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GOVERNING ANTICIPATORY ACTION AND LOSS AND DAMAGE IN BANGLADESH: EVIDENCE FROM FLOOD AND COASTAL FRONTLINES

Abstract

This paper examines governance effectiveness in anticipatory action and loss and damage across flood and coastal hazard contexts in Bangladesh. It uses a mixed-methods design that combines a household survey of 390 respondents in Kurigram and Bagerhat with Focus Group Discussions (FGDs), Key Informants' Interviews (KIIs), and index-based analysis. Results indicate high early warning coverage across both sites (over 80 per cent), confirming the technical functionality of national forecasting and dissemination systems. However, pre disaster assistance remained limited (around 8 to 12 per cent), revealing a persistent gap between warning and action at the local government level. Regression findings show that institutional trust significantly increases the likelihood of receiving anticipatory support ($OR = 1.67, p = .018$), and that lack of such support is associated with higher loss severity ($\beta = 0.42, p < .001$). Loss patterns vary by context, with higher economic loss in flood prone Jatrapur and higher overall loss severity in coastal Southkhali (LDESI 3.92 vs 3.14, $p < .01$), driven largely by non-economic impacts related to health and salinity exposure. The findings indicate that governance effectiveness is shaped by legal authority, fiscal autonomy, and institutional legitimacy rather than forecasting capacity alone. The paper calls for strengthened pre disaster financing mechanisms, decentralised trigger-based decision making, and integration of non-economic loss into national assessment systems.

Keywords: Anticipatory Action, Loss and Damage, Disaster Governance, Institutional Trust, Early Warning Systems

1. Introduction

Governments, humanitarian agencies, and climate risk practitioners have been rethinking disaster governance over the past decade in response to growing climate risks.¹ Traditional disaster management focused on emergency relief after

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¹ Tanzania Zaman et al., "Disaster Risk Reduction and Anticipatory Action Governance in Bangladesh," *Frontiers in Climate* 4 (2022): 944736, <https://doi.org/10.3389/fclim.2022.944736>.

an event has struck, with limited mechanisms for preventive or pre-impact action.² International policy frameworks have begun to challenge this model by promoting anticipatory interventions that link scientific forecasting and pre-arranged financing with predefined action triggers.³ The Sendai Framework for Disaster Risk Reduction 2015 to 2030 highlights the need to enhance disaster preparedness and reduce disaster effects by strengthening governance systems that incorporate knowledge, early warning, and risk information into proactive measures.⁴ This emphasis reflects a broader shift toward risk governance that integrates pre-impact risk reduction with anticipatory financing mechanisms.

Forecast-based financing and anticipatory action protocols have emerged as operational tools to bridge the gap between early warning and timely interventions that save lives and reduce losses. Anticipatory action is defined as planned and financed action triggered by forecast information that enables actors to intervene ahead of hazard impacts.⁵ The philosophy underlying these approaches is that measurable prediction and pre-ordered resources create a window of opportunity for action, often referred to as the forecast-to-action continuum of risk governance. The integration of such mechanisms aims to reduce the compound effects of disasters by enabling actors to act when scientific thresholds are met, rather than waiting for impacts to expand.⁶

At the climate change policy level, recent decisions under the United Nations Framework Convention on Climate Change have elevated the issue of Loss and Damage. These decisions include an agreement to establish a dedicated financing mechanism to support vulnerable developing countries facing climate impacts that adaptation efforts cannot avert or adequately address. The decision at the twenty seventh Conference of Parties to create a Loss and Damage Fund signalled a recognition that impacts beyond existing adaptation capacity require specific policy

² M. Anwar Hossen et al., “A Governance Perspective for Climate Change Adaptation: Conceptualizing the Policy-Community Interface in Bangladesh,” *Environmental Science and Policy* 137 (2022): 174–84, <https://doi.org/10.1016/j.envsci.2022.08.012>.

³ Muhammad Muzammil, Karlijn Muiderman, and Joost M. Vervoort, *Approaches through Which Anticipation Informs Climate Governance in South Asia*, CCAFS Working Paper no. 387 (Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security, 2021).

⁴ UNDRR, *Sendai Framework for Disaster Risk Reduction 2015 to 2030* (Geneva: United Nations Office for Disaster Risk Reduction, 2015).

⁵ Anticipation Hub, “Statement of the Anticipation Hub, Global Platform for Disaster Risk Reduction 2022,” last modified 2022, <https://globalplatform.undrr.org/2022/publication/statement-anticipation-hub-global-platform-disaster-risk-reduction-gpdrr-2022.html>; Sean Wilkinson, Sarah Dunn, Russell Adams, Nicolas Kirchner-Bossi, Hayley J. Fowler, Samuel Gonzalez Otalora, David Pritchard, Joana Mendes, Erika J. Palin, and Steven C. Chan, “Consequence forecasting: a rational framework for predicting the consequences of approaching storms,” *Climate Risk Management* 35 (2022): 100412.

⁶ Md. Mokhlesur Rahman and Md. Saiful Islam, “Institutional Dynamics and Climate Adaptation: Unveiling the Challenges and Opportunities in Coastal Bangladesh,” *SN Social Sciences* 4, no. 8 (2024): 150, <https://doi.org/10.1007/s43545-024-00950-3>.

responses.⁷ Progress toward operationalising this fund was further advanced through transitional processes leading up to the twenty eighth Conference of Parties, which included provisions for financing urgent actions that help communities manage residual risk.⁸

Improvements in forecasting technology, impact-based prediction models, and early warning dissemination systems have expanded the evidence base for anticipatory interventions.⁹ Yet governance arrangements that allow resources to flow based on forecast thresholds remain underdeveloped in many national systems.¹⁰ Forecast data may be available, but the legal and institutional mechanisms that authorise pre-event fund allocation are often absent or unclear. In other words, technical capacities for prediction have outpaced governance capacities for acting on these predictions in a timely and transparent manner.¹¹ This dynamic underlines the need to reconceptualise both anticipatory action and Loss and Damage as governance innovations that redefine authority, accountability, and resource allocation in risk management systems, rather than as purely technical or humanitarian instruments.

Bangladesh has historically confronted recurrent climate hazards, including cyclones, riverine floods, and storm surges. Over several decades, the country has developed a structured disaster governance system that integrates national policies, local institutions, volunteer networks, and community actors into an operational apparatus for risk management.¹² Early components of this system, such as the Cyclone Preparedness Programme, demonstrate institutionalised roles for local volunteers in early warning dissemination and evacuation, contributing to lowering mortality in extreme events.¹³ The Standing Orders on Disaster 2019 provides a comprehensive policy framework for disaster risk management in Bangladesh.

⁷ UNFCCC, “COP27 Reaches Breakthrough Agreement on New Loss and Damage Fund for Vulnerable Countries,” last modified November 20, 2022, <https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries>; Erin Roberts et al., “Loss and Damage Finance and Climate Justice,” *Nature Climate Change* 13, no. 1 (2023): 10–13, <https://doi.org/10.1038/s41558-022-01580-5>.

⁸ Anticipation Hub, “COP28: A Call for Action on the Loss and Damage Fund,” 2023, https://www.anticipation-hub.org/Documents/Policy_Papers/COP_28_Call_to_action_Briefing.pdf; FAO, *Outcomes of COP27 and COP28 for the NENA Region* (Cairo: FAO Open Knowledge Repository, 2024); Lisa Vanhala and Cecilie Hestbaek, “The Politics of Loss and Damage Governance,” *Global Environmental Politics* 23, no. 1 (2023): 1–21.

⁹ Zaman et al., “Disaster Risk Reduction”.

¹⁰ Pia-Johanna Schweizer and Ortwin Renn, “Governance of Systemic Risks for Disaster Prevention and Mitigation,” *Disaster Prevention and Management* 28, no. 6 (2019): 862–874, <https://doi.org/10.1108/DPM-02-2019-0069>.

¹¹ UNDRR, *Sendai Framework*; Wilkinson et al., “Consequence forecasting”.

¹² Hossen et al., “A Governance Perspective”.

¹³ Zohra I. Farid and Mahbuba Nasreen, “Where Lies the Problem with Elderly Population beneath the Non-Response to Evacuation Order?: A Study on Cyclone Bulbul in Cyclone-Affected Islands of Bangladesh,” in *Coastal Disaster Risk Management in Bangladesh*, ed. Mahbuba Nasreen et al. (London: Routledge, 2023), 193–213; Bishawjit Mallick et al., “Disaster Preparedness and Cyclone Response in Coastal Bangladesh,” *Environmental Hazards* 19, no. 1 (2020): 1–19, <https://doi.org/10.1080/17477891.2019.1705469>.

It defines and distributes responsibilities across multiple tiers of government, including Union Disaster Management Committees, Upazila Disaster Management Committees, as well as district- and national-level bodies. However, governance systems that excel in immediate crisis response do not automatically translate into formal structures for anticipatory governance.¹⁴

Differences between flood and coastal contexts further illustrate governance variation. Riverine flood systems benefit from predictable seasonal patterns that enable early warning and preparation. Coastal regions face compound risks where sudden onset cyclones interact with slow onset salinity processes, creating complex governance demands.¹⁵ These differences highlight the need to examine governance effectiveness across diverse hazard contexts.¹⁶

This study addresses these research gaps through a mixed-methods design. It integrates quantitative survey data collected from 390 respondents with focus group discussions and key informant interviews conducted across flood and coastal governance frontlines in Bangladesh. The study develops a Governance Effectiveness Index for anticipatory action and a Loss and Damage Experience Severity Index to systematically measure and compare local experiences across hazard contexts. The analysis examines how institutional readiness, predefined anticipatory action triggers, and governance performance relate to observed loss outcomes. Economic and non-economic dimensions of Loss and Damage are assessed through a composite measurement framework, enabling comparison across flood and coastal settings. Statistical analysis links governance failures and institutional constraints with variations in loss severity, providing empirical evidence on how local governance structures facilitate or hinder anticipatory action and shape residual risk outcomes. This integrated approach positions the study to address the central research question of the extent to which local governance arrangements influence anticipatory action effectiveness and Loss and Damage mitigation across diverse hazard contexts in Bangladesh.

¹⁴ Zaman et al., “Disaster Risk Reduction”.

¹⁵ Muzammil, Muiderman, and Vervoort, *Approaches through Which Anticipation Informs*; Sonja Ayeb Karlsson et al., “Loss and Damage from Climate Change: A New Perspective on Vulnerability,” *Global Environmental Change* 68 (2021): 102243, <https://doi.org/10.1016/j.gloenvcha.2021.102243>; Golam Rabbani et al., “Salinity-Induced Loss and Damage in Coastal Bangladesh,” *International Journal of Global Warming* 5, no. 4 (2013): 400–415.

¹⁶ Jana Bhowmik, Haseeb Md. Irfanullah, and Shaila Ahmed Selim, “Empirical Evidence from Bangladesh of Assessing Climate Hazard-Related Loss and Damage and State of Adaptive Capacity to Address Them,” *Climate Risk Management* 31 (2021): 100273, <https://doi.org/10.1016/j.crm.2021.100273>.

2. Literature Review

Existing literature on anticipatory climate governance highlights a transition from reactive disaster response to proactive risk management systems that integrate forecasting, finance, and institutional coordination.¹⁷ This shift reflects recognition that early warning systems alone do not reduce disaster losses unless they are linked with predefined actions, financial mechanisms, and institutional mandates. Studies in Bangladesh document significant progress in early warning dissemination and community preparedness. However, they also identify persistent institutional gaps in linking forecasts with timely financial action.¹⁸ Policy developments such as the National Early Action Protocol approved by the Ministry of Disaster Management and Relief in 2024 aim to formalise anticipatory action within national systems, though gaps remain in financing arrangements and operational mandates for pre event response.¹⁹ Forecast based financing pilots have demonstrated the effectiveness of early cash transfers in reducing asset loss, though these initiatives often remain project based and externally supported rather than embedded in routine public financial systems.²⁰ As a result, technical forecasting capacity has advanced faster than institutional mechanisms that authorise and deliver anticipatory action.

Governance research emphasises that local level implementation depends on administrative authority, coordination mechanisms, and trust between communities and institutions.²¹ The concept of governance effectiveness in disaster contexts has been examined through indicators such as transparency, responsiveness, accountability, and institutional coordination.²² These dimensions reflect how institutions process risk information, allocate resources, and respond under uncertainty. Empirical studies show that institutional trust and perceived fairness influence household decisions related to evacuation, preparedness, and engagement with local authorities. Farid

¹⁷ Muzammil, Muiderman, and Vervoort, *Approaches through Which Anticipation Informs*; Emmanuel M. Attoh and Giriraj Amarnath, “A Framework for Addressing the Interconnectedness of Early Warning to Action and Finance to Strengthen Multiscale Institutional Responses to Climate Shocks and Disasters,” *Climate Risk Management* 47 (2025): 100689, <https://doi.org/10.1016/j.crm.2024.100689>.

¹⁸ Zaman et al., “Disaster Risk Reduction”; Hossen et al., “A Governance Perspective”.

¹⁹ MoDMR, *National Early Action Protocol* (Dhaka: Ministry of Disaster Management and Relief, Government of Bangladesh, 2024); Anika Haque et al., “Institutional Challenges for Anticipatory Action in Bangladesh,” *International Journal of Disaster Risk Reduction* 91 (2023): 103692, <https://doi.org/10.1016/j.ijdr.2023.103692>.

²⁰ ICCCAD, “An Overview of Disaster Risk Reduction and Anticipatory Action in Bangladesh,” *Frontiers in Climate* 4 (2022): 846391, <https://doi.org/10.3389/fclim.2022.846391>; Ashley Pople et al., “Forecast-Based Financing: Evidence from Bangladesh,” *Disasters* 45, no. 3 (2021): 606–626, <https://doi.org/10.1111/disa.12452>.

²¹ M. S. Uddin, C. E. Haque, and M. N. Khan, “Good Governance and Local Level Policy Implementation for Disaster-Risk-Reduction: Actual, Perceptual and Contested Perspectives in Coastal Communities in Bangladesh,” *Disaster Prevention and Management* 30, no. 2 (2021): 94–111, <https://doi.org/10.1108/DPM-06-2020-0198>.

²² Hossen et al., “A Governance Perspective”; Schweizer and Renn, “Governance of Systemic Risks”.

and Nasreen²³ demonstrate that weak institutional communication and limited trust can reduce compliance with evacuation orders in cyclone prone areas. These insights support the use of composite indices that capture multiple dimensions of governance performance. The Governance Effectiveness Index developed in this study builds on this body of work by operationalising governance through household-level perceptions of early warning access, institutional trust, and the functional activity of Union Disaster Management Committees. It treats governance effectiveness as measurable through both institutional performance and public perception. This approach aligns with broader risk governance literature, which conceptualises effectiveness as an outcome of both institutional design and societal perception.

The Bangladesh context provides a distinct empirical setting where governance effectiveness can be examined across diverse hazard profiles. Riverine flood systems operate with relatively predictable seasonal patterns and established early warning channels, whereas coastal areas face compound risks that include cyclones, storm surge, and salinity intrusion.²⁴ Slow onset processes such as salinity intrusion and riverbank erosion challenge governance systems that are structured around discrete events, exposing gaps in legal and financial instruments that address cumulative and irreversible impacts.²⁵ This contrast illustrates a policy divide between sudden onset hazards with established response mechanisms and slow onset processes that remain weakly integrated into formal governance frameworks. Existing research has largely focused on forecasting accuracy, early warning infrastructure, and pilot interventions, with limited attention to how institutional arrangements shape anticipatory action and loss outcomes across hazard contexts.²⁶

Research on Loss and Damage has expanded to include both economic and non-economic dimensions. Economic losses are typically measured through asset damage and income reduction, whereas non-economic losses include health impacts, displacement, social disruption, and psychosocial stress.²⁷ Studies in Bangladesh highlight that non-economic impacts are particularly significant in coastal regions where salinity intrusion affects water access, health conditions, and livelihood stability.²⁸ These impacts often develop over extended periods and remain

²³ Farid and Nasreen, “Where Lies the Problem”.

²⁴ Muzammil, Muiderman, and Vervoort, *Approaches through Which Anticipation Informs*; Ayeb Karlsson et al., “Loss and Damage from Climate Change”.

²⁵ Rabbani et al., “Salinity-Induced Loss and Damage”.

²⁶ Schweizer and Renn, “Governance of Systemic Risks”; Attoh and Amarnath, “A Framework for Addressing the Interconnectedness”.

²⁷ UNFCCC, *Technical Paper on Approaches to Avert, Minimize and Address Loss and Damage Associated with Climate Change Impacts* (Bonn: United Nations Framework Convention on Climate Change, 2019); Bhowmik, Irfanullah, and Selim, “Empirical Evidence from Bangladesh”.

²⁸ Ayeb Karlsson et al., “Loss and Damage from Climate Change”; Rabbani et al., “Salinity-Induced Loss and Damage”.

underrepresented in conventional damage assessments that prioritise visible and immediate losses. Recent work also identifies the interaction between governance conditions and loss outcomes, where limited institutional capacity and delayed response can intensify both economic and non economic impacts.²⁹ Empirical evidence linking governance quality with measured Loss and Damage severity, however, remains limited, particularly at the local level.³⁰

Composite indices have emerged as a method to capture the multidimensional nature of Loss and Damage in a systematic and comparable manner. Such approaches combine standardised indicators across economic and non-economic domains to generate aggregate measures of severity.³¹ The Loss and Damage Experience Severity Index developed in this study follows this approach by integrating income-based loss estimates with reported impacts on health, displacement, education, and social wellbeing. The index structure reflects the need to account for both measurable economic loss and less tangible but persistent non-economic impacts that shape long term vulnerability. In parallel, the Governance Effectiveness Index provides a structured way to quantify institutional performance and link governance conditions with observed outcomes. The combined use of these indices responds to a gap in existing literature, where governance and loss dimensions are often studied separately rather than in an integrated analytical framework.

Recent scholarship emphasises the value of mixed methods approaches in examining complex governance systems, where quantitative measurement alone cannot capture institutional dynamics and lived experiences.³² Integration of qualitative insights enables interpretation of statistical relationships through contextual explanations related to administrative practice, political incentives, and social structures. This study adopts this approach to connect index-based measurement with qualitative evidence from focus group discussions and key informant interviews. The analytical framework, therefore, links governance effectiveness with Loss and Damage outcomes across hazard contexts, providing empirical insight into how institutional arrangements shape anticipatory action and residual risk.

²⁹ Rahman and Islam, “Institutional Dynamics”.

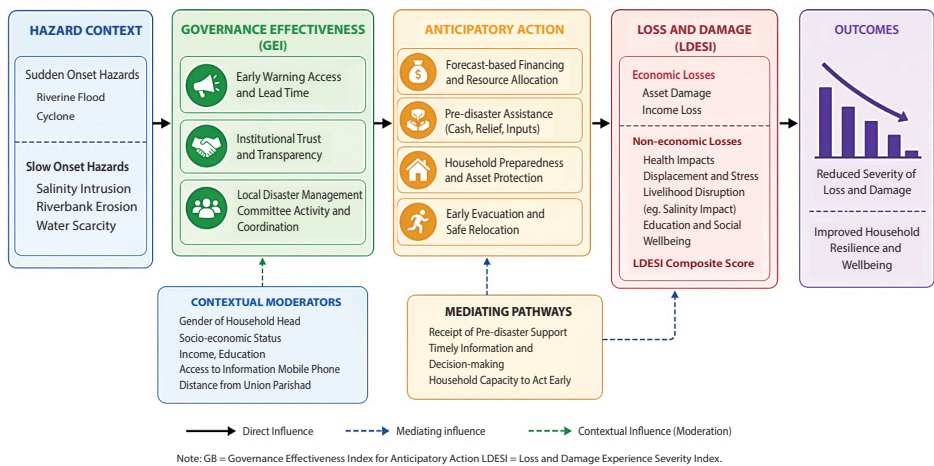
³⁰ Uddin, Haque, and Khan, “Good Governance”; Vanhala and Hestbaek, “The Politics of Loss and Damage Governance”; Emily Boyd et al., “Loss and Damage from Climate Change: A Risk-Oriented Approach,” *Climate Policy* 21, no. 6 (2021): 740–755, <https://doi.org/10.1080/14693062.2021.1879103>.

³¹ UNFCCC, *Technical Paper on Approaches*.

³² John W. Creswell and Vicki L. Plano Clark, *Designing and Conducting Mixed Methods Research*, 3rd ed. (Thousand Oaks, CA: Sage Publications, 2018).

3. Conceptual Framework

Figure 1: Conceptual Framework linking Anticipatory Action and Loss & Damage



The conceptual framework presents the analytical relationship between governance effectiveness, anticipatory action, and Loss and Damage outcomes at the household level. It positions anticipatory action as the central mechanism through which governance systems influence the severity of disaster impacts.

The framework begins with hazard context, which includes both sudden onset events such as floods and cyclones and slow onset processes such as salinity intrusion and riverbank erosion. These hazard types shape the timing, predictability, and nature of risk, which in turn influence the scope for anticipatory action.

Governance effectiveness, measured through the Governance Effectiveness Index, represents the enabling institutional environment. It includes three core dimensions: access to early warning and lead time, institutional trust and transparency, and the activity and coordination of local disaster management committees. These elements determine whether forecast information is translated into actionable decisions at the local level.

Governance effectiveness directly influences the extent and quality of anticipatory action. This includes forecast based financing, pre disaster assistance such as cash or relief, household level preparedness measures, and early evacuation or relocation. The framework assumes that stronger governance increases both the likelihood and timeliness of such actions.

The outcomes of anticipatory action are captured through the Loss and Damage Experience Severity Index, which combines economic and non-economic impacts. Economic loss refers to income and asset damage, whereas non-economic loss includes health effects, displacement, livelihood disruption, and social stress. Effective anticipatory action is expected to reduce the overall severity of these impacts.

The framework also incorporates mediating pathways and contextual moderators. Mediating pathways include actual receipt of pre disaster support, timely access to information, and household capacity to act. Contextual moderators include gender of household head, socio economic status, access to communication tools such as mobile phones, and distance from local government institutions. These factors shape how governance translates into action and how action influences outcomes.

4. Methodology

4.1 Study Design and Study Area

This study employed a convergent mixed-methods design in which quantitative and qualitative data were collected during the same research phase and integrated at the interpretation stage. The design followed established mixed methods scholarship that emphasises triangulation of numerical patterns with institutional and experiential explanations in governance research.³³ Quantitative data were collected through a semi structured household questionnaire designed to measure governance effectiveness, access to anticipatory action, and Loss and Damage severity. The questionnaire was translated into Bangla to ensure clarity, accessibility, and consistent understanding among respondents across study sites. Qualitative data were collected in parallel to examine institutional practices, decision making authority, and governance constraints shaping observed outcomes.

Two study areas were selected to capture contrasting climate risk governance contexts in Bangladesh. Jatrapur Union of Kurigram Sadar Upazila represented a riverine flood and erosion setting located along the Teesta and Brahmaputra river system. This area experiences recurrent monsoon flooding and riverbank erosion with relatively predictable seasonal patterns. Forecasts are usually issued several days in advance, which provides a defined governance window for anticipatory action. The site offered an empirical setting to assess whether predictable risk translates into timely institutional response.

³³ Creswell and Clark, *Designing and Conducting Mixed Methods Research*.

Southkhali Union of Sharankhola Upazila in Bagerhat District represented a coastal hazard context exposed to cyclones, storm surge, and salinity intrusion. This area faces compound risks where sudden onset cyclone impacts interact with slow onset salinity processes affecting agriculture, drinking water, and livelihoods. Governance challenges in this context extend beyond early warning to the management of residual impacts that exceed adaptation capacity.

The paired site design enabled comparison between predictable seasonal risk associated with river flooding and complex compound risk associated with coastal salinity and storm surge. This contrast supported analysis of how governance effectiveness varies across hazard types and temporal risk profiles. Both unions operate under the same national disaster management framework, including Union Disaster Management Committees and Standing Orders on Disaster, which strengthened comparability of governance structures across sites.

4.2 *Sampling and Data Collection*

The quantitative component included 390 household respondents, with 195 respondents selected from each study site. Sample size determination followed the standard proportion estimation formula for cross-sectional surveys:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{d^2}$$

Where $Z=1.96$ corresponds to a 95 per cent confidence level, $p=0.5$ represents maximum variability, and $d = 0.05$ indicates the acceptable margin of error. The calculated minimum sample was adjusted to support site wise and gender based comparative analysis.

A multi-stage stratified random sampling method was applied. In the first stage, household lists were obtained from Vulnerability Group registers maintained by Union Parishads, which include households classified as flood affected, cyclone affected, landless, or livelihood vulnerable. In the second stage, households were stratified by gender of household head and primary livelihood category. In the final stage, households were randomly selected proportionate to stratum size. Eligibility criteria required at least five years of residence and direct experience of a major hazard event after 2017.

Qualitative data were collected in August of 2025 through six Focus Group Discussions and ten Key Informant Interviews. FGDs were gender segregated to capture differentiated governance experiences.

Table 1: Focus Group Discussions

District	Location (union)	FGD	Gender	Participants
Kurigram	Jatrapur	FGD 1	Women	9
		FGD 2	Men	10
		FGD 3	Mixed	8
Bagerhat	Southkhali	FGD 4	Women	9
		FGD 5	Men	12
		FGD 6	Mixed	8

Table 2: Key Informant Interviews

Level	Designation	Number
Kurigram Sadar and Sharonkhola Upazila	Upazila Nirbahi Officer (UNO)	2
	Project Implementation Officer (PIO)	2
Kurigram and Bagerhat District	District Relief and Rehabilitation Officer (DRRO)	2
Jatrapur (Kurigram Sadar) and Southkhali (Sharonkhola)	Union Parishad Member/Secretary and UDMC Member	2
Local	NGO coordinator/ Community leader	2

4.3 Analytical Strategy and Index Construction

Quantitative analysis followed a structured analytical sequence using standard statistical techniques applied in governance and disaster research.³⁴ Initial analysis involved descriptive statistics, including frequencies, means, and standard deviations for demographic variables, early warning access, warning lead time, anticipatory support, and loss categories. Site wise and gender-based comparisons used Independent Sample t tests for continuous variables and Chi square tests for categorical associations.

A Governance Effectiveness Index for Anticipatory Action (GEI) was constructed to quantify institutional performance at the household level. The index comprised three components: access to early warning, trust in local disaster institutions, and perceived activity of Union Disaster Management Committees. Each component was measured using Likert scale items, standardised using z score transformation, and aggregated with equal weights. Higher GEI values represented stronger governance effectiveness.

A Loss and Damage Experience Severity Index (LDESI) measured residual impacts beyond anticipatory action and adaptation. Economic loss was

³⁴ Andy Field, *Discovering Statistics Using IBM SPSS Statistics*, 5th ed. (London: Sage Publications, 2018).

operationalised as the percentage of annual household income lost due to hazard events. Non-economic impacts included health disruption, displacement, education interruption, and psychosocial stress. Economic loss contributed 60 per cent and non-economic impacts contributed 40 per cent to the composite index based on established loss and damage measurement approaches.³⁵

Inferential analysis applied Binary Logistic Regression to identify determinants of effective anticipatory action, with GEI categorised into effective and ineffective governance outcomes. Independent variables included gender, education, livelihood type, warning lead time, and institutional contact. Additional models examined predictors of high LDESI scores. Qualitative data were coded thematically using governance related categories and integrated with quantitative findings during interpretation.

Qualitative analysis was conducted to explain and contextualise statistical relationships observed in the quantitative data. Thematic coding was applied to FGD and KII transcripts using predefined governance categories such as institutional coordination, decision making authority, and access to support. This process enabled identification of mechanisms that explain observed quantitative patterns, such as the gap between warning dissemination and anticipatory action. Integration of qualitative and quantitative findings was carried out at the interpretation stage of the study. At this stage, qualitative evidence was used to validate, explain, and refine the statistical results in accordance with mixed methods research principles.³⁶

4.4 *Quality Control and Ethical Considerations*

For the quality control, enumerators were trained prior to data collection through a structured orientation that covered survey objectives, questionnaire content, ethical protocols, and field procedures. Training included mock interviews and field testing to ensure consistency in data collection and accurate interpretation of survey items. Special attention was given to translating technical terms into locally understandable language to maintain reliability across respondents.

Ethical considerations were integrated throughout the research process. Informed consent was obtained from all participants before data collection. Respondents were informed about the purpose of the study, voluntary participation, and confidentiality of their responses. No personally identifiable information was recorded in the dataset. Data were stored securely and used only for research purposes.

³⁵ UNFCCC, *Technical Paper on Approaches*.

³⁶ Creswell and Plano Clark, *Designing and Conducting Mixed Methods Research*.

4.5 *Study Limitations and Future Research Directions*

This study has several limitations. The sampling frame is based on Vulnerability Group registers maintained by Union Parishads, which may introduce selection bias by overrepresenting households already identified as vulnerable. Households outside these registers may have different experiences of anticipatory action and loss outcomes. The study also focuses on two unions representing distinct hazard contexts. This site-specific design limits generalisability to other regions with different socio ecological and governance conditions.

Future research can expand geographic coverage across multiple districts and hazard types to improve external validity. Longitudinal designs can track changes in anticipatory action and loss outcomes over time and across hazard events. Future research can refine and validate the Governance Effectiveness Index and the Loss and Damage Experience Severity Index by applying larger datasets and alternative weighting structures. It can also extend the analysis through comparative cross-country studies to examine how different governance arrangements influence anticipatory action and residual risk outcomes.

5. Results

5.1 *Demographic Profile and Vulnerability Characteristics*

The full sample showed a mean age of 44.8 years (SD = 11.6), with limited variation between sites. Respondents in Jatrapur Union reported an average age of 45.3 years, compared to 44.2 years in Southkhali Union. This distribution indicates a working age population highly exposed to livelihood disruption from climate hazards. Female headed households comprised 17.9 per cent of the total sample. Southkhali Union showed a slightly higher proportion (19.5 per cent) compared to Jatrapur Union (16.4 per cent).

Table 3: Demographic and Socio-Economic Characteristics of Respondents (N = 390)

Variables	Jatrapur Union (n = 195)	Southkhali Union (n = 195)	Total (N = 390)
Mean age (years)	45.3 (SD 11.4)	44.2 (SD 11.8)	44.8 (SD 11.6)
Female headed households (%)	16.4	19.5	17.9
No formal or primary education (%)	41.5	33.8	37.7
Secondary or higher education (%)	17.4	19.0	18.2
Primary livelihood day labor (%)	48.7	29.2	39.0
Fishing or shrimp labor (%)	9.7	36.4	23.1

Landless households (%)	39.5	57.9	48.7
Mean monthly income (BDT)	7,860 (SD 2,710)	8,380 (SD 3,130)	8,120 (SD 2,940)
Kutcha or semi kutcha housing (%)	55.4	68.7	62.1

This pattern reflects heightened gendered vulnerability, particularly in coastal areas impacted by hazard related displacement and male out migration. Educational attainment varied across sites. Jatrapur Union reported 41.5 per cent of respondents with no formal schooling or incomplete primary education. The corresponding figure in Southkhali Union was 33.8 per cent. Secondary or higher education attainment remained low across both sites, reported by 18.2 per cent of all respondents.

Livelihood composition revealed distinct vulnerability profiles. In Jatrapur Union, 48.7 per cent of respondents relied primarily on day labor or seasonal agricultural work. In Southkhali Union, dependence on fishing and shrimp related labor was more prominent (36.4 per cent), combined with informal wage work. Landlessness emerged as a defining feature in Southkhali Union, where 57.9 per cent of households reported owning no cultivable land. The corresponding figure in Jatrapur Union was 39.5 per cent, reflecting historical erosion and repeated cyclone related displacement in the coastal site.

Household income levels were low across both sites. The mean reported monthly household income was 67 USD (SD = 24). Jatrapur Union reported a slightly lower mean income (64 USD) compared to Southkhali Union (69 USD), although income variability was higher in the coastal site. These income levels fall below national rural averages and signal limited financial buffers to absorb hazard related shocks.

Housing characteristics further reinforced baseline vulnerability. Across the sample, 62.1 per cent of households lived in kutcha or semi kutcha structures. Southkhali Union showed higher exposure to fragile housing materials (68.7 per cent) compared to Jatrapur Union (55.4 per cent), increasing susceptibility to cyclone and surge impacts.

5.2 *The Warning-Action Gap: Comparative Analysis*

Early warning dissemination reached a high proportion of households surveyed in both sites. As shown in Table 4, 85.6 per cent of respondents in Jatrapur Union and 83.1 per cent in Southkhali Union reported receiving at least one formal warning message prior to the most recent major hazard event. Warning sources included Cyclone Preparedness Programme volunteers, local government announcements, mobile phone messages, and mosque-based announcements. The

similarity in warning coverage indicates broad penetration of warning systems across hazard contexts.

FGD participants in both unions consistently described warning messages as frequent and credible, with several respondents stating that warnings now arrive earlier and through multiple channels compared to past events.

In contrast, access to anticipatory support prior to hazard impact remained extremely limited. Only 12.3 per cent of respondents in Jatrapur Union and 8.2 per cent in Southkhali Union reported receiving any form of pre disaster assistance. Reported support included small cash transfers, dry food distribution, and evacuation facilitation. The absolute number of beneficiaries remained low across both sites, indicating a substantial disconnection between warning dissemination and material action. Key informant interviews with Union Parishad members and Union Disaster Management Committee representatives indicate that pre-disaster assistance is rarely disbursed without formal directives from higher administrative authorities. This remains the case even when early warnings are issued several days in advance.

Warning lead time differed sharply between the two hazard contexts. Respondents in Jatrapur Union reported a mean warning lead time of 96.4 hours ($SD = 28.7$), equivalent to approximately four days. In Southkhali Union, the mean reported lead time was 34.8 hours ($SD = 15.6$), corresponding to one to two days. These figures reflect the seasonal predictability of upstream flooding compared to the rapid onset characteristics of cyclone and storm surge events.

An independent sample t test was conducted to examine regional differences in warning lead time. Results indicate a statistically significant difference between Jatrapur and Southkhali ($t = 25.84$, $df = 388$, $p < .01$). The magnitude of this difference confirms substantially longer preparation windows in the riverine flood context.

A parallel t-test assessed regional differences in receipt of pre disaster cash or in-kind support. Mean values for anticipatory support receipt remained low in both sites and the difference between Jatrapur ($M = 0.12$, $SD = 0.33$) and Southkhali ($M = 0.08$, $SD = 0.27$) was not statistically significant ($t = 1.41$, $df = 388$, $p = .159$). This result indicates that extended warning lead time did not translate into higher likelihood of action through institutional support. FGD respondents in Jatrapur explicitly noted that early warnings mainly prompted household level coping actions such as livestock relocation or savings withdrawal, rather than receipt of formal assistance.

Table 4: Early Warning Access, Lead Time, and Anticipatory Action by Study Site (N = 390)

Variable	Jatrapur Union (n = 195)	Southkhali Union (n = 195)	t value	p value
Received early warning (%)	85.6	83.1	-	-
Mean warning lead time (hours)	96.4 (SD 28.7)	34.8 (SD 15.6)	25.84*	< .01
Received pre disaster support (%)	12.3	8.2	-	-
Mean pre disaster support (binary)	0.12 (SD 0.33)	0.08 (SD 0.27)	1.41	.159

*Note: Binary variable coded 1 = received support, 0 = did not receive support. *p < .01*

In Table 5, gender disaggregation reveals systematic disparities in warning timeliness. Female headed households reported significantly shorter warning lead times compared to male headed households. Across the full sample, female headed households reported a mean lead time of 52.6 hours (SD = 31.2), compared to 71.4 hours (SD = 42.8) among male headed households. An independent sample t test confirms that this difference is statistically significant ($t = 4.37$, $df = 388$, $p < .01$). Lower access to mobile phones, reduced participation in community committees, and delayed relay of information were frequently cited in survey responses as contributing factors. Women participants in FGDs reported relying on secondary information from neighbors or male relatives, which often arrived after initial warning dissemination.

Gender differences in access to anticipatory support followed a similar pattern. Only 6.1 per cent of female headed households reported receiving pre disaster assistance, compared to 11.4 per cent among male headed households. The absolute numbers remained low, yet the disparity suggests uneven inclusion within anticipatory governance processes. KIIs with local officials (UNO and PIO) acknowledged difficulties in identifying and prioritising female headed households for early assistance due to incomplete beneficiary lists and limited outreach capacity.

Table 5: Gender Differences in Warning Lead Time and Anticipatory Support (N = 390)

Variables	Male Headed (n = 320)	Female Headed (n = 70)	t value	p value
Mean warning lead time (hours)	71.4 (SD 42.8)	52.6 (SD 31.2)	4.37*	< .01
Received pre disaster support (%)	11.4	6.1	-	-

**p < .01*

5.3 *Severity of Loss and Damage: Economic vs. Non-Economic*

Economic loss patterns differed markedly between the two study areas. As shown in Table 6, households in Jatrapur Union reported higher average monetary losses linked to crop damage, homestead erosion, and asset displacement. The mean reported economic loss per household in Jatrapur was USD 917 (SD = 480). In Southkhali Union, the corresponding mean economic loss was USD 622 (SD = 336). Riverbank erosion and repeated homestead relocation accounted for a substantial share of losses in Kurigram, as reflected in survey responses on land loss and housing reconstruction, especially in the charlands. FGD participants in Jatrapur frequently described permanent land loss as the most severe impact, noting that erosion forced repeated rebuilding without compensation.

Non-economic loss indicators followed an opposite pattern. Respondents in Southkhali Union consistently reported higher scores across non-economic impact items measured on a five-point Likert scale. Health related impacts, including skin disease, hypertension, and drinking water related illness, recorded a mean score of 4.1 (SD = 0.7) in Southkhali compared to 2.8 (SD = 0.9) in Jatrapur. Salinity related livelihood disruption, including reduced agricultural productivity and increased care burden, produced similarly elevated scores in the coastal site. Women participants in coastal FGDs emphasised chronic illness and care responsibilities linked to saline water exposure, describing these impacts as ongoing rather than event specific.

Displacement-related stress and social disruption were more prevalent in Southkhali. Respondents reported prolonged periods of displacement and repeated temporary migration associated with saline intrusion. These impacts were measured through questionnaire items on duration of displacement, schooling disruption, and loss of community ties. KIIs with PIO and NGO personnel in Southkhali highlighted increasing clinic visits for water related illnesses following cyclone seasons, reinforcing survey reported health impacts.

The combined index results reflect these divergent loss profiles. The mean LDESI score in Southkhali Union was 3.92 (SD = 0.61), compared to 3.14 (SD = 0.68) in Jatrapur Union. Independent sample t tests indicate that the difference in overall LDESI scores between the two sites is statistically significant ($t = 12.47$, $df = 388$, $p < .01$). The index structure assigns equal weight to standardised economic loss percentages and aggregated non-economic scores, which amplifies the contribution of irreversible impacts in the coastal context.

Gender disaggregation shows higher non-economic impact scores among female respondents across both sites, particularly for health and care related burdens. Female headed households in Southkhali recorded a mean non-economic impact

score of 4.3 (SD = 0.6), compared to 3.9 (SD = 0.7) among male headed households. FGDs with female headed households linked these higher scores to limited access to safe water sources and increased unpaid care responsibilities following hazard events.

Table 6: Economic and Non-Economic Loss Indicators by Study Site (N = 390)

Indicator	Jatrapur Union (n = 195)	Southkhali Union (n = 195)	t value	p value
Mean economic loss (USD)	918 (SD 480.3)	623 (SD 336.8)	7.36	< .01
Health impact score (1–5)	2.8 (SD 0.9)	4.1 (SD 0.7)	15.92	< .01
Salinity livelihood impact score (1–5)	2.5 (SD 1.0)	4.3 (SD 0.6)	22.41	< .01
Displacement stress score (1–5)	3.1 (SD 0.8)	4.0 (SD 0.7)	12.08	< .01
LDESI composite score	3.14 (SD 0.68)	3.92 (SD 0.61)	12.47	< .01

Note: LDESI combines standardised economic loss proportion and aggregated non-economic impact scores.
** p < .01*

5.4 Determinants of Effective Anticipatory Action

Table 7 presents the regression results. The model demonstrates acceptable fit (Nagelkerke R² = 0.31) and correctly classifies 78.6 per cent of cases. Institutional trust emerged as the strongest positive predictor of effective Anticipatory Action. Households reporting high trust in Union Parishad and disaster management committees were 1.67 times more likely to receive pre disaster support (OR = 1.67, p = .018). Trust was measured using a composite score derived from questionnaire items on confidence in warning accuracy, fairness of beneficiary selection, and responsiveness of local officials. KIIs with community leaders indicated that households perceived as cooperative or engaged with local institutions were more likely to be informed about upcoming assistance distributions.

Mobile phone ownership also showed a statistically significant positive association with receipt of anticipatory support (OR = 1.89, p = .011). Respondents with access to personal or household mobile phones were more likely to receive timely information on assistance distribution and evacuation coordination. FGD participants noted that information about relief timing often circulated through informal mobile messaging rather than public announcements.

Distance from the Union Parishad office produced a statistically significant negative effect. Each additional kilometer of distance reduced the odds of receiving pre disaster assistance by approximately 21 per cent (OR = 0.79, $p = .032$). Distance was measured using self-reported travel time and approximate walking distance categories converted into continuous estimates. KIIs with DRROs of both study area (Kurigram and Bagerhat district) confirmed logistical constraints in reaching remote settlements before hazard impact.

Education level did not show a statistically significant relationship with effective Anticipatory Action (OR = 1.08, $p = .417$). The absence of significance suggests that formal schooling did not differentiate access to anticipatory support once governance and communication variables were accounted for. Household income also remained statistically insignificant in the model.

Table 7: Binary Logistic Regression Predicting Receipt of Pre-Disaster Assistance (N = 390)

Predictor	B	SE	Odds Ratio	p value
Institutional trust score	0.51	0.22	1.67	.018**
Mobile phone ownership (1 = yes)	0.64	0.25	1.89	.011**
Distance from Union Parishad (km)	-0.23	0.11	0.79	.032**
Education level (years)	0.08	0.10	1.08	.417
Monthly household income	0.00	0.00	1.00	.561
Constant	-2.14	0.61	—	.001*

*Model fit: Nagelkerke $R^2 = 0.31$ (Moderate); Correct classification = 78.6 per cent. * $p < .01$, ** $p < .05$*

5.5 Association between Governance and Loss and Damage Outcomes

The Governance Effectiveness Index was constructed from questionnaire items assessing perceived transparency of Union Parishad decision making, responsiveness during hazard warnings, fairness in beneficiary selection, and coordination with disaster management committees. Scores were categorised into low, medium, and high governance effectiveness groups for categorical analysis. Health loss was categorised into low and high impact groups based on aggregated Likert scale responses covering illness incidence, treatment disruption, and water related disease exposure following hazard events. KIIs with the DRROs and PIOs of both areas confirmed that health related responses are rarely planned as part of disaster preparedness and are instead addressed reactively after impact.

Bivariate analysis using Chi-square tests reveals a statistically significant association between governance effectiveness and health related loss outcomes.

Households reporting low governance effectiveness were more likely to fall within the high health loss category. As presented in Table 8, 63.8 per cent of households with low governance effectiveness reported high health loss, compared to 34.6 per cent among households reporting high governance effectiveness. The Chi-square statistic confirms a significant association between the two variables ($\chi^2 = 14.72$, $df = 2$, $p = .001$).

This association aligns with descriptive patterns observed in responses to survey questions on early warning clarity, access to clean water support, and availability of local health services during hazard periods. Respondents reporting weak governance frequently indicated delayed warnings, unclear evacuation guidance, and absence of coordinated health outreach. FGD participants in Southkhali explicitly linked delayed local coordination with prolonged illness following saline water exposure, noting limited outreach from health workers during hazard periods.

Table 8: Association between Governance Effectiveness and Health Loss Category (N = 390)*

Governance Effectiveness Category	Low Health Loss n (%)	High Health Loss n (%)	Total
Low governance effectiveness	47 (36.2)	83 (63.8)	130
Medium governance effectiveness	74 (56.9)	56 (43.1)	130
High governance effectiveness	85 (65.4)	45 (34.6)	130
Total	206	184	390

*Chi-square (χ^2) = 14.72, $df = 2$, $p = .001$

To further assess predictors of Loss and Damage severity, a multiple linear regression model was estimated with LDESI score as the dependent variable. Independent variables included receipt of anticipatory action, governance effectiveness score, mobile phone ownership, household income, education level, and distance from Union Parishad office. Anticipatory action was measured using a binary indicator derived from questionnaire items on receipt of pre disaster cash, food, evacuation support, or early relocation assistance.

The regression model demonstrates adequate explanatory power with an adjusted R^2 of 0.38, indicating that governance and anticipatory action variables explain a substantial proportion of variance in LDESI scores. Table 9 presents the regression coefficients.

Lack of anticipatory action emerged as a statistically significant predictor of higher LDESI scores ($\beta = 0.42$, $p < .001$). Households that did not receive any form of pre disaster support recorded substantially higher loss severity scores. This

effect remained robust after controlling for income, education, and communication access. Focus group discussions in both sites highlighted that households lacking pre-disaster support were compelled to adopt distress coping strategies, including unsafe water use and delayed medical treatment. These coping strategies contributed to higher reported losses.

Governance effectiveness score also showed a significant negative association with LDESI ($\beta = -0.31$, $p = .004$). Higher governance effectiveness corresponded to lower overall loss severity, particularly through reductions in non-economic losses linked to health and displacement. Questionnaire responses indicate that households reporting stronger governance experienced earlier warnings, clearer evacuation instructions, and better coordination of relief distribution. KIIs with UDMC members noted that areas with active committee coordination were better able to organise temporary health support and water access during hazard periods.

Mobile phone ownership retained a modest but statistically significant negative association with LDESI ($\beta = -0.18$, $p = .021$). Education level and household income did not demonstrate statistically significant effects, indicating limited protective influence once governance and anticipatory mechanisms were accounted for.

Distance from Union Parishad office showed a positive association with LDESI scores, though the coefficient approached but did not reach conventional significance thresholds ($p = 0.067$). This pattern mirrors earlier findings related to anticipatory action access. FGD respondents from remote settlements from both sites reported limited physical contact with Union Parishad representatives during hazard events, reinforcing survey-based distance effects.

Table 9: Multiple Linear Regression Predicting LDESI Score (N = 390)

Predictors	B	SE	Standardised β	t	p
Lack of anticipatory action (1 = yes)	0.48	0.07	0.42	6.86	< .001*
Governance effectiveness score	-0.36	0.12	-0.31	-2.98	.004*
Mobile phone ownership (1 = yes)	-0.21	0.09	-0.18	-2.32	.021**
Distance from Union Parishad (km)	0.11	0.06	0.12	1.84	.067
Education level (years)	0.04	0.05	0.06	0.79	.431
Monthly household income	0.00	0.00	0.03	0.54	.589
Constant	3.92	0.41	—	9.56	< .001*

*Model fit: Adjusted $R^2 = 0.38$; $F(6, 383) = 40.17$, $p < .001$ * $p < .01$, ** $p < .05$*

6. Discussion

6.1 *The “Last Mile” Governance Failure in Anticipatory Action*

Findings from Section 5.2 reveal a clear disjuncture between early warning dissemination and the operational delivery of anticipatory support. High rates of warning receipt across Kurigram and Southkhali confirm that technical forecasting systems and dissemination channels are functioning effectively at the community level. Household survey data show that approximately 85 per cent of respondents received hazard warnings prior to recent flood and cyclone events, aligning with national level evidence on the performance of early warning systems in Bangladesh.³⁷ These outcomes reflect sustained investments in meteorological forecasting, flood prediction, and institutional coordination under SOD 2019, involving agencies such as the Bangladesh Meteorological Department and the Flood Forecasting and Warning Centre.³⁸

However, the very low coverage of pre disaster support identified in this study highlights a structural governance failure at the final stage of the forecast to action chain. Only 12.3 per cent of households in Kurigram and 8.2 per cent in Bagerhat reported receiving any form of anticipatory assistance, including pre disaster cash, food, evacuation support, or relocation assistance. This pattern mirrors documented global and national challenges in forecast-based financing, where technical forecasting capacity advances more rapidly than institutional mechanisms for releasing and authorising funds linked to forecast thresholds.³⁹

Governance scholarship emphasises that anticipatory action requires delegated authority, legally protected fiscal procedures, and clear accountability arrangements for acting under uncertainty.⁴⁰ In Bangladesh, these enabling conditions remain weak at the Union Parishad level. Survey responses and qualitative insights suggest that local officials remain hesitant to authorise pre disaster spending due to fear of audit objections if forecasted hazards do not result in visible impacts. This institutional risk aversion reflects broader public financial management norms that prioritise post event verification and tangible damage assessment.⁴¹

³⁷ Bangladesh Anticipatory Action, *National Anticipatory Action Annual Report* (Dhaka: Government of Bangladesh, 2024); WFP and Ministry of Disaster Management and Relief (MoDMR), *Anticipatory Action Implementation Report: Bangladesh* (Dhaka: World Food Programme, 2025); Zaman et al., “Disaster Risk Reduction”.

³⁸ Anticipation Hub, *Forecast-Based Financing: Scoping and Challenges* (Berlin: Red Cross Red Crescent Climate Centre, 2021).

³⁹ Anticipation Hub, *Forecast-Based Financing*; Muzammil, Muiderman, and Vervoort, *Approaches through Which Anticipation Informs*; Attoh and Amarnath, “A Framework for Addressing the Interconnectedness”.

⁴⁰ Schweizer and Renn, “Governance of Systemic Risks”; Thomas Tanner et al., “The Triple Dividend of Resilience,” *Nature Sustainability* 2, no. 6 (2019): 503–505.

⁴¹ Hossen et al., “A Governance Perspective”; Anticipation Hub, *Forecast-Based Financing*.

Key informant interviews with Union Parishad representatives and Upazila officials reinforce this finding. They indicate that expenditure undertaken without a formal disaster declaration is widely perceived as administratively unsafe. Several KII participants noted that pre disaster spending without observable damage creates personal liability risks under audit scrutiny, reinforcing reliance on reactive relief mechanisms. This aligns with previous governance analyses that identify fiscal accountability regimes as a critical barrier to anticipatory governance in Bangladesh.⁴²

The persistence of reactive disaster governance is reinforced by institutional norms embedded in the Standing Orders on Disaster 2019 and associated relief frameworks, which provide clear mandates and legitimacy for post-disaster assistance. However, these frameworks offer limited guidance on ex ante financial activation for anticipatory action. Editorial and policy commentary further suggests that relief distribution remains politically visible and socially recognised as an appropriate use of public funds, thereby reinforcing institutional incentives for post-impact responses.⁴³ Similar dynamics have been documented in coastal Bangladesh, where local governance legitimacy is often tied to visible relief distribution rather than preventive action.⁴⁴

Gender-disaggregated results from Section 5.2 further indicate that female-headed households experience shorter warning lead times and lower access to anticipatory support. These findings are consistent with earlier studies documenting gendered disparities in access to early warning interpretation, mobility, and institutional support in anticipatory action contexts.⁴⁵ FGD participants in Kurigram reported that women often receive warnings later through informal channels, limiting their ability to prepare or relocate assets in advance.

Overall, the evidence demonstrates a classic last-mile governance failure, where technical early warning systems function effectively. However, local-level institutional arrangements lack the legal authority, fiscal autonomy, and accountability safeguards needed to translate forecasts into timely action. This gap reinforces a reactive governance paradigm that constrains the potential of forecast based financing to reduce loss and damage before hazards strike.

⁴² Diego Massella and M. H. Sarker, “Institutional Barriers to Disaster Risk Reduction at Local Level in Bangladesh,” *International Journal of Disaster Risk Reduction* 31 (2018): 1012–1021; Simon Levine and Emma Gogerty, “Twelve Ways to Take Anticipatory Action to Scale in Conflicts and Recurring Crises,” policy brief (London: SPARC Knowledge, 2025); Zaman et al., “Disaster Risk Reduction”.

⁴³ “We Need to Integrate Anticipatory Action into Disaster Management,” *The Daily Star*, August 20, 2025; “Anticipatory Action is the Key,” *New Age*, October 14, 2025.

⁴⁴ Uddin, Haque, and Khan, “Good Governance”.

⁴⁵ Farid and Nasreen, “Where Lies the Problem”; Anticipation Hub, *Toolkit for Anticipatory Action in Fragile, Conflict- and Violence-Affected Settings* (Berlin: Anticipation Hub, 2024).

6.2 *The Invisible Crisis: Non-Economic Loss in the Coastal Belt*

Results from Section 5.3 demonstrate that non-economic loss and damage scores are significantly higher in Southkhali Union of Bagerhat compared to Jatrapur Union. Survey data reveal elevated health impacts, prolonged exposure to salinity, and displacement related stress that are not captured by conventional economic loss indicators such as crop damage or housing repair. These findings align with a growing body of literature that frames non-economic loss and damage as a core dimension of climate impacts affecting health, social relations, dignity, and wellbeing.⁴⁶

Conceptual work on non-economic loss and damage highlights that many climate impacts occur outside market valuation systems and therefore remain invisible within standard damage assessment frameworks.⁴⁷ In coastal Bangladesh, salinity intrusion represents a slow onset process that degrades drinking water quality, increases disease prevalence, and disrupts daily life over extended periods.⁴⁸ The survey results from Southkhali reflect these dynamics, with households reporting chronic health problems and persistent stress linked to saline water exposure.

National disaster damage assessment practices continue to privilege quantifiable economic losses, particularly infrastructure damage and agricultural loss. Policy analyses of loss and damage governance in Bangladesh show limited institutional mechanisms for systematically recording health impacts, psychosocial distress, cultural disruption, or displacement related stress.⁴⁹ This asset biased orientation constrains the visibility of non-economic losses and shapes funding priorities toward material compensation rather than human centred recovery.

Health related non-economic losses identified in this study are consistent with broader empirical evidence from coastal Bangladesh linking salinity exposure to hypertension, skin disease, waterborne illness, and long-term physical stress.⁵⁰ These impacts generate indirect economic costs through treatment expenditure and productivity loss yet remain largely excluded from disaster loss accounting systems. FGD participants in Southkhali described repeated illness episodes and treatment

⁴⁶ Marlies van Schie, Zinta Zommers, and Chandni Singh, "Governing Non-Economic Loss and Damage: Methodological and Policy Challenges," *Climate Policy* (2024), <https://doi.org/10.1080/14693062.2024.2301124>; Urbanet, *Non-Economic Loss and Damage in Coastal Urban Systems*, Urbanet Research Series (Berlin: Urbanet, 2025); UNFCCC, *Technical Paper on Approaches*.

⁴⁷ ADB and International Centre for Climate Change and Development (ICCCAD), *Assessing Non-Economic Loss and Damage Associated with Climate Change* (Mandaluyong City: Asian Development Bank, 2014); Bhowmik, Irfanullah, and Selim, "Empirical Evidence from Bangladesh".

⁴⁸ Zaman et al., "Disaster Risk Reduction"; Rahman and Islam, "Institutional Dynamics".

⁴⁹ Susan M. Sterett, review of *Governing the End: The Making of Climate Change Loss and Damage*, by Lisa Vanhala, *Law & Society Review* (2026): 1–5; Hossen et al., "A Governance Perspective".

⁵⁰ Zaman et al., "Disaster Risk Reduction"; Bhowmik, Irfanullah, and Selim, "Empirical Evidence from Bangladesh".

disruption following saline water exposure, reinforcing the quantitative patterns observed in the survey.

International climate governance frameworks increasingly recognise the importance of integrating non-economic loss and damage into national systems to ensure equitable access to climate finance.⁵¹ The Loss and Damage Fund established under the United Nations Framework Convention on Climate Change explicitly recognises non-economic losses and damages. However, operational pathways for integrating such losses into national reporting and financing mechanisms remain limited. This study argues that the absence of non-economic loss and damage indicators at the local level risks excluding highly vulnerable coastal communities from meaningful support.

Governance scholarship emphasises the need for expanded damage assessment frameworks that incorporate health, psychosocial wellbeing, and social disruption as legitimate loss categories.⁵² Incorporating such indicators into routine assessments would create institutional entry points for health services, psychosocial support, and long-term adaptation planning. The high non-economic loss scores observed in Bagerhat underscore the urgency of this governance transition.

In sum, the coastal findings illustrate an invisible crisis produced by governance systems that prioritise asset loss over human experience. Addressing non-economic loss and damage requires methodological innovation and institutional reform to ensure that climate governance reflects the full spectrum of harm experienced by frontline communities.

6.3 *Trust as a Governance Currency*

Regression results from Section 5.4 identified institutional trust as a significant positive predictor of effective anticipatory action. Households reporting higher trust in local government and Union Disaster Management Committees (UDMC) were more likely to receive pre-disaster support, use warnings, and take protective actions such as storing food or evacuating livestock. This finding reflects a broader scholarly consensus that trust functions as a core governance resource in disaster risk management. Institutional trust influences community responses to risk information, shapes compliance with official advisories, and contributes to collective action outcomes.⁵³

⁵¹ UNFCCC, *Technical Paper on Non-Economic Losses*; van Schie, Zommers, and Singh, “Governing Non-Economic Loss and Damage”.

⁵² Schweizer and Renn, “Governance of Systemic Risks”.

⁵³ Raffaella C. Bonfanti et al., “The Role of Trust in Disaster Risk Reduction: A Critical Review,” *International Journal of Environmental Research and Public Health* 21, no. 1 (2023): 29; Sheng Zhong et al., “Trust in Authorities and Public Response to Early Warning Systems: A Systematic Review,” *Climate Risk Management* 44 (2024): 100587, <https://doi.org/10.1016/j.crm.2024.100587>.

Research on disaster risk reduction consistently identifies trust as a key determinant of whether communities respond to early warning messages. A critical review of trust in disaster risk reduction shows that individuals with higher pre-event trust in public authorities demonstrate stronger readiness to act on hazard information and adopt preparatory behaviours.⁵⁴ Trust shapes perceptions of warning credibility and institutional authority, which in turn influences actions such as evacuation, property protection, and engagement with anticipatory support protocols.⁵⁵ Contexts characterised by low institutional trust often see communities ignore early advisories even when warnings are timely and technically reliable.⁵⁶

Evidence across hazard types confirms that local governance legitimacy strongly affects preparedness and response behaviour. Trust in disaster management authorities increases willingness to rely on official risk communication and participate in preventive action.⁵⁷ In contrast, distrust weakens compliance and reduces the uptake of protective measures. Research on COVID-19 response behaviour shows that trust in government institutions significantly predicted adherence to public health directives during crisis situations, suggesting that institutional trust remains important beyond natural hazard contexts.⁵⁸

The association between governance effectiveness and anticipatory action highlights that infrastructure and logistics alone do not ensure early action. Governance legitimacy refers to perceptions of institutional authority and the quality of engagement between officials and communities. Procedural legitimacy relates to transparent and inclusive decision making, distributive legitimacy reflects fairness in resource allocation, and performance legitimacy concerns visible governance outcomes.⁵⁹ Lower governance effectiveness may lead communities to view institutional actions as illegitimate, which reduces cooperation with official guidance.

Trust also operates through social cohesion and collective capacity. Studies show that social trust, including trust in local government, correlates with community

⁵⁴ Zhong et al., “Trust in Authorities”; Robert K. Goidel, Christopher M. Freeman, and Steven T. Procopio, “Institutional Trust and Public Compliance during Disaster Warnings,” *Risk Analysis* 44, no. 2 (2024): 321–336, <https://doi.org/10.1111/risa.14102>.

⁵⁵ Zhong et al., “Trust in Authorities”.

⁵⁶ Zhong et al., “Trust in Authorities”.

⁵⁷ Yoonseok Choo and Dong Keun Yoon, “Trust, Governance Legitimacy, and Disaster Preparedness Behaviour: Evidence from Multi-Hazard Contexts,” *International Journal of Disaster Risk Reduction* 101 (2024): 104143, <https://doi.org/10.1016/j.ijdrr.2024.104143>.

⁵⁸ E. Paul, A. Steptoe, and D. Fancourt, “Trust in Institutions and Compliance with Public Health Policies during the COVID-19 Pandemic,” *Social Science and Medicine* 275 (2021): 113888, <https://doi.org/10.1016/j.socscimed.2021.113888>.

⁵⁹ Fritz W. Scharpf, *Governing in Europe: Effective and Legitimate?* (Oxford: Oxford University Press, 2025).

preparedness and participation in risk reduction planning.⁶⁰ Higher trust environments facilitate coordination among community members as well as between citizens and institutions, thereby strengthening shared risk understanding and enabling collective early action. In contrast, weak trust conditions often push households toward individual coping strategies or complete disengagement, which can exacerbate loss and damage. Household survey findings from this study indicate that lower trust aligns with reduced use of anticipatory support and higher loss outcomes, consistent with disaster governance theory.

The disaster governance context of Bangladesh further illustrates the importance of institutional trust. Research on decentralised disaster risk management in coastal Bangladesh shows that Union Disaster Management Committees and other local bodies face limited financial and administrative autonomy, restricting their capacity for early action.⁶¹ Repeated warnings without visible follow-up actions can erode trust over time. Institutional trust functions as a governance resource that communities draw upon when deciding whether to evacuate, follow guidance, or invest in preparedness measures.

Governance literature on Bangladesh emphasises that community engagement and institutional collaboration contribute to trust formation and improve disaster responsiveness.⁶² Trust evolves through experience and performance. Recurrent gaps between warnings and action weaken confidence and reduce compliance with future advisories, particularly in settings exposed to repeated hazards and constrained institutional support. Trust also interacts with socioeconomic conditions such as communication access and gender. Studies show that trusted information channels vary across social groups, and gaps in mobile access, community networks, or inclusive communication approaches can weaken confidence in official messaging.⁶³ Participatory local governance and inclusive decision making therefore remain essential for building institutional trust in disaster risk reduction systems.⁶⁴

Strengthening trust requires transparency, timely delivery of support, and accountability within early warning and anticipatory action systems. Feedback mechanisms that enable communities to observe institutional responsiveness can improve legitimacy and encourage proactive behaviour. The role of trust identified in the regression analysis suggests that accountability and community engagement at the local level function as prerequisites for effective anticipatory action governance. This

⁶⁰ Goidel, Freeman, and Procopio, “Institutional Trust”.

⁶¹ M. Abdul Quader, M. M. Rahman, and B. Ahmed, “Local Governance Capacity and Trust in Disaster Risk Management Institutions in Coastal Bangladesh,” *Environmental Hazards* 22, no. 4 (2023): 417–433, <https://doi.org/10.1080/17477891.2023.2170194>.

⁶² Zaman et al., “Disaster Risk Reduction”.

⁶³ Quader, Rahman, and Ahmed, “Local Governance Capacity”.

⁶⁴ Choo and Yoon, “Trust, Governance Legitimacy”; Quader, Rahman, and Ahmed, “Local Governance Capacity”.

interpretation aligns with broader governance scholarship that recognises legitimacy as a foundational element of effective disaster risk reduction and community resilience.⁶⁵

7. Conclusion

This study examined the governance effectiveness of Anticipatory Action and the severity of Loss and Damage across riverine flood and coastal hazard contexts. The empirical evidence demonstrates a clear institutional pattern. Early warning dissemination functions effectively, with high coverage and reasonable lead time in both study areas. This confirms that the technical components of the early disaster warning system operate as intended under existing national frameworks, including the Standing Orders on Disaster. However, the governance mechanisms that translate warnings into pre disaster action remain weak. Very limited proportions of households received anticipatory support, which indicates a failure of financial and administrative trigger systems rather than a failure of forecasting or communication.

The analysis further shows that Loss and Damage in coastal areas is dominated by non-economic impacts related to health, salinity exposure, and livelihood erosion. These losses persist over time and fall outside the scope of existing relief and compensation mechanisms. Current disaster assessment practices prioritise visible and infrastructure-based damage, which leaves slow onset and non-economic losses largely undocumented and uncompensated. This governance gap is reflected in higher Loss and Damage Experience Severity Index scores in coastal areas, even when economic losses appear lower than in flood prone locations.

Based on these findings, three policy directions emerge. First, legal reform is required to amend the Standing Orders on Disaster to grant Union Parishads formal pre disaster spending authority. Such authority must include audit protection when forecast based actions do not culminate in an actual disaster event. Second, a national Loss and Damage tracking mechanism should be established to systematically record health impacts, salinity related costs, displacement, and livelihood disruption alongside infrastructure damage. This mechanism would provide the empirical foundation required for effective use of Loss and Damage finance. Third, trigger decision authority should be decentralised to the Upazila level. Such decentralisation would shorten decision timelines, reduce administrative delays, and align anticipatory finance with local risk conditions. Together, these measures address governance failures at the final delivery stage of disaster risk management and provide a pathway for aligning Anticipatory Action and Loss and Damage frameworks with institutional realities at the local level.

⁶⁵ Zhong et al., “Trust in Authorities”; Choo and Yoon, “Trust, Governance Legitimacy”; Quader, Rahman, and Ahmed, “Local Governance Capacity”.