December 21, 2024

Developing Relationships and Policy Frameworks to Address the Economic and Non-Economic Losses and Damages of Local Hazards

Project Report

December 22, 2024

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1. Introduction

Local hazards, including floods, droughts, cyclones, and erosion, pose ongoing challenges to communities globally, resulting in a diverse range of losses and damages (L&D) that impact both economic and non-economic aspects of human well-being (Chiba et al., 2017; Naz et al., 2024). Climate change is increasing both the frequency and intensity of hazards, creating the problem of loss and damage, a significant concern for researchers and policymakers (UNFCCC, 2013; Rawat et al., 2024; Mechler et al., 2020). The typical emphasis on economic losses, including property damage and income reduction, does not adequately address the full range of impacts. This includes non-economic losses that involve cultural disruption, social instability, psychological trauma, and biodiversity loss (Prabhakar et al., 2024). Policy frameworks established by the United Nations Framework Convention on Climate Change (UNFCCC) and the Warsaw International Mechanism have highlighted the necessity of incorporating both economic and non-economic loss and damage in climate adaptation and disaster risk management strategies (UNFCCC, 2013). Putting these frameworks into practical policies at both national and subnational levels presents a considerable challenge (Somanathan et al., 2014; Gualini, 2023). For effective L&D management strategies, a thorough understanding of the local context and the specific vulnerabilities encountered by communities is essential. This research aims to connect local hazards with their associated economic and non-economic L&D, while suggesting policy frameworks to effectively tackle these issues in regions susceptible to hazards.

Bangladesh is an appropriate case study in this context because of its high susceptibility to a variety of natural disasters (Murshed, et al., 2023). The country, located in a deltaic region and crossed by more than 700 rivers, faces recurrent flooding, riverbank erosion, and cyclones, leading to significant disruptions in livelihoods, infrastructure, and social structures (Haque & Jakariya, 2023). Beyond apparent economic effects, including crop damage, housing loss, and income reduction, communities encounter significant non-economic impacts, such as displacement, erosion of cultural identity, and heightened mental health challenges (Bhowmik et al., 2024; Ali et al., 2023). Coastal regions exhibit significant vulnerability due to the interplay of sea-level rise and saline water intrusion,

resulting in decreased agricultural productivity and negatively affecting food security and health (Sultan et al., 2023). The interdependencies between economic and non-economic losses compound the effects; for instance, the loss of livelihoods frequently triggers migration, leading to social disintegration and mental stress (Ayeb-Karlsson et al., 2021). Despite identifying these complex interactions, the country's current studies and policy frameworks have been slow to comprehensively address the non-economic aspects of loss and damage.

Many international agreements have talked about the need for policies that take into account both economic and non-economic losses. However, there are still not many specific ways for countries to include these different effects in their plans (UNFCCC, 2014). In Bangladesh, disaster risk management and climate adaptation policies primarily emphasise infrastructural resilience and immediate economic recovery while insufficiently addressing long-term non-economic impacts (Chiba et al., 2017). Existing frameworks recognise the significance of fostering community resilience and protecting social systems; however, there is a necessity for more focused policies that tackle the less tangible yet equally important non-economic losses, including the degradation of social networks, decrease in health, and the loss of traditional knowledge (Pearson et al., 2023; Chandra et al., 2023). Following a flood or cyclone, displaced families frequently face interruptions in their children's education, reduced access to communal resources, and changes in gender dynamics that change household roles and responsibilities (Begum, 2017; Alam and Rahman, 2019). However, traditional L&D assessments rarely include non-economic impacts, which can have enduring effects on social cohesion and community resilience (Mechler et al., 2019; Correia, 2024).

A significant challenge in tackling the non-economic aspect of L&D is the lack of effective methodologies for assessing and quantifying these losses (Bahinipati et al., 2022; Prabhakar et al., 2024). While we can measure economic losses in monetary terms, non-economic losses such as cultural heritage erosion, mental health deterioration, and biodiversity loss are intrinsically subjective and context-dependent (Dorkenoo, 2024; Ruiu & Ragnedda, 2024; Amirmoradi & Shokoohi, 2024). The variety of hazards impacting various regions of Bangladesh exacerbates the disparity. Riverbank erosion in northern Bangladesh leads to the permanent loss of arable land, exacerbating poverty among marginalised farmers. In coastal regions, salinity intrusion disrupts local food systems, contributing to malnutrition and heightened health risks (Rahman et al., 2007; Hassan & Shaw, 2015). Because these risks are so different, they need unique, hazard-specific strategies for L&D management that look at more than just money and include psychological, social, and cultural factors (Mechler et al., 2019; Gill et al., 2022).

This study aims to enhance comprehension of the distinct effects of various hazards on communities and the subsequent implications for policy requirements (Smith, 2013; Wachinger et al., 2013). For example, comprehension of the non-economic consequences of riverbank erosion can guide social protection and land-use planning, while knowledge of the psychological effects of cyclone displacement can direct the incorporation of psychological support into disaster recovery initiatives (Rabbani, 2022; Nasreen et al., 2023). Establishing these relationships will create a basis for suggesting policy frameworks that are more attuned to the comprehensive spectrum of L&D and consistent with local contexts (Darling-

Hammond et al., 2020; Shan and Wang, 2024). The study seeks to examine the enhancement of existing policy frameworks in Bangladesh to address the interconnections between economic and non-economic loss and damage, thereby fostering more comprehensive and sustainable risk management strategies.

Although addressing both economic and non-economic losses is crucial, notable research gaps remain. There is a lack of empirical evidence regarding the variation of non-economic loss and damage across diverse hazards and regions in Bangladesh (Bhowmik et al., 2021; Chiba et al., 2017). Many studies have concentrated on immediate economic impacts, while non-economic losses remain largely ignored (Pill, 2022; Boafo et al., 2024; Engdaw et al., 2024). Secondly, there is an absence of comprehensive frameworks that connect hazard-specific learning and development to policy interventions, leading to fragmented and reactive responses to hazards (Marshall et al., 2024; Abdela, 2024). Third, existing research frequently considers economic and non-economic losses as distinct categories instead of analysing their interactions, potentially resulting in misguided policy priorities (Meyer, 2024; Spash, 2024; Düvel & García-Portela, 2024). This study aims to improve the understanding of L&D in relation to local hazards and offer practical recommendations for policymakers in Bangladesh and similar hazard-prone areas.

At this critical stage, both economic and non-economic loss and damage have gained attention to demonstrate how communities are affected by the long-term consequences of climate change impacts that have already surpassed local adaptation and mitigation efforts. Loss and damage refer to "the actual and/or potential manifestation of impacts associated with climate change in developing countries that negatively affect human and natural systems" (UNFCCC, 2012). Economic losses are characterized as losses of "resources, goods and services that are commonly traded in markets." Non-economic losses are defined as "the remainder of items that are not economic items" (McShane, 2017). Economic losses are assessed based on the market value of the lost goods, while non-economic losses are considered more challenging to quantify (McShane, 2017). Recently, much research has been conducted on economic (Ishibashi, 2024; Kotz et al., 2024) and non-economic (McNamara et al., 2021; Boafo et al., 2024) losses and damages in the context of climate change impacts worldwide. In the context of Bangladesh, several studies have reported on economic and non-economic losses and damages due to climate-induced disasters. Therefore, it is important to identify the locally predominant hazards and their related economic and non-economic losses and damages. Moreover, insufficient attention has been given to identifying detailed hazards and their associated losses, as well as to the assessment of current policy frameworks to effectively address these insights and promote resilient adaptation strategies within communities.
The objectives of this study are as follows:

- To understand the locally predominant hazards
- To explore the hazard-specific economic and non-economic losses and damages
- To establish a relationship between hazards and the corresponding losses and damages

2. Research Methods

2.1 Study area

This study was conducted in Bangladesh, located between 20°34' to 26°38' north latitude and 88°01' to 92°41' east longitude. Geographically, Bangladesh is highly vulnerable due to its location and exposure to climate-associated hazards, which have been increasing the vulnerability of its population and causing significant losses and damages under unprecedented climate change impacts. As a representative study, research was carried out in five districts: Kurigram (northern area), Bagerhat (south-western area), Sunamganj (north-eastern area), Rajshahi (north-western area), and Rangamati (south-eastern area). These districts were selected based on their high climate vulnerabilities. Their locations, distributed across the country, are shown in Figure 1. These areas are significantly exposed to climate-driven multi-hazards, including droughts, floods, extreme heat, cyclones, waterlogging, landslides, salinity, and riverbank erosion. The consequences of these hazards severely impact socio-economic, environmental, and social factors, progressively increasing the vulnerability of affected populations. The recurring nature of these devastating hazards has resulted in loss of life and escalating damages. Over the past few decades, thousands of people have been forced to leave their homes. Given the intensifying impacts of climate change, it is critical to assess how local threats accelerate economic and non-economic losses and damages in the context of specific hazards.

2.2 Research Design

This study employed a mixed-method approach for data collection, incorporating both quantitative and qualitative methods. For the quantitative aspect, a household questionnaire survey was used to gather household-level information. For the qualitative aspect, focus group discussions and key informant interviews were conducted to capture in-depth insights. The integration of these techniques ensured a comprehensive understanding of the research problems and provided a pathway for the next steps.

2.3 Data Collection

For data collection, both qualitative and quantitative methods were used, including household questionnaire surveys, focus group discussions, and key informant interviews. Prior to designing the questionnaire, an extensive literature review was conducted to contextualize economic and non-economic losses and damages. A semi-structured questionnaire was then developed, comprising four sections:

- Section 1: Demographic information (11 questions)
- Section 2: Local hazards (18 questions)
- Section 3: Economic losses and damages (27 questions)
- Section 4: Non-economic losses and damages (29 questions)

The questionnaire included open-ended, binary, and 5-point Likert scale questions. After preparation, it was pilot-tested at the field level to ensure consistency, clarity, and reliability. A total of 523 questionnaires were administered across five study sites using simple random sampling techniques. Well-trained enumerators conducted face-to-face interviews in Bengali, and each survey took approximately 30 minutes to complete. All respondents willingly participated and shared their information.

Focus group discussions (FGDs) were conducted in the five study areas to gain deeper insights into local hazards and economic and non-economic losses and damages. Three FGDs were carried out in each study area, totaling 15 discussions. Each FGD included 6 to 10 participants from affected communities, representing diverse perspectives. Participants were invited to share their knowledge, perceptions, and ideas on how local hazards predominantly lead to losses and damages. Open-ended questions were designed to facilitate broad discussions, all conducted in Bengali. Discussions were moderated by a well-trained facilitator, with an assistant present to take notes and record non-verbal cues. Ethical guidelines were strictly followed to ensure participant confidentiality and data security. Similarly, key informant interviews (KIIs) were conducted to obtain in-depth insights from experts with knowledge of economic and non-economic losses and damages and adaptation strategies related to hazards. Fifteen key informants were interviewed, including community leaders, academics, disaster management officials, and practitioners. Semi-structured interviews provided flexibility to explore specific insights and perspectives. Each interview lasted 30 to 40 minutes and was conducted in Bengali. Notes were taken during the interviews to document important points. Ethical guidelines were adhered to, ensuring data security and confidentiality. Both FGDs and KIIs were employed as part of a triangulation approach to validate and enhance the reliability of the findings. In the questionnaire survey, all variables related to climatic hazards were considered independent variables, while variables related to economic and non-economic losses and damages were treated as dependent variables.

2.4 Data Analysis

After data collection, all data were coded and checked before performing statistical analyses. Data were then organized accordingly for statistical procedures. Cluster analysis was performed to explore relationships among climatic hazards, economic losses, and non-economic losses and damages based on their similar characteristics. This analysis was conducted in two ways: first, by examining climatic hazards (e.g., salinity) in relation to economic losses (e.g., migration-associated costs) and damages, and second, by analyzing climatic hazards in relation to non-economic losses and damages. To assess the effects of climatic hazards—such as drought, extreme heat, floods, riverbank erosion, salinity, waterlogging, and landslides—on economic and non-economic losses and damages, a MANOVA was performed. Additionally, regression analysis was used to identify statistically significant relationships between independent and dependent variables. Climatic hazards were treated as independent variables, while economic and non-economic losses and damages were considered dependent variables. All recorded audio and video data were transcribed to identify patterns of hazards-related economic and non-economic losses and damages, as well as community responses. Informants' audio statements were transcribed verbatim from Bengali into English. A thematic analysis was conducted to uncover patterns and key insights regarding economic and non-economic losses and damages caused by climatic hazards.

3. Results and Discussion

All the study locations, including Sunamganj, Bagerhat, Kurigram, Rangamati, and Rajshahi, were found to be affected by drought and extreme heat. According to the survey, 85%, 96%, and 87% of respondents reported vulnerability to flood hazards in Bagerhat, Kurigram, and Sunamganj, respectively. Approximately 56% and 98% of respondents stated that Bagerhat

and Kurigram are highly vulnerable to riverbank erosion. About 87% of respondents indicated that Rangamati is highly vulnerable to landslides. Furthermore, 97% and 94% of respondents in Bagerhat reported vulnerability to salinity hazards and waterlogging problems, respectively.

3.1 Linkages between climatic hazards and economic and non-economic loss and damages

According to the cluster analysis, the dendrogram of waterlogging and economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 1 is further divided into two sub-clusters: Cluster 1a and Cluster 1b. Cluster 1a comprises waterlogging, a decrease in development opportunities, loss of existing income, decrease in existing income, decrease in agricultural yield, damage to agricultural land, costs associated with migration, loss of employment opportunities, infrastructure impacts, and energy infrastructure damage.

The dendrogram of waterlogging and non-economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 is further divided into two sub-clusters: Cluster 2a and Cluster 2b. Cluster 2b consists of waterlogging and the deterioration of community or social networks, loss of natural looks or scenic landscapes, prompting family members to migrate, cultural tradition or site loss, loss of indigenous knowledge, decreased quality of ecosystem services, and difficulty in accessing clean water.

For riverbank erosion, the dendrogram of economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 is divided into two sub-clusters: Cluster 2a and Cluster 2b. Cluster 2b is associated with riverbank erosion, costs associated with migration, a decrease in development opportunities, loss of existing income, loss of employment opportunities, business interruptions, and community costs related to relief and recovery.

The dendrogram of riverbank erosion and non-economic loss and damage variables also reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 includes riverbank erosion and its impacts, such as hampering children’s schooling, damage to school goods and books, impacts on travel capacity, loss of natural looks and scenic landscapes, effects on a sense of identity, decreased control over resources, harm to cultural or traditional practices, damage to historical land, cultural tradition or site loss, and changes in dietary practices.

For salinity hazards, the dendrogram of economic loss and damage variables reveals three distinct clusters: Cluster 1, Cluster 2, and Cluster 3. Cluster 1 includes a decrease in development opportunities, loss of existing income, decrease in agricultural yield, costs associated with migration, damage to agricultural land, and healthcare expenses.

The dendrogram of salinity and non-economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 1 is divided into two sub-clusters: Cluster 1a and Cluster 1b. Cluster 1a includes salinity and harm to cultural or traditional practices, cultural tradition or site loss, loss of indigenous knowledge, decreased quality of ecosystem services, difficulty in accessing clean water, loss of natural looks and scenic landscapes, prompting family members to migrate, displacement, changes in dietary practices, impacts

on a sense of identity, damage to school goods and books, a sense of security and safety, decreased biodiversity, and disruption of children's schooling.

For landslides, the dendrogram of economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 is further divided into two sub-clusters: Cluster 2a and Cluster 2b. Cluster 2a includes landslides and impacts such as infrastructure damage, decreased agricultural yield, irreversible loss of natural resources, decreased ecosystem services, damage to agricultural land, and costs associated with migration.

The dendrogram of landslides and non-economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 1 is further divided into two sub-clusters: Cluster 1a and Cluster 1b. Cluster 1b includes landslides and their impacts on a sense of identity, travel capacity, cultural tradition or site loss, decreased control over resources, changes in dietary practices, fatalities, and prompting family members to migrate.

For floods, the dendrogram of economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 is divided into two sub-clusters: Cluster 2a and Cluster 2b. Cluster 2a is further divided into two sub-clusters: Cluster 2ai and Cluster 2aii. Cluster 2b includes floods and their impacts, such as business interruptions, infrastructure damage, decreased development opportunities, community costs associated with relief and recovery, and costs related to migration. Cluster 2aii includes decreased agricultural yield, damage to agricultural land, loss of significant amounts of money, loss of existing income, and loss of employment opportunities.

The dendrogram of flood and non-economic loss and damage variables also reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 is further divided into two sub-clusters: Cluster 2a and Cluster 2b. Cluster 2a includes impacts such as fatalities, deterioration of social connections, detrimental effects on health, disruption of community and social networks, disrupted daily activities, loss of indigenous knowledge, damage to school goods and books, and prompting family members to migrate.

For drought and extreme heat, the dendrogram of economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 includes drought and extreme heat impacts such as decreased productivity of fisheries, decreased ecosystem services, decreased agricultural land, decreased agricultural yield, damage to agricultural land, loss of significant amounts of money, reduced land productivity, decreased development opportunities, and extreme temperatures damaging farming tools.

The dendrogram of drought and extreme heat and non-economic loss and damage variables reveals two distinct clusters: Cluster 1 and Cluster 2. Cluster 2 includes drought and extreme heat impacts, such as difficulty accessing clean water and reduced capacity to access traditional water sources.

3.2 Effects of climatic hazards on economic and non-economic loss and damages

MANOVA identified significant differences between perceived waterlogging and economic loss and damage variables. The results revealed effects of waterlogging on perceived energy infrastructure damage, additional restoration costs, loss of employment opportunities, less

productive land, damage to agricultural land, community expenses for relief and recovery, and decreased development opportunities.

Similarly, MANOVA identified significant differences between perceived waterlogging and non-economic loss and damage variables. Waterlogging significantly affected the deterioration of community and social networks, loss of natural beauty or scenic landscapes, prompting family members to migrate, and loss of cultural traditions or sites.

MANOVA analysis revealed significant differences between riverbank erosion and economic loss and damage variables. The effects of riverbank erosion were observed on migration-related costs, decreased development opportunities, community expenses for relief and recovery, loss of existing income, loss of employment opportunities, monetary losses related to farming, damage to agricultural land, infrastructure damage, and decreased agricultural yield.

Similarly, MANOVA highlighted significant effects of riverbank erosion on non-economic loss and damage variables, including reduced access to resources, loss of cultural traditions or sites, and diminished access to traditional water sources.

Regarding salinity hazards, MANOVA identified significant differences between salinity and economic loss and damage variables. Salinity significantly impacted decreased development opportunities, loss of existing income, reduced agricultural yield, migration-related costs, less productive land, decreased tourism revenue, health-related economic losses, and business interruptions.

Likewise, MANOVA revealed significant differences between salinity and non-economic loss and damage variables. Salinity significantly influenced harm to cultural or traditional practices and values, loss of cultural traditions or sites, loss of indigenous knowledge, diminished ecosystem service quality, changes in dietary practices, impacts on sense of identity, reduced children's access to education, fatalities, and reduced access to traditional water sources.

MANOVA analysis also revealed significant differences between landslides and economic loss and damage variables. Landslides significantly affected decreased agricultural yield, irreversible loss of natural resources, reduced ecosystem services, damage to agricultural land, migration-related costs, disruption of communication systems, property damage, and evacuation and resettlement expenses.

Similarly, MANOVA showed significant effects of landslides on non-economic loss and damage variables. These included impacts on sense of identity, loss of cultural traditions or sites, reduced access to traditional water sources, changes in dietary practices, fatalities, decreased biodiversity, detrimental impacts on physical health, loss of natural beauty or scenic landscapes, reduced ecosystem services, weakened social structures, deterioration of community and social networks, and displacement.

MANOVA results identified significant differences between floods and economic loss and damage variables. Floods significantly impacted business interruption costs, disruption of

communication systems, decreased development opportunities, property damage, energy infrastructure damage, and decreased tourism revenue.

Similarly, MANOVA revealed significant effects of floods on non-economic loss and damage variables, including fatalities, detrimental impacts on physical health, deterioration of community and social networks, disruption of daily activities, prompting family members to migrate, reduced ecosystem service quality, displacement, damage to historical lands, changes in dietary practices, reduced access to traditional water sources, and increased difficulty in accessing clean water.

For drought and extreme heat, MANOVA identified significant differences in economic loss and damage variables. The effects included decreased ecosystem services, harm to natural resources, reduced agricultural yield, damage to agricultural land, monetary losses related to farming, less productive land, reduced fisheries productivity, decreased development opportunities, extreme temperatures damaging farming tools, decreased property value, loss of existing income, and irreversible loss of natural resources.

Similarly, MANOVA found significant effects of drought and extreme heat on non-economic loss and damage variables. These included reduced access to traditional water sources, increased difficulty in accessing clean water, decreased biodiversity, impacts on ecosystem or biodiversity health, reduced ecosystem service quality, changes in dietary practices, loss of natural beauty or scenic landscapes, and detrimental impacts on physical health.

4. Conclusions

The intricate and varied effects of climate-related hazards on Bangladeshi communities are highlighted by this study. It offers a thorough grasp of both economic and non-economic losses and damages by fusing statistical analysis with qualitative insights. Even though there has been a lot of work in identifying vulnerabilities and repercussions, overcoming these obstacles calls for a comprehensive strategy that incorporates social and cultural factors with technical solutions. To create integrated and context-specific policies that improve resilience, protect cultural heritage, and advance sustainable development, policymakers, scholars, and practitioners must collaborate. Bangladesh may set an example for climate adaptation in vulnerable areas across the globe by achieving this.

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