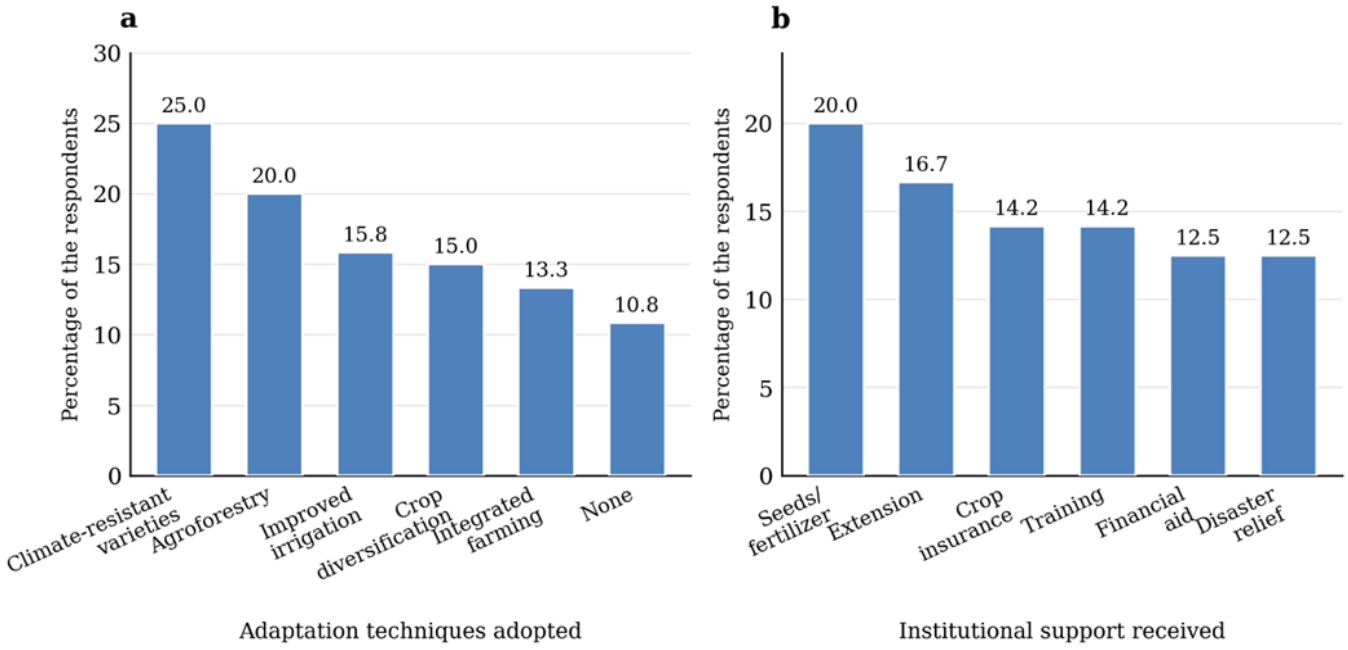


Figure 5: (A) Adaptation Techniques Adopted and (B) Types of Institutional Support Received (N = 120). Source: (Field Survey, 2026)

Figure 5: (a) Adaptation techniques adopted and (b) types of institutional support received (N = 120). Source: Field Survey (2026).



5.4. Internal Structure of the Impact Index

In alignment with its initial design, the six impact indicators exhibited little inter item correlation (mean r = –.01) and almost no internal consistency reliability (KR 20 = –.03). This is anticipated for causative indicators of separate risks and validates that the CII ought to be interpreted as a cumulative tally of independent exposures instead of as a reflecting psychometric measure; no assertion of reliability is made for it. A negative or near-zero internal consistency coefficient of this kind is expected, and does not indicate a flaw in the instrument, for formative indices whose component items represent distinct causes of an outcome rather than interchangeable reflections of a single underlying construct; unlike reflective scales, formative indicators are not required to correlate with one another (Bollen & Lennox, 1991; Diamantopoulos & Winklhofer, 2001).

5.5. Bivariate Associations

Contrary to expectations derived from the adaptation determinants literature, none of the examined factors exhibited significance.

Chi square analyses concerning education, credit availability, irrigation access, institutional assistance, gender, and land tenure instability in relation to adaptation yielded non-significant results, exhibiting minimal impact sizes (Cramér's V < .23; Table 4); similarly, correlations with migration were also non-significant. Independent samples t tests revealed no substantial age disparities among adopters against non-adopters, migrants versus non migrants, or those with credit compared to those without (Table 5), and the associations were minimal (age–CII r = –.10, p = .27; education–adaptation ρ = .10, p = .26).

Table 4: Chi square tests of association between household characteristics and adaptation/migration (N = 120)

Association	χ^2	df	p	V	Fisher p
Education × adaptation	6.36	4	.174	.230	–
Credit access × adaptation	1.51	1	.220	.112	.254
Irrigation access × adaptation	1.20	1	.274	.100	.379
Institutional support × adaptation	0.47	1	.493	.063	.618
Gender × adaptation	0.01	1	.929	.008	1.000
Land insecurity × adaptation	0.57	1	.451	.069	–
Age group × migration	2.47	3	.481	.143	–
Institutional support × migration	1.68	1	.195	.118	.291

Credit access × migration	1.08	1	.298	.095	–
Land insecurity × credit access	0.42	1	.519	.059	–

No association is significant at $p < .05$. Fisher's exact test for 2×2 tables with small expected counts. Source: Field survey (2026)

Table 5. Independent samples t tests of mean age by adaptation, migration, and credit status (N = 120)

Comparison	M_1	M_0	t	p	95% CI of diff	d
Adopters vs. non adopters	48.8	52.2	−1.28	.202	[−8.03, 1.23]	−.38
Migrants vs. non migrants	49.3	48.7	0.32	.747	[−3.07, 4.33]	.07
Credit vs. no credit	49.3	48.7	0.30	.768	[−3.27, 4.54]	.07

Levene's test indicated equal variances in all comparisons. Source: Field survey (2026).

5.6. Multivariable Logistic Regression

The logistic regression analysis of adaptation adoption using the whole set of predictors yielded no overall statistical significance (likelihood ratio χ^2 (8) = 7.49, p = .485; McFadden pseudo-R^2 = .09). The model correctly classified 90% of cases, with an AUC of .71; given that 89.2% of households had adopted at least one adaptation practice, a naive classifier that predicted "adapter" for every household would also achieve roughly 90% accuracy. The AUC therefore indicates that the model is performing close to the level of this base rate rather than demonstrating genuine discriminative ability, which is consistent with the non-significant likelihood ratio test: the AUC should not be read as evidence of meaningful predictive performance when the overall model is not statistically significant. No predictor achieved statistical significance (Table 6); access to financing, irrigation, and institutional support indicated the anticipated facilitative trend, however their confidence ranges included unity. Multicollinearity was minimal (all VIFs < 1.06) and calibration satisfactory (Hosmer–Lemeshow p = .22). A parallel migration model also yielded non-significant results (LR $\chi^2(8) = 3.72$, p = .88).

Table 6. Binary logistic regression predicting adoption of any adaptation practice (N = 120)

Predictor	B	OR	95% CI	p
Age (years)	−.055	0.95	[0.88, 1.02]	.156
Female	−.273	0.76	[0.07, 8.38]	.824
Education (ordinal)	.323	1.38	[0.86, 2.21]	.178
Credit access	.955	2.60	[0.65, 10.39]	.177
Irrigation access	.830	2.29	[0.49, 10.73]	.292
Institutional support	.760	2.14	[0.37, 12.24]	.393
Climate Impact Index	−.194	0.82	[0.41, 1.66]	.588
Land tenure insecurity	−.521	0.59	[0.17, 2.12]	.423

Model LR $\chi^2(8) = 7.49$, p = .485; McFadden R^2 = .09; AUC = .71; Hosmer–Lemeshow p = .22; VIFs ≤ 1.06. Source: Field survey (2026).

Table 7. Triangulation matrix juxtaposing survey findings and open-ended themes

Survey finding	Open ended theme (content analysis, N = 120)	Integration assessment
Near universal, multi domain exposure: median 5 of 6 impact domains; 73–88% per specific impact	Theme 1: Compounding stress and multi-channel loss; salinity intrusion emerges spontaneously	Convergence, with expansion (salinity; health channel losses)
Adaptation adopted by 89.2%; no significant socio demographic or resource determinants	Theme 2: Coping rather than transformation — 26.7% no coping strategy; 34.2% erosive coping (working harder, selling livestock)	Divergence on depth (breadth vs. depth of adaptation), resolved as expansion
Institutional support 90.0%, led by one off inputs; credit 81.7%, concentrated in cooperatives and moneylenders	Theme 3: Thin community support (57.5% little or none); demand for irrigation, drainage, credit, and climate information	Convergence, with expansion (specific demand profile)

Female respondents 8.3%; gender not analysable within the survey	Theme 4: Gendered burdens and uneven voice — 30.0% limited participation; 21.7% women work harder	Expansion (extends the survey into gendered terrain)

Integration assessment follows Fetters et al. (2013). Percentages are category frequencies from content analysis of the ten open ended items (N = 120). Source: Field survey (2026).

5.7. Qualitative Findings and Triangulation

The examination of the ten open ended questions revealed four overarching themes: (i) exacerbating climatic pressures and multifaceted losses; (ii) adaptation instead of transformation; (iii) minimal community and institutional backing, alongside a need for water infrastructure, credit, and information; and (iv) gender specific burdens and disproportionate representation. Table 7 contrasts the two strands and documents an integration evaluation for each topic.

Theme 1: Compounding climatic stress and multi-channel loss

When asked about the alterations they perceived, participants mostly identified floods (20.0%), saltwater intrusion (19.2%), elevated temperatures (18.3%), and intensified rainfall (18.3%), while 24.2% indicated no significant change — closely reflecting the closed item exposure profile. Significantly, saltwater intrusion, which was not addressed by the closed items, arose unexpectedly, broadening the exposure profile of this border upazila. The documented impacts on agriculture mostly focused on the destruction or impairment of crops (44.2% combined), a rise in pests (18.3%), and challenges in harvesting (15.8%); the most notable losses reported were instances of waterborne diseases (25.0%), animal casualties (20.0%), revenue reductions (16.7%), and crop failures (13.3%). According to the participants' perspective, the effects of climate are multifaceted, influencing productivity, assets, income, and health, hence supporting the comprehensive rationale of the Climate Impact Index.

Theme 2: Coping rather than transformation

The open-ended coping inquiry corroborates the almost universal adoption rate shown by the closed item (89.2%). When enquired about their actions during floods, droughts, or other calamities, 26.7% of participants indicated a lack of coping strategy yet 30 out of 32 families had claimed to employ at least one adaptation method on the closed item while an additional 34.2% recounted detrimental or self-depleting reactions (increased labour, 20.8%; liquidation of livestock, 13.3%). Intentional agricultural adaptations including cultivating vegetables on aquatic beds (20.0%) and diversifying crops (19.2%) were identified by a small fraction. The main adaptation issues reported were insufficient irrigation apparatus (20.0%), poor governmental assistance (20.0%), water saturation (18.3%), and insect infestations (17.5%). Collectively, these reactions suggest that the extent of adaptation documented by the closed item overstates its depth: a significant portion of daily responses involves exogenous coping or resource depletion rather than sustainable adaptation.

Theme 3: Thin community and institutional support; demand for water, credit, and information

Narratives about networks of assistance were much less prevalent than the quantitative support data: 38.3% indicated a lack of community assistance during environmental emergencies, while an additional 19.2% characterized the support as minimal, with familial support (21.7%) and community mutual help (20.8%) being the primary positive aspects. Articulated institutional and policy requirements coalesced around water infrastructure, emphasizing improved irrigation access (25.0%) and drainage systems (20.8%), followed by credit availability (15.8%) and education on climate resilient agriculture (14.2%). Recommendations for enhancing future livelihood stability included superior weather forecasting (23.3%), upgraded irrigation systems (22.5%), drainage improvements (19.2%), and increased access to loans (18.3%). These requests reflect the disparities in credit and support observed in the study, where credit was mostly held by cooperatives and moneylenders, while institutional assistance was limited to singular contributions.

Theme 4: Gendered burdens and uneven voice

Responses regarding gendered effects revealed that climate stress is influenced by unequal involvement: 30.0% noted women's restricted participation, 21.7% observed that women exert more effort under weather stress, and 11.7% identified gender specific obstacles, whereas 20.0% suggested that women do engage in decision making. Narratives about the formulation of livelihood choices were disjointed government driven (23.3%), community dialogues (21.7%), personal (20.0%), familial (15.0%), or without a discernible procedure (20.0%) indicating weak and inconsistent deliberative frameworks for adaptation strategy. Due to the fact that women represented just 8.3% of the survey participants, this subject broadens the survey into areas it was unable to examine.

The integration of the two strands (Table 7) reveals a convergence regarding the knowledge and influence profile as well as the structure of institutional support; an expansion where the open-ended material introduces elements lacking in the closed things (salinity invasion, erosive coping, sexist burdens); and a significant divergence the disparity between the nearly universal acceptance of the resolved item and the limited coping strategies articulated by respondents. Instead

of detracting from the study, this discrepancy enhances its primary conclusion: adaptability in Sharsha is extensive but superficial.

6. Discussion

Three conclusions are prominent: exposure and effects are almost ubiquitous; adaptation, migration, and resource accessibility are prevalent; and no household attributes often regarded as factors influencing adaptation differentiated adopters from non-adopters. The open-ended strand aligns with the first two patterns, amplifies them (salinity incursion, gendered responsibilities), and elucidates the third (Table 7). Figure 7 consolidates these results.

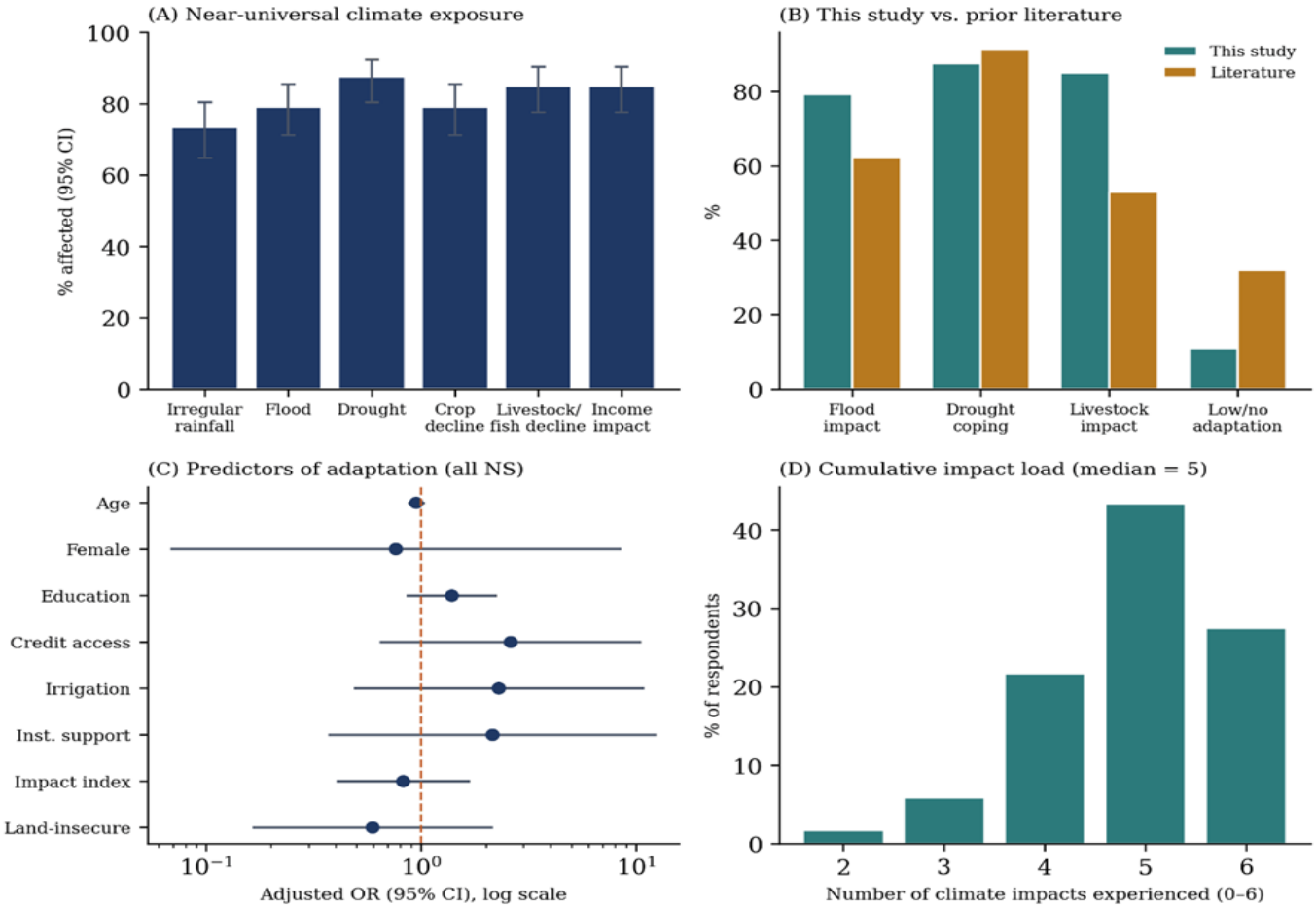


Figure 7: Summary of key findings: (a) widespread occurrence of six climate impact categories with 95% confidence intervals; (b) comparison of the present results with existing literature; (c) adjusted odds ratios for predicting adaptation, all with confidence intervals that include 1.0; (d) distribution of the Climate Impact Index (median = 5 out of 6). Source: Author, derived from the field survey (2026).

The observation that the majority of families encountered floods, stress due to drought, and concomitant losses in output and income (median five out of six categories) corresponds with regional data indicating that farmers in the southwest confront compounded rather than singular risks (Kabir, 2015; Hossain et al., 2012). The significance of irrigation expenses linked to drought and fish fatalities resonates with specialised studies in the Barind drought area (Hossain et al., 2016) and in aquaculture under thermal stress (Al Asif & Habib, 2017). Previous research on figure specific perception indicates a notably high overall awareness (e.g., Kabir, 2015), however the current disaggregated methodology reveals awareness spread among many distinct, concurrent stresses, hence complementing rather than opposing that body of knowledge.

The adoption of adaptation measures (89.2%) aligns with research indicating proactive farm level reactions in coastal and drought affected regions of Bangladesh (Hossain et al., 2016; Bhuyan et al., 2024). The extent of adoption should not be conflated with its depth: the majority of participants indicated a single predominant practice, with loans mostly sourced via cooperatives and moneylenders instead of formal financial institutions, and institutional assistance favored

sporadic inputs rather than continuous support. Adaptation in Sharsha seems authentic yet gradual, focused on managing persistent stress rather than undergoing fundamental change (Kabir et al., 2022), and the elevated migration rate (76.7%) aligns with migration being a standard element of the household livelihood strategy (Uddin, 2024). The unbounded content enhances and clarifies this interpretation: 26.7% of participants were unable to identify any coping strategies, even though a majority indicated the use of techniques in the closed item; additionally, 34.2% reported engaging in erosive coping methods like increasing work effort or liquidating livestock (Theme 2), while expressed needs centred around irrigation, drainage, credit, and climate data instead of the prevalent one time inputs (Theme 3).

The most conceptually prominent finding is the lack of substantial factors influencing adaptation. This stands in stark contrast to a considerable body of Bangladeshi literature: Ahmed and Fatema (2023) identified gender, farming knowledge, age, income, and farm size as significant factors; Begum et al. (2023) noted the importance of education, income, and institutional influences; and in a wetland investigation with an identical sample size (N = 120), Bithi et al. (2026) recognized family size, alternative income, perception, and access to loans as key predictors (this comparison was made at the writing/revision stage, as Bithi et al. (2026) was published around the same period as this study's fieldwork). Multiple non-exclusive rationales account for these discrepancies. Primarily, when exposure and adaptation are nearly ubiquitous, the variance between households diminishes, resulting in a ceiling effect (a compressed distribution) that signifies a highly and uniformly stressed community rather than a mere artefact; the open-ended coping data support this view, indicating that what is common among households is a wide yet superficial repertoire rather than a distinguishing asset (Theme 2). Secondly, the singular response, categorical tool recorded the kind rather than the degree of exposure and adaptation, diminishing the nuanced variance that continuous or Likert scales often use. Third, the non-probability, convenience driven selection of available agricultural families may have resulted in a very uniform cohort and raises the potential for selection biases, which is an additional rationale for considering the null findings as peculiar to the sample. Ultimately, Sharsha's unique circumstances a border upazila with the Benapole land port, relatively dense market accessibility, and a vibrant presence of cooperatives and NGOs may perhaps facilitate a more equitable distribution of adaptable resources compared to more isolated or distinctly stratified environments. Collectively, these factors suggest that determinant models are influenced by ecological context, measurement precision, and sampling methods, and that "generalized adaptation" is a feasible and policy relevant framework in some rural economies.

These results can also be read through the Sustainable Livelihoods Approach's five capitals framework introduced in Section 2.3. The SLA predicts that the composition and flexibility of a household's natural, human, social, financial, and physical capital should differentiate adaptation outcomes, since better endowed households are expected to convert exposure into adaptive action more readily than asset poor ones. The null determinants finding suggests that this differentiating role of asset portfolios is muted in Sharsha, plausibly because the near universal severity of exposure compresses the range over which capital differences would ordinarily matter, an interpretation consistent with the ceiling effect discussed above. The qualitative themes reinforce this reading: rather than a subset of well-resourced households drawing on distinctive capital to adapt more deeply, the open-ended data show a broadly shared, comparatively shallow repertoire of coping across the sample (Theme 2), with need expressed collectively for irrigation, drainage, credit, and climate information (Theme 3) rather than concentrated in particular capital rich households. This does not invalidate the SLA as a descriptive framework for the components of livelihoods in Sharsha; rather, it suggests that in a uniformly and severely exposed border upazila, the five capitals shape the depth and quality of adaptation more than they shape whether a household adapts at all, echoing the paper's broader distinction between the breadth and the depth of adaptation.

7. Conclusion and Policy Implications

This micro level, mixed methods investigation of Sharsha Upazila chronicles an agricultural economy beset by extensive, multi-faceted climatic pressures, whereby the median family endures five out of six detrimental effect areas, and adaptation, migration, and resource accessibility are prevalent. The primary contribution is the discovery that adaptation is generalized instead of being socially differentiated: no socio demographic or resource variables typically considered as determinants distinguished adopters from non-adopters, regardless of whether assessed bivariately or through a multivariable model. Instead of being dismissed as a null outcome, this trend has significant value — it challenges the notion that adaptation is exclusive to affluent resources and indicates a society where climate responses are almost universal but still shallow in their implementation. Three policy trajectories emerge: due to the widespread nature of adaptation and exposure, community centric support is expected to be more effective than narrowly focused assistance; the reliance on informal credit necessitates enhanced access to formal, cost-effective agricultural financing; and the prevalence of singular input distribution suggests a transition from sporadic relief to ongoing extension services, climate data dissemination, and irrigation infrastructure development. Incorporating gender considerations into adaptation planning is crucial, considering the limited representation of women, the gender specific costs, and the uneven involvement highlighted in the open-ended replies (Theme 4), together with the gendered effects recorded in other studies (Islam, Das, et al., 2024).

8. Limitations and Future Research

Numerous constraints characterize these results. Primarily, the sample was obtained via non probability methods (purposive and convenience sampling) instead of random selection, thus it cannot be presumed to reflect the farming demographic of Sharsha Upazila; all statistics pertain specifically to the sample, the inferential analyses are exploratory, and any broader applicability of the results relies on analytical rather than statistical generalization. Secondly, the obtained sample of 120 households is less than the approximately 385 suggested by conventional formulas for probability designs, resulting in the study being underpowered for multivariable analysis; thus, the null determinant results should be interpreted as tentative rather than conclusive evidence of no effect. The singular categorical instrument recorded type but failed to assess intensity or frequency, resulting in ceiling effects and restricted variance; the qualitative dataset comprises succinct coded open-ended responses and interview field notes instead of comprehensive narrative transcripts, constraining the depth of thematic analysis; the minimal representation of women (8.3%) hinders gender specific analysis; the cross sectional, self-reported design cannot determine causality. Subsequent research ought to utilize a more extensive, stratified probability sample (approximately 385 households, incorporating a gender quota), substitute single response questions with continuous metrics and validated multi item Likert scales (reinstating the variance essential for determinant and reliability assessment), and implement longitudinal and comparative methodologies across diverse upazilas to ascertain if the generalized adaptation pattern persists beyond this border, market integrated context. Focusing on the intricacies and efficacy of adaptation, together with its gendered aspects, would enhance both academic research and policymaking.

Declarations

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Author(s) Contributions

M. E. Hasan: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft. S. Akter: Investigation, writing – Original Draft (literature review and discussion), Writing – Review & Editing. S. Rahman: Supervision, Project Administration, Writing – Review & Editing. All authors have read and approved the final version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

AI-assisted tools were used during the preparation of this manuscript for language editing, reference formatting and the verification of bibliographic details and DOIs. No AI tool was used to generate the research design, the primary data, the analysis or the interpretation of the findings. The authors take full responsibility for the accuracy and integrity of all content presented in this manuscript.

Data Availability Statement

The anonymized survey dataset supporting the findings of this study is available from the corresponding author upon reasonable request.

Ethical Approval

All participants gave their verbal informed permission after being told of the study's objectives. Respondents were allowed to reject or withdraw at any time, participation was anonymous, and no personally identifying information was

collected. Formal institutional review board permission was not acquired at the time of fieldwork because the institution did not have a standing review board for non-clinical social survey research; this is recognized as a study restriction.

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