EVALUATING THE IMPACTS OF CLIMATE CHANGE ON THE COASTAL REGIONS OF BANGLADESH FROM SOCIETAL AND ECONOMIC PERSPECTIVES

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ABSTRACT

The impacts of climate change on the coastal regions of Bangladesh were assessed using both quantitative and qualitative methods in this study. The research adopts an inductive research approach and aligns with the positivism research philosophy. Data analysis was conducted using a combination of Readsh, Metabaase, and Lokker. The literature review section of the paper discusses the multifaceted impacts of climate change on Bangladesh's coastal areas, emphasizing the different risks and challenges associated with natural disasters. Notably, the study underscores the role of both anthropogenic and geographic processes in driving the rise of sea levels in these vulnerable coastal areas. Furthermore, the research highlights the critical fact that approximately one-fifth of Bangladesh's population resides in these at-risk coastal zones, where environmental hazards pose a significant threat. The study's research area encompasses the hazards arising from environmental changes, including issues such as waterlogging, low elevation in coastal regions, escalating salinity levels, and the rise of sea levels. The abstract provides a comprehensive overview of the research's focus on evaluating the impacts of climate change on Bangladesh's coastal regions, but further clarification of the paper's specific objectives is needed.

Keywords: *Bangladesh, Coastal Regions, Socio-Economic Conditions, climate change, Inflation*

INTRODUCTION

Climate change occurs due to constant global warming, and the accumulation of greenhouse gases in the earthly atmosphere, and one of its effects is the flooding of the coastal regions due to the rise in sea levels (Ali and Hossen 2022). One of the coastal areas that face the maximum amount of problems in relation to flooding constitutes Bangladesh because it is directly connected with the coastal plains, and also, it is associated with the region in the middle of two main rivers called Ganges and Brahmaputra (Mudasser et al. 2020). Also, it is observed from the study that coastal area flooding impacts the socio-economic conditions of Bangladesh like inflation, which increases the prices of food products.
Along with that, it is also observed from the study that flooding of coastal areas is connected with the loss of homes mainly due to the erosion of mud houses, and financial constraints increasing the number of the refugee population in the world (Hoque, Haque and Islam 2022). Moreover, it is also observed from the study that climate change affects the coastal regions owing to the creation of a condition that creates unfavorable living conditions. Firstly, climate change alters the pattern of tidal waves in the surrounding areas, which helps in developing a situation that ensures the right kind of improvement in connection with the changes in the area.

Secondly, climate change results in the extensive inundation of coastal regions. It's important to note that Bangladesh is particularly susceptible to these effects due to its geographical characteristics. Bangladesh is situated in low-lying floodplains known as delta plains, and it houses a population of 129 million people in this Holocene delta region formed by the Ganga-Brahmaputra rivers. Additionally, a significant proportion of West Bengal's population in India also resides in this area (Islam and Shamsuddoha 2018). Due to these specific conditions, Bangladesh is often categorized as a vulnerable nation, with climate change being a major driver of its vulnerability, particularly in terms of rising sea levels and the increased occurrence of storm surges.
The primary objectives of this research are twofold. Firstly, the research aims to thoroughly understand how climate change affects the coastal areas of Bangladesh in various ways. It wants to explore how this impacts the people living there and the country's economy as a whole. This means looking closely at the problems coastal communities face and how it affects the country's money situation.

Secondly, the study tries to find out the things that make the coastal areas risky when natural disasters happen. It pays attention to how these places are sensitive to problems caused by climate change, like higher sea levels, cyclones, and changes in rain patterns. By doing all of this, the research wants to give useful ideas that can help make better rules and plans to reduce the bad effects of climate change in the region.

Climate change is a big problem worldwide that we can't ignore. Most scientists agree that it's happening because of things people do, like burning fossil fuels, cutting down forests, and industrial activities. These actions put a lot of greenhouse gases into the air, which cause climate change (Legg 2021). There has been a cascade of environmental changes associated with this global phenomenon, such as more frequent and severe heatwaves, altered precipitation patterns, and, most critically, rising sea levels.

Bangladesh, often referred to as one of the ground zeros of climate change, is acutely vulnerable to these impacts. Situated along the Bay of Bengal, it bears the brunt of rising sea levels, as its vast coastal regions, home to millions, face inundation and increased salinity. Furthermore, Bangladesh's vulnerability is compounded by its geographical location within the delta plains of the Ganges and Brahmaputra rivers, characterized by low-lying floodplains (Nicholls et al. 2021).

Internationally, climate change is a subject of paramount concern. The Paris Agreement, a global treaty adopted in 2015, signifies the collective acknowledgment of the urgent need to address climate change at a global scale (Agreement 2015). As part of the Agreement, efforts will be made to limit global warming to 1.5 degrees Celsius above pre-industrial levels.

The critical intersection of global climate change concerns and Bangladesh's unique vulnerability underscores the importance of comprehensive research and international cooperation. Understanding the nuances of climate change impacts on Bangladesh's coastal regions is essential for informed policymaking and sustainable development. Moreover, Bangladesh's experiences provide valuable insights for other low-lying and coastal regions grappling with similar challenges.

In this context, collaborative efforts within Bangladesh and on the international stage are imperative. Shared knowledge, technology transfer, and financial support are crucial components of building resilience and adaptation strategies in the face of a changing climate (Conceição 2020). The global community must work together to address climate change, protect vulnerable populations, and preserve the planet for future generations.

The paper primarily focuses on Bangladesh due to the country's unique vulnerability to the impacts of climate change, particularly in its coastal regions. Bangladesh is situated in a low-lying delta plain between the Ganges and Brahmaputra rivers, making it highly susceptible to rising sea levels, frequent cyclones, and altered precipitation patterns. Additionally, a significant portion of Bangladesh's population resides in these coastal areas, magnifying the societal and economic implications of climate change. The country's experiences serve as a compelling case study with lessons and insights that are relevant not only for Bangladesh but also for other low-lying and coastal regions worldwide grappling with similar challenges.

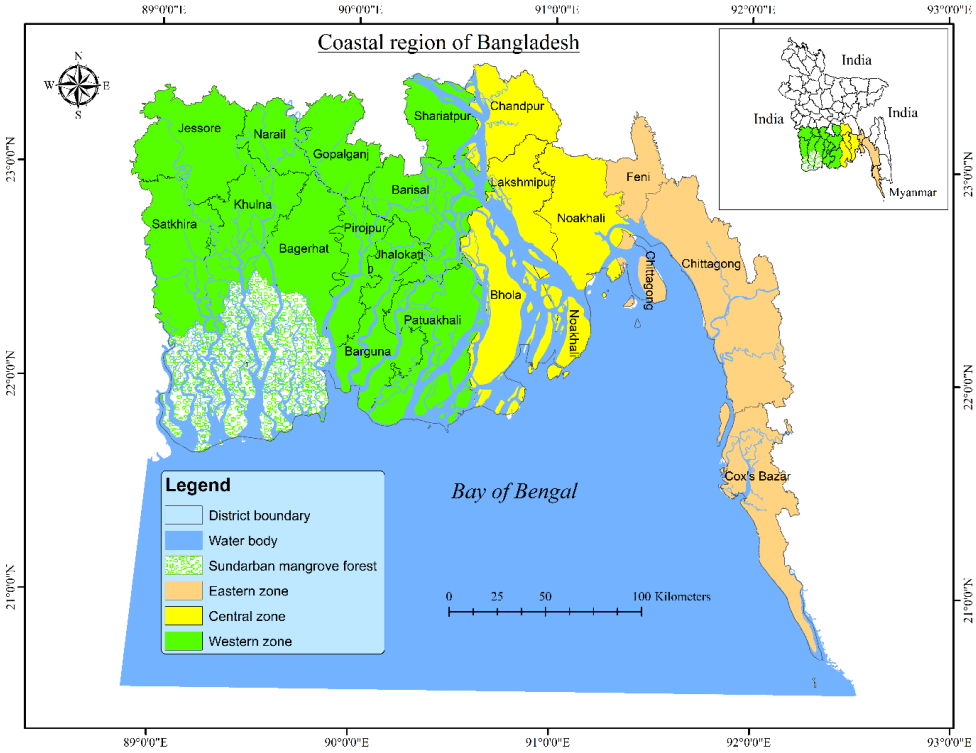
PROBLEM STATEMENT

Climate change is causing problems in Bangladesh's coastal areas, and this worries both the people and the economy. The sea levels are rising, and cyclones are happening more often and getting stronger. Rain patterns are also changing.
For the people living there, climate change is a big deal. They rely on farming, fishing, and forestry to make a living, and these things are sensitive to climate changes. Climate change can lead to not having enough food, people having to leave their homes, and more poverty.
Bangladesh's economy is also affected. The coastal areas make a lot of money for the country, especially from fishing and tourism. But climate change is causing floods and damage to buildings and roads. This means less money, fewer jobs, and people earning less.
It is very important to study and understand how climate change is affecting Bangladesh's coastal areas. This knowledge can help make decisions and plans to reduce the bad effects of climate change in this region.

STUDY AREA

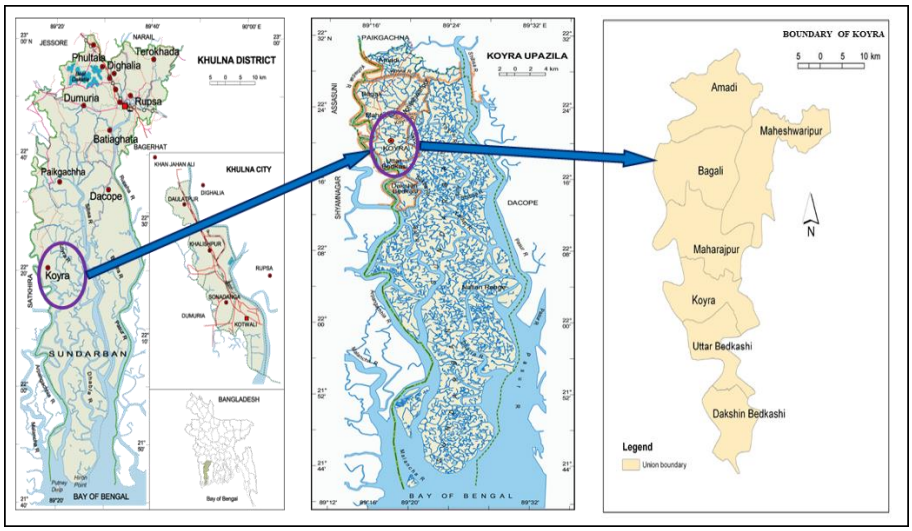
The study mainly focuses on the risks or hazards related to environmental changes in the coastal region of Bangladesh. The socioeconomic vulnerability to climate change impacts the entire economy of these coastal regions. Coastal Bangladesh is a vast region encompasses an area of 47,211 km2. There have three main coastal zones south western, central, and south-eastern are divided into nineteen coastal district, namely Bagerhat, Barguna, Barishal, Bhola, Jessore, Chandpur, Chittagong, Cox's Bazar, Feni, Gopalganj, Jhalkati, Lakshmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira and Shariatpur. Figure 1 shows the coastal areas.

Figure1: Costal Regions of Bangladesh .Source: (Hoque, Cui, Xu, et al. 2019)



This research examined the coastal region's south western areas, specifically the Khulna districts inter to Koyra upazila for analysis. The study's main focus was "exposed coastal districts of Bangladesh" pertains to the districts that directly confront the sea. This area covers 1775.41 km2, and the total number of households is almost 28000. According to the report of the Bangladesh census, Koyra has a total population of approx. 193,930. Among them, 50.24% are female, 49.72% are male, and the literacy rate of this location is 50.5% compared to the “national average rate” of Bangladesh (N. Ahmed et al. 2021). Koyra has been affected due to several natural disasters, such as waterlogging, saline intrusion, storms, floods, cyclones and sea-level rise. This area has adopted various strategies to reduce the impact of natural disasters, such as obtaining credit, changing cropping patterns and food consumption patterns, and reducing expenditure and migration (Sadik et al. 2018; Banglapedia 2021). This study area was selected to know the socioeconomic vulnerability in this area and determine the characteristics to identify the connection between the major socio-economic factors (Rahman and Gain 2020).

Figure 2: Map -Location map of the study area (Union, Koyra, Khulna district)



The top two maps in Figure 2 depict the research area's position in relation to Bangladesh and the Khulna district, while the bottom figure depicts the study area's administrative entities, known as unions.

According to the Department of Public Health Engineering (DPHE), sea level rise has greatly contaminated groundwater. The strategies that have been taken to overcome natural disasters and reduce soil erosion, storm surges, floods, cyclones, and waterlogging include changes in food consumption patterns, reduce migration and expenditure, and changing cropping patterns (Tada 2019). The socioeconomic vulnerability to climate change impacts the entire economy of these coastal regions. In that case, lots of organizations work in this area to develop better infrastructure such as “Grameen Bank”, BRAC, Prodipan, world vision, “Ahsania Mission”, Proshika, “GrameenSwanirvar,” JSS, and Setu, those organizations develop a partnership with government for developing better water resources as well as develop infrastructure for hospitality services (Ahmad 2019). On the other hand, the research zone covers Physiographic factors that influence climate change such as water logging, low elevation in the coastal regions, increase salinity, and rise of sea level. In this regard, several disasters reflected the study areas including Cyclone “Aila” which damaged almost every part of the coastal regions of Bangladesh. In that case, the government adopted specific plans to manage the adverse situation such as the “Annual Development Plan” and preparing projects for handling the affected areas of the coastline (Imran et al. 2020). In context, critically identifying those areas help to adapt s well as formulate better plans for managing natural disasters.

RESEARCH METHODOLOGY

In order to conduct the research both the secondary and primary data collection strategies had been granted here. The research strategy is mainly based on the “step-by-step” strategy for conducting the overall research in a systematic way. On the other side, both the quantitative and qualitative study has been taken here. The quantitative study helps in understanding the core experiences, interactions, and even the core beliefs of the people. In contrast, the qualitative strategy helps in evaluating and obtaining those minds of data that are related to the alteration of the climate mainly within the coastal areas of Bangladesh (Hoque, Cui, Lilai, et al. 2019). Along with this, the quantitative research even helps in the collection of a number of numerical data that are based on the affected areas and made a high impact on the alteration of the climate in several coastal locations in the country Bangladesh. With the help of the use of both strategies helps in a significant execution of the data about the core impact of climate change on the factors of social and economic factors in Bangladesh.

Apart from this, the research philosophy is mainly stated as the core assumption of the data regarding the significant methods of analyzing, gathering, and even utilizing both the secondary and even the primary data that helps in making a core interference for meeting the objectives and aim of the researchTo conduct the research, primarily the "positivism research philosophy" has been adopted. This philosophy helps in defining the pros and cons that have been experienced by society in Bangladesh due to climate change.

The geographic location that had been taken here for the conduction of the study is based on Koyra Upazila which is located in the “southwest part” mainly in the Khulna district in the country Bangladesh (Ferdous and Mallick 2019). The working areas which are focused on in this study are based on healthcare service institutions, topography, physiographic factors, and general geology. The working areas which have been granted are mainly based on the BRAC, NGOs, Absania mission, and even the Grameen bank. Along with this, the healthcare institution which has been considered for the data collection is included “Upazila health complex”.

A correlational research design has been adopted for this research, which helped to show the phenomenon and population of this study. It helps to understand the impact of climate change on the coastal areas of the country, which shows the correlation between different situations. This research design analyzed the relationship between socioeconomic and climate changes. This research design also helps to understand the dependent and independent variables, which helps to conduct the study (Rahman and Hickey 2019). The research approach involves the assumption of collecting the information and helps to address the research objectives.

In this research, an inductive research approach has been used to draw a conclusion regarding the impact of climate change on the socioeconomic status of the population. This research approach helps to understand influencing factors. In this research, primary and secondary data collection method has been used to collect data. An open-ended questionnaire was used to collect primary data, on the other hand, relevant scholarly articles are used to collect secondary data. Systematic sampling has been used for sampling data, which is a less time-consuming method. Python, Readsh, Excel, Metabaase, Lokker, and other data analysis tool is used for collecting data. SPSS and ArcGIS tools are also used for the analysis of primary and secondary data. Graphs, charts, and maps are used for visualizing the data.

RESULTS

It is found from the primary data that the respondents with higher experience in climate specialist jobs indicate a significant accuracy and validity of the data, which helped in analyzing this work. There are 40% of participants think that climate change is noticeable in the coastal areas of the country Bangladesh. However, from the perspectives of the participants, the factors associated with the condition include declination in the underground water level, declination in the purity of the soil, a high difference between the high and low temperature, the variance between the seasonal temperature level, a hike of the frequency of cyclone and flood incidents and increment of the effects of the greenhouse. From the regression test among the participants, it has been found that the optimum value of & “R” and “R square”, which has been derived from the regression analysis authenticates the truth of the stated impact of climate change in the coastal areas of Bangladesh on its socio-economic level, and this indicates a substantial relationship between the respective variables.

Table 1: Impact of climate change in Coastal area of Bangladesh Source: (Mudasser, Hossain, Rahaman, & Ha-Mim, 2020)

Number of the catastrophe (1980-2010) (EM-DAT, 2013)

Events No	235
No of killed people	191837
No of affected people	323480265
Average killed each year	6189
Economic damages (US$ X 1000)	17072501

The information in Table 1 shows that climate change has caused a lot of harm and people have lost their lives. Also, when we looked at other information, we found that the coastal area in Bangladesh is really big, about 47,201 square kilometers, which is almost one-third of the whole country. This expansive coastal region has facilitated the growth of numerous industries. Additionally, specific areas within the country exhibit elevated levels of iron in groundwater, evident through dark grey and black indicators, signifying both low water levels and poor water quality in these regions. It has also been found that the water level of the areas that are situated at a distance from the coastal areas is due to agricultural irrigation, and it is worth meaning that 12.91% of the population of the country, which depends on agriculture (Rahman and Hickey 2019). Additionally, pumping water for a longer period of time decreases the water level underground. However, there are fewer industries has developed in those areas along with lower population density(Chowdhury and Perry 2020). Furthermore, the water in these areas is harmful for the people to consume and has negatively impacted the health of them to a huge extent.

DISCUSSION

The analysis has stated that people are mainly suffering from the shortage of water. Along with this, in the areas of coastal areas, it has been estimated that the WPI of all of those areas is ranged between 0.5 and 0.75. It has meant that the level of the coastal areas is too below but also, the water quality is too better (Z. Ahmed et al. 2021). The situation highly affects the socioeconomic conditions mainly of the people and the level of water in those areas is mainly situated at the core distance significantly from the coastal areas due to the irrigation of the agriculture. On the other side, the qualitative analysis has stated that 13% of the total population in those areas highly relies on the development of agriculture. Due to that changes, the alteration of the climate can reduce the livelihood of those people who are highly dependent on agriculture in those areas of Bangladesh.

In some major areas of Bangladesh such as Upazila and Koyra, the level of water purity is highly moderated and those areas are located mainly at a moderate distance significantly from those coastal areas. However, it even indicates that the main reason for the pollution of water in Bangladesh is the pollutants from the industry (Hoque, Cui, Lilai, et al. 2019). On the other side, in the ArcGIS photographs, all of those areas are mainly indicated with white, and even the WPI is around 0.76-1. However, the exact ecosystem in the coastal areas is highly impacted mainly due to the irrigation of agriculture.

According to the above assessment, people in coastal areas suffer from several diseases caused by the water, such as typhoid, cholera, and even diarrhoea, due to poor water quality. People who drink water that is polluted, they are highly suffered from several diseases such as arsenicosis. Mainly in the water, the level of arsenic in Bangladesh has resulted between 0.11 and even 0.96 µg/g. Furthermore, it has been noted that air pollution levels are extensively elevated, particularly within the coastal regions of Bangladesh, where a high concentration of industries is also evident. Along with this, the carbon monoxide quantity is even recognized as too high which is stated as the main reason for the effects of greenhouse in those areas.

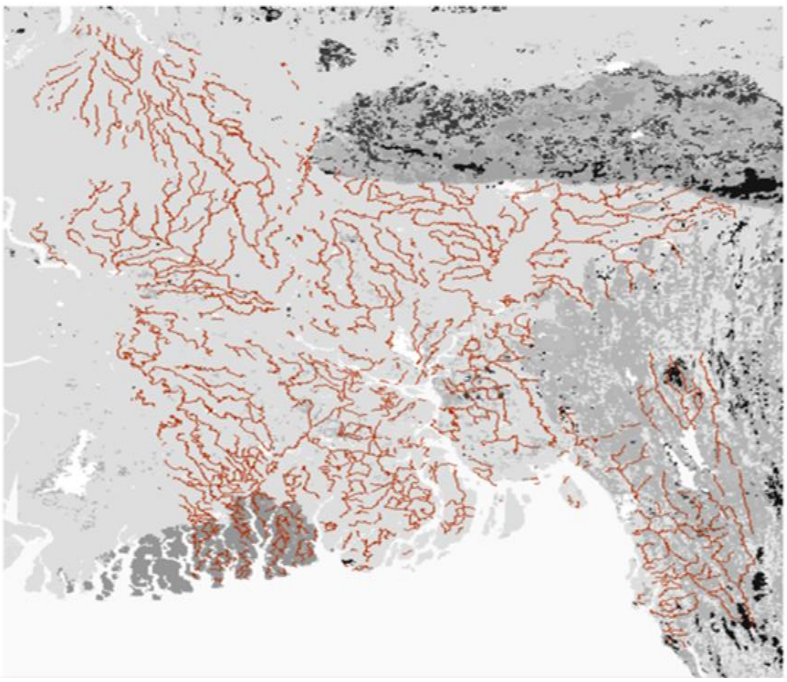
It has even been observed that the CO2 amount in Bangladesh's air is around 90741kt and even per the rate of capita rate of the emissions of CO2 is highly expanded which is more than 5.33%. Along with this, it has even been observed that more than 1.13 million well mainly in Bangladesh are highly degraded with arsenic and it is even estimated that more than 76 million individuals are significantly exposed to the contamination of the water with arsenic (Rahman and Hickey 2019). It has observed that the areas which represented the total population are more than 109% whereas the “1-m SLR affected population” is only sound 15% among the overall population. Along with this, more than 29.59% of the individuals in Bangladesh rely on industries, and even the industries are mainly developed in the side of coastal areas in Bangladesh. Based on that reason, the high rate of PN2.5 is stated as the profitability of more than 13% of the increased rate of difficulties in breathing which can even make a chance for wet cough and even “respiratory tract infections”.

As per the above evaluation, it has been stated that the alteration in the climate mainly within the coastal areas in this country, and even different types of disasters are significantly highlighted with several types of colors in the picture analysis in the result section. Along with this, it has even been stated that the floods significantly affect around 1503750 households each year and even which is more than 35% of the households in total number. As per the evaluation, it has even been observed that floods significantly affect a number of areas in Bangladesh. The total economic losses for flood in this country is significantly calculated as more than 224247.42 million mainly during the year from 2010 to 2020.

It has even been calculated that during this era of 2010-2020, within 10 years, the losses for the damage to crops are around 22164.30 million (Ferdous and Mallick 2019). Apart from this, it has even been observed that the rate of injury even so high in this country mainly in the coastal areas are more than 48% of the total population due to the high flood, and even the rate of sickness is more than 42% among the overall individual in the coastal area. The overall economic loss in each year is mainly calculated as more than 7041 BDT which is mainly around 5.3% of the overall average income of the core households during this exact duration of 2010-2020.

Moreover, the overall result stated that the temperature of this country is mainly calculated at approximately 0.65% in the year 2018 annually (Shammi et al. 2020).On the other side, after the alteration of the climate, the sea level has increased between approximately 0.5 to 1.6 meters which mainly results in making negative impacts on the country by displacing people and even destroying the homes their homes. On the other side, it has even been stated that the increased rate of temperature also has made a negative impact on the high increase of salinity within the water. Moreover, the results mainly of the ArcGIS tool used in this research evaluation are important because it helps in determining the exact challenging areas with a core integration of the educational effectiveness and even the income mainly in the core changes within the land areas.

Figure 3: Changes in the “underground water level” along with the “purity in the coastal ecosystem”, Source: (Goswami et al. 2022)



The above Figure 3 of geospatial outcomes is mainly based on the recognition of the changes in the "underground water level" along with the "purity in the coastal ecosystem", it has been observed that the red portion significantly reflects the overall coastal areas in the country Bangladesh and the black and white region mainly reflects the level of underground water along with its purity. From these outcomes, it has been observed that the society which is living in the coastal region has irrationally exploited water and it highly impacts the decreased level of underground water. It has even been observed that mainly the Koyra and Upzila area of Bangladesh is highly suffering from a high level of decrease of the water level that is the underground water, overall ecosystem, and even the purity of the water consumption.

The overall discussion has mainly stated that the null hypothesis has been significantly rejected and the “alternative hypothesis” has been taken here. This evaluation has stated that the effects of the significant climate change make a core negative effect on the economic downfall and social downfall of Bangladesh. The alteration in the climate mainly affects social life and decisions that are related to the residential location, employment, and even the overall lifestyle. Moreover, the high economic downfall has been faced mainly due to the agricultural challenges in the coastal areas due to high floods and rain.

CONCLUSION AND RECOMMENDATIONS

In conclusion, this comprehensive study has shed light on the multifaceted impacts of climate change on the coastal regions of Bangladesh from both societal and economic perspectives. Through a mixed-methods approach, it has become evident that climate change is a pressing issue in these vulnerable areas. The research revealed that rising sea levels, increased flooding, changes in rainfall patterns, and the consequent environmental alterations have substantial socio-economic consequences for the population residing in these coastal zones. From a societal perspective, the study highlighted the challenges faced by coastal communities, including displacement, health issues, and changes in livelihoods, especially in agriculture-dependent regions. The research also emphasized the alarming levels of arsenic contamination in the water sources, leading to severe health problems for the affected population.

On an economic front, the study showcased the significant economic losses incurred due to climate change-related disasters, particularly floods, which have a substantial impact on agriculture and infrastructure. Moreover, the rise in salinity levels and waterlogging has further compounded economic challenges, affecting industries and livelihoods.

The findings of this research underscore the urgency of addressing climate change in Bangladesh's coastal areas. Policymakers and stakeholders must prioritize adaptation and mitigation strategies to protect vulnerable populations, preserve economic stability, and ensure sustainable development in the face of ongoing climate change. International collaboration and support are essential to address this critical issue and provide a brighter future for the coastal communities of Bangladesh.

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