Climate Change Impact, Loss and Damage in 45-Polder Area (Barguna): Land Use and Land Cover Change (LULC) and Local Led Adaptation (LLA).

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This Thesis Report Presented in Partial Fulfilment of the Requirements for the Degree of Bachelor of Science (B.Sc.) in Environmental Science and Disaster Management (ESDM)

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APPROVAL

This thesis report titled **"Climate Change Impact, Loss and Damage in 45-Polder Area (Barguna): Land Use and Land Cover Change (LULC) and Local Led Adaptation (LLA)"** submitted by Mongurul Islam to the Department of Environmental Science and Disaster Management (ESDM), Daffodil International University (DIU) has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science (B.Sc.) in Environmental Science and Disaster Management (ESDM) and approved as to its style and contents.

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DECELERATION

I hereby declare that this research project has been done by me under the supervision of **Dr. Mahfuza Parveen, Ph.D., Associate Professor, Department of Environmental Science and Disaster Management (ESDM), Daffodil International University (DIU)**. And Co-Supervised by **Engr. Md. Shahadat Hossain Environment, Water & Climate Change Specialist, CEO of Onushandhani Creeds Limited (O. CREEDS LTD.).** Also declare that neither this research project nor any part of this research project has been submitted elsewhere for the award of any degree.

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ABSTRACT

In Bangladesh, loss and damage are increasing rapidly due to climate change. Bangladesh needs the most reliable climate change adaptation strategy for the coastal areas. The study utilized qualitative and quantitative surveys through the KOBO toolbox. Determined socioeconomic loss and damage, as well as local lead adaptation using statistical analysis. This study takes a total of 402 respondents for local lead adaptation and 98 respondents for socioeconomic damage. The study analyzed land use and land cover using ArcGIS. The study finds that from 2007 to 2020, a total of six major climatic disasters occurred, and the total loss and damage of the respondents was 34.826 million takas. Individual average loss and damage is 0.355 million takas. The study also analyzed how much time an individual household needs to get recover from loss and damage from a single disaster. To combat this climatic disaster, local people adopted three major local lead adaptations. Building a raised house, water harvesting, and alternative farming practices. 78.61% of respondents adopted the Building Raised House strategy. On the other hand, only 3.73% of respondents adopted the alternative farming strategy.

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LIST OF SYMBOL AND ABBREVIATION

L&D	Loss and Damage
LLA	Local Led Adaptation
LULC	Land Use and Land Cover
CBA	Community-Based Adaptation Practice
FGD	Focus Group Discussion
CEP	Coastal Embankment Project
DDM	Department of Disaster Management
DoE	Department of Environment
DPHE	Department of Public Health Engineering
FGD	Focus Group Discussion
GBM	Ganges-Brahmaputra-Meghna
GIS	Geographic Information System
GOB	Government of Bangladesh
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KII	Knowledge Informant Interviews
LLA	Locally Led Adaptation
USGS	United States Geological Survey
VGP	Vulnerable Group People
WARPO	Water Resources Planning Organization
WB	World Bank

CHAPTER 1: INTRODUCTION

The chapter introduction covers the initial details of the research endeavor. There is a concise overview of the study's background and its primary objective.

1.1 Background

Bangladesh is recognized as one of the most vulnerable countries to disasters and climate change impacts on a global scale. Cyclones, storm surges, sea level rise, intrusion of saline water, and the impacts of climate change are all persistent threats to this zone, with disastrous results for this low-lying coastal area. Bangladesh's coastline ranges around 47,201 km2, or 32% of the country's total land area, which is made up of 19 districts.

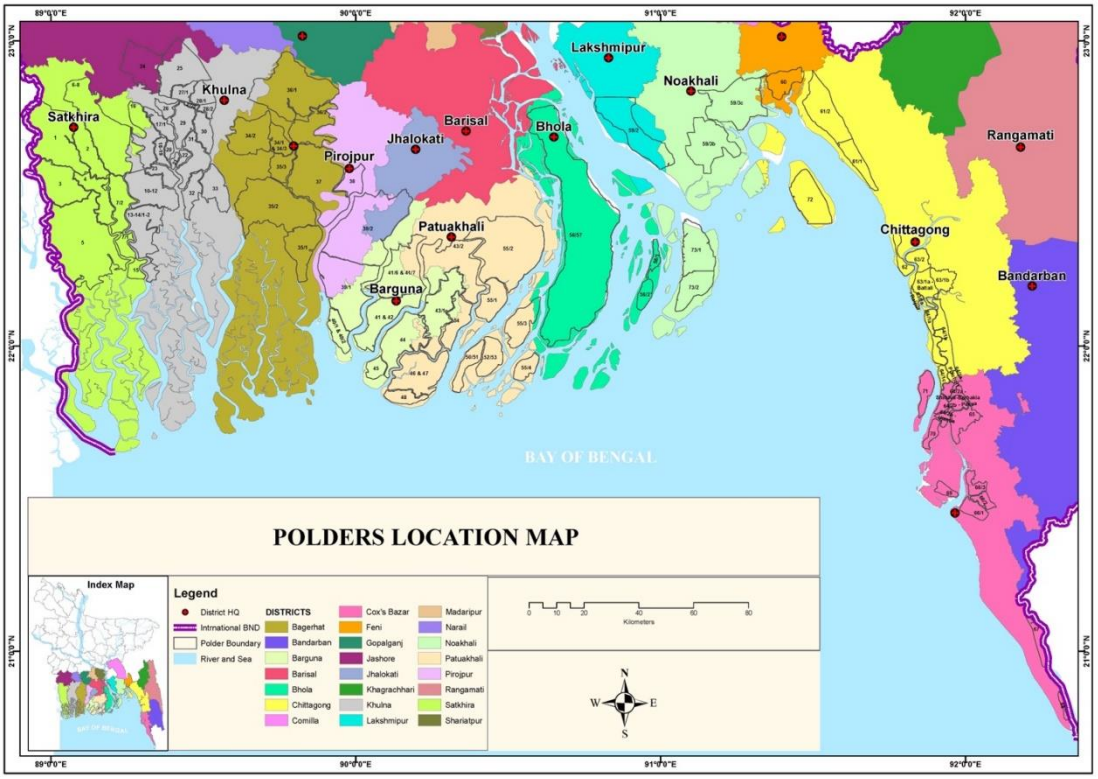

Figure 1: Polder area of Bangladesh

Source: Bangladesh Water Development Board

Approximately 35 million people, or 29% of the total population, reside in the coastline region. Jessore, Narail, Gopalganj, Shariatpur, Chandpur, Satkhira, Khulna, Bagerhat, Pirozpur, Jhalakati, Barguna, Barisal, Patuakhali, Bhola, Lakshmipur, Noakhali, Feni, Chittagong, and Cox's Bazar are the 19 coastal districts that makeup Bangladesh's

coastal zone (H. Ahmed, 2019). Approximately 33% of the population residing in the coastal region are classified as living below the poverty threshold. These individuals are vulnerable to challenges such as insufficient access to food, financial resources, potable water, and healthcare. Saltwater intrusion is another major issue that most families who live in coastal areas and use ponds have to deal with polluted drinking water (Bernard et al., 2022). Sea level rise plays a tremendous role in saltwater intrusion in coastal areas (Sarwar, 2005). Several studies demonstrated that Bangladesh's coastal regions had to contend with problems like erosion, saline intrusion, and the effects of global warming. Sundarbans is the largest mangrove forest in the world and plays a vital role in restoring the ecosystem (Brammer, 2014; Hafez Ahmad, 2019).

The largest mangrove forest in the world and a vital ecosystem, the Sundarbans, was in danger. Forestry, community-based adaption strategies, and coastal embankments were being used to address these problems. However, the long-term resilience of these sensitive zones depended heavily on continuous monitoring and sustainable management. Situated between Patuakhali and Khulna, the Barguna district is located in the southern region of Bangladesh. There are several rivers and coastal streams in this flat area, and the low and high tides are regular. Usually, most flash floods occur in these areas (Kormoker et al., 2017).

Maps of Land Use Land Cover (LULC) in a specific area offer useful knowledge of the existing landscape. Yearly land use and land cover data stored in national spatial databases can help track changes over time in agricultural ecosystems, forest conversions, surface water bodies, and more. (*EO_LULC_Objective | NRSC Web Site*, n.d.).

The Global Human Modification of Terrestrial Systems data set models the physical extent of 13 anthropogenic stressors and their estimated impacts using spatially-explicit global data sets. The Global Development Potential Indices data set offers global land suitability data for 13 sectors related to renewable energy, fossil fuels, mining, and agriculture. The Development Threat Index dataset is a worldwide terrestrial development threat map created by combining various habitat threats including agricultural expansion, urban expansion, mining, and energy development (oil and gas, coal, biofuels, solar, and wind). Chandra Giri and colleagues created the mangrove map, which outlines the distribution of mangroves around the year 2000. Yale and Texas

A&M Universities researchers developed the global urban expansion grid to analyze potential future urban growth and land use changes. The project evaluated the effectiveness of current and future terrestrial protected areas in safeguarding landscape biodiversity using vegetation types identified through remote sensing.(*Land Use and Land Cover (LULC) | SEDAC*, n.d.)

1.2 Importance and Significance of the Study

Climate change scenarios present a significant threat to Bangladesh. There is still a noticeable absence of an in-depth systematic investigation of the impacts of climate change in Bangladesh (S. Ahmed & Khan, 2023). Several researchers have already conducted thorough studies on the amount of loss and damage caused by major climatic disasters caused by climate change. However, the climatic disasters that have taken place in Bangladesh over the past 20 years, from 2000 to 2020, have not targeted any particular region. There needs to be more research in this area. Furthermore, a significant area that requires further investigation is the analysis of past data to make correct future predictions.

According to 2023 research, between 2000 and 2019, climate change-related losses and damages cost the world at least $2.8 trillion, or around $16 million every hour (*About Loss and Damage | UNEP - UN Environment Programme*, n.d.). When negative effects are measured in terms of costs, like crop production reduction or infrastructure damage, they are referred to as economic loss and damage. Negative effects that are difficult to measure in monetary terms and are not easily provided on markets, such as the loss of culture, way of life, or displacement, are referred to as non-economic loss and damage. On the first day of COP28, the UN Climate Change Conference of the Parties, delegates decided to officially set up a loss and damage fund to help countries that are especially vulnerable deal with the effects of climate change. The harmful floods, droughts, and sea level rise spurred on by climate change have primarily affected developing nations, who have made the least contribution to the problem. Considering that $100 million has reportedly been given to the fund by the United Arab Emirates, whose Minister of Industry and Advanced Technology, Sultan Ahmed al-Jaber, is also the president of COP28. Germany promised an additional $100 million, the European Union $245.39 million, Britain $51 million "at least," the United States $17.5 million, and Japan $10 million, according to Reuters (*COP28 Agrees to Establish Loss and Damage Fund for Vulnerable Countries | World Economic Forum*, n.d.). The meetings and events for

COP28 took place on the site of Expo City, outside of Dubai, until December 12. 85,000 people attended the meeting, including delegates, scientists, environmental activists, young people, and climate negotiators (*COP28 Agreement Signals "Beginning of the End" of the Fossil Fuel Era | UNFCCC*, n.d.). Barguna district is one of the most climatic vulnerable places. If we successfully measure the loss and damage then we would take possible step to reduce loss and damage and based to the result we will make some rules and policy to mitigate the situation. And most significant things we can present to the world how much loss and damage we have caused due to climate change and how much fund will need to recover the loss and damage.

1.3 Objectives of the Study

The main goal of this study is to figure out how much damage and loss were caused by flooding in the Polder area and to teach people there how to fight storms and floods. The study will also look at how land use and cover have changed over time because of climate change and local-led adaptation.

The study's precise objectives are the following:

- To find out the loss damages from the survey.
- To Find out the recovery Phase to individual households.
- To discover the Local Led Adaptation from the survey.
- To measure the land use and land cover using GIS.

provides the literature review. Previously many studies have been conducted on flood damage and its management. We have reviewed previous studies and briefly described their findings.

2.1 Climate Change Impact

For the geographical location and geomorphology conditions, Bangladesh is one of the most disaster-prone countries in the world. According to the World Health Organization (*Calcium and Magnesium in Drinking-Water: Public Health Significance - World Health Organization - Google Books*, n.d.) one of the defining issues of the twenty-first century is protecting health from the effects of climate change. Flood, drought, and salinity events are predicted to occur more frequently in Bangladesh's coastal regions as a result of climate change, which will provide many difficulties for agrarian communities.

Climate factors such as changes in precipitation, temperature, and sea level rise are expected to have an impact on the availability of freshwater around the world. Climate change has been shown to have a negative influence on water resources, which has a negative impact on human health.

The person responsible for the study by Abedin et al. (2019) The research focused on the effects of climate change on water resources and human health in a coastal area. A questionnaire survey was conducted in two villages on the southwestern coast to investigate the current state of safe water supplies and health care facilities, as well as their effects on the local community. The researchers observed notable changes in temperature, precipitation patterns, salinity intrusion, water scarcity, and availability, as well as the proliferation of diverse infectious diseases that exhibit direct or indirect associations with climatic conditions.

In their study By Keith Wade, Chief Economist and Strategist, and Marcus Jennings Wade & Jennings. (2016) it is evident that there are both advantages and disadvantages associated with the global warming phenomenon. The potential influence of technological progress on the trajectory of global warming remains uncertain and justification further investigation. The assessment process necessitates adopting a long-term perspective that extends beyond the typical time horizon employed by financial market participants. Extreme weather occurrences will increase due to global warming,

causing property and infrastructure damage. Hurricane Sandy, which flooded much of New York in 2012, illustrates the economic damage extreme weather can wreak. As businesses and houses are damaged by rising sea levels, economic productivity may suffer. As the earth heats, Keith Wade, Chief Economist and Strategist, and Marcus Jennings note some benefits and disadvantages. How technological growth will affect global warming is unknown. Any judgment requires a long-term perspective beyond that of financial market participants. The aforementioned statements indicate that elevated global temperatures have the potential to impact food security, facilitate the transmission of infectious diseases, and hinder individuals engaged in outdoor occupations. These factors have the potential to lead to increased disability and social discontent, resulting in a decrease in both productivity and the labor force available for output production Wade & Jennings. (2016) According to their perspective, it was claimed that the year 2011 recorded the highest expenditure on record for natural calamities, resulting in insured losses that surpassed $126 billion for this industry. The report titled "Counting the Cost 2022" by Christian Aid presents a comprehensive analysis of the ten climate disasters in the year that incurred financial costs of $3 billion or above. Significantly, Hurricane Ian suffered the cost of $100 billion in the United States and Cuba, but Europe's heatwave and floods in Pakistan resulted in substantial economic and human detriments. Less affluent countries were similarly affected to a significant extent, underscoring the imperative for climate mitigation efforts and the establishment of the loss and damage fund, as stipulated in the agreement reached during the 27th Conference of the Parties (COP27). The occurrence of extreme events resulted in extensive human hardship, such as the occurrence of drought in East Africa and floods in West Africa. The previously mentioned repercussions exerted their influence on all continents, including those populated by major fossil fuel pollutants. Europe, a notable contributor to greenhouse gas emissions, encounters obstacles in its endeavor to achieve its climate objectives. Immediate action is necessary in order to adhere to the temperature increase objective of 1.5°C set forth in the Paris Agreement (*New Report: Top 10 Climate Disasters Cost the World Billions in 2022 | PreventionWeb*, n.d.).

2.2 Loss & Damage

The concept of loss and damage (L&D) has become an established term within the discourse surrounding climate change. The historical origins of the concept within the realm of climate change can be traced back to the 1990s. During this period, deliberations regarding an insurance pool gained prominence, with the Alliance of Small Island States and Vanuatu taking a leading role in these discussions Intergovernmental Negotiating Committee For A Framework Convention on Climate Change. (1991) In recent years, there has been a notable emergence of concrete policy. The establishment of the Warsaw International Mechanism (WIM) on Loss and Damage (L&D) occurred during the 2013 Conference of the Parties to the United Nations Framework Convention on Climate Change (*Report of the Conference of the Parties on Its Eighteenth Session, Held in Doha from 26 November to 8 December 2012. Addendum. Part Two: Action Taken by the Conference of the Parties at Its Eighteenth Session.* | *UNFCCC*, n.d.).

A study conducted by Wrathall Wrathall et al. (2015) argues that there is a significant gap in the current approaches to addressing climate change adaptation, disaster risk reduction, and public/private risk transfer mechanisms. They concluded that these measures are inadequate for populations and regions that are disproportionately affected by the impacts of climate change. The consideration of impacts that extend beyond the boundaries of adaptation is a key aspect of the L&D framework. However, it is important to note that within the policy document, this conceptualization is primarily addressed in the introductory section of the WIM. The subsequent sections of the policy primarily focus on outlining a program that is oriented towards mitigating the risks associated with L&D. Numerous researchers and nations in the Global South share a common interest in the establishment of liability and compensation mechanisms, thus indicating a convergence of L&D policy objectives in this regard. However, it is important to note that nations in the Global North perceive this particular issue as a non-negotiable boundary, and UNFCCC has currently excluded any potential avenues for addressing liability and compensation. Notwithstanding the aforementioned arguments, which will be further elaborated upon in the subsequent sections of this manuscript, the concept of the WIM is widely acknowledged as a favorable advancement.

This is primarily due to the inadequacy of existing international policies in effectively addressing the challenges posed by loss and damage (L&D) that cannot be sufficiently mitigated or adapted to. The emergence of studies on Loss and Damage (L&D) in the context of climate change can be traced back approximately eight years. It is worth noting that before this, there existed a more extensive lineage of studies on L&D originating from related fields like disaster studies. Notable examples include the works of Amato et al. (1998) and Hoque et al. (2019). This study demonstrates a notable surge in research endeavors about learning and development (L&D) within the framework of climate change, particularly in the period following 2013. The observed increase in the number of studies in this field is noteworthy, as it addresses the previous lack of research, particularly those grounded in empirical investigation, before the establishment of international policy such as the Warsaw International Mechanism.

The present study aims to conduct a comprehensive analysis of the existing literature on the topic of learning and development (L&D) in the context of climate change. By critically examining a wide range of intellectual works, this paper seeks to identify prevailing trends, discern patterns, and offer valuable insights for future research activities in this field. They established the study's responsibility Haque et al. (2019) This study examines the establishment of a national mechanism in Bangladesh to effectively address loss and damage. Bangladesh is a country that is highly vulnerable to climate change, experiencing significant social and economic losses and damages. The main focus of this study is to identify any gaps in the current policy framework. The researchers then propose a strong mechanism framework and a comprehensive system. Additionally, consider the perspective of climate change when designing disaster policy. This mechanism is presented as a national solution to address losses and damages. It is not limited to just one country but rather focuses on climate-vulnerable counties for disaster risk reduction within the timeframe of 2015-2030 or beyond. They are also addressing the Paris Agreement through this mechanism. Developing nations, organizations, and agencies can adopt a mechanism to address the challenges posed by climate change and its impact on vulnerability. This study explores the collaboration between various ministries and departments during times of disaster, including their planning processes, individual responsibilities, and stakeholder engagement.

Overall, this study highlights the weaknesses in the current policy framework and proposes a comprehensive solution in the form of a flexible and scalable national mechanism that can be implemented by other countries facing climate-related challenges. this work greatly contributes to the global discourse on climate change adaptation and resilience by highlighting the significance of coordination, stakeholder engagement, and long-term planning.

The esteemed article research gap is following- Various types of disasters occur in Bangladesh at various times. Loss and damage from different disasters are different. There can be variations in disaster policies. What approach can be taken during a particular disaster and how can the community participate in the development of policies? What strategies are being implemented locally to mitigate loss and damage? Furthermore, there is no mention of providing specific attention to the Agrarian community, such as giving priority to the Agrarian community, it would be beneficial to develop a comprehensive framework that includes measures like offering affordable agricultural insurance, facilitating access to climate-resilient seeds, and providing training in modern farming techniques. A framework can be developed by focusing on the needs of the Agrarian community.

The study highlights Chiba et al. (2019) the threat of climate change non-economic loss and damage. The objective of this study was to create an evaluation framework that can effectively identify and prioritize non-economic losses and damages in critical vulnerable sectors. Additionally, policy recommendations were formulated to address these non-economic losses and damages. The research was conducted in between two countries Japan and Bangladesh based on their friendship project. The study location chosen was Koyra Upazila in the Khulna district of Bangladesh and another study was conducted in Nachikatsuura Town, located in Wakayama Prefecture, Japan. The cyclone severely affected Koyra killing 57 people. The findings indicate that mental health disorders can have a significant impact on both Bangladesh and Japan, despite their different developmental contexts. More specifically Japan has ranked the issue of mental health disorders. Bangladesh has identified significant problems related to not enough access to sanitation, loss of human functions, and the raise of waterborne diseases.

Not much work has been done on climate change non-economic loss and damage. but its plays a vital role for climate change effects. This issue receives very little attention

from stakeholders. They always think about their economic loss, like how much their crops have been lost, and how much their houses have been damaged.

They have contacted several works among them some research gaps in this study, In Koira upazila, the total population was 192931, with women making up 50.9 percent. It is important to consider the impact on women and children, as they are often more vulnerable to non-economic losses and damages (*The Impact of Climate Change on Urban Women in Bangladesh | The Business Standard*, n.d.). This includes looking at the percentage of women and children affected by mental health diseases and water-borne diseases. There is room for improvement in future risk reduction policies and plans for climate change. Another thing is that they just selected one Upazila in Bangladesh, if they had worked with a larger area, more people would have been involved, like they could have taken Manpura, an upazila of Bhola district. Because Manpura is a hot spot of climatic disaster (Almwd Hafi, 1995).

Another study provides Practical Action. (2021) policy recommendations to reduce flood damage and loss in Bangladesh at the national level. This involves increasing local action and coordinating across ministries to minimize and address climate-related loss and harm. They also discuss implications for preventing, minimizing, and addressing loss and damage under the UNFCCC and Paris Agreement. The study conducted on three districts in Bangladesh those are Faridpur, Satkhira, Munsihiganj. The authors selected three different districts due to different climatic disaster. Here, Faridpur was selected for loss and damage in a flood and drought-prone district, Satkhira chosen for loss and damage in a cyclone-affected district and Munshiganj picked out for loss and damage in a coastal district affected by multiple hazards. The way of side selection in this research carried extra value and importance. They collected lots of information from a review of relevant policy and academic literature as well as focus group discussions and key informant interviews, the researcher engaged with local and national stakeholders present in loss and damage.

This research has several findings based on their way of selected location. Faridpur, is a district in southern Bangladesh. The floods that occurred in 2020 caused significant harm to crops, infrastructure, and the local economy. Furthermore, the floods fostered an environment that was favorable for snakes, resulting in a rise in snake bite incidents and subsequent economic burdens. Out of a sample of 50 individuals who suffered snakebites, the majority, 70%, were male while the remaining 30% were female (Alam

et al., 2015) Additionally, 60% of the patients encountered venomous bites. The majority of victims were farmers (53%) and housewives (13%), experiencing bites primarily during rural foot walking (32%) and outdoor agricultural activities (55%) (Alam et al., 2015). Satkhira, a coastal area in southern Bangladesh, this research discovered a 30-50% rise in freshwater salinization based on focus group participants. Satkhira faces crop, livestock, and vegetation loss owing to salinization, as well as water supply loss and increased drinking water costs. Munshiganj, the frequency of river bank erosion has increased. Salinization is increasing also.

In this study, I conducted a thorough literature review, during which I identified some research opportunities. In this research, they talk about snake bites taking place when a flood happens but they didn't give any statistical information about this topic. This is one of the research gaps in this research.

2.3 Land Use and Land Cover

Land use results from human activities and the specific purposes for which a particular land area is utilized. The text explains how individuals use land resources for different purposes, including housing, business, industry, farming, leisure, and environmental preservation. Understanding land use allows us to gain a deeper understanding of how humans shape and adapt the natural environment to meet their unique needs and desires.

Land cover, on the other hand, encompasses the various elements that make up the Earth's surface, such as natural vegetation, water bodies, bare soil, and artificial structures like buildings and roads. It offers a comprehensive account of the physical and biological characteristics found on the Earth's surface without explicitly mentioning the human activities or intentions linked to these features.

The study Islam et al. (2016) investigates the quantitative land use and land cover changes in the coastal area of Bangladesh from 1989-2000-2010, utilizing Landsat images. The research specifically focuses on three significant agroecological zones. (With a specific focus on the coastal zones of Bangladesh). Discusses the impact of land use changes in the distinct coastal zones of Bangladesh, stressing the conversion of farmland into shrimp agriculture, changes in mudflat and water bodies, and the expansion in settlement areas. Provides quantitative coastal land use change data for improved management and planning of sustainable development resources in vulnerable coastal zones. Data used in this paper Periodic Land Use Maps obtained

from Soil Resource Development Institute, Bangladesh, were utilized to compare with current land use features in order to identify suitable training sites for land use and land cover (LULC) classification.

The study area was analyzed using satellite images from different time periods, including January 1989, November 1999-2001, and January 2009-2010. The images were obtained from Landsat 4 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM), and Landsat 5 TM. The most noticeable findings of this paper is Landsat photos were used to assess land use and cover changes in three coastal Bangladeshi agroecological zones from 1989 to 2010. Classification accuracy for land use and land cover maps in 1989, 2000, and 2010 ranged from 0.82 to 0.91, 0.88 to 0.96, and 0.93 to 0.94, respectively, demonstrating consistent identification of long-term changes. The study found increased shrimp aquaculture, farmland conversion, and settlement expansion in Bangladesh's coastal region. The study discovered that low and variable food production in coastal regions affects land use dynamics. They have done really appreciable work but it has some limitations like the classification accuracy may have been affected by the limited availability of optical satellite images for the study area, which could be attributed to the monsoon weather conditions.

The study lacks specific numerical data or statistical analysis of the results, which hinders the assessment of the observed land use changes and their significance.

The study Xu et al. (2020) emphasizes the notable changes in land use and land cover conversion between agricultural land and waterbodies, as well as between forest and shrubland. It also identifies the factors that drive these changes, including climate dynamics, extreme events, urban and rural household dynamics, population growth, distance to cities and major roads, and precipitation dynamics. Data has been used these papers from the Landsat satellite was utilized to analyze the changes in land use and land cover in Bangladesh between 2000 and 2010. The analysis of LULCC considered the influences of water seasonality by utilizing the Global Surface Water Dataset. Data on biophysical drivers, such as seasonal mean temperature and precipitation from 2000 to 2010, were incorporated using the CRU NCEP Reanalysis data. This paper offers a comprehensive view of land use and land cover change (LULC) and the factors that drive it, focusing on a ten-year timeframe and a national level. It serves as a valuable scientific resource for the development of land policies in Bangladesh. The limitation of the study, this paper's analysis of land use and land cover changes focuses solely on

decadal changes, potentially overlooking variations that occur within each decade due to the omission of intermediary land uses. Additional investigation could be carried out to examine variations in land use and land cover changes (LULC) within specific decades, as well as to gain insights into the intermediate land uses that may occur between significant changes.

2.4 Locally led adaption

Communities often carry the brunt of climate change impacts, yet their voices are often overlooked when determining how best to protect themselves. Many adaptation interventions are led by decision-makers from different countries and within the country. Funding for climate change, development, and adaptation initiatives often fails to reach the local level.

Poor individuals are significantly affected by the limited control and access to resources. By 2030, the impact of climate change will push more than 130 million people into a state of extreme poverty, exacerbating an already dire situation.

The local community possesses massive potential to develop adaptation solutions that are adapted to their specific needs. These solutions are characterized by consistency, accountability, democratic nature, agility, diversity, and cost-effectiveness. With access to the right resources, collaborations, information, voice, and agency, the local people can effectively build resilience.

There is a growing movement to support locally-led adaptation (LLA), empowering local actors and communities to make their own decisions about how, when, and where to adapt. LLA highly values the expertise and understanding of the local community to address climate risk effectively (*Locally Led Adaptation | World Resources Institute*, n.d.).

This study highlights that Westoby et al. (2021) the relevance of locally led adaptation (LLA) in tackling the effects of climate change at the local scale, emphasizing the need for local decision-making, resources, and indicators for success. The paper presents an attractive case for the potential benefits of LLA in decreasing dependency, promoting local autonomy, and encouraging diverse capabilities and creativity in adaptation efforts. The proposal outlines nine interconnected factors that can enhance grassroots activities, such as empowering local decision-making, utilizing local assets and resources, taking into account local vulnerability contexts and inequities, and backing

local priorities. The case studies presented in the study are derived from empirical research conducted with native populations in Bangladesh, the Philippines, and Vanuatu. The study utilized qualitative data collection methods, which involved conducting individual interviews (both formal and informal) that were in-depth and structured, as well as organizing focus group discussions. Data were gathered across various periods, from 2013 to 2015 in the Philippines and in 2018 for Bangladesh and Vanuatu. Local individuals with expertise in the field were engaged in the projects to assist with gathering and analyzing data. The findings highlight the importance of recognizing the power of local individuals, their expertise, connections, and ability to comprehend their intricate circumstances. LLA offers the chance to explore beyond climatic vulnerabilities and includes larger vulnerability contexts and livelihood priorities. Indicates that future work should prioritize the implementation of the nine drivers of locally led adaptation (LLA) proposed in the study. These drivers align with the recent findings from the Global Commission on Adaptation.

The study investigates Roy et al. (2022) the effects of rising sea levels on coastal communities in Bangladesh and their efforts to adapt, using qualitative methods for data collection. It highlights five significant impacts caused by SLR: salinity increase, land erosion, waterlogging, rising water levels, and the emergence of char land. The rise in salinity levels and the erosion of land have had a significant negative impact on agriculture, causing significant economic losses. The study focuses on the perceptions of coastal communities regarding the impacts of sea level rise (SLR) and the advantages of various adaptation processes, such as development projects and local interventions. The study utilized a qualitative approach and used a multistage sampling procedure. Data collection involved the use of Participatory Rural Appraisal (PRA) tools, such as Focus Group Discussions (FGDs) and Community Meetings (CM). Two Community Meetings were organized, one in each Union, to gather additional perspectives from stakeholders such as governmental and non-governmental organizations. Two Community Meetings, one in each Union, were held to gather more information from stakeholders such as governments and non-governmental organizations. The study primarily examined qualitative data collection methods, including Focus Group Discussions (FGDs) and Community Meetings (CMs), which may limit the applicability of the findings. The paper needs a thorough examination of the specific

adaptation measures implemented by the communities, potentially hindering a comprehensive understanding of their effectiveness.

The study Khalil et al. (2020) explores the involvement of Gabura women in creating innovative methods to deal with climate change following cyclone Aila. It emphasizes their valuable contributions to generating income, introducing agricultural developments, and crafting handmade products. It also inquiries the idea of women being seen as helpless victims of climate change and highlights the importance of recognizing the specific gender dynamics in post-cyclone aid interventions for climate change adaptation. It highlights the significant role played by Gabura women in generating income through various activities, both within and outside their homes. These activities include agricultural innovations and the production of handmade goods. Exploring the gendered aspects of adaptation strategies, with a specific emphasis on the valuable contributions made by women following the consequences of cyclone Aila in Bangladesh. The study revealed that male household members frequently had to leave due to migration, which presented opportunities for Gabura women to develop innovative adaptation strategies. These strategies involved collaborating with aid agencies, adjusting gender roles, making use of social connections, and tapping into local knowledge. This paper's scope was limited to a specific context in Gabura, Bangladesh, so its findings may not apply to other regions or countries grappling with climate change adaptation issues. This paper's scope was limited to a specific context in Gabura, Bangladesh, so its findings may not apply to other regions or countries grappling with climate change adaptation issues. Limitations of the thematic analysis approach taken in this study are not discussed at detail.

The paper Islam et al. (2018) explores the growing seriousness of flooding in Bangladesh and the importance of differentiating between strategies for managing individual flooding incidents and strategies for adapting to flooding as a whole. It highlights the significance of local knowledge in developing effective coping mechanisms. The findings of the study In Bangladesh's floods, local knowledge is crucial to managing and adapting to calamity. Discusses how governance, social networks, and income diversification affect flooding coping and adaptation. Assesses local bodies' coping and adaptive capabilities. Determining how local institutions are impeded in adopting these steps and using knowledge in decision-making. The study involved visits to Bangladesh in 2010 and 2015, where in-depth interviews were

conducted with people from villages that experience frequent flooding. The interviews utilized open-ended questions and typically spanned from one to one and a half hours. The study underlines the need to separate flood coping techniques from flood adaptation tactics, stressing the expansion of local knowledge-based coping mechanisms in the absence of planned adaptation initiatives. Both coping and adaptation techniques focus on governance, social networks, and economic diversification, and the research evaluates local bodies' support for these approaches. Local governance systems use local knowledge and community needs to assess flooding and disasters. Data collection biases and research technique constraints are not adequately discussed in the paper. The research does not address constraints related to generalizability or external influences affecting the results. The report proposes more research on integrating local knowledge into governing body adaption strategy decision-making. Future research might examine how local institutions assist coping and adaptation measures and how knowledge is used in decision-making. More research is needed to determine if local knowledge can help governments implement adaptation plans.

CHAPTER 3: METHODOLOGY

This chapter presents the methodology for this study. It contains details about data collection and methodology.

3.1 Study Area

Barguna district is a southwestern coastal part of Bangladesh. My study area particularly Taltali Upazila at 45 number Polder. Encircled embankments known as Polders were built in Bangladesh's coastal region in the early 1960s. The common consensus is that because of sedimentation in the surrounding rivers, Polders are the source of water logging inside the protected land and household (Haque et al., 2019).

Figure 2: Houses near Nishanbaria Union at Barguna District

There are nearly 130 plus polders in the Coastal Zone of Bangladesh. Taltali Upozila is very much vulnerable to natural disasters which experienced the devastating impact of cyclone Sidr 2007, Aila2 009, Heavy Rainfall 2010, Tidal effect 2012, Bulbul 2019, Amphan 2020, and many more respectively. Due to the dense population, ultra-poor resident region, and frequent occurrence of various climatic disasters, the residents of the area are especially vulnerable to natural hazards. The Upazila covers an area of 258.98 square kilometers, including 39.70 square kilometers of forest. It is situated between the latitudes of 22.0876 N and the longitudes of 90.1770E. The Upazila is

made up of one Paurashava, nine Wards, seven unions, and 63 villages (Bangladesh Bureau of Statistics, 2022).

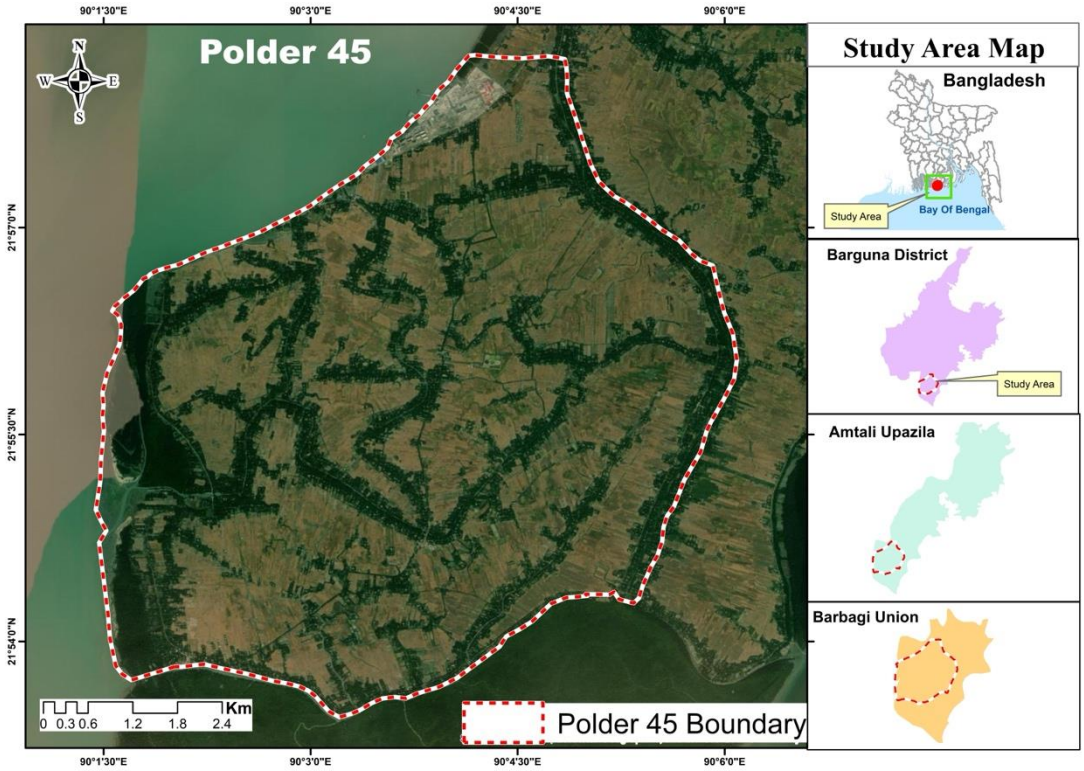

Figure 3: Location Map of Polder 45

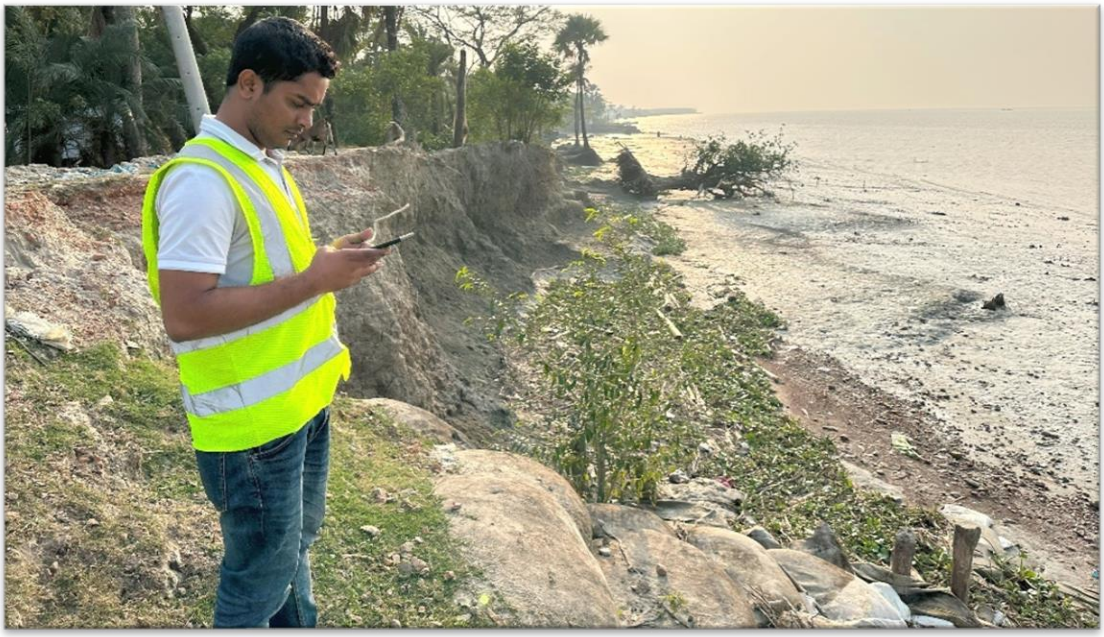

Figure 4: River erosion in Sonakata union

Figure 5: Saltwater problem in Taltali Upazila

3.2 Methodological farmwork

Some steps have been developed to analyze the loss and damage. This chapter discusses all of these steps in detail. The steps and flow chart for the overall method are given below.

- Qualitative & Quantitative Survey
- Data Collection through Surveys
- Socioeconomic Loss & Damage
- The Recovery phases
- Local Led Adaptation
- Land use & Land cover Analysis using Geographic Information System (GIS)

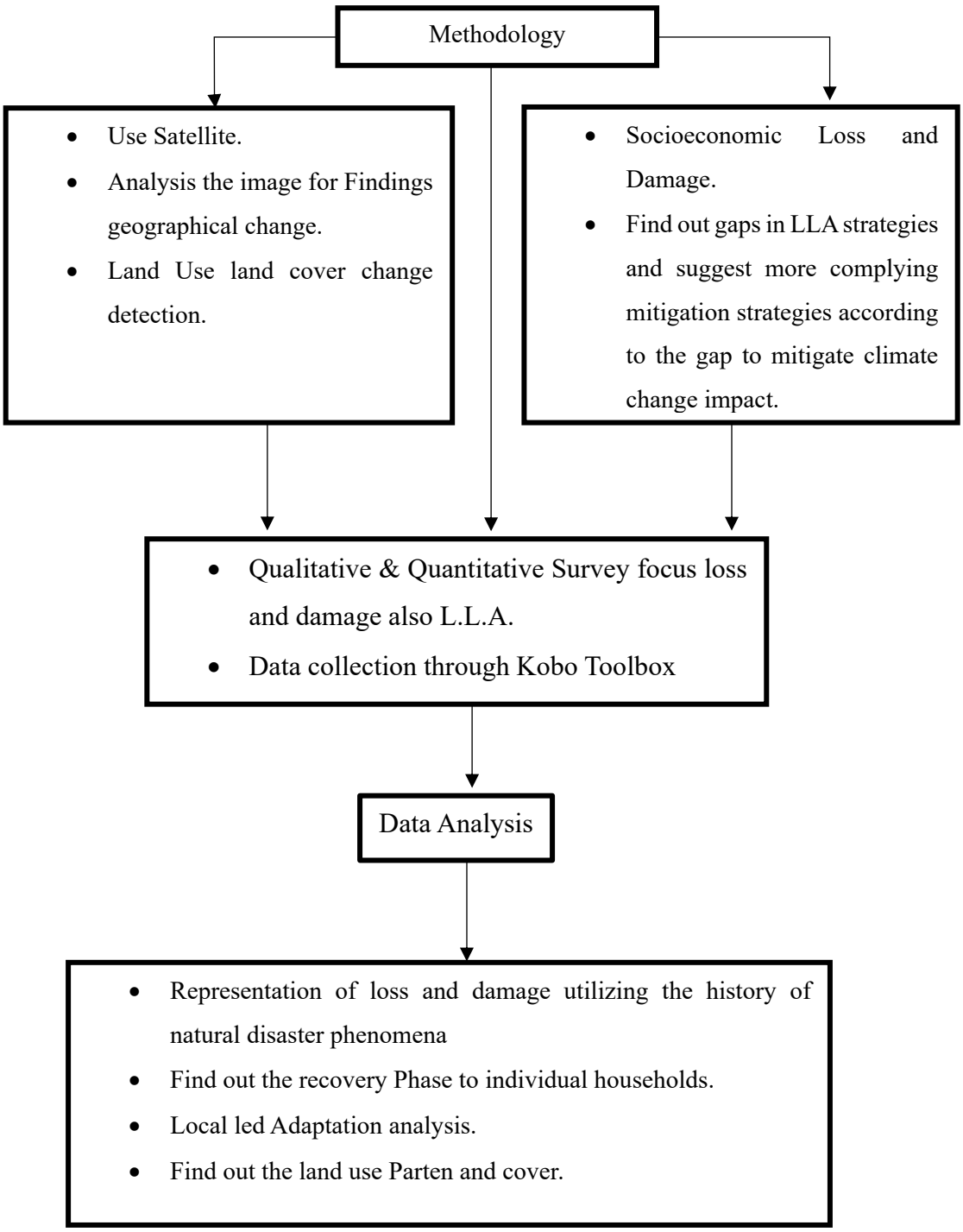

Figure 6: Methodological framework of the study

3.3 Quantitative & Qualitative Survey

As was already indicated, numerous challenges are associated with establishing an effective loss and damage system for Local Led Adaptation in a natural disaster. Some

of the most important issues in loss & damage and Local Led Adaptation such as findings type of loss & damage, establishment of relation between climate change and LLA, also climate change and loss and damage value. due to the diverse nature of the study, the tools and techniques utilized in this research would vary significantly. The study has utilized a combination of qualitative and quantitative techniques. The quantitative aspect will be based on a survey method using various sampling techniques. A questionnaire will be developed based on a literature review of existing research, careful analysis of the project proposal, and a logical framework to collect quantitative data from the randomly selected respondents. Qualitative method has been applied for the purpose of validation and cross check and reinforcing quantitative data. Based on Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). All the necessary tools and techniques were developed during the initial phase of the assignment.

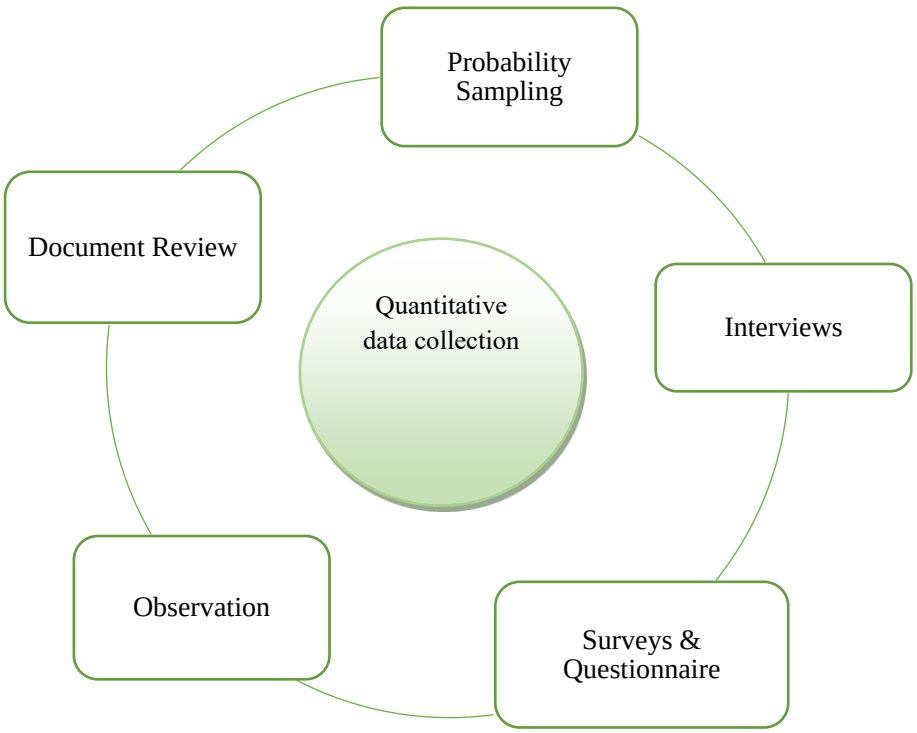

Figure 7 : qualitative Data collection method

Figure 8 : Quantitative data collection methods

3.3.1 Focus Group Survey (FGD)

A focus group discussion (FGD) is a qualitative research strategy for gathering data where a pre-selected group of participants engages in in-depth discussion about a specific topic or issue under the guidance of a trained, external moderator. The method depends on the notion that group processes involved in an FGD help uncover and clarify collective knowledge among groups and communities, which would be difficult to determine through a series of individual interviews. During these 'open' discussion rounds, an FGD allows for the exploration of both the participants' shared narrative and their differences in experiences, attitudes, and perspectives.

Figure 9: Discussions with local people on the Taltali Polder 45 near Bay of Bengal

Figure 10: Discussions with local Farmer and housewife on the Taltali Polder-45

Figure 11*: Discussions with local fishermen on the Taltali Polder-45*

3.3.2 Key Information Interview (KII):

Key informant interviews involve conducting qualitative in-depth interviews with individuals who have a deep understanding of the community's dynamics. The purpose of conducting key informant interviews is to gather information from a diverse group of individuals, such as community leaders, professionals, or residents, who have valuable firsthand knowledge about the community. These knowledgeable individuals, with their expertise and understanding, can offer valuable insights into the nature of problems and provide recommendations for solutions.

Here are two commonly used techniques for conducting key informant interviews:

- Conducting interviews over the phone.
- Conducting Face-to-Face Interviews.

In this case study, face to face interviews has been conducted to complete the survey. Site visit has been conducted to understand the sanitation scenario and waste disposal of the proposed area. There are some tools which is used at the time of conducting survey. The tools are checklists, map layout, KML Boundary, GPS/GNS (KOBO Toolbox)

Figure 12: Discussions with local farmers on the Taltali Polder-45

Figure 13: Discussions with local businessmen on the Taltali Polder- 45

3.3.3 KOBO Toolbox Survey & Techniques:

KOBO Toolbox is also known as Open Data Kit. Open Data Kit provides a comprehensive set of tools for collecting data using mobile devices and submitting it to an online server, even when there is no Internet connection or mobile network service available during the data collection process. Data collection can be done without an Internet connection or access to a cell carrier. Collect various types of information using a mobile device. Then, the host collected data online using Google's powerful hosting platform, Google App Engine and visualized the data as a map using Google Fusion Tables and Google Earth.

The developed tools and techniques have grounded in the study area for pre-testing. Focus group discussion and household survey have been conducted by the study team to receive the response of the respondents. Then the questionnaire and checklists were cross-checked considering the field test outputs. There are multiple Advantages of using KOBO TOOLBOX in collecting field data.

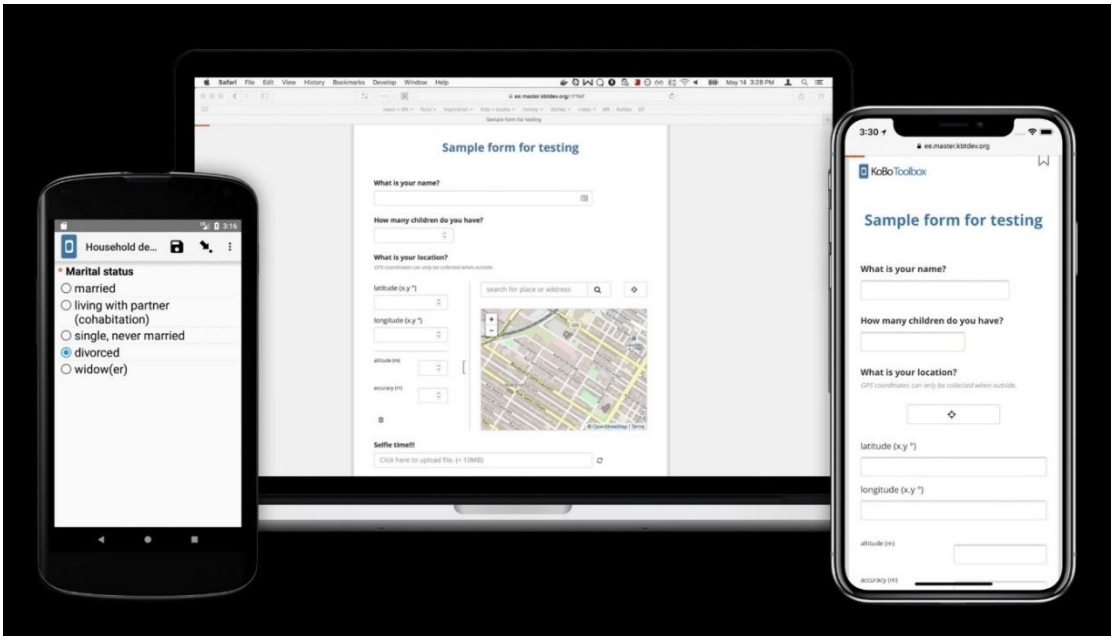

Figure 14: Data Collection by KOBO Toolbox

There are several benefits to consider:

- Better implementation.
- Improved analysis.
- Enhanced reporting.
- Greater transparency.
- Improved accountability.
- Increased Timeliness.
- More time can be spent analyzing the data and making useful information products because less time is spent on collecting data.

3.4 DATA COLLECTION

A thorough research project requires adequate data to be conducted. To undertake a study on urban drainage, information on the following topics is generally required. Technical information on a variety of topics, such as annual climatic event conditions.

- Meteorological data.
- Agricultural information.
- Socio-economic information.
- Climate change condition.
- Disaster early warning system condition.
- Community building status.
- Climatic change affects current conditions.

- Local led adaptation status.

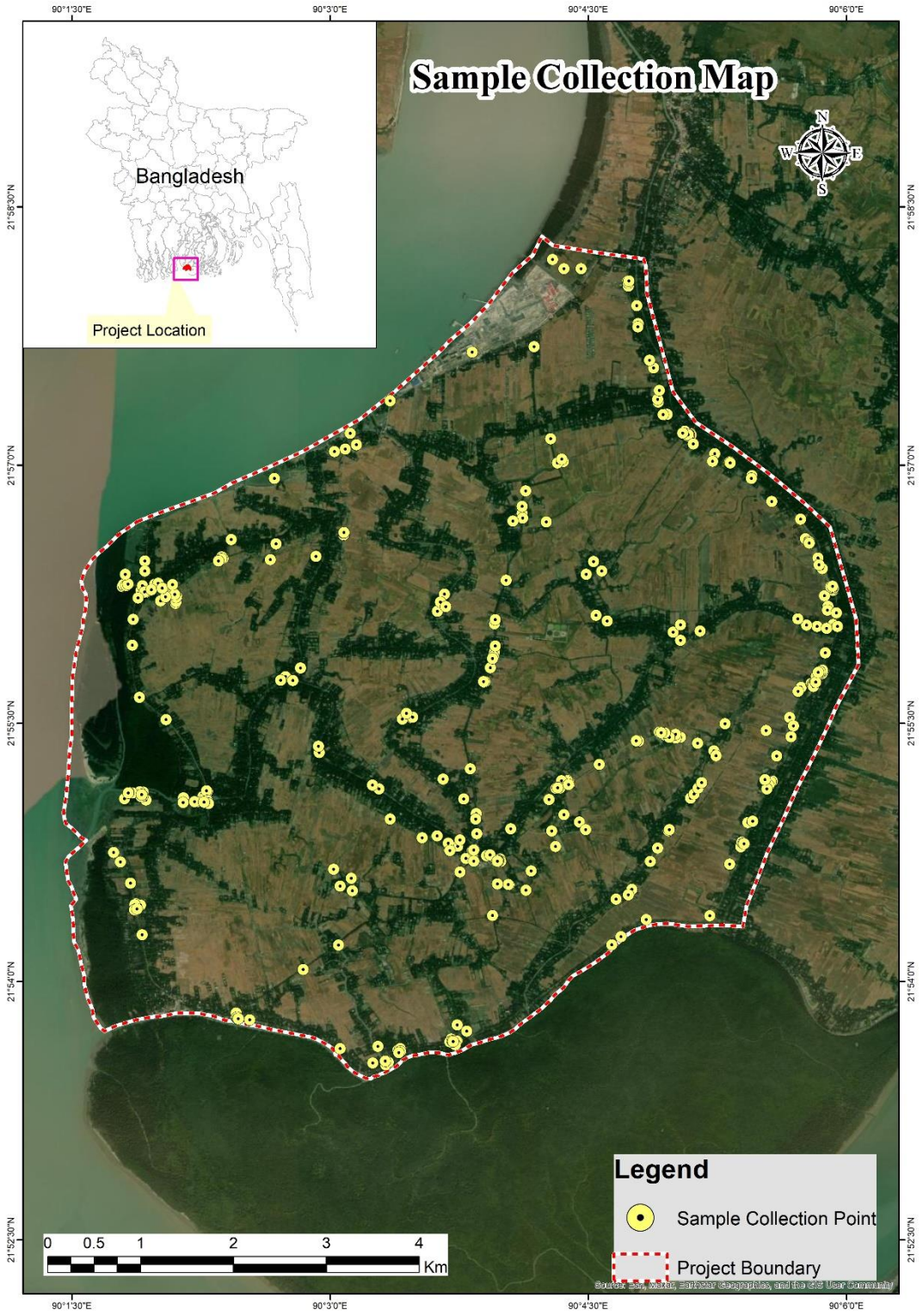

Figure 15: sample collection Map

3.4.1 Primary Data

Table 1: Collected Data from Primary Field Survey

General Social Data	Total Asset Values	Damages to Disasters
• Latitude • Longitude • Village Name • Upazila Name • Union Name • District Name • Name of the Respondent • Age • Income Source • Total Monthly Income • Land use and Land cover change. • Climate change effects. • Communities building.	• Lands • Ponds • Size of House • Household Assets • Poultry • Cattle • Other	• Natural Disaster duration. • Household Damage • Cost of Household Repair & Maintenance • Total Crop Damage • Total Pond Area Damage • Total Fish Damage • Total Cattle Damage • Cost of Drinking Pure Water

3.1 GIS Analysis Procedures

The study utilized geography information system (GIS) to detects land use land cover change (LULC) in the study area. The study performs supervised image classification for execute LULC. For accuracy assessment used overall accuracy assessment method. For determined overall accuracy assessment used equation 1

Overall Accuracy = (Number of Correctly Classified Pixels in Diagonal)/Total Number of Reference Pixels) *100

3.4.2 Secondary Data Collection

- Scientific research paper
- Book
- Government report
- NGO website

CHAPTER 4: RESULT AND DISCUSSION

This chapter broadly discusses the findings and results of the study in this section, we will discuss the results and evaluations of our investigation, focusing on the primary objectives established at the beginning of this work. We aimed to combine the gathered data from different perspectives and perform a thorough analysis to fully understand the scope of our objectives. As a result, the "Results and Discussion" section is methodically divided into three primary subsections: Loss and Damage, Recovery phase, Local-led Adaptation, and LULC.

Here, we present a summary of our main discoveries, delving into each objective frequently. We explore the aspects of loss and damage, LULC, and local-led adaptation strategies, providing a thorough analysis of their interconnections and specific effects. This chapter analyzes the impacts of major climatic events such as Cyclone Sidr (2007), Cyclone Aila (2009), the 2010 heavy rainfall event, tidal effects in 2012, Cyclone Bulbul (2019), and Cyclone Amphan (2020). We evaluate the total loss and damage to household assets caused by these events, including home damage, repair cost, crop and fishery losses, livestock and poultry damages, and other losses in household assets. Furthermore, this analysis explores measuring the time needed for affected households to recover, estimating the duration in months or years to bounce back from the losses and damages suffered. After this, we investigate Local-led Adaptation (LLA) strategies, analyzing the actions taken to reduce the impact of climate-related disasters and identifying the organizations participating in these mitigation efforts.

This chapter aims to provide an in-depth review of our findings regarding climate change impacts, adaptive responses, and changes in land use and cover. This will contribute to the discussion on environmental resilience and sustainability.

4.1 Major findings of loss and damage

Loss and damage have been analyzed based on different disaster-related events such as SIDR, Amphan, Aila, Bulbul, heavy rainfall, and tidal effects. We have analyzed the total amount of loss and damage suffered by each household during various climatic disasters, including agricultural losses, house damages, repair costs, and business impacts. and determined which catastrophe resulted in the least harm. This study identified the duration of the recovery time of the losses caused by climate events based on their income sources.

4.1.1 Overall, Loss and Damage to Householder Assets

This study counts economic loss and damage. Losses and damages refer to the impact on resources, goods, and services that are usually traded in markets, like harm to vital infrastructure, property, or disruptions in the supply chain. The effects on individual farmers or communities. Table 1 represents the amount of loss and damage caused by individual noticeable climatic disasters in the study area.

Table 2: Overall Loss and Damage Householder assets

Year	Amount (BDT)
Sidr, 2007	15136000
Aila, 2009	6238000
Heavy Rainfall, 2010	2056900
Tidal Effect, 2012	8370000
Bulbul, 2019	1704000
Amphan, 2020	1321200

Table 1 shows 6 different climatic disaster events that happened between 2007 to 2020. The most lost and damaged occurred by the SIDR (15.13m BDT) of the households and assets and the lowest when striking Amphan (1.32m BDT). And most recent climatic disasters were Bulbul 2019 and Amphan 2020. The loss and damage caused by Bulbul to the overall household asset amount was 1.7m BDT, while Amphan was 1.32m BDT.

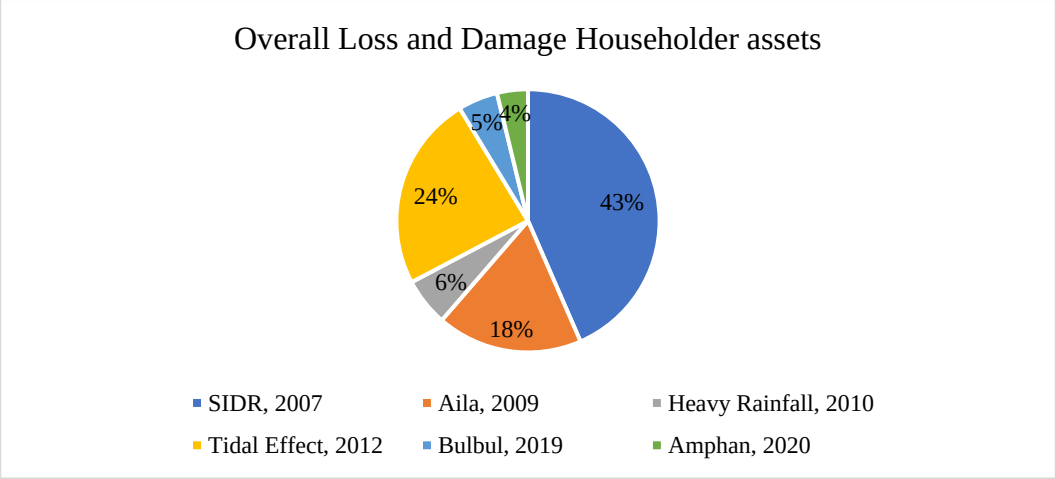

Figure 16: Overall Loss and Damage Householder Assets Percentage

The pie chart shows the frequency of the six major climatic disasters of the study area in the 45 number polder. Sidr is responsible for 43%, with Aila (2009) at 18 %, Heavy rainfall (2010) at 6%, Tidal effect (2012) was the second position which is 43%, Bulbul (2019) and Amphan (2020) together responsible for remaining 9%. This is the frequency of economic effects of natural disasters in the region.

4.1.2 Damage of Household

The table signifies the primary focus, which is the extent of damage to houses during six major climatic disasters in the study location. Table 2 shows 6 significant climatic disaster events occurring between 2007 and 2020.

Table 3: House Damage in Six Major Climatic Disasters

Year	Amount (BDT)
Sidr, 2007	6310000
Aila, 2009	1168000
Heavy Rainfall, 2010	650000
Tidal Effect, 2012	140000
Bulbul, 2019	408000
Amphan, 2020	334000

In 2007, the results indicated that the total damage to households from SIDR was 6.31m BDT, the highest among six major disasters. In 2007, Aila hit Polder 45 resulting in a total damage of 1.16m taka to the households. Which is lower compared to SIDR. In 2010, there was a significant heavy rainfall event, followed by a tidal effect in 2012, which caused damage to households amounting to 0.65m BDT and 0.14m BDT, respectively. The most recent cyclones Bulbul and Amphan occurred in 2019 and 2020. The damage caused by Bulbul to households amounted to 0.40m BDT, while the damage caused by Amphan to households was 0.33m BDT. Out of the 6 events in 2012, the tidal effect caused the least amount of damage.

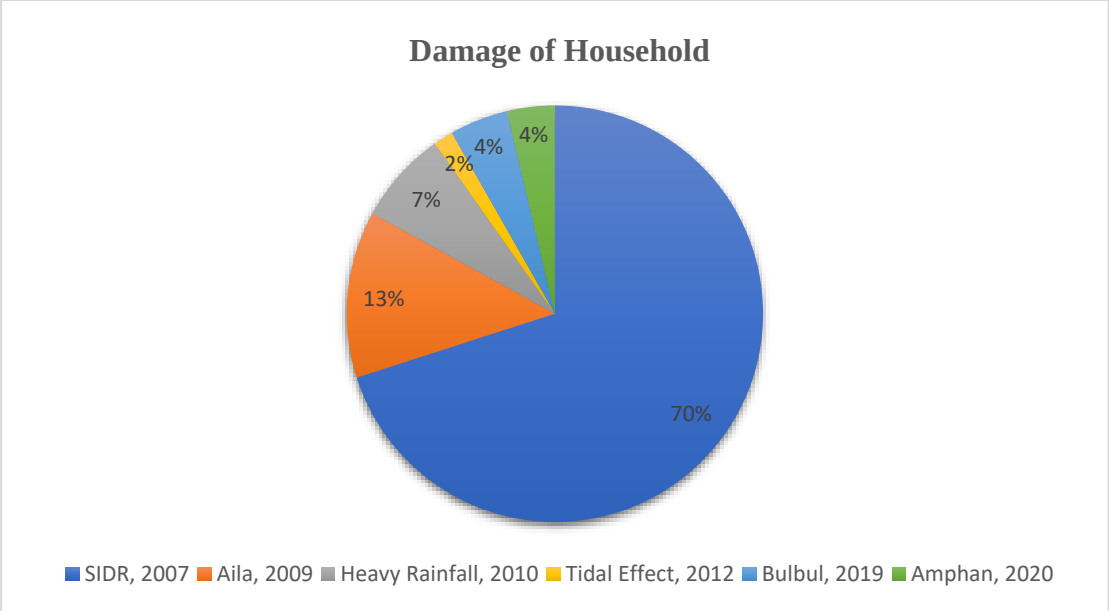

Figure 17: Six major climatic disaster damage frequency

This study shows that Sidr (2007) had the most disastrous event. It causes 70% of the total damage, Aila (2009) 13% hold the second position of damage. Ampan (2019) and Bulbul (2020) hold 8% combinedly. The lowest impact was Tidal effect (2012) at 2%. Over 450,000 homes were destroyed by Cyclone Sidr in 30 districts as a result of wind, flooding, and tidal surge. In each of the six areas that were most severely affected, about 50% of the households suffered damage or were destroyed (Projects, 2009).

4.1.3 Cost of repair of the house

Table-3 speaks for the total cost of repair of the house after six major climatic disasters happened. From 2007 to 2020 the study area was affected by many natural disasters among them Sidr, Aila, Heavy Rainfall, Tidal Effects, Bulbul, and Amphan.

Table 4: Cost of repair of house

Year	Amount (BDT)
Sidr, 2007	5785000
Aila, 2009	1373000
Heavy Rainfall, 2010	506000
Tidal Effect, 2012	210000
Bulbul, 2019	640000
Amphan, 2020	258000

Over the thirteen-year period of time, the cost of repair of the house data represents Sidr (2007) as the height repair cost associated then any natural disaster, and Aila (2009) is the second most which is 0.13m BDT. The lowest repair cost was Tidal Effect (2012) at 21000 BDT. The tides raise the water level and then enter into the households and agricultural fields, so in this time the discharge options like canals, and river stay clear then, the water moves faster and the damage is reduced. Heavy rainfall (2010), was 506000 BDT BDT. And most recent event was Bulbu and Amphan occurred in 2019 and 2020. The repair cost was Bulbul and Ampana amounted to 640000 BDT and 258000 BDT.

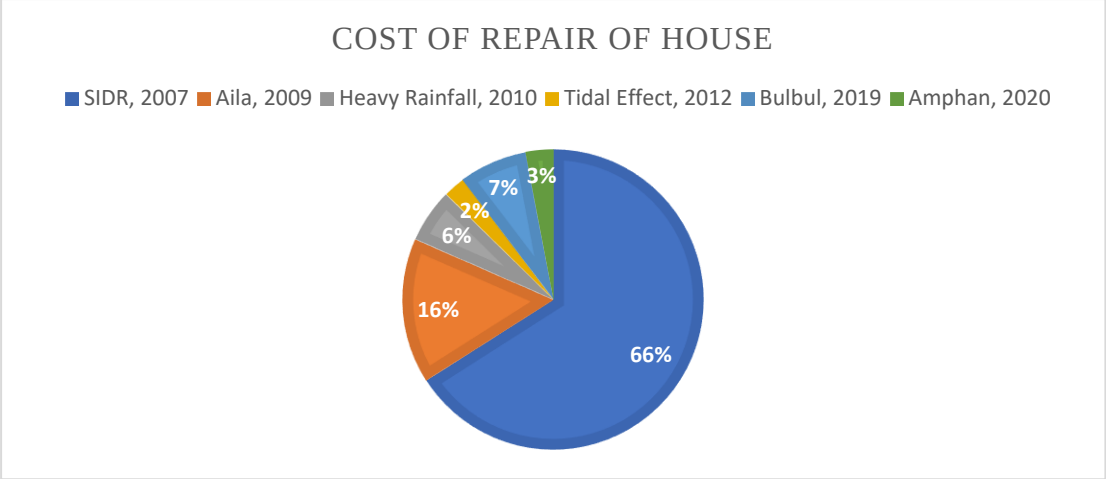

Figure 18: Cost of repair of the house in percentage.

The pie chart demonstrates house repair costs in percentage. A study said that Sidor (2007) loss and damage were concentrated in the housing sector 57 BDT billion, 50 percent of the total loss (GoB, 2008). This is the highest amount of loss and damage percentage over the last decade. Damage and repair costs are vice versa. If the damage is high then the repair cost will be huge. At that time, considering Bangladesh's vulnerability to natural disasters, it was recommended to address recovery and reconstruction with a focus on increasing resilience and improving infrastructure.

4.1.4 Total crop damage

This table shows the total crop damage of all major events in the study area.

Table 5: Total crop damage

Year	Amount (BDT)
Sidr, 2007	3455000
Aila, 2009	1162000
Heavy Rainfall, 2010	333000
Tidal Effect, 2012	215000
Bulbul, 2019	444000
Amphan, 2020	630000

Bangladesh is one of the countries in the world that focuses most on agricultural work. 45 number Polder in my study area where people mostly connect agricultural work. From 2007 to 2020 the total amount of crops damaged by major six climatic events were 6,239,000 BDT in the study area. Among them, SIDR (2007) destroyed crops worth 3,455,00 BDT and is still on top based on damage rate. This is one of the most devastating cyclone effects in BD. High-speed wind and tidal effects were the main cause of Sidr's crop loss and damage. Aila (2009) was the second largest competitor at 11,62,000. Back in 2012, the Tidal Effect impacted Polder 45, causing a total damage of 2,15,000 BDT to the Crop. It is lower in comparison to SIDR. In 2010, there was a notable heavy rainfall event, totaling 3,33,000 BDT. In 2019 and 2020, the most recent cyclones were Bulbul and Amphan. Bulbul caused 4,44,000 BDT worth of damage to crops, while Amphan resulted in 6,30,000 BDT worth of damage to crops.

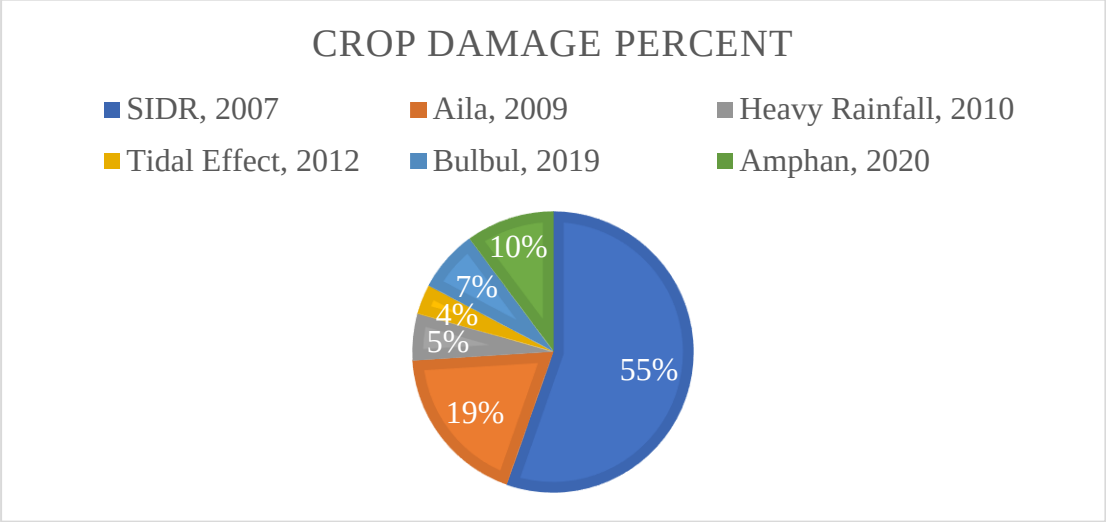

Figure 19: Total Crop damage percentage of six major disaster

The pie chart shows the data, with Sidr 2007 appearing as the largest segment, primarily because of the significant crop damage it caused. The visual aid provided facilitates comprehension of the varying effects of different events on agriculture, underscoring the significance of implementing climate change adaptation measures to reduce potential future damages

4.1.5 Total fishery damage

The table indicates total fish damage over the time from 2007 to 2020 for six major climatic disasters in the study area.

Table 6: Total fishery damage

Year	Amount BDT
Sidr, 2007	2501000
Aila, 2009	941000
Heavy Rainfall, 2010	329000
Tidal Effect, 2012	75000
Bulbul, 2019	369000
Amphan, 2020	243000

Sidr (2007) is the most harmful disaster for the fishery sector. The damage amount is 25, 01,000 BDT. Then Aila (2009) is in the second position, loss is 9,41,000 BDT. And the lowest position is the Tidal Effect (2012) at 75000 BDT. The latest cyclones were Bulbul and Amphan. Bulbul caused damage worth 3,69,000 BDT to the fishery, while Amphan resulted in damage of 2,43,000 BDT to the fishery.

Bangladesh has moved up two places to become the third-largest producer of freshwater fish. Bangladesh has consistently ranked fifth in fish farming for the past six years (*Bangladesh Globally Ranks Third in Fish Farming | Prothom Alo*, n.d.).

Fish farming is not done by many people who do it on a very large scale. When we went for the survey, we met three-four such people and interviewed three-four people who used to have fish farms, but now they are not doing so because they have lost a lot of money in Sidr (2007). After that, they were heavily indebted and fish farming.

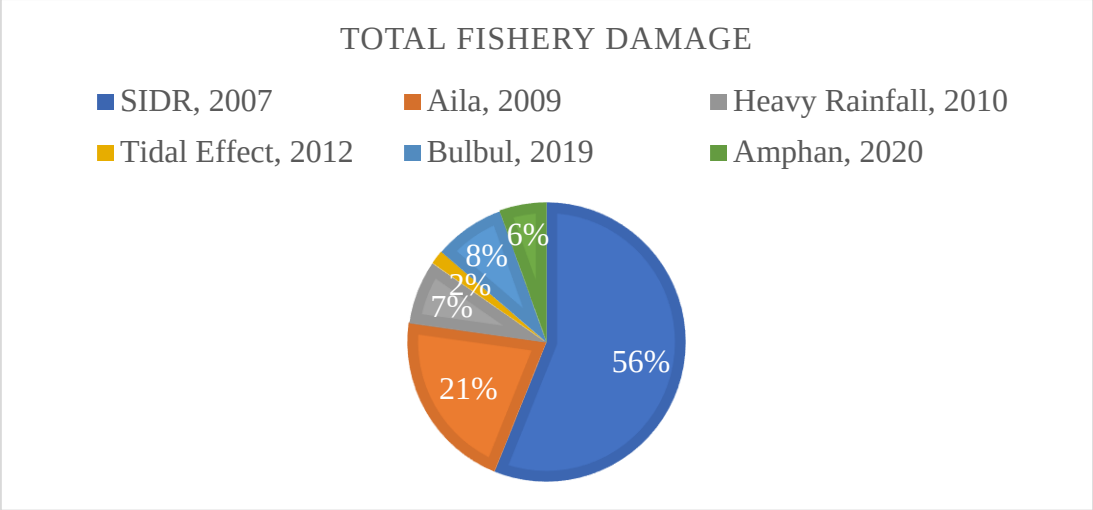

Figure 20: Total fishery damage in percentage

The pie chart represents the percentage of the six major climatic disaster fishery damage from 2007 to 2020. This pie chart describes the percentage of fishery damage caused by the six major climatic disasters from 2007 to 2020. Sidr (2007) caused the most significant adverse effects on fisheries, accounting for 56% of the damage. In the study by Aila (2009), it was found that 21% of damage occurred in fisheries. In the Title Effect (2012), the damage was minimal at just 2%. The heavy rainfall in 2010, Bulbul in 2019, and Amphan in 2020 have caused damage of 7%, 8%, and 6% respectively.

4.1.6 Total damage of cattle/poultry

Table 7: Total damage of cattle/poultry

Year	Total damage of cattle/poultry
Sidr, 2007	2870000
Aila, 2009	184000
Heavy Rainfall, 2010	5000
Tidal Effect, 2012	0
Bulbul, 2019	66000
Amphan, 2020	61000

This table shows total poultry/cattle damage of 13-year big natural disaster from 2007 to 2020. Along the coast, each household typically raises 1-2 cows, goats, or sheep. There are individuals who own 5-6 cows and others who have 5-7 goats. The polarity level is extremely minimal. When there is no extra water and flooding, typically there is no livestock loss. 2007 cyclone Sidr There were numerous floods with high water levels, resulting in the loss of livestock and their displacement. Due to this incident, there has been a loss of cattle and poultry, resulting in damages amounting to Rs 2,870,000 in Sidre (2007). In 2012, there was no loss due to the tidal effect.

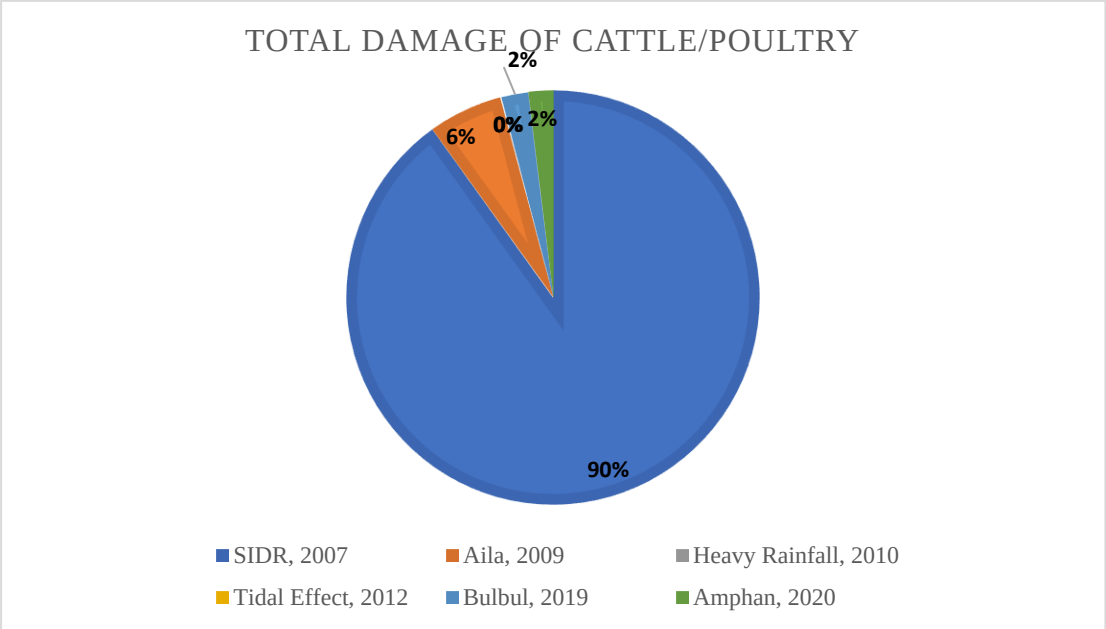

Figure 21: Total damage of cattle/poultry in percentage

If we look closely at the pie chart, we see that 90% of the total damage is SIDR (2007) and the remaining 10% is Aila, (2009) The heavy rain, (2010), Bulbul, (2019) Amphan, (2020) in these 4 natural disasters. And Tidal Effect, (2012) damage is 0%.

4.1.7 Total damage of other household assets

This table provides a detailed breakdown of the overall damage to additional household possessions in coastal Bangladesh due to different natural calamities. The SIDR 2007 event caused significant damage, leading to losses of BDT 4.8 million. In 2009, Aila and Heavy Rain in 2010 caused significant impacts, leading to losses of 1.41 million and 739,900 BDT respectively.

Table 8: Total damage of other household assets

Year	Total damage of other household assets
Sidr, 2007	4845000
Aila, 2009	1410000
Heavy Rainfall, 2010	739900
Tidal Effect, 2012	407000
Bulbul, 2019	417000
Amphan, 2020	43200

Despite the reduced impact of tides in 2012, Bulbul 2019, and Amphan 2020, there were still considerable losses reported. This data emphasizes the extensive impact of climate-related events on household resources, underscoring the necessity for comprehensive climate resilience and adaptation strategies in vulnerable regions like coastal Bangladesh.

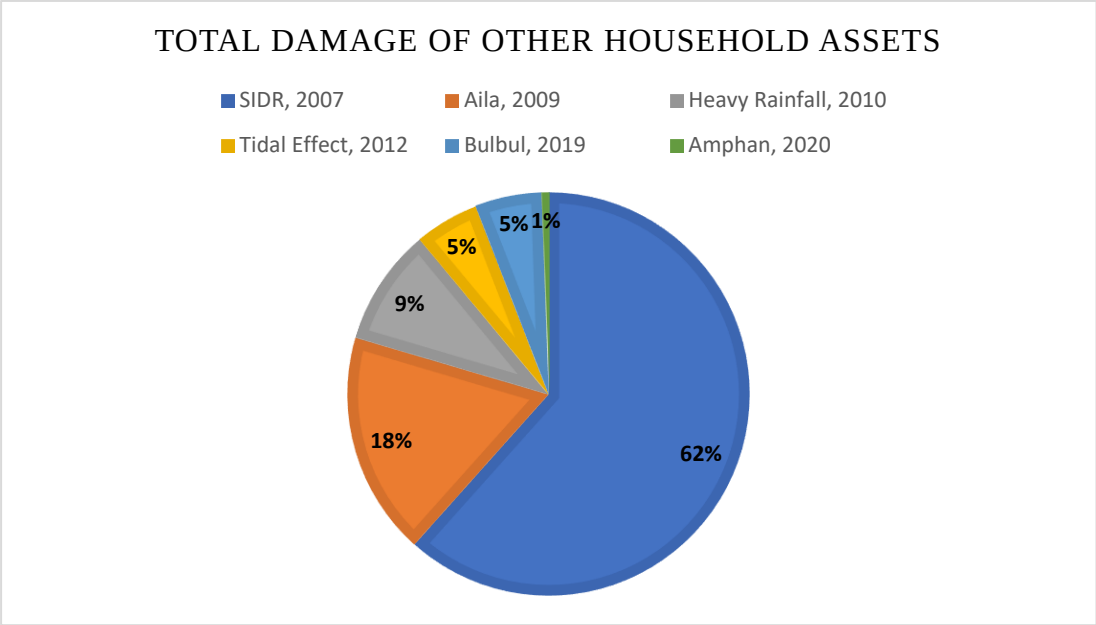

Figure 22: Total damage of other household assets in percentage.

An analysis of household asset losses in the coastal region of Bangladesh showed that Sidr 2007 was the most significant event, leading to more than 61% of losses. In 2009, Aila caused an 18% increase, showing a notable effect from the cyclone. In 2010, the significant rainfall and tidal events in 2012 contributed to approximately 14.5% of the total damage, emphasizing the influence of severe weather conditions and tidal waves.

In 2019, Bulbul demonstrated a notable effect of approximately 5.3%. In 2020, Amphan had a minimal impact, accounting for slightly more than 0.5% of the overall loss.

4.2 Recovery Phase

Every climatic disaster has lots of loss and damage in individual household. Its effects their house, agriculture, business and household assists. They need time to recover the loss and damage. How much time they need to recover their loss and damage. Bangladesh is one of the most disaster-prone country in the world. So, we see maximum time coastal areas people failed to recover their assists as disasters have become the constraints issue the past decades.

4.2.1 Sidr

In households in Bangladesh, particularly in coastal regions prone to cyclones and flooding, the graph indicates that increased recovery costs linked to the extent of damage, resulting in longer repair and rebuilding times.

The following scatter plot demonstrates a direct relationship between the overall recovery cost and the recovery year for household assets in the coastal region of Bangladesh (BD). The graph illustrates a positive correlation between the total cost of recovery and the recovery year. Higher costs for recovery efforts are linked to extended recovery times.

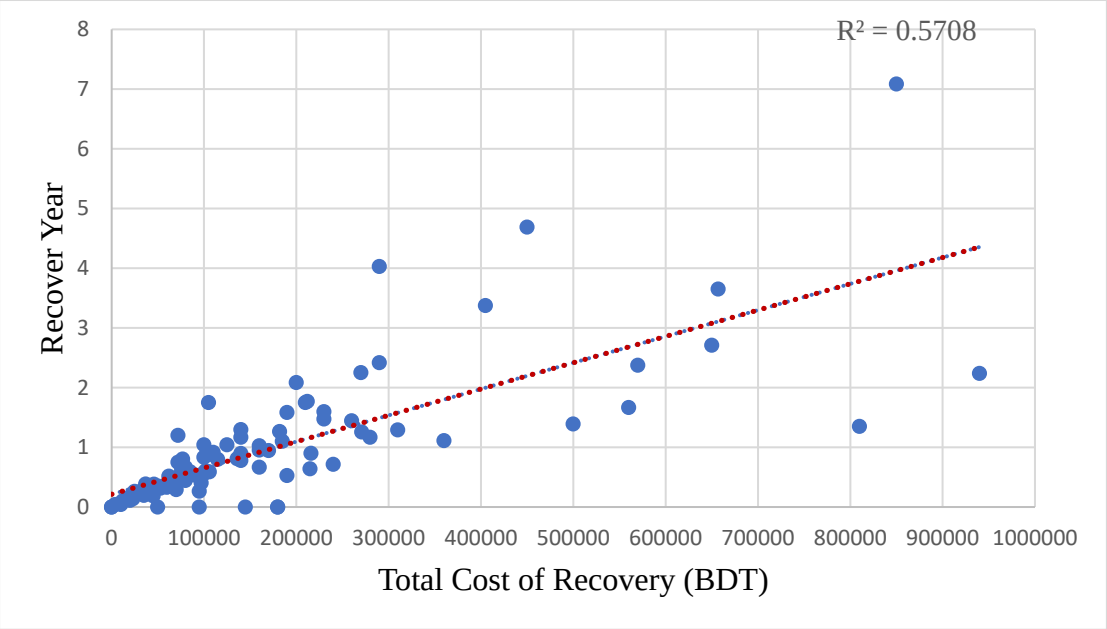

Figure 23: SIDR recovery year and cost

With a R^2 value of 0.5708, The correlation indicates a connection between cost and recovery time, but additional factors not depicted on the graph also influence the recovery period.

4.2.2 Aila

These statistics highlight the significance of disaster preparedness and efficient recovery planning for Bangladesh, a nation that experiences natural disasters frequently as a result of its geographic location.

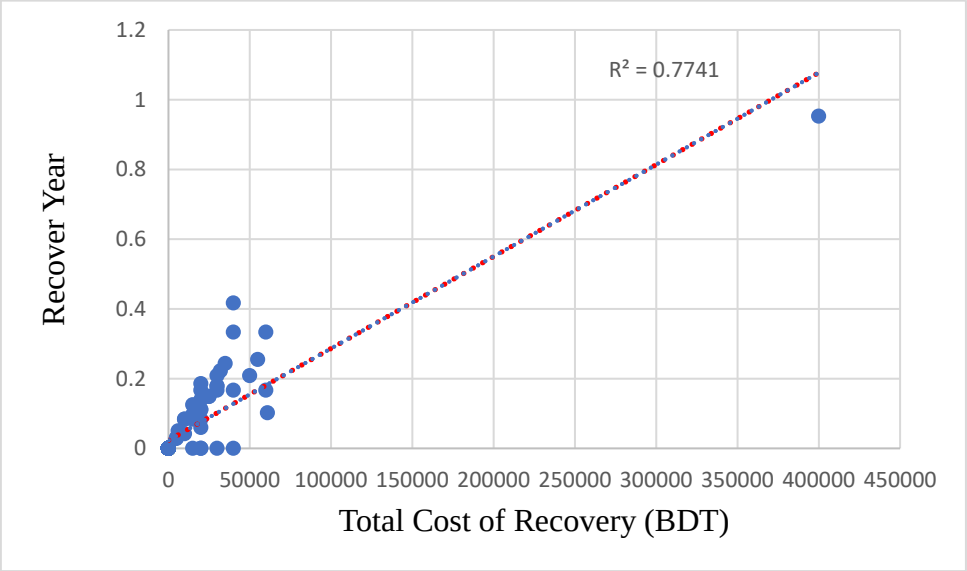

Figure 24: Aila recovery year and cost

The scatter plot for AILA shows that, for individual household assets in Bangladesh's coastal region, there is a stronger correlation between the recovery year and the total cost of recovery. R^2 value of 0.7741, the total cost of recovery accounts for about 77% of the variation in the recovery year.

Consider what's not on the graph, too. A high R^2 value does not indicate causality, as other factors may impact recovery cost and time, such as damage severity, recovery effectiveness, or community resilience before the event.

4.2.3 Heavy Rainfall

The relationship between the cost of recovering from heavy rainfall and the recovery year for individual household assets is shown in the scatter plot you have provided.

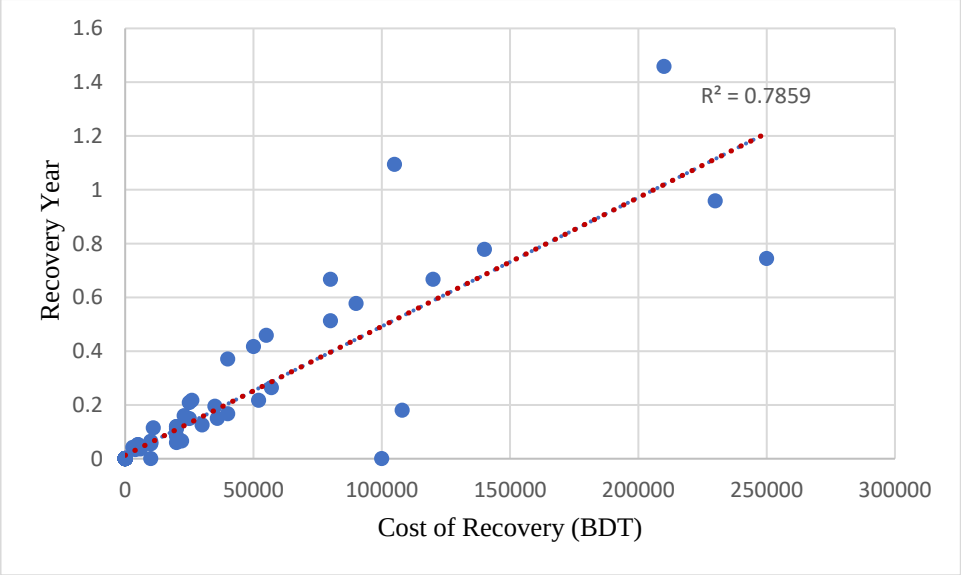

Figure 25: Heavy rainfall recovery year and cost

The recovery cost can account for roughly 78.59% of the variance in the recovery year, according to the coefficient of determination R^2, of 0.7859. Given the relatively high value, a strong linear relationship is indicated.

This information can be very important to someone who lives in Bangladesh. It suggests that longer recovery times are typically needed to offset higher recovery costs following heavy rainfall, which may be caused by more severe losses or damage. This may indicate that more substantial financial strains could postpone the restoration of normalcy to people's businesses or work environments. The information could be used to support the case for speedier response times and stronger support networks to help communities recover from natural disasters, since the financial strain can have a long-lasting impact on their ability to support themselves. It might also serve as a wake-up call for improved planning and infrastructure to reduce future costs and recovery times.

4.2.4 Tidal Affect

This graph shows the "Recovery Year" and the "Total Cost of Recovery" for each household asset in Bangladesh's (BD) coastal areas that have been impacted by tidal phenomena.

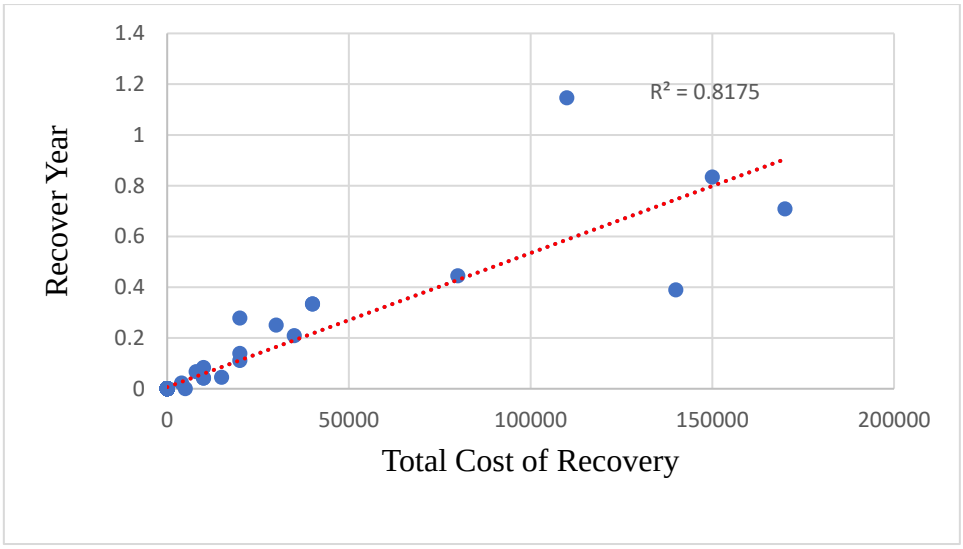

Figure 26: Tidal affect recovery year and cost

The R^2 correlation value of 0.8175 suggests a strong positive relationship between the total cost of recovery and the recovery time, indicating that as the cost rises, the time needed for recovery also increases. In the context of the situation in Bangladesh, the duration of the recovery process is directly related to its cost.

4.2.5 Bulbul

The scatter plot illustrates the correlation between recovery cost. A trend line in the plot indicates that the recovery year and the cost of recovery are positively correlated. With an R-squared value (R^2) of 0.7126, this suggests that the recovery appears to occur over a longer time span as the cost of recovery rises.

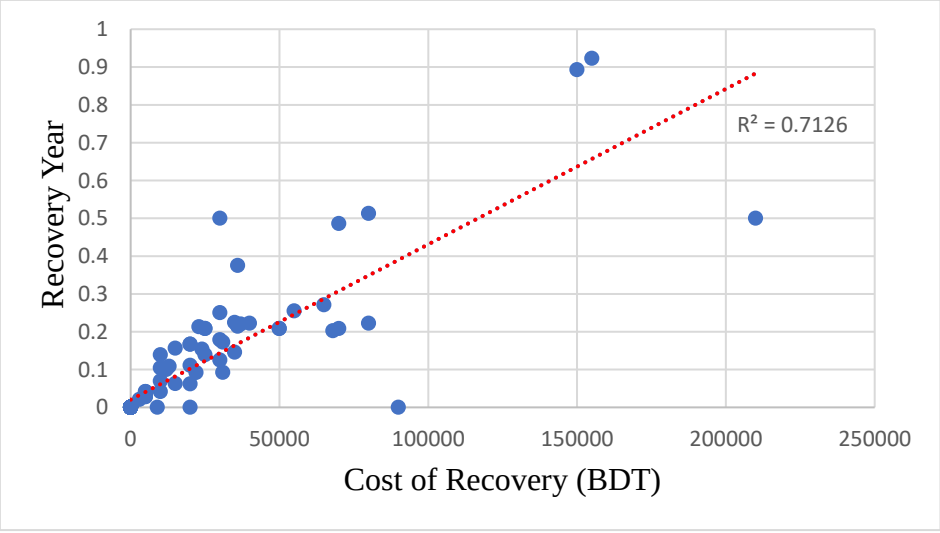

Figure 27: Bulbul affect recovery year and cost

With an R2 value of 0.7126, the cost of recovery can account for roughly 71.26% of the variation in the recovery year. This is a significant amount, but it also suggests that other factors may be at play in the recovery process. Understanding the correlation between cost and time can facilitate more effective planning and resource allocation for rehabilitation endeavors.

4.2.6 Amphan

The scatter plot shows the relationship between the cost of recovery and the recovery Year for coastal Bangladeshis who lost and damaged their assets.

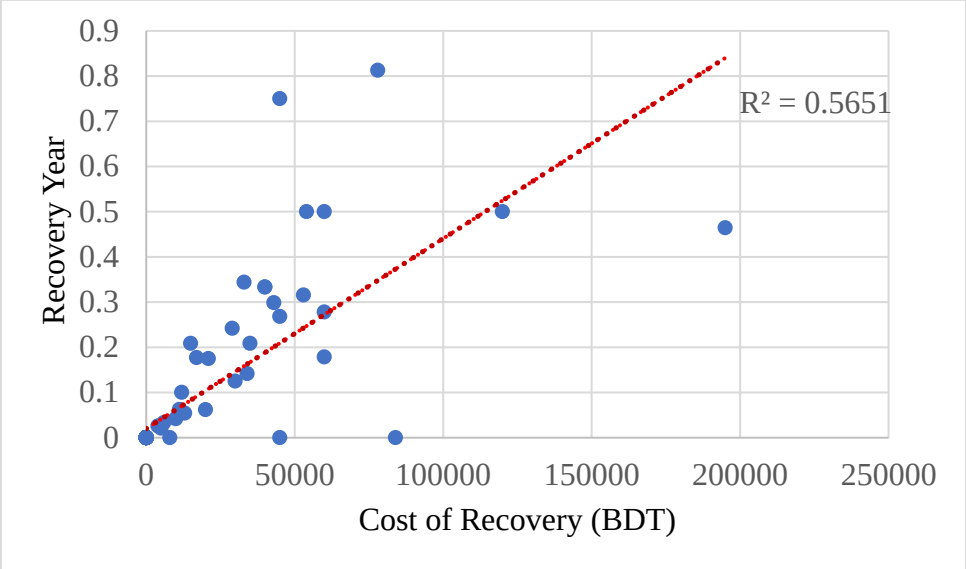

Figure 28: Amphan recovery phase

For an individual in Bangladesh, particularly in the vulnerable coastal areas. It indicates that making up for losses and damages is a major financial hardship that may require some time to complete. A high cost of recovery could mean a long wait before one's livelihood is restored, which could be difficult for someone with limited resources. It also shows that in order to help those impacted by losses and damages in these areas become more resilient and recover, planning and financial support are necessary. This could be accomplished through community support networks, insurance, or government assistance programs that help spread the cost over time and promote a quicker rate of recovery.

Policymakers, non-governmental organizations, and community leaders involved in disaster management and recovery may find this information helpful. It could be used to support the case for more effective resource distribution in the wake of tidal disasters,

to assist the most impacted households, and to improve resilience against similar occurrences in the future.

4.3 Climate data analysis

4.3.1 Temperature and Precipitation

Three lines and one set of bars, each representing different data, describe a coastal area's conditions from 2000 to 2022. A bar chart shows the rainfall data from 2000 to 2022.

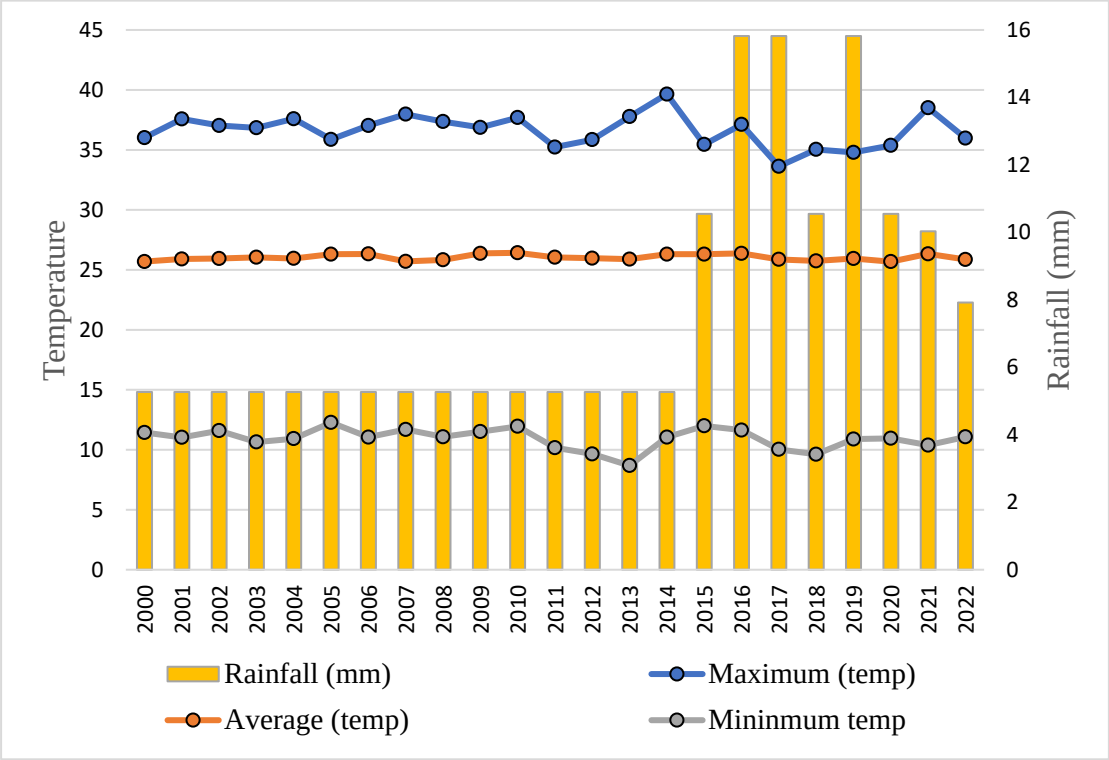

Figure 29: Comparative analysis of rainfall and temperature in the period 2000-2022

The annual rainfall is indicated by the yellow bars. Certain years, like 20015, 2016, and 2019, saw a lot of rain, while other years saw less. It's comparable to an up-and-down rollercoaster.

The lines with various markers show the temperatures, which are given in degrees Celsius (°C). On the left side of the graph is the temperature scale.

The annual maximum temperature is displayed as a blue line with circle markers. It varies slightly but stays between 35°C and slightly over 40°C. The average temperature is shown by the orange line with diamond markers; it varies slightly over time but

typically hovers around 25 to 30 degrees Celsius. The minimum temperature is shown by the black line with square markers, which is continuously between 15°C and 20°C.

4.3.2 Humidity vs Average Temperature.

The bar chart, shows the humidity in (g/kg), clearly shows that humidity is higher from June to September. This could mean that the coastal area is experiencing a rainy or monsoon season. It appears that the months of January and December, which may be drier and colder, have the lowest humidity levels.

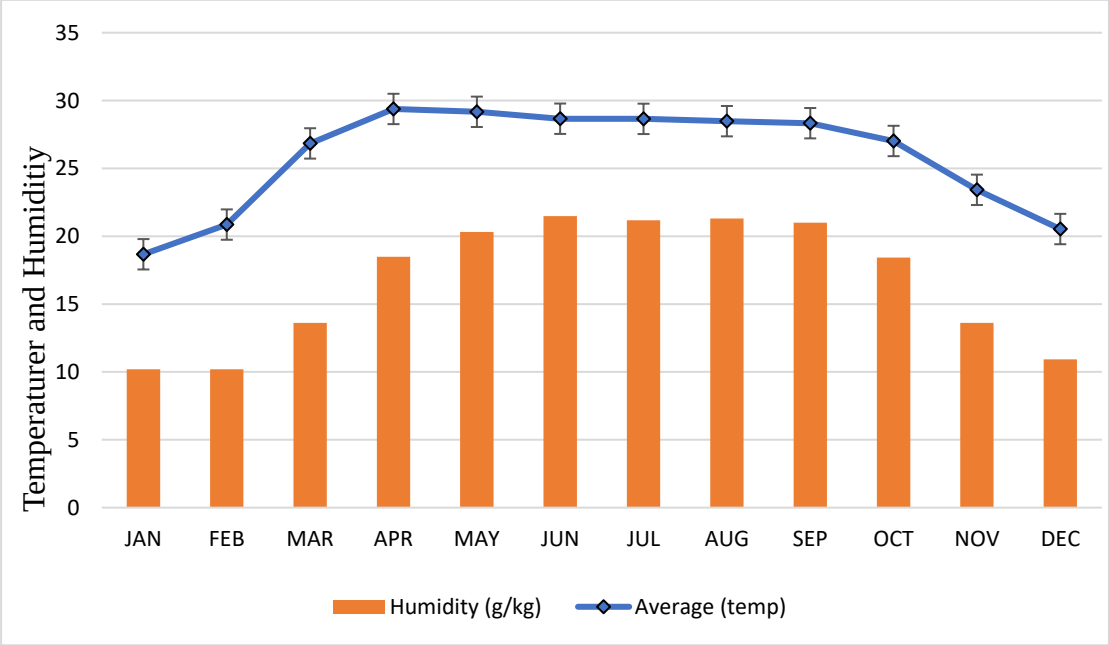

Figure 30: Monthly variation of temp and humidity in 2022

The average temperature (shown as "Average (temp)") in degrees Celsius is displayed on the line graph. A discernible trend indicates that the temperature increases gradually starting in January and peaks around June, coinciding with the onset of increased humidity. These conditions are suggestive of the hot and muggy summers that many places experience. The temperature starts to drop after June, but it stays mostly high until October when it starts to drop more dramatically.

4.3.3

The two line and a set of bar each representing different data, describe a coastal area's conditions from 2000 to 2022. A bar chart shows the Average temperature data from 2000 to 2022.

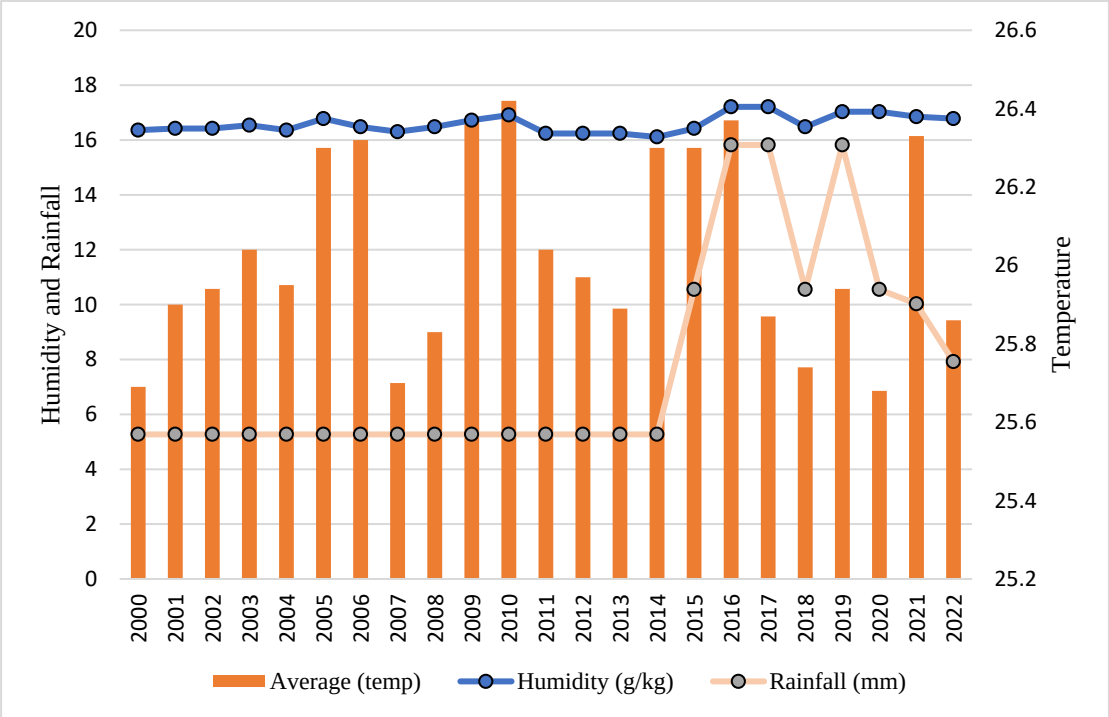

Figure 31: Comparative analysis of temperature, humidity and rainfall in 2000 to 2022

4.4 Local Led Adaptation

Individuals and communities directly impacted by climate change are frequently at the forefront of creating new and effective ways to adapt. Unfortunately, many times, individuals do not have the necessary resources and authority to successfully put them into practice. Locally Led Adaptation (LLA) has the power to unleash, assist, and harness the enormous potential and ingenuity of communities to create and execute solutions. Empowering local stakeholders to guide adaptation efforts can lead to effective, fair, and transparent outcomes without placing the entire burden on them. Bangladesh is one of the most climate vulnerable countries in the world. To address this issue of vulnerability to climate change, it is essential to empower leaders within the local community. Bangladesh boasts a vast coastal region inhabited by 33 million individuals. In order to safeguard these at-risk populations from climate vulnerabilities, it is essential to create an adaptation plan in collaboration with them. During the LLA

process, local communities have the authority to determine the implementation details, including what, how, and by whom it will be carried out. When pursuing LLA, it is essential to actively support the leadership, inclusivity, and agency of local actors at various stages of an intervention's design and implementation. Furthermore, local expertise and skills are integrated into the decision-making process, while diverse involvement helps prevent redundancy, ultimately enhancing efficiency and decreasing reliance on vulnerable systems.

4.4.1 Major findings of LLA

The primary outcome of this study is to determine what problems are faced by local people due to climate change. How do they deal with these problems? Whether there has been any specific change in land use and cover in their area over a decade. Whether they prefer an adaptation strategy to reduce the impact of climate change. Moreover, when there is a natural disaster, it will be helpful for people to give leads.

4.4.2 Changes in climate patterns over the last decade

Table 9: changes in climate patterns over the last decade.

Stage of Categories	**Number of Participants**	**Percentage of the Participants**
Low change	2	0.5%
Moderate Change	179	44.5%
Significant Change	217	54.0%
Extreme Change	4	1.0%

Only 0.5% of individuals saw low change. It shows that most people have noticed climate change. Moderate Change (44.5%): Nearly half of participants report moderate climate change. This large percentage shows that these participants have seen changes but do not find them worrying. Significant Change (54.0%). Over half the sample considers changes significant. The general view is that climate change is a big issue, but they do not consider it as extreme.

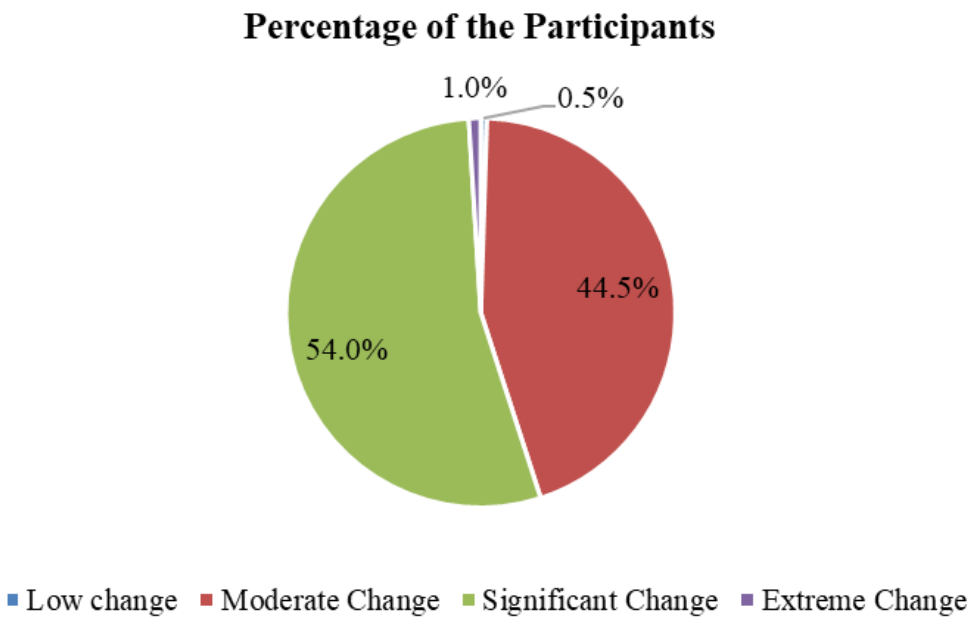

Figure 32: Changes in climate patterns over the last decade in percentage.

dramatic Change (1.0%). Few people consider changes dramatic. This suggests that while participants perceive changes, they may not yet view them as catastrophic or have enough evidence to define them as excessive.

Participants agree that change is happening 99% put it above the lowest category. The perspective leans toward 'Significant Change' rather than 'Extreme Change,' suggesting that climate patterns are changing but can be mitigated or adapted before they become disastrous. The research suggests that climate change perceptions are serious, which may reflect participants' local climate change experiences. The majority rank the changes as important but not excessive, suggesting that adaptation measures can be implemented before they become irreversible or highly damaging.

This data can show environmental planners that the public is concerned about climate change, which may increase support for local adaptation efforts. Data suggests that education and communication methods to enlighten the public about climate change's extent and effects may increase community engagement in adaption strategies.

4.4.3 Climate change impact on LULC over 20 years

Table 10 displays Climate change affects LULC over 20 years.

Table 10: climate change impact on LULC

Climate change impact on LULC over 20 years	Number of the Participants	Percentage of the Participants
Agricultural	214	53.23%
Construction	1	0.25%
House	8	1.99%
No	15	3.73%
Land lost	164	40.80%

Six major disasters happen in the study area over the course of 20 years. Because of those disasters, the people who live in this area have to deal with a lot of problems, such as LULC changes. The most people in this area (53.23%) face impacted in agriculture. 40.80% people of this area face impacted in land lost. Together, construction, house, and no impact had an effect of about 5%.

Figure 33: Discuss LLA with the UP Chairman

4.4.4 Disaster faced due to climate change

Disaster is frequently occurred on polder 45 in Barguna district. Table 1 illustrated percentage of people faced disaster due to climate change

Table 11: Disaster faced due to climate change

Diester	Number of the Participants	Percentage of the Participants
Cyclone	138	34.33%
Flood	86	21.39%
saline water intrusion	177	44.03%
Others	1	0.25%

The impact of climate change on the lives of local people is significant. 44.03% of individuals experienced saline water intrusion as a result of changes in the environment. Approximately 34.33% of the population experienced cyclones as a result of changes in the climate.

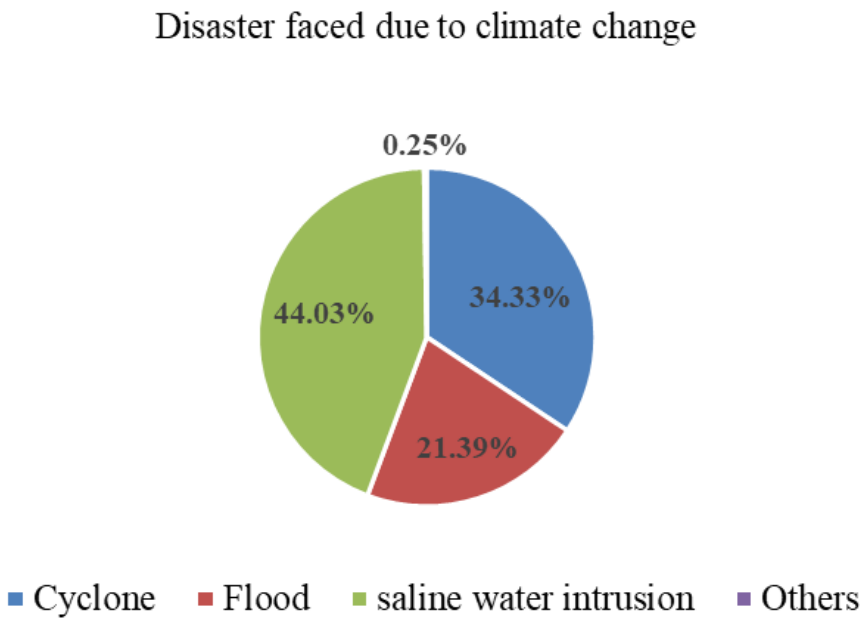

Figure 34: Disaster faced due to climate change

Approximately 21.39% of the population experienced flood intrusion, Finally, only 0.025% of the population experienced and acknowledged other disasters caused by changes in the climate.

4.4.5 Adaptation strategies

According to the data, participants have shown preferences for three adaptation strategies. alternative farming practices, high-rise houses, and water harvesting.

Table 12: Adaptation strategies

Prefer adaptation strategies	Number of the Participants	Percentage of the Participants
Building Raised House	316	78.61%
Water harvesting	71	17.66%
Alternative farming practice	15	3.73%

people of the study area are mostly taken 3 major adaption strategy to combated climate change impact. Most of the people (78.61 %) taken a most popular and effective adaption strategy that is Building Raised House. If there are raised houses, they can be sheltered when flood happen. People are scared when they have mud or friable house. Another adaption strategy taken by local people is Water harvesting and 17.66% people practice this strategy. Saline water intrusion is the most vital problem of this area. In farming season due to high salinity in water, farmer can't use high salinity water. Some individual harvest fresh water in the lake. And Farmers is bought fresh water from those individuals from irrigation proposed. There are few farmers taken Alternative farming practice strategy. Result shows farmer is sticking their traditional farming practice.

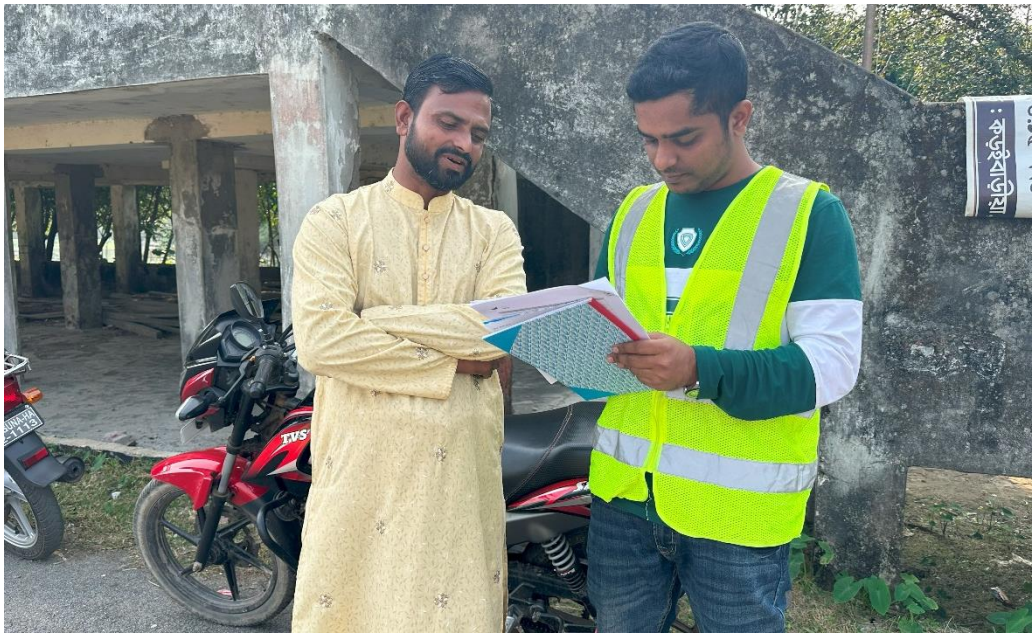

Figure 35: Discuss about LLA with UP Member

4.4.6 Organization's role in combating climate change impact

This data table provides various organizations who lead when any kind of disaster takes place.

Table 13: Organization's role in combating climate change impact

Lead in Dealing with Climate Change	Number of the Participants	Percentage of the Participants
Red Crescent	368	91.54%
Local Government	11	2.74%
Own community	18	4.48%
NGO	5	1.24%

Red Crescents is the most active and dedicated organization who work in the costrel area for the costrel propel. Bangladesh Red Crescent Society (BDRCS), along with the International Federation of Red Cross and Red Crescent Societies (IFRC) and Participating National Societies (PNSs) in the country, has monitored the situation from the start and coordinated closely with the Government of Bangladesh (GoB), especially

the Ministry of Disaster Management and Relief (MoDMR), and other stakeholders at national and local levels, including Anticipatory Actions platform (Tozier de la Poterie et al., 2023).

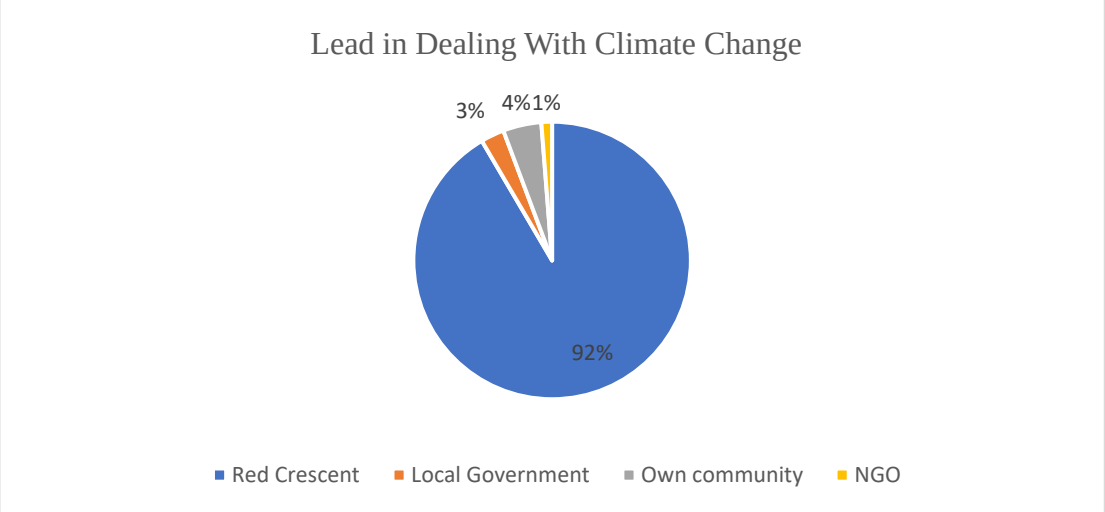

Figure 36: Organization's role in combating climate change impact

Among four organization Red Crescent most taking action to reduce climate change impact of the study area. RCS contribute 91.54% lead to combated climate change impact. The study area's people strongly recommend, the local people believe red crescent most effetely manage after and disaster situation they demand if RCS when disaster occurred manage the situation.

Small percentage of people (4.48%) participant believe that there won community manage the whole situation after and before disaster.

Only Few people trust Local Government able to manage the led in climate change mitigation and adaptation strategy.

Non-governmental organizations (NGOs) are seen by the least number of participants as leading in the fight against climate change.

Figure 37: Discuss about LLA with locals

4.4.7 LLA Respondent List

Table 14: Respondent list for LLA

Name	Occupation
Imtiaz Hossain Rasel	LGED Engineer
MD Alomgir Miya	UP Chairman
Mawlana anwar hossain	UP Member
Safiq Hossain	Red Crescent Representative
Topu Ghos	Bazar Sobapoti
Samiya Begum	Red Crescent Representative
Salauddin Maji	Fish Boat owner
Mohammad Ibrahim	Imam of Mosque
Md Jahangir Alom	Headmaster of Primary School
Monir	Fisherman
Sumon Bissas	Fisherman
Md miraj molla	Political leader

MD mosharaf	Doctor
Md Chan Mia	Senior Citizen
Md Faruk sordar	Senior Citizen
Ali Mohammad foraji	UP Member
Sultan ahmed	UP Member
Anwar khan	UP Member
Abdul Salam	Local leader
Maksud Miya	Business man

4.5 LULC

The rapid use of natural resources has led to the continuous development of human civilization and changes in global land surfaces. LULC is essential to look into patterns of land use and assist in predicting future sustainable land management. The study area resembles to a newly formed and rapidly reducing waterbody in Bangladesh's one of the district named Barguna, and it’s polder area numbered 45. With Arc GIS 10.8, the Landsat 5, 7, and 9 images have been used to detect the change over the last 20 years. There was a 58.34% decrease in the water body between year 2003 and 2013. From year 2013 to 2023, this change remained the same. However, with an additional decrease of nearly 19.89% in year 2013 to 2023.

The table is represented in acres for various features—including water, vegetation/forest, agricultural land, settlement, and bare land. During the years 2003, 2013, and 2023 illustrates the changes that have occurred in the landscape.

Table: LULC change from 2003 to 2023

Change dictation (Acres)			
Feature	**2023**	**2013**	**2003**
Water	356.60	445.13	1068.38
Vegetation/Forest	3173.14	3119.00	2528.28
Agricultural Land	7249.62	7169.34	6074.27
Settlement	893.08	520.23	422.31
Bare Land	6.12	424.76	1585.25

Over the decade from 2003 to 2023, these data shows a trend of declining water bodies and rising agricultural land and vegetation. This is the result of imbalanced land uses in coastal regions brought by human activities like agriculture and building infrastructures. Natural phenomenon influencing these alterations include sedimentation and modifications to water bodies.

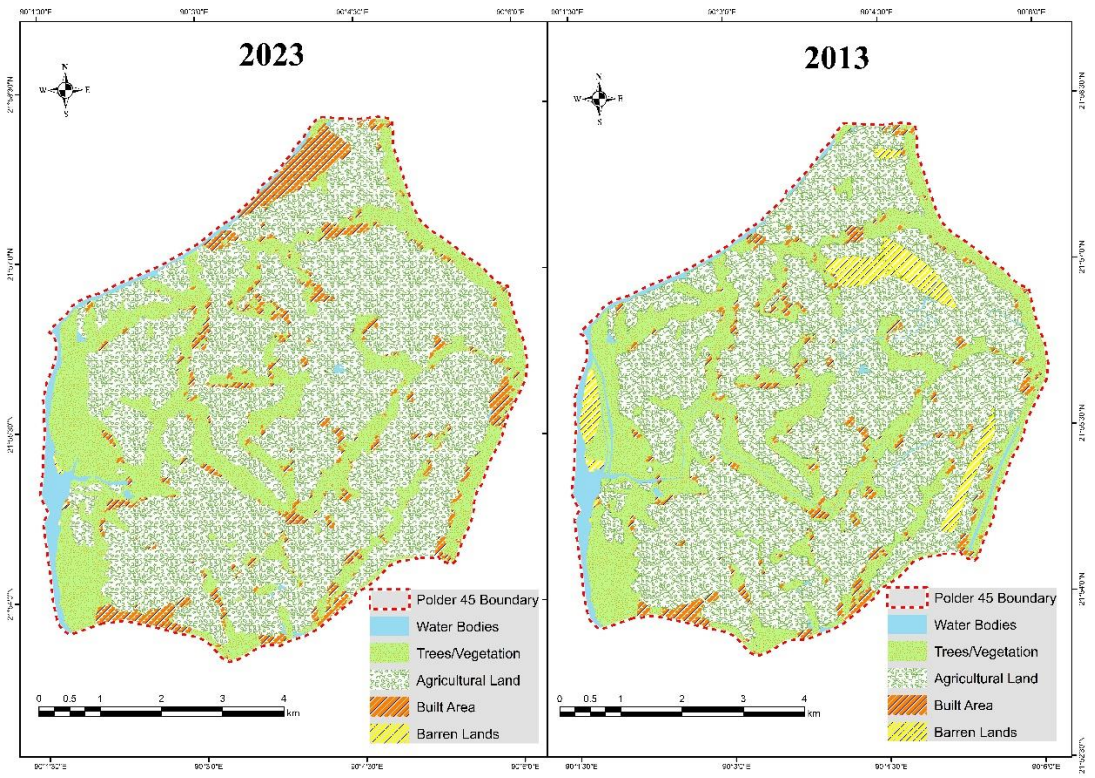

Figure 38: LULC 2013 to 2023 Map

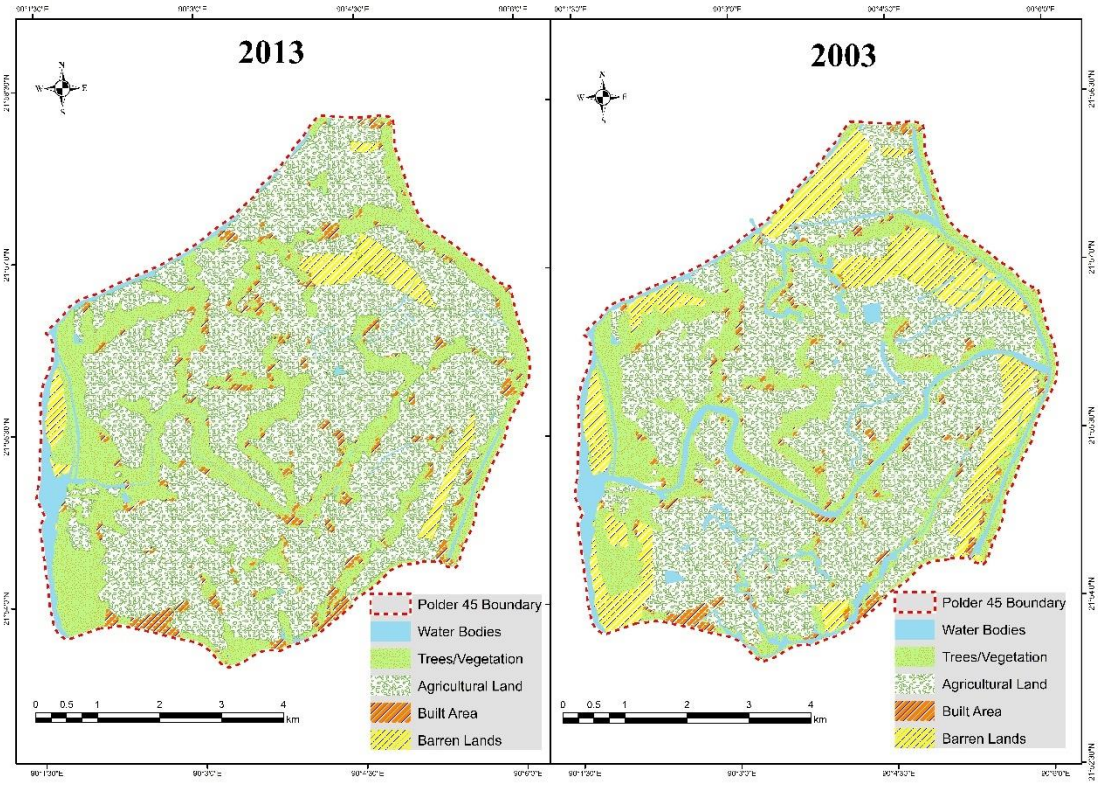

Figure 39: LULC 2003 to 2013 Map

In year 2003,2013 & 2023 the LULC map showing clearly how much of canals and waterbody has been reduced. Canals that were alive in year 2003, has been completely died in year 2023 as per my study analysis. In year 2003 the waterbody was about 1068.38 Acre and which then reduced to 445.13 Acre on the year 2023, similarly in year 2023 the waterbody has been into a drastic reduction which led it to 356.60 Acre.

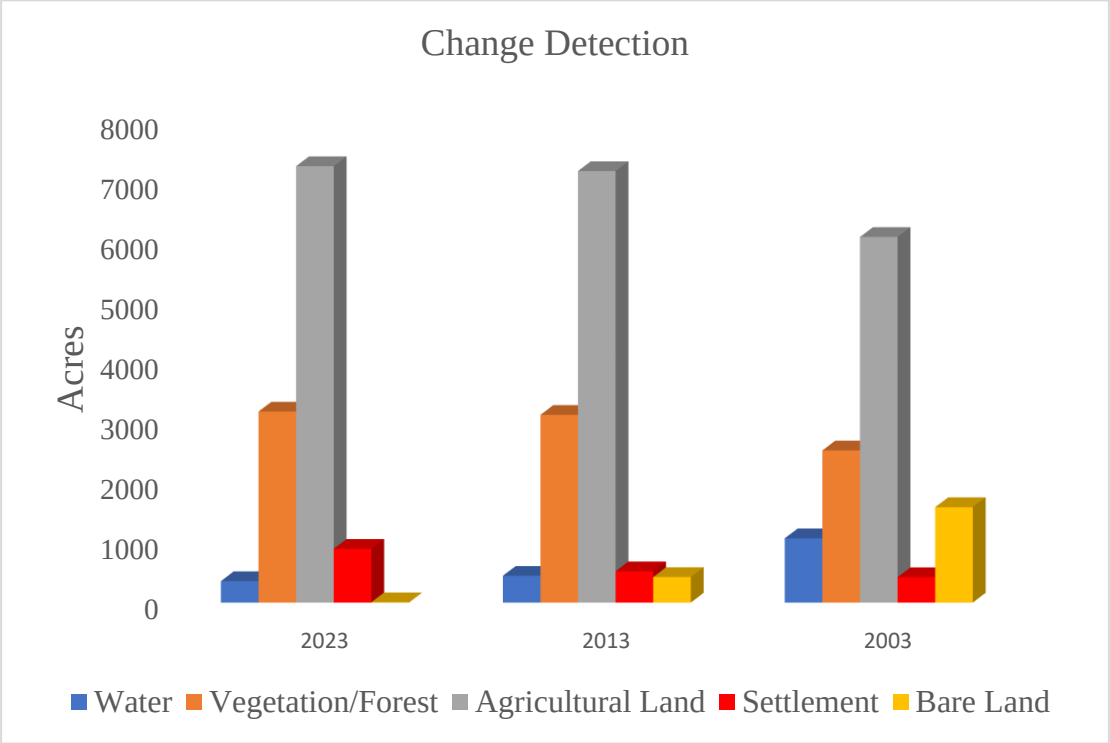

Figure 40: Change dictation 2003, 2013, 2023

After my survey on the study area the main reason that arose in front as the main reason for canal death is human activity, such as in month of June-July the canals were obstructed by the locals to bring down the salt water intrusion. The reason is simple as the waters from sea flow through the canals and sediments to agricultural field however that has a huge impact on the crop production. Another reason is, on the monsoon season the locals doesn't bring down the obstruction of canals which led to lessen the water flow. Another cause of the canal death altered by local leaders for their own commercial benefit as they do prawn farming by obstructing the canals.

As we know during the flood, the coastal areas are impacted really fast, thus any upcoming flood may take turn into a disaster as the canals were shut down and the waters won't be discharged easily and may be turn into a loss and damage scenario.

For this reason, policymakers, local community, local leaders should take appropriate steps to make the canals live again and if that's not happening then any upcoming flood may take longer to revive which will be an immense reason of loss and damage.

4.5.1 Accuracy assessment

Table 15: Accuracy assessment of polder-45 of Bangladesh on 2003 map

Detected study area Accuracy Assessment 2003						
	Water Body	Vegetation	Agricultural land	Build up	Barren land	Total (USER)
Water Body	18	2	0	0	0	20
Vegetation	0	20	0	0	0	20
Agricultural Land	0	1	18	0	1	20
Build-up	0	0	0	20	0	20
Barren land	0	0	1	2	17	20
Total (Producer)	19	22	19	21	19	100

Overall accuracy 93%.

Table 16: Accuracy assessment of polder-45 of Bangladesh on 2013 map

Detected study area Accuracy Assessment 2013						
	Water Body	Vegetation	Agricultural land	Build up	Barren land	Total (USER)
Water Body	19	1	0	0	0	20
Vegetation	0	18	2	0	0	20
Agricultural Land	0	1	19	1	0	20
Build-up	0	1	0	19	0	20
Barren land	0	2	1	0	17	20
Total (Producer)	19	23	22	20	17	100

Overall accuracy= 92%

Table 17: Accuracy assessment of polder-45 of Bangladesh on 2023 map

Detected study area Accuracy Assessment 2013						
	Water Body	Vegetation	Agricultural land	Build up	Barren land	Total (USER)
Water Body	17	0	3	0	0	20
Vegetation	0	16	2	0	2	20
Agricultural Land	0	1	17	1	3	20
Build-up	0	2	0	18	0	20
Barren land	1	1	1	0	17	20
Total (Producer)	19	23	22	20	17	100

Overall accuracy = 85 %

CHAPTER 5: CONCLUSION AND RECOMMENDATION

At the conclusion of this chapter, the literature review, data collection, analysis, results, and discussions were summarized. Furthermore, an effort was made to provide a rationale for the study objectives. Further suggestions are offered to aid researchers in enhancing their comprehension of upcoming research.

5.1 Overview

Climate change loss and Damage is a significant global issue, including in Bangladesh. loss and damage fund and LLA are a widely recognized and sustainable salutation for reduced climate change effects. For this study, we have analysis Statistically assessed socioeconomical loss and damage and local lead adaptation. The study examined land use and cover with ArcGIS. From 2007 to 2020, six major climatic disasters occurred, costing respondents 34.826 million takas. The average individual loss and damage is 0.355 million takas. Locals built raised houses, harvested water, and changed their farming methods to combat this climatic disaster. 78.61% used Building Raised House. However, only 3.73% used alternative farming.

5.2 Conclusion

The main conclusions from the study are as follows:

- Between 2007 and 2020, a total of six significant climate-related disasters took place, resulting in a total loss and damage of 34.826 million takas according to the study. The average individual loss and damage amount to 0.355 million takas.
- Six major disasters occurred in the study area over 20 years. Because of those disasters, locals face many issues, including LULC changes. Most people (53.23%) are affected by agriculture. 40.80% of residents lost land. No impact, construction, and house had a 5% effect.
- Red Crescent must take action to reduce the climate change impact of the study area. RCS contributes 91.54% leading to combated climate change impact.
- This study has taken 3 major climate change adaptation strategies. Most people (78.61%) use Building Raised House, a popular and effective adaptation

strategy. Water harvesting and alternative farming 17.66% and 3.73% people practice this strategy.

5.3 Recommendation

- Improve community education regarding climate change impacts and adaptation strategies.
- Increase accessibility to alternative and climate-resilient agricultural practices.
- Enhance investment in infrastructure for water collection and retention.
- Promote the implementation of raised homes in regions at risk of flooding.
- Support community-driven climate adaptation planning and execution.
- Enhance early warning systems and disaster preparedness initiatives.
- Encourage expanding income sources to lessen susceptibility to climate-related incidents.
- This information might be useful for policy-makers, NGOs, and community leaders who are engaged in disaster management and recovery.

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APPENDIX I

ANNEXURES 01: Sample Question for Loss and Damage

ANNEXURES 01: SAMPLER QUESTIONS

Polder NO_____

Recode your current location

GPS location of the respondent's

Latitude (x.y)_____

Longitude (x.y)_____

Altitide(m)_____

Village name_____ Union name_____

Upazila name_____ District name _____

Name of respondent_____ _____

Mobile Number_____ Age_____

1 | P a g e

Main income sources of the household-

Total monthly income of the household

- No income
- 0-5000
- 5001-10000
- 10001-15000
- 15001-20000
- 20001-30000
- 30001-40000
- 40001-60000
- 60001- above

Is the respondent receive any flood early warning?

- Yes
- No
- If yes then lead -time?

Total asset value of the Household

Lands (amount in BDT)_____

Pond (amount in BDT)_____

Household assets (amount in BDT)_____

Cattle (amount in BDT) _____

Poultry (amount in BDT)_____

Others (amount in BDT)_____

Flood duration (days)_____

Water depth (m)_____

Size of house_____

Total damage of house (taka)

_____

Cost of repair of house (taka)

_____

Market value of the house

(taka)_____

Total agricultural lands (acres)

_____

Total crop

damage_____

Total pond area damage

(acres)_____

Total fish damage

(taka)_____

Total damage of cattle/

poultry_____

Total damage of others household

assets_____

Cast of the buy drinking

water_____

Flood (Aila, May 2009) Information with damages of the household

Flood duration (days)

_____

Water depth (m)

_____

Type of house

_____

Size of house (sqm)

_____

Total damages of house (taka)

Cost of repair of house (taka)

Market value of the house (taka)

Total agricultural lands (acres)

Total crop damage

Total pond area damage (acres)

Total fish damage

Total damage of cattle/poultry

Total damage of other household assets

Costs to buy drinking water

Flood (Heavy Rainfall 2010) information with damages of the household

Flood duration (days)

Water depth (m)

Type of house

Size of house (sqm)

Total damages of house (taka)

Cost of repair of house (taka)

Market value of the house (taka)

Total agricultural lands (acres)

Total crops damage

Total pond area damage (acres)

Total fish damage

Total damage of cattle/poultry

Total damage of other household assets

Costs to buy drinking water

Flood (Tidal affect, 2012) information with damages of the household

Flood duration (days)

Water depth (m)

Type of house

Size of house (sqm)

Total damages of house (taka)

Cost of repair of house (taka)

Market value of the house (taka)

Total agricultural lands (acres)

Total crops damage

Total pond area damage (acres)

Total fish damage

Total damage of cattle/poultry

Total damage of other household assets

Costs to buy drinking water

Flood (Bulbul, Nov 2019) information with damages of the household

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Flood duration (days)

Water depth (m)

Type of house

Size of house (sqm)

Total damages of house (taka)

Cost of repair of house (taka)

Market value of the house (taka)

Total agricultural lands (acres)

Total crops damage

Total pond area damage (acres)

Total fish damage

Total damage of cattle/poultry

Total damage of other household assets

Costs to buy drinking water

Flood (Amphan, May 2020) information with damages of the household

Flood duration (days)

Water depth (m)

Type of house

Size of house (sqm)

Total damages of house (taka)

Cost of repair of house (taka)

Market value of the house (taka)

Total agricultural lands (acres)

Total crops damage

Total pond area damage (acres)

Total fish damage

Total damage of cattle/poultry

Total damage of other household assets

Costs to buy drinking water

Surveyor Name

Remarks

ANNEXURES 02: Sample Question for LLA

Question

Latitude_____ Longitude_____

Village name_____ Union name_____

Upazila name_____

Name of the respondent_____

Mobile number_____ Age_____

1. **How long have you lived in this area?**_____

2. **On a scale from 1-10, how would you rate the changes in climate patterns over the last decade? (1 being no change and 10 being extreme change)**_____

3. **Have you noticed any specific changes in the land use and cover in your area over the past years? If it is yes then**

   a) River bank erosion

   b) House

   c) Construction

   d) Agricultural

   e) Business

   f) Others ----------

4. What difficulties do you meet because of climate change?

    a) Flood

    b) Cyclone

    c) Drought

    d) Saline water intrusion

    e) Others_____

5. Which of the following adaptation strategies would you prefer?

    (List potential strategies)

    a) building raised houses.

    b) water harvesting.

    c) alternative farming practices.

    d) Others_____

6. Do you believe it's better when local communities take the lead in dealing with climate change, rather than outsiders telling them what to do? Why do you think so or why not?

    Yes or No. If yes,

    a) NGO

    b) Local Government

    c) Own community

    d) Red Crescent

7. What natural resources, like
    a) water sources
    b) Farmland,
    c) Others important to the health and survival of your community? How has climate change changed these resources?

_____

_____

8. Are there any good examples or lessons learned from nearby communities or regions that yours could use to learn how to adapt to climate change?

_____

_____

_____

ANNEXURES 03: Survey Picture