INVESTIGATION OF RIVERBANK EROSION TOWARDS MIGRATION PATTERN IN KAZIPUR UPAZILA, SIRAJGONJ AREA

BY

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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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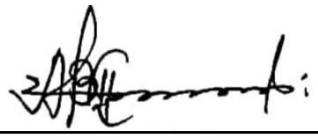
APPROVAL

This thesis report titled **"Investigation of riverbank erosion towards migration pattern in Kazipur upazila, Sirajganj area",** submitted by Mahmud Sadiq 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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DECLARATION

I hereby declare that this research project has been done by me under the supervision of **Dr. A.B.M. Kamal Pasha Ph.D., Professor and Head, Department of Environmental Science and Disaster Management (ESDM),** Daffodil International University (DIU). I 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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DEDICATION

TO,

"My loving parents"

Md. Salim Hossain

&

Mahbuba Sultana

My respected teachers

Dr. A. B. M. Kamal Pasha

Dr. Mahfuza Parveen

Md. Azharul Haque Chowdhury

and

In loving memory of my cherished classmate, seniors, juniors, coordination officers, and staff members from ***the Department of***

Environmental Science and Disaster Management (ESDM) at Daffodil International University (DIU) *with whom I shared every moment of my undergraduate journey from 1st January, 2020, to March 10, 2024*

ABSTRACT

Worldwide, communities who live near riverbanks face a serious threat from riverbank erosion, which can cause migration and displacement patterns that have a substantial influence on both environmental sustainability and socioeconomic dynamics. In the Kazipur Upazila of Sirajganj District, Bangladesh, this thesis focuses on the Jamuna River and examines the connection between riverbank degradation and migration trends. Over time, significant erosion has occurred in the Jamuna River, a significant tributary of the Brahmaputra River, causing many homes to be uprooted and livelihoods to be disrupted. In order to determine the amount and geographical distribution of riverbank erosion along the Jamuna River, this study uses a mixed-methods approach that includes remote sensing analysis, geographic information system (GIS) mapping, and qualitative interviews. Qualitative interviews shed light on the socioeconomic effects of migration and displacement brought on by erosion, while remote sensing data and GIS methods are utilized to examine historical changes in riverbank morphology and land cover. The findings reveal a complex relationship between riverbank erosion and migration patterns in the study area. Analysis of remote sensing data indicates significant erosion along the Jamuna River, leading to the loss of agricultural land, homesteads, and infrastructure. Qualitative interviews with affected communities shed light on the socio-economic consequences of displacement, including loss of livelihoods, increased vulnerability to poverty, and challenges in accessing essential services. Furthermore, this study examines the coping strategies adopted by affected communities in response to riverbank erosion, such as temporary resettlement, livelihood diversification, and reliance on social networks. The research also explores the role of government policies and interventions in addressing the challenges posed by riverbank erosion and supporting affected populations. This thesis advances knowledge of the socioeconomic effects of environmental change in riverine areas by clarifying the relationship between riverbank erosion and migration dynamics. In order to lessen the effects of riverbank erosion and promote sustainable development in susceptible areas like Kazipur Upazila, Sirajganj, the findings have implications for disaster risk reduction, policy creation, and community resilience-building initiatives.

Keywords: Riverbank erosion, Migration Pattern, Displacement, GIS, Sustainable development, Community resilience, Climate change.

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CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

In Bangladesh, riverbank erosion is a dangerous hazard that causes permanent displacement and impoverishment of people. The majority of Bangladesh's northern region is covered by the flood plain of the Jamuna River. Human habitation and activities are severely disrupted by irregular flooding and abrupt changes in riverbank elevation. By counting the number of people displaced and analyzing the frequency of riverbank erosion in a specific area of the Jamuna river floodplain, this study illustrates the extent of the problem. Rivers are dynamic systems because they alter course frequently. Erosion and accumulation are normal parts of the natural process. Even when erosion can occasionally outpace accretion and ruin lives and livelihoods, the impoverished typically suffer the most. (Mollah & Ferdaush, 2015)

Riverbank erosion is a result of both natural processes and human activity. Beneficial results from the natural erosion of riverbanks include the creation of alluvial terraces and productive floodplains. Erosion can occur in stable rivers as well, but unstable rivers and erosion that occurs on either bank beyond typical range are major concerns. One of the most pressing global challenges at the moment is environmental migrants. Bangladesh, a country with many rivers, is experiencing catastrophic riverbank erosion that is forcing millions of people to leave their homes. As a result, Bangladesh's 2400 kilometers of riverbank line, 85 cities and growth hubs, and 283 places are susceptible to erosion (Islam & Rashid, 2011)

1.1.2.: MIGRATION FOR RIVERBANK EROSION

Since the beginning of human civilization, migration has played a major role in human history as people have moved in pursuit of food, housing, or more civilized living conditions.

Human migration, whether forced or not, is the most important effect of climate change in the present and the future decades. Large-scale population movement may be caused by environmental deterioration and climate change, which the world is now ill-equipped to prevent or effectively manage. The global mass of migrants is increasing due to both climatic and non-climatic factors. (Piguet et al., 2011)

When it comes to climate drivers, factors including rising sea levels, salinization of agricultural land, erosion of riverbanks, population migration, rural vulnerability in Bangladesh, desertification, and increased water scarcity, as well as climate extremes like storms and flooding, are pushing people to migrate. However, non-climate factors like population expansion and community preparedness for natural disasters have a significant role in government policy. The magnitude of the disasters and the social and economic capacity of the affected communities to deal with them, however, determine the rate of migration and population. (Islam & Rashid, 2011)

1.1.3.: CLIMATE CHANGE AND RURAL VULNERABILITY

The migration that has been brought about by climate change in Bangladesh, where a number of institutional, political, social, and economic forces work together to cause natural calamities like floods, salinization, droughts, and river erosion to force people from their homes. Both permanent and transient migration happens.

When people have no other means of surviving in a certain location for example, when they lose their land and settlements to river erosion and tidal surges permanent migration takes place. Natural disasters in Bangladesh cause a significant number of people to be uprooted from their homes and forced to migrate, both temporarily and permanently, on a yearly basis.

When the floods of 2005 permanently submerged Bhola Island, around 500,000 residents were forced to flee (Saifuzzaman & Alam, 2006). Furthermore, the recurrence of powerful cyclones such as Sidr in 2007 and Aila in 2009 could serve as a warning sign for an increasingly frequent and severe climate disaster.

However, there is still a lack of public knowledge of climate change and a lack of agreement among the parties involved regarding its presence, its forms, the number of environmental displacements it has caused, and its effects on the environment. (Rhodes, 2008)

1.2. PROBLEM STATEMENT

Riverbank erosion, measured in terms of its magnitude and spatial distribution: A complete study of the magnitude and spatial distribution of riverbank erosion along the Jamuna River in Kazipur Upazila is required to be carried out as part of this component. It is necessary to collect information on the rates of erosion that have occurred in the past, analyse satellite imagery or aerial photography in order to map areas of high erosion, and make use of Geographic Information

Systems (GIS) in order to visualise and quantify the areas that have been damaged. In addition, field studies could be required in order to corroborate the data obtained from remote sensing and evaluate the effects of erosion at the ground level.

Possible Repercussions for Human Settlements and Ways of Life: Conducting surveys and interviews with communities that have been impacted by riverbank erosion in order to chronicle their experiences is necessary in order to gain an understanding of the socio-economic implications that riverbank erosion has on human settlements and livelihoods. Among the most important issues that need to be investigated are the following: the loss of homes, agricultural land, and infrastructure; changes in access to essential services such as education and healthcare; disruptions to livelihood activities such as agriculture, fishing, and small-scale businesses; and the socio-psychological effects of displacement and loss.

Characteristics of Migration and Methods of Coping: In order to investigate migratory patterns that are the result of riverbank erosion, it is necessary to conduct household surveys, analyse demographic data, and engage in qualitative interviews with both migrants and non-migrants. The purpose of this study is to investigate the elements that influence migration decisions. These factors include push and pull forces, such as displacement caused by erosion, economic possibilities, social networks, and policies implemented by the government. In addition to this, it entails determining the coping methods that impacted communities have chosen, such as the utilisation of informal support networks, the diversification of livelihoods, the implementation of community-based adaptation projects, and the temporary relocation of affected communities.

Responses at the Institutional and Policy Level: The process of evaluating the efficiency of the policies and institutional mechanisms that are now in place comprises doing a study of the pertinent legislation, policies, and programmes that are associated with disaster risk management, riverbank erosion mitigation, and support for communities that have been displaced. This study should find gaps, inconsistencies, and hurdles to implementation in policy frameworks and institutional arrangements at the local, national, and international levels. For example, this analysis should identify weaknesses in policy frameworks. As part of this process, it is also necessary to assess the role that government agencies, non-governmental organisations, community-based organisations, and other stakeholders play in addressing the difficulties that are brought about by riverbank erosion and providing assistance to communities that are impacted by it.

Measures to Adapt to Climate Change: In order to investigate the connections between riverbank erosion, climate change, and migratory patterns, it is necessary to incorporate climate science, hydrological modelling, and vulnerability assessments into the research framework. This involves analysing climate data in order to identify trends and projections in precipitation patterns, river discharge, and extreme weather events that have the potential to exacerbate riverbank erosion. The assessment of the adaptive capacity of communities, the identification of barriers to adaptation, and the development of strategies to enhance resilience to future environmental shocks are also included in this process. These strategies include early warning systems, nature-based solutions, community-based adaptation initiatives, and capacity-building programmes.

1.3. SIGNIFICANCE

Impact on Humanitarians: There are major humanitarian consequences associated with riverbank erosion along the Jamuna River in Kazipur Upazila, Sirajganj, Bangladesh. Identification of vulnerable populations and the creation of efficient disaster response plans depend on an understanding of the connection between migration patterns and riverbank erosion.

Consequences for society and economy: Communities impacted by riverbank erosion frequently experience greater susceptibility to poverty, job loss, and displacement. Examining the migratory patterns brought on by erosion of riverbanks informs targeted measures to assist impacted populations and offers insights into the socio-economic effects of environmental change.

Environmental Sustainability: Loss of agricultural land, destruction of habitats, and alterations to river shape are only a few of the environmental effects of riverbank erosion that also have an impact on human populations. Sustainable land management techniques are informed and ecosystem resilience is better understood by looking at the dynamics of riverbank erosion.

Implications for Policy and Planning: The investigation's conclusions can guide the creation of policies and planning procedures meant to lessen the effects of riverbank erosion and foster community resilience. Planning for infrastructure development, catastrophe risk reduction, and land use requires an understanding of the movement patterns brought on by riverbank erosion.

Adaptation to climatic Change: Future riverbank erosion is expected to worsen due to rising climatic variability and extreme weather events. Enhancing early warning systems, identifying high-risk locations, and encouraging adaptive livelihood alternatives are just a few of the ways

that studying the connection between riverbank erosion and migration patterns might help with climate change adaptation efforts.

Regional and Global Significance: The research region, situated beside the Jamuna River in Bangladesh, serves as a microcosm of the wider issues raised by erosion of riverbanks in riverine societies across the globe. The investigation's conclusions have effects on Kazipur Upazila's local residents as well as similar riverine regions around the world that deal with comparable environmental issues.

Interdisciplinary Approach: An interdisciplinary approach that incorporates knowledge from development studies, geography, social science, and environmental science is necessary to investigate riverbank erosion and migratory trends. An all-encompassing grasp of the intricate relationships between environmental change, human migration, and socioeconomic dynamics is made possible by this interdisciplinary viewpoint.

Enhancing Community Resilience: The study can help communities affected by riverbank erosion by providing insight into the coping mechanisms they have used. Promoting sustainable development and lowering susceptibility to upcoming environmental shocks require an understanding of communities' adaptive capacity and the elements that make them resilient.

In conclusion, because riverbank erosion has global, policy, socioeconomic, environmental, and humanitarian ramifications, it is important to look into how it affects migration patterns in Kazipur Upazila, Sirajganj, Bangladesh. The results hold promise for informing focused actions, bolstering community resilience, and supporting sustainable development initiatives in riverine regions confronting comparable issues across the globe.

1.4. OBJECTIVES

- To detect Spatio temporal changes in kazipur upazilla, Sirajgonj area, Bangladesh
- To identify changes in Migration pattern in kazipur upazilla, Sirajgonj area, Bangladesh

CHAPTER 2: LITERATURE REVIEW

The northern region of Bangladesh is extremely prone to many natural disasters such as floods, cyclones, riverbank erosion, and landslides as documented by (Ali, 1996, 1999; Dewan, 2015; Mirza, 2003). Climate change, namely global warming, is expected to worsen these disasters by raising the likelihood and strength of floods and cyclones (Ali, 1999; Mirza, 2003).

The disasters have substantial repercussions, leading to extensive damage to infrastructure, agriculture, and the economy (Dewan, 2015). The government has adopted several mitigation measures to tackle these difficulties, such as flood shelters, water and flood control projects, and early warning systems (Dewan, 2015). A comprehensive, long-term mitigation policy that incorporates scientific, indigenous, and traditional knowledge is necessary (Dewan, 2015).

(Islam, 2018) and (Barman et al., 2012) emphasize that natural disasters including floods, river bank erosion, and cyclones play a significant influence in causing migration. (Gray & Mueller, 2012) and (Etzold et al., 2014) propose a more detailed perspective, indicating that the effect of disasters on migration is shaped by variables including gender, poverty, and food insecurity.

(Gray & Mueller, 2012) highlights the significance of local adaptive capability in influencing migration choices. The results highlight the intricate relationship between environmental, social, and economic factors in influencing migration trends in the area.

The events have substantial socio-economic effects, especially on the livelihoods of the impacted population (Faruqee & Choudhry, 1996). The region's susceptibility is worsened by deforestation, unregulated infrastructure development, and inadequate enforcement of land use planning (Sarker & Rashid, 2013).

Implementing mitigative measures, such as rehabilitating existing embankments and constructing new ones, is essential for safeguarding coastal communities against cyclonic storm surges and floods (Khalil, 1992).

However, (Tse, 2011) discovered that earthquakes, volcanic eruptions, and floods in Indonesia decreased migration rates and had varying impacts on household assets and wages.

(Mbaye & Zimmermann, 2016) observed the intricate nature of the link, where certain research indicated a rise in migration following disasters, while others reported no impact or a decline.

(Mbaye & Zimmermann, 2016) emphasized that migration serves as an insurance mechanism to mitigate the impact of environmental shocks, with remittances playing a key role in reducing households' susceptibility.

(Belasen, 2019) highlighted the substantial effect of disasters on migration in emerging economies, where the frequency of disasters plays a role in migration choices.

Migration decisions could be influenced by various factors such as demographic and economic characteristics (Simpson, 2017), the number of young males in the family, education levels, and household wealth (Regmi et al., 2020) and access to social protection programs (Himmelstine, 2012). Expected income also plays a significant role, with individuals often moving in search of better income prospects (Kennan & Walker, 2003).

Various variables impact migration trends in the northern region of Bangladesh after disasters. (Gray & Mueller, 2012) and (Penning-Rowsell et al., 2013) emphasize that economic losses and the necessity for income recovery are significant factors that motivate short-term migration. Permanent migration from hazard-prone places is restricted by strong "anchoring" forces and the negative impacts of movement.

(Black et al., 2013) highlights the intricate nature of these trends by differentiating between migration, relocation, and immobility resulting from catastrophic occurrences.

(Hunter, 2005) emphasizes how contextual factors and risk perception influence migration decisions, especially for disadvantaged populations. The studies highlight the complex nature of migration caused by disasters in the region.

CHAPTER 3: METHODOLOGY

3.1. STUDY AREA

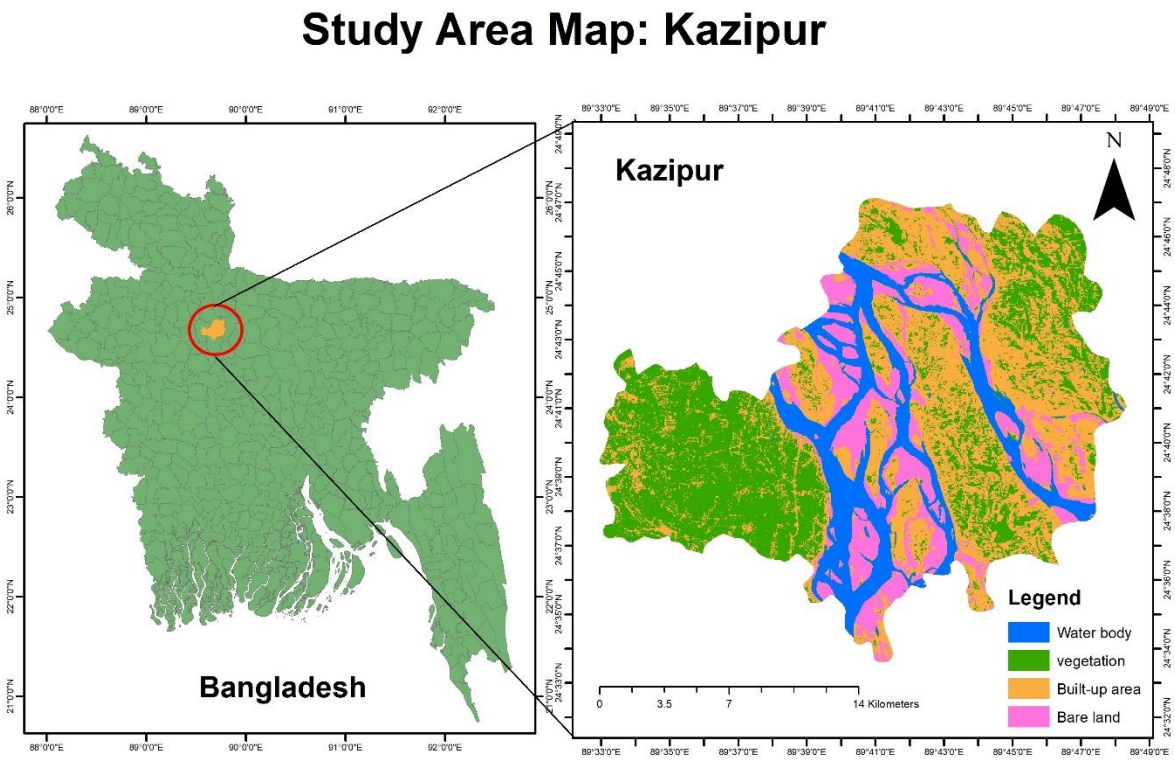

Figure 1: Study Area Map

The geographic coordinates of Kazipur Upazila are 24°38'30" to 24°64'17" north latitude and 89°39'00" to 89°65'00" east longitude. 368.63 sq km make up Kazipur Upazila and it is bordered to the north by Dhunat, Sariakandi, and Sarishabari Upazilas; to the south, by Sirajganj Sadar Upazila; to the east, by Sarishabari Upazila and the Jamuna River; and to the west by Dhunat Upazila [7, 10]. There a number of habitations, such as Tarakandi, Meghai, Kazipur, Dhulaura, Maijbari, Manik Patal, and Tengalahata, are frequently disappearing along riverbanks erosion. Constructed in 1960 on the western bank of the Jamuna, the Jamuna-Bhramaputra Flood Protection Dam did little to prevent river erosion or manage flooding.

3.2. DATA METHODS

Analyzing and identifying the temporal and spatial changes taking place in the Kazipur Upazilla area of the Shirajgonj district is the goal of this mission. Changes or variations that occur in both space (a geographical region) and time (over a given duration) are referred to as "spatio-temporal changes". Usually, the following goals fall under this aim:

Using remote sensing or geographic information systems (GIS), spatial analysis looks at how the Kazipur Upazilla area's land use, land cover, urbanization, deforestation, agricultural patterns, and other geographical aspects have changed over time. This entails identifying and measuring changes Analysis of historical data, time-series satellite imagery, census data, or other pertinent temporal datasets is known as temporal analysis. It is the process of examining changes over time. Trends in infrastructural development, economic growth, population increase, environmental deterioration, and other temporal events taking place in the research area might all be examined in this way.

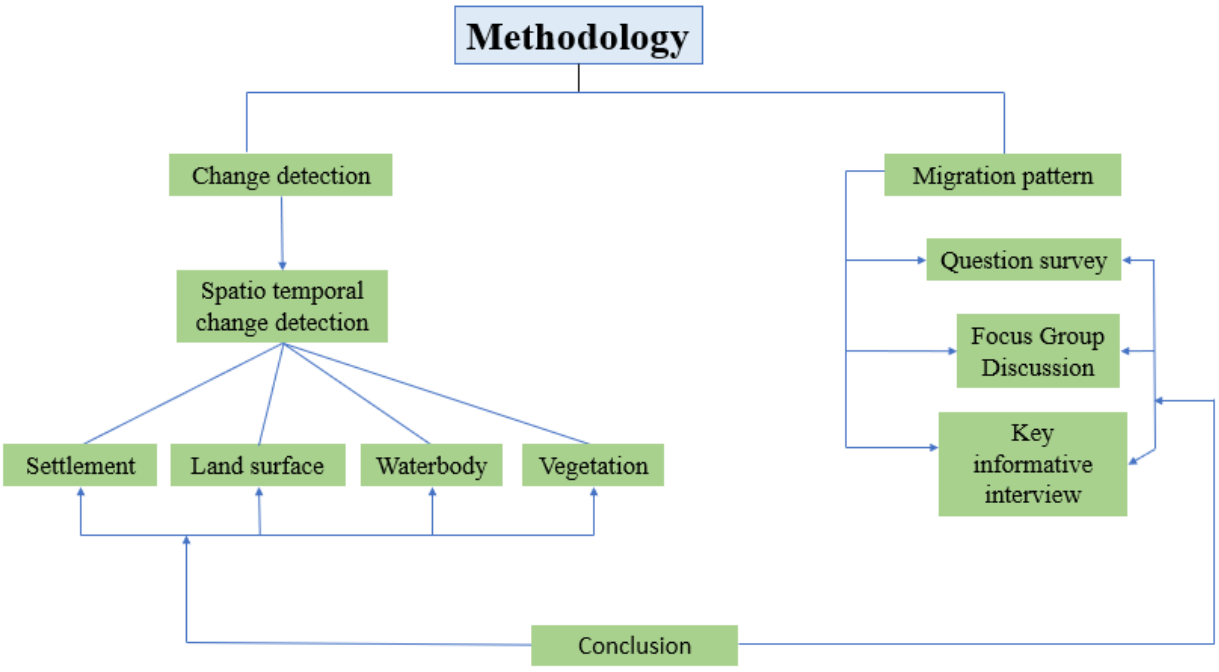

Figure 2: Structure of Methodology

Finding patterns, trends, or correlations between geographical properties and their temporal dynamics is accomplished through the integration of spatial and temporal data. Statistical analysis,

spatial modeling, or time-series analysis techniques may be used to comprehend the temporal evolution of spatial phenomena and their reciprocal relationships.

Finding the underlying causes or drivers of the observed spatiotemporal changes, such as changes in the population, economic activity, legislative actions, natural disasters, or the effects of climate change. Comprehending these factors is essential for making well-informed decisions and devising plans for sustainable development.

Within the Kazipur Upazilla region of the Shirajgonj district, this purpose primarily looks at changes in migration trends. Over time, individuals move into, out of, and within a specific geographic area, which is referred to as migration patterns. Typically, this aim's goals include the following:

This is the design of the research. There are two different ways that this research design collects data. Take 1) Primary and 2) Secondary as examples.

This research approach divides the thesis's entire work into two sections. The first uses GIS to acquire secondary data for the purpose of spatiotemporal change detection. The primary data collecting method includes the migration procedure, which is the second. The primary data gathering is divided into three sections. As an illustration:

1) Questionnaire Survey.

2) Talk in Focus Groups

3) Key Informative Interview

Conversely, the collection of secondary data involves the detection of spatiotemporal changes, which are achieved by various GIS analyses on four subjects. The examination is as follows:

1) Erosion and Accretion

2) Land Use Land Cover

3) Change Detection

Compiling information on migration flows, including both internal migration occurring within the study area or nation and external movement occurring across regions or nations, is known as

migration data collection. To trace an individual's or household's migration, this may entail examining data from surveys, administrative records, censuses, and other migration sources.

Analysis of Migration Flows: This method looks at patterns of migration across time to find trends in the volume, direction, duration, and features of migration flows. Examining trends in rural-urban migration, seasonal migration, international migration, or other migration categories pertinent to the study region may be part of this.

Mapping the Geographic Distribution of migratory: This study aims to map the migratory flows' spatial distribution within the Kazipur Upazilla area in order to discover high-migration locations, depopulation or urbanization patterns, and spatial differences in migration outcomes. Understanding the spatial dynamics of migration and its effects on nearby communities and infrastructure can be gained from this.

A study of the socioeconomic, demographic, environmental, and policy aspects influencing migration decisions made by individuals or households in the studied area. Determining the push and pull forces influencing migration patterns and developing migration management solutions require an understanding of these variables.

Implications of Migration Changes: Evaluating the financial, cultural, and environmental effects on sending and receiving communities in the Kazipur Upazilla area as a result of shifting migration patterns. The effects on labor markets, social cohesiveness, resource allocation, infrastructure development, and community resilience may all be examined in this way.

Various softwares have been used to prepare this thesis paper. Such as-

Figure 3: Data Analyst Software

CHAPTER 4: RESULTS

4.1. ANALYSIS OF SPATIO TEMPORAL CHANGE DETECTION

Land Use and Land Cover is referred to as LULC. It describes how various land uses and land covers are categorized and classified in a certain location. The term "land use" refers to human uses of land, including residential, commercial, industrial, agricultural, and recreational ones. On the other hand, land cover describes the biological or physical covering of the Earth's surface, including grasslands, marshes, forests, urban areas, and aquatic bodies. For a number of reasons, including land use policy formulation, urban planning, environmental management, and the preservation of natural resources, LULC classification is crucial. To gather information and examine LULC patterns, field surveys, geographic information systems (GIS), and remote sensing methods are frequently employed.

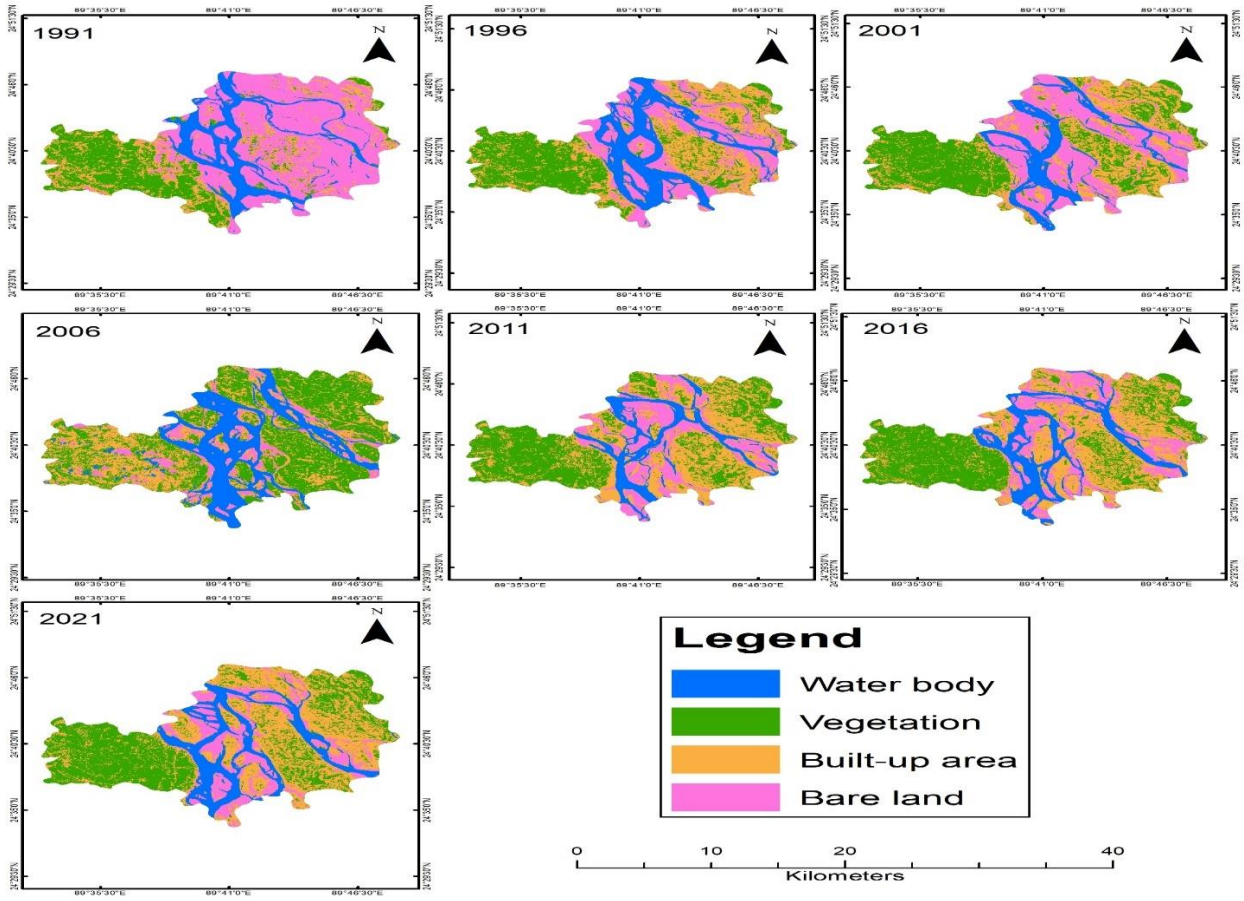

Figure 4: Land Use Land Cover Map

This map, which is based on 30 years of satellite data from Kazipur Upazila in Sirajganj from 1991 to 2021, has been created using the LULC categorization system to cover 4 subjects. correspondingly, four contents are-

1) Body of water

2) Vegetation

3) Area built up

4) Vacant land

Every five years, a map produced using LULC is displayed to demonstrate the spatial changes over the previous thirty years. For instance, 1991, 1996, 2001, 2006, 2011, 2016, and 2021. This makes it evident where Kazipur Upazila of Sirajganj has been during the last 30 years in relation to the four issues listed, as well as the changes that have occurred in those areas.

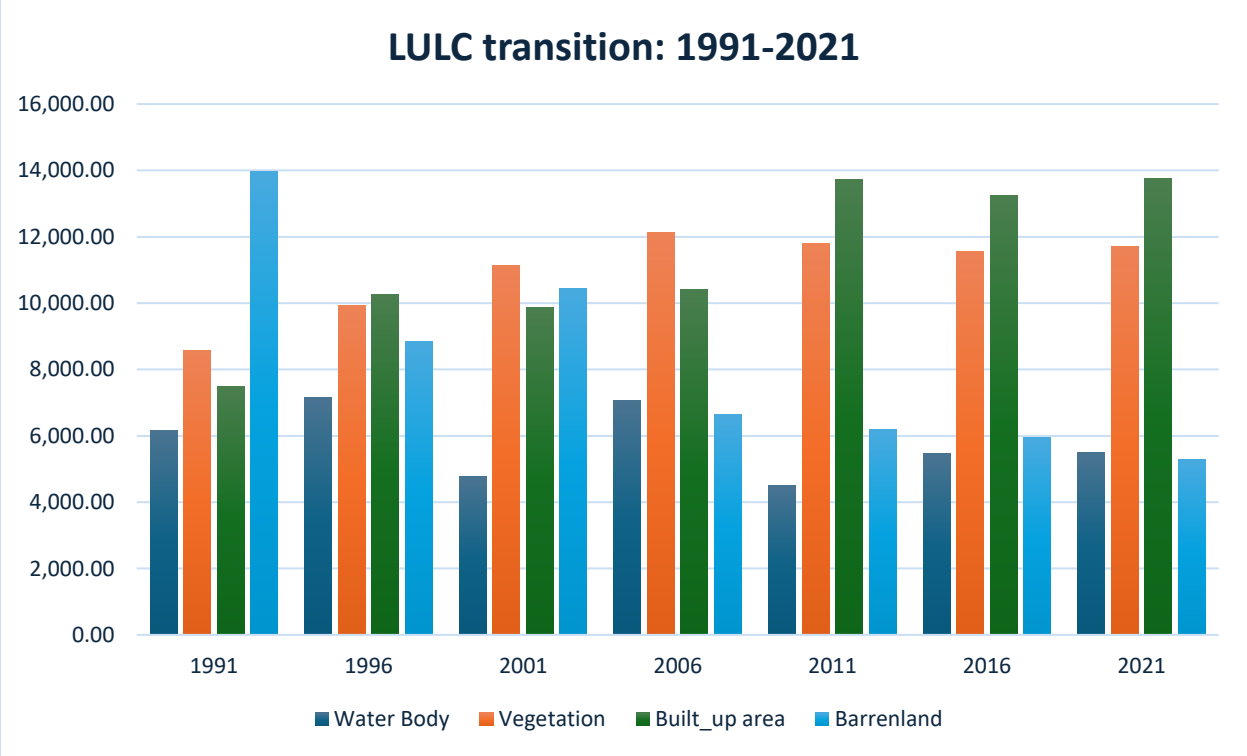

Figure 5: LULC Transition (1991-2021)

4.1.1. LULC AREA TRANSITION TABLE

Table 1: LULC Area Transition Table

Year	Water Body	Vegetation	Built_up area	Barrenland	Accuracy assessment
1991	6,164.84	8,586.64	7,482.68	13,978.46	0.92
1996	7,165.34	9,943.97	10,247.28	8,856.02	0.91
2001	4,765.03	11,124.93	9,872.58	10,450.08	0.91
2006	7,061.65	12,115.33	10,401.19	6,634.36	0.88
2011	4,501.56	11,794.32	13,716.39	6,200.33	0.89
2016	5,467.34	11,566.08	13,231.07	5,948.12	0.90
2021	5,489.73	11,693.73	13,745.87	5,283.28	0.92

The provided table presents data on land cover for a specific area over seven different years, along with an accuracy assessment score for each year. The land cover categories include Water Body, Vegetation, Built-up area, and Barren land. Here's a breakdown of the table:

Temporal Trends in Land Cover:

- **Water Body:** There appears to be some variability in water body coverage over time, with fluctuations observed between 1991 and 2021.
- **Vegetation:** Vegetation coverage seems relatively stable over the years, with minor fluctuations observed.
- **Built-up Area:** There is a noticeable increase in built-up area from 1991 to 2021, indicating urbanization or infrastructure development in the area.
- **Barren Land:** Barren land coverage shows fluctuations over time, with decreases observed in recent years compared to earlier periods.

Accuracy Assessment:

- The accuracy assessment scores range from 0.88 to 0.92, indicating a high level of accuracy in the land cover data across all years.
- The consistency in accuracy scores suggests reliability in the data collection and measurement methods used over the years.

Comparative Analysis:

- By comparing the land cover categories across different years, it is possible to identify trends and changes in the landscape over time.
- For instance, the increase in built-up area and decrease in barren land may indicate urban expansion or changes in land use patterns.

Interpretation and Additional Study:

- Significant trends, correlations, or spatial patterns in the data can be found with the aid of additional research, such as statistical testing or spatial analysis.
- Gaining knowledge of the elements that influence land cover changes, such as environmental conditions, economic development, or population increase, would be beneficial in understanding the dynamics of the area under study.

In conclusion, the table offers insightful data on the dynamics of land cover over time as well as an evaluation of the accuracy of the data. The observed changes in land cover within the examined area can be explained by underlying patterns and factors that can be found through further investigation.

4.1.2. LULC CHANGE DETECTION MAP

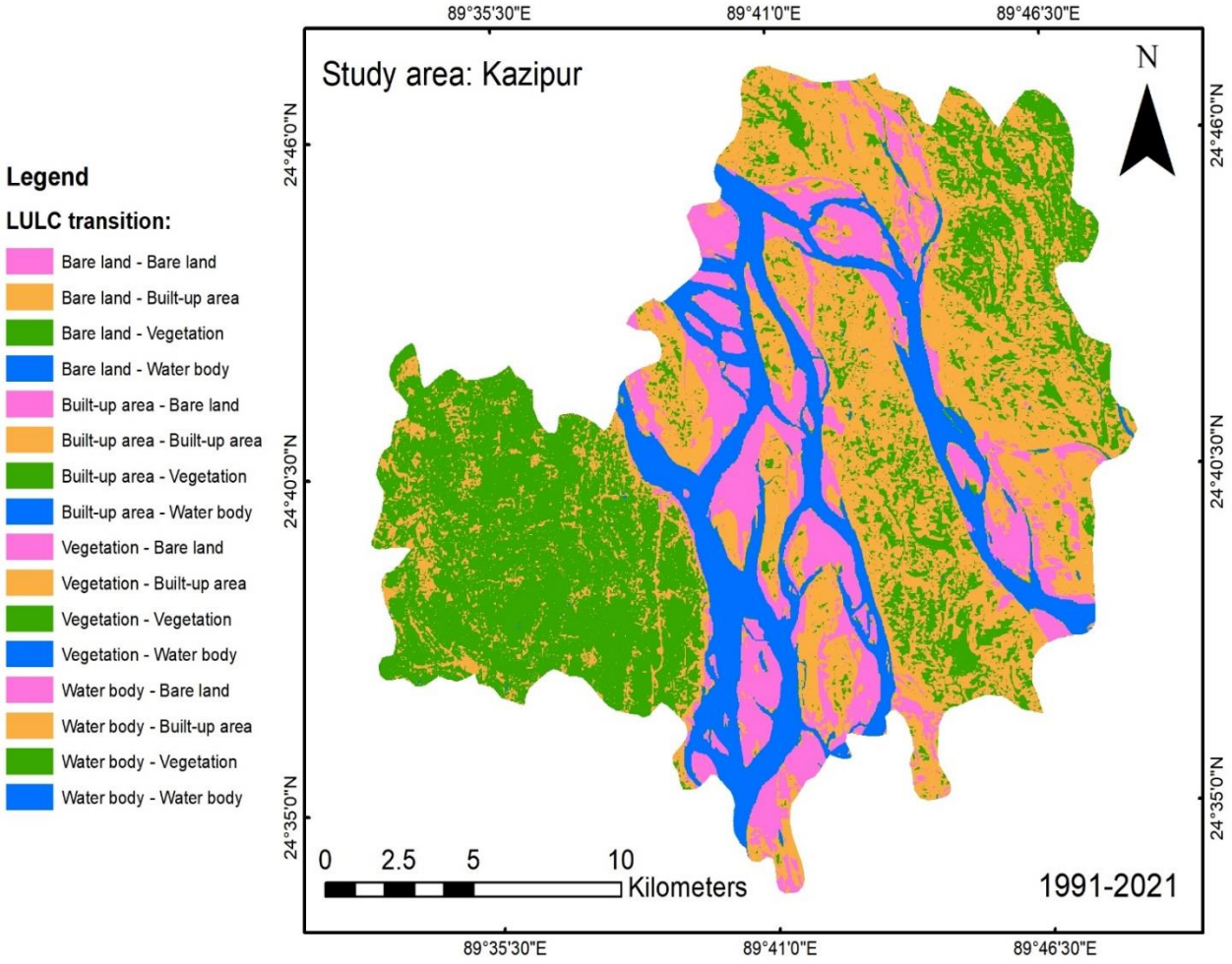

Figure 6: LULC Change detection Map

Interpretation of the Legend

- The ratio of bare land to built-up area shows the level of infrastructural development or urbanization.
- A barren landscape with lots of vegetation shows efforts at afforestation or reforestation.
- Built-up areas with vegetation could be signs of urban greening or green infrastructure initiatives.
- Changes in water bodies may be caused by man-made or natural processes, such as the construction of reservoirs or the deterioration of water bodies.

4.1.3. EROSION AND ACCRETION ANALYSIS

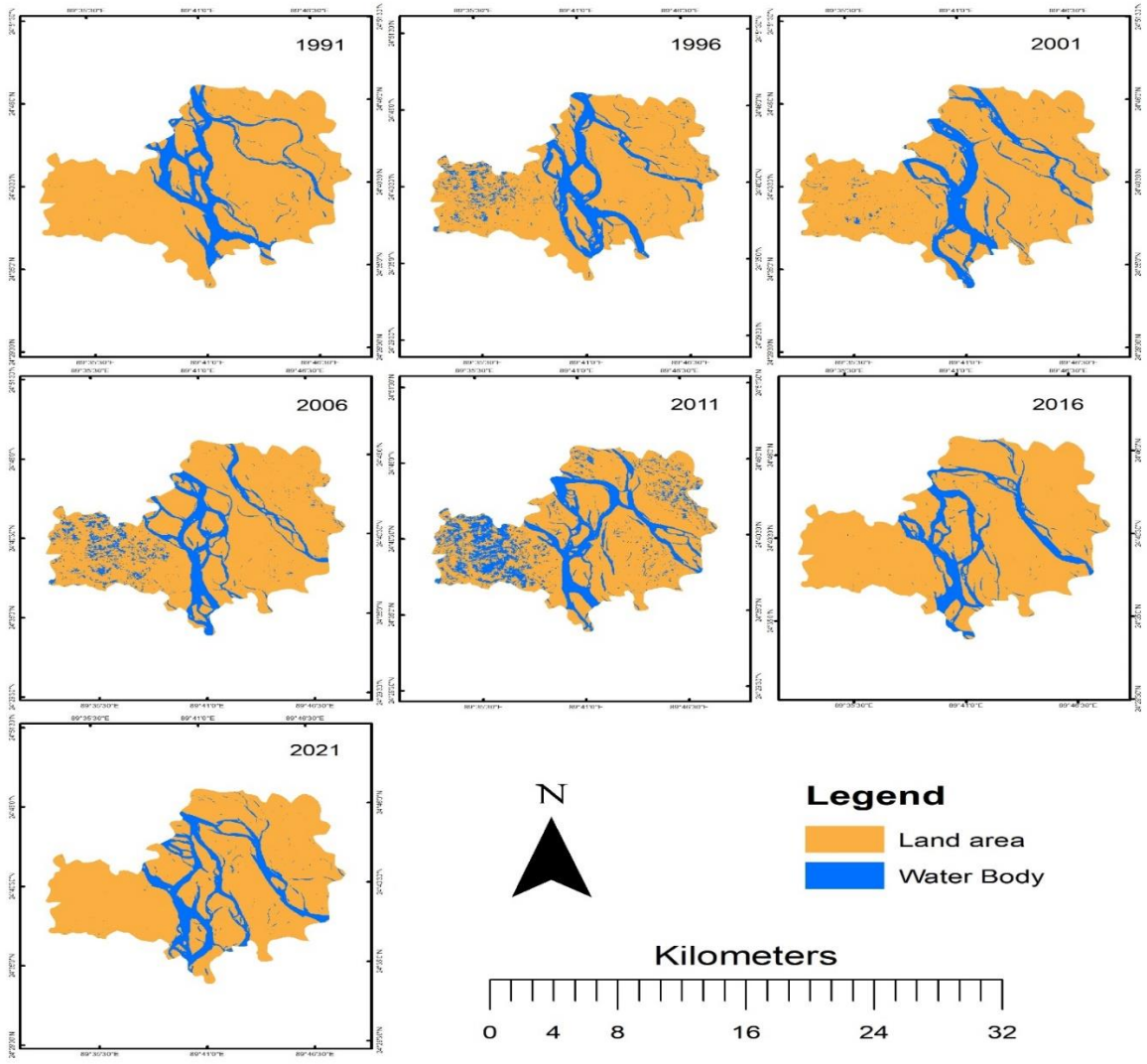

Figure 7: Erosion and Accretion Map

EROSION: Erosion is the process by which natural forces like water, wind, ice, and gravity wear away or remove material from the Earth's surface. It usually entails moving soil, sediment, or weathered rock from one place to another. Erosion can happen gradually over a long period of time or more quickly in response to natural occurrences like landslides, storms, and floods. The creation of river valleys, coastal cliffs, and canyons are typical instances of erosion.

ACCRETION: Accretion is the reverse of erosion and describes the slow process of material building or accumulation on the surface of the Earth. Usually, this build-up is caused by the

deposition of soil, silt, or other elements that have been carried by ice, wind, or water during erosion. The material that has accumulated throughout time may cause some landforms to grow or produce new ones. Sandbars, coastal beaches, and river deltas are a few examples of accretion. In conclusion, erosion is the process of removing material from the Earth's surface, whereas accretion is the process of material building up or accumulating on the surface. In order to shape the Earth's landscape over time, both processes are essential.

From, Figure 6: Erosion and Accretion Map

Here, a map of two issues by erosion and accumulation has been created using satellite data from Kazipur Upazila in Sirajganj spanning the thirty years from the previous year, 1991, to 2021. The two contents are, respectively-

1) Surface area

2) A body of water

Every five years, a map displaying the positional changes caused by erosion and accumulation over the previous thirty years is displayed. For instance, 1991, 1996, 2001, 2006, 2011, 2016, and 2021.Through this, it is easy to see Kazipur Upazila of Sirajganj's past, present, and changes over the last 30 years.

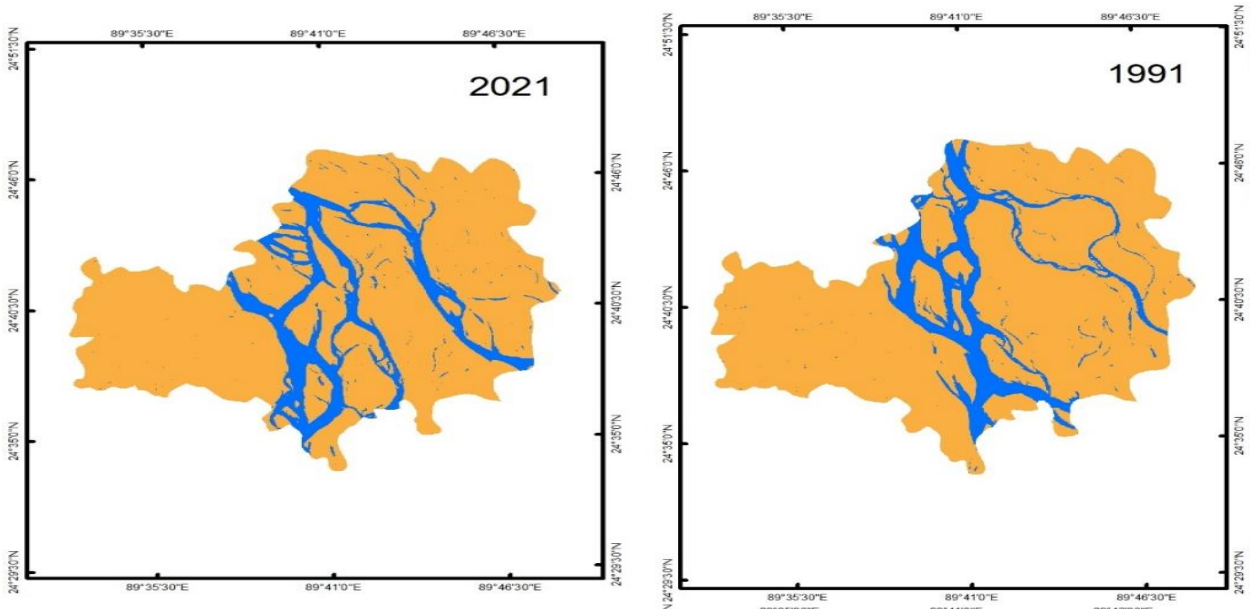

Figure 8: River path change determined a huge within 30 years.

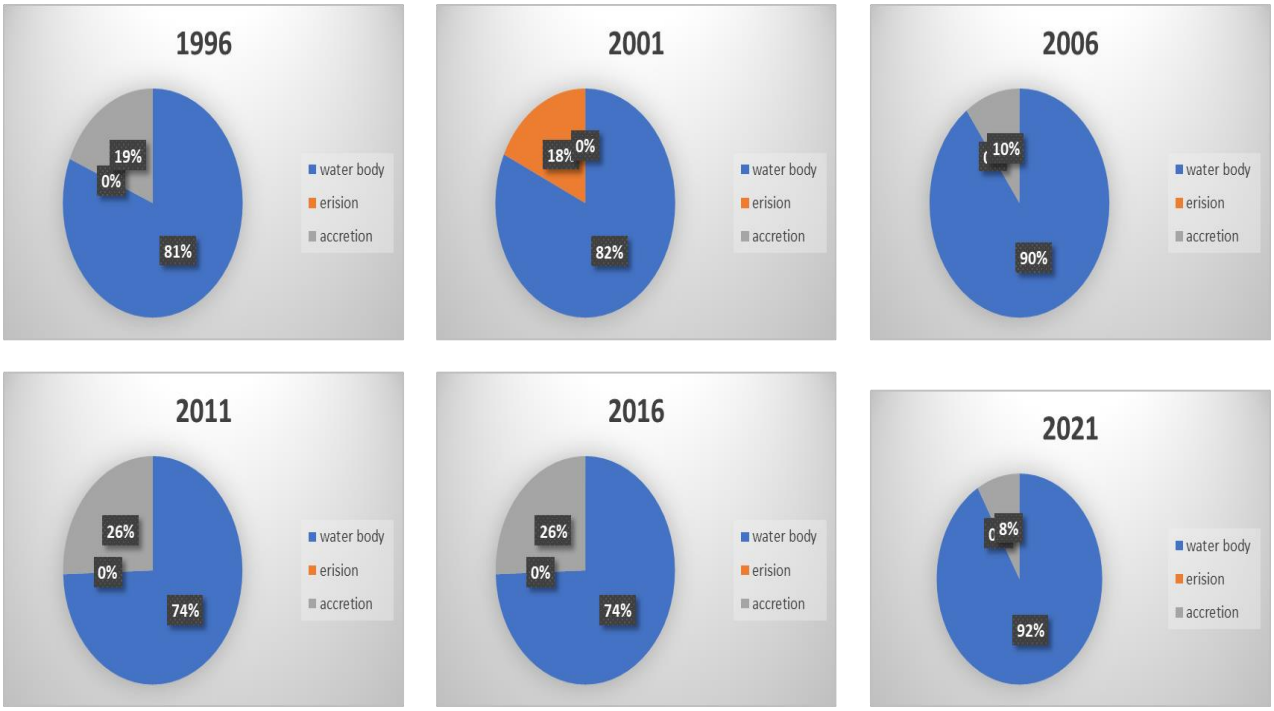

Figure 9: Percentage of changes in erosion and accretion

Table 2: Erosion and Accretion table (Water body)

Year	Water body (area)	Erosion	Accretion
1991	5115.16		
1996	6642.97	0	1527.81
2001	5445.95	1197.02	0
2006	6128.06	0	682.11
2011	9330.32	0	3202.26
2016	4919.66	4410.66	0
2021	5416.84	0	497.18

To analyze the provided table, we are examining data regarding a water body's area, erosion, and accretion over a series of years. Here are the key points of analysis:

Trend in Water Body Area:

- The water body area fluctuates over the years. It starts at 5115.16 in 1991, increases to a peak of 9330.32 in 2011, and then decreases to 5416.84 in 2021. This indicates

some natural variability or potential human intervention affecting the water body's size.

Erosion and Accretion:

- Erosion refers to the process of wearing away land or soil by the action of water, wind, or ice. Accretion, on the other hand, refers to the process of gradual accumulation or increase, typically by the addition of new material.
- In 1996, there's no recorded erosion but a significant accretion of 1527.81.
- In 2001, there's notable erosion of 1197.02, but no recorded accretion.
- In 2006, there's accretion of 682.11 with no recorded erosion.
- In 2011, there's a significant accretion of 3202.26 with no recorded erosion.
- In 2016, there's significant erosion of 4410.66 but no recorded accretion.
- In 2021, there's accretion of 497.18 with no recorded erosion.

Overall Changes:

- The years 1996, 2011, and 2021 stand out as years with significant accretion.
- The year 2016 stands out as a year with significant erosion.
- There seems to be a cyclical pattern of erosion and accretion, albeit not perfectly regular.

Possible Implications:

- The fluctuations in erosion and accretion could be influenced by various factors such as natural processes like sedimentation, human activities like dredging or construction, or environmental changes like climate variations.
- Understanding these patterns can help in managing the water body effectively, including erosion control measures, habitat restoration efforts, and overall environmental conservation strategies.

Further Analysis:

- Further statistical analysis, including trend analysis, correlation studies with potential influencing factors (e.g., precipitation, land use changes), and predictive modeling, could provide deeper insights into the dynamics of the water body's changes over time.

4.2. QUESTIONNAIRE SURVEY RESULT ANALYSIS

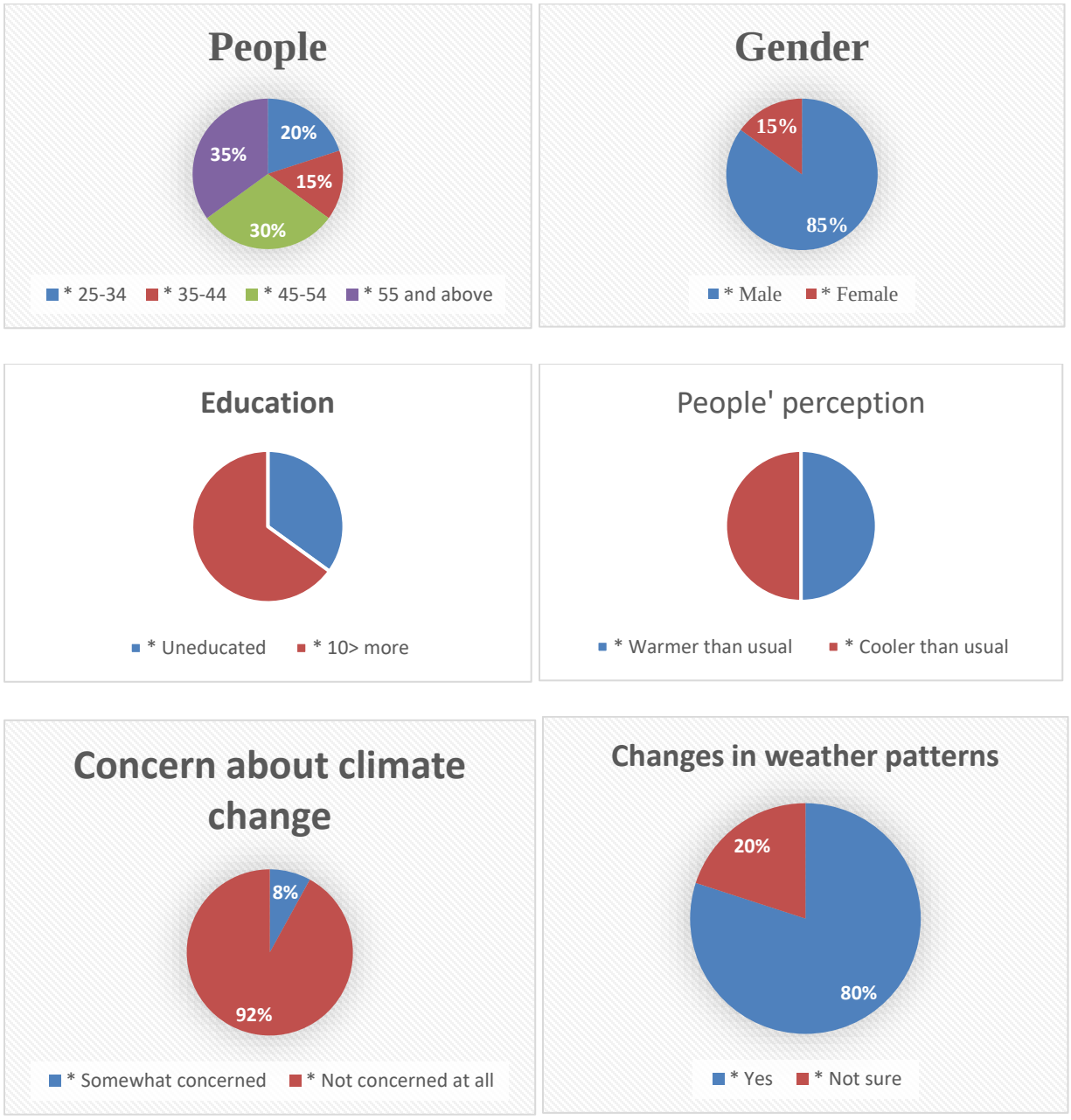

Figure 10: Questionnaire Survey Analysis

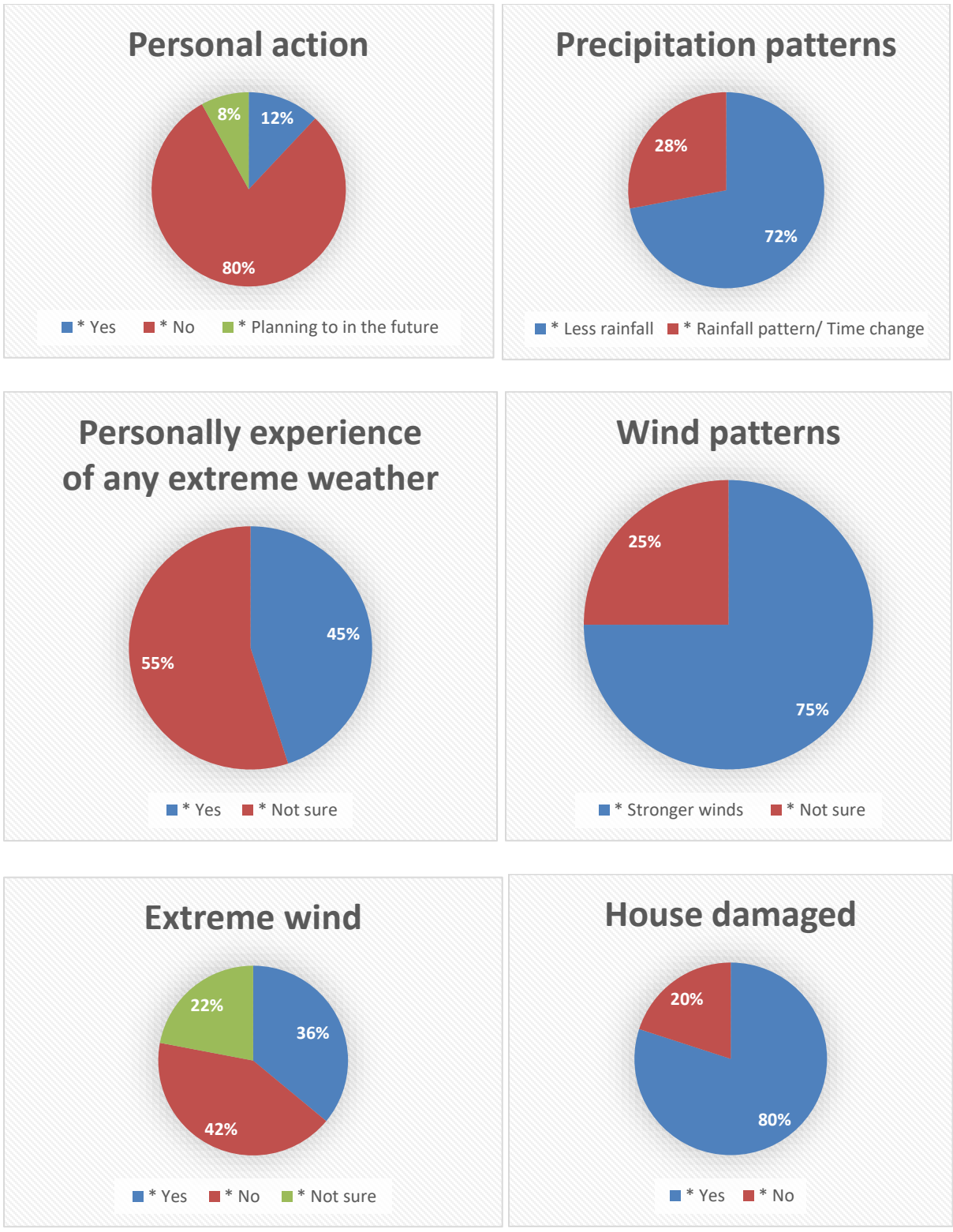

Figure 11: Questionnaire Survey Analysis

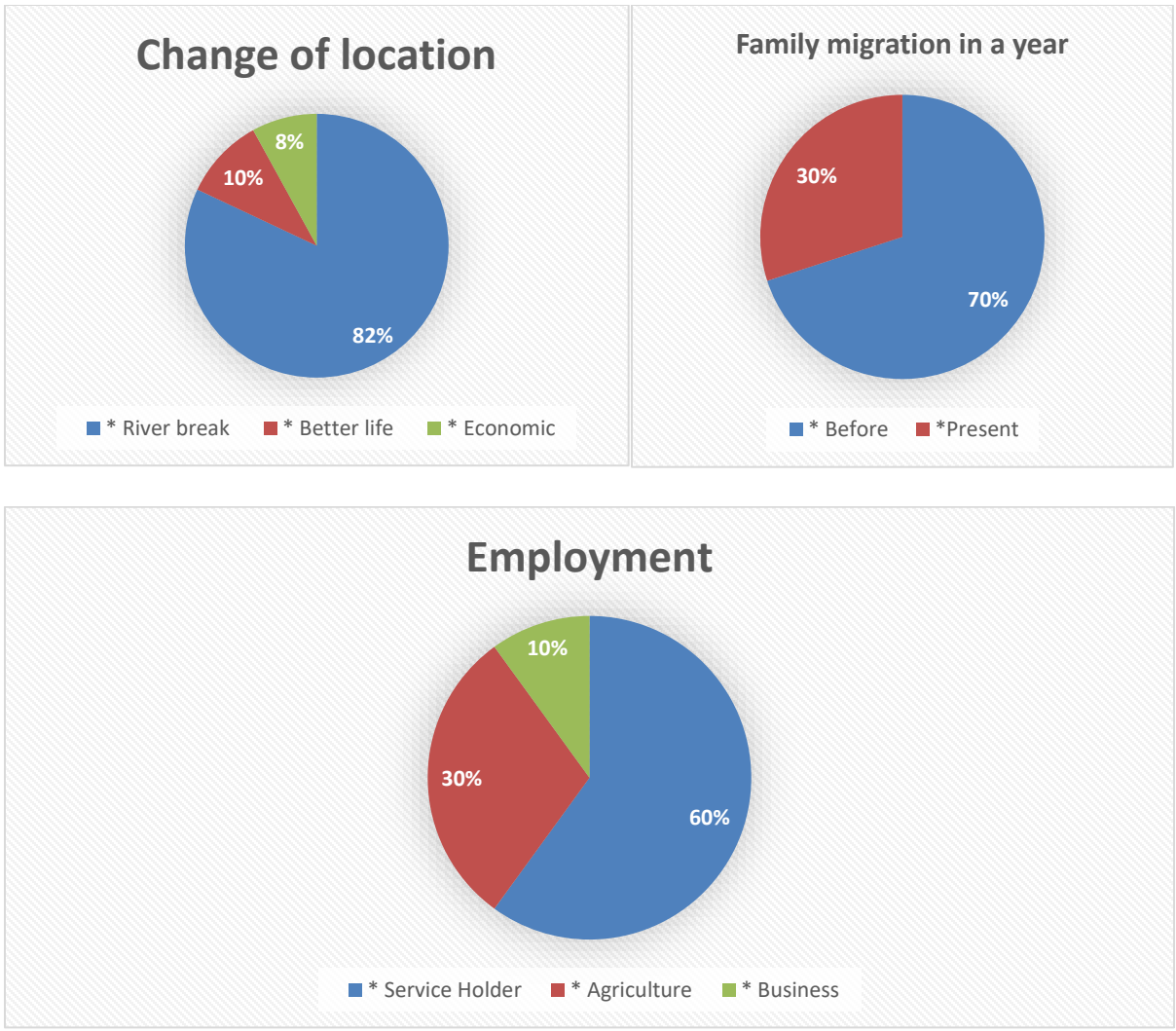

Figure 12: Questionnaire Survey Analysis

The provided survey questionnaire aims to gather insights into various aspects related to weather, climate change awareness, precipitation patterns, wind patterns, and migration dynamics in Kazipur Upazila. Here's a detailed analysis of each section:

4.2.1. DEMOGRAPHICS

- The survey covers a range of age groups, with a slightly higher representation of older individuals.
- The gender distribution skews heavily towards males.

- Majority of respondents are long-term residents of Kazipur Upazila.
- Education levels vary, with a significant portion having some level of education.

4.2.2. WEATHER AND CLIMATE PERCEPTION

- The perception of temperature trends is evenly split between warmer and cooler than usual.
- A significant portion of respondents have noticed changes in weather patterns over the past decade.

4.2.3. CLIMATE CHANGE AWARENESS

- There is a low level of concern about climate change among respondents.
- Only a small percentage have taken personal actions to reduce their carbon footprint.

4.2.4. PRECIPITATION

- The majority perceive less rainfall over the last five years, with some noting changes in rainfall patterns.
- All respondents characterize the heat patterns as increasing over the last five years.
- Many respondents have experienced extreme weather events related to precipitation.

4.2.5 WIND

- Most respondents perceive stronger wind patterns over the past five years.
- A significant portion have experienced extreme weather events related to wind.

4.2.6. MIGRATION

• A significant portion of respondents claim that the river has damaged their homes, and river breaks are the main cause of location changes.

• A sizable number of families relocate each year.

• Most migrants go back within a year.

• The majority of jobs in the area, both past and present, have been in agriculture.

• Employment is somewhat diversified, encompassing business, agriculture, and services.

• Most people think that with the right work arrangements, people may reside in the area permanently.

• A sizable portion of families reside in the Upazila permanently.

4.2.7. OVERALL IMPLICATIONS

- The survey reveals a range of perceptions and experiences related to weather, climate change, and migration dynamics in Kazipur Upazila.
- It highlights the importance of addressing climate change awareness and mitigation strategies, as well as considering the impacts of extreme weather events on communities and migration patterns.
- The findings can inform local policies and interventions aimed at sustainable development, disaster preparedness, and livelihood diversification.

CHAPTER 5: DISCUSSION

Over the period of the last three decades, the examination of spatiotemporal changes and community perceptions in Kazipur Upazila has provided a complete understanding of the changing landscape and the socio-environmental dynamics that have occurred via these changes. In order to evaluate the patterns of land use and land cover (LULC), the dynamics of erosion and accretion, and the opinions of the community about weather, climate change, and migration, the research utilised a combination of remote sensing techniques, geographic information systems (GIS), and questionnaire surveys.

Throughout the course of the research, the examination of LULC patterns uncovered significant shifts in the various land cover categories. Within Kazipur Upazila, there was a discernible increase in the concentration of built-up areas, which is indicative of the increasing urbanisation and infrastructure development that is taking place. There appears to be a complicated interaction between natural processes and human activities that are modifying the landscape, as seen by fluctuations in the covering of water bodies and barren land. When the implications of urban growth on ecological integrity and resource sustainability are taken into consideration, these

findings highlight the significance of taking a holistic approach to land management and environmental conservation.

The understanding of the dynamics of erosion and accretion within the study region provides insights into the changing shape of water bodies within the area under investigation. The dynamic nature of fluvial systems and their susceptibility to both natural and anthropogenic impacts are brought to light by the oscillations in water body area and erosion-accretion patterns that have been documented. For efficient management of water resources, including the implementation of erosion control measures and habitat restoration initiatives, it is vital to have a solid understanding of these processes.

The questionnaire study provided useful insights into the perspectives and experiences of the community in relation to the weather, climate change, and migratory dynamics. In spite of the fact that people have different perspectives on climate, a sizeable percentage of respondents have claimed that temperatures have climbed and rainfall has decreased over the course of the last ten years. This highlights the importance of developing measures to adapt to climate change. In addition, the survey brought to light the socioeconomic repercussions of riverbank erosion, which results in a significant number of households being forced to relocate and facing difficulties in maintaining their livelihoods.

The findings, taken as a whole, highlight the interconnectivity of environmental changes, community dynamics, and socioeconomic issues in the process of creating the landscape and livelihoods within Kazipur Upazila. Through its findings, the study highlights the significance of evidence-based policymaking and integrated approaches to sustainable development, disaster preparedness, and the diversification of livelihoods. Policymakers and stakeholders may strive towards a more sustainable and resilient future for Kazipur Upazila by addressing the concerns that have been highlighted and utilising the resilience of the community. This will ensure the well-being of both the environment and the communities that are geographically located within the area.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

Kazipur Upazila's changing terrain and community dynamics from 1991 to 2021 are illuminated

by a thorough examination of survey results and remote sensing data spanning three decades. Notably, changes in the amount of water bodies and undeveloped land, which may indicate interventions or natural processes, and a significant rise in the built-up area, which highlights the fast rate of urbanisation and infrastructure development, are noteworthy. The crucial necessity for appropriate water management measures is highlighted by the observed cyclical pattern of erosion and accretion in the water body, especially in 2011 and 2016. In addition, different communities have different views on how much the temperature has changed, and there have been constant reports of increased heat and less rain in the last five years, so it's clear that we need to do something about climate change immediately. The potential for long-term settlement initiatives is underscored by the presence of a sizeable permanent population in the Upazila, while riverbank erosion is a major factor driving migration, particularly impacting agricultural livelihoods. Based on these findings, some suggestions for what needs to be done next are to look into what causes LULC change more, create detailed plans for managing water bodies, raise more awareness about climate change, make sure everyone is ready for disasters, encourage people to diversify their livelihoods, and find long-term solutions to riverbank erosion. Policymakers and stakeholders can make Kazipur Upazila more resilient and sustainable by implementing these recommendations. This will protect the environment and the people living there from the effects of changing demographics and social-environmental dynamics.

CHAPTER 7: APPENDIX

Survey Question	
Section 1: Demographics	

1.1 Age:			**People**					
*** 25-34**			**20**					
*** 35-44**			**15**					
*** 45-54**			**30**					
*** 55 and above**			**35**					
1.2 Gender:			**People**					
*** Male**			**85**					
*** Female**			**15**					
1.3 How long have you lived in Kazipur Upazilla?								
***By born**								
1.4 Education								
			People					
*** Uneducated**			**35**					
*** 10> more**			**65**					
2.1 In the last five years, how would you characterize the average temperature in Kazipara Upazilla?								

					People				
*** Warmer than usual**					**50**				
*** Cooler than usual**					**50**				
2.2 Have you personally noticed any changes in weather patterns in Kazipur Upazilla over the past decade?									
						People			
*** Yes**						**80**			
*** Not sure**						**20**			
Section 3 : Climate Change Awareness									
3.1 How concerned are you about climate change?									
						People			
*** Somewhat concerned**						**8**			
*** Not concerned at all**						**92**			
3.2 Have you taken any personal actions to reduce your carbon footprint? (e.g; using energy-efficient appliances, reducing waste, using public transport)									
				People					
*** Yes**				**12**					

*** No**				**80**					
*** Planning to in the future**				**8**					
Section 4: Precipitation									
4.1 In what way would you characterize the last five years' precipitation patterns in Kazipur Upazilla?									
				People					
*** Less rainfall**				**72**					
*** Rainfall pattern/ Time change**				**28**					
4.2 In what way would you characterize the last five year's heat patterns in Kazipur Upazilla?									
			People						
*** More heat**			**100**						
4.3 Have you personally experienced any extreme weather events related to precipitation in Kazipur Upazilla?									
			People						
*** Yes**			**45**						

*** Not sure**			**55**						
Section 5: Wind									
5.1 How would you describe the wind patterns in Kazipur Upazilla over the past 5 years?									
			People						
*** Stronger winds**			**75**						
*** Not sure**			**25**						
5.2 Have you personally experienced any extreme weather events related to wind in Kazipur Upazilla?									
			People						
*** Yes**			**36**						
*** No**			**42**						
*** Not sure**			**22**						
6. Migration									
6.1 Has your house ben damaged by the river?									
			People						
*** Yes**			**80**						

*** No**			**20**						
6.2 What is the reason for the change of location?									
			People						
*** River break**			**82**						
*** Better life**			**10**						
*** Economic**			**8**						
6.3 How many families migrate a year?									
									People
*** Before**									**70**
***Present**									**30**
6.4 What percentage of migrant people returen in a year									
*** 60% people**									
6.5 What was the previous employment in this area?									
				People					
*** Agriculture**				**100**					
6.6 What employment is there in this area now?									
						People			
*** Service Holder**						**60**			

*** Agriculture**						**30**			
*** Business**						**10**			
6.7 Do you think pepole can live permanently in this area if there are any employment arrangments?									
					People				
*** Garments**					**85**				
6.8 What is the number of families living permanently in this Upazilla?									
*** 40%**									

Figure 13: Questionnaire Survey

Figure 14: Picture of Kazipur Upazila, Sirajgonj

Figure 15: Survey Pictures

CHAPTER 8: REFERENCES

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