

Multi-Hazard Vulnerability Assessment and its Impacts on Kishoreganj District

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Abstract:

This multi-hazard vulnerability assessment aims to comprehensively evaluate the susceptibility and potential impacts of various hazards in the Kishoreganj district, Bangladesh. The evaluation considered a range of hazards including heavy rainfall, floods, flash floods, erosion of riverbanks, heat waves, cold waves, and thunderstorms, and examines how they interact and composite to affect the district's social, economic, and livelihood aspects. This evaluation, which takes a multidisciplinary approach, uses geospatial analysis, sustainable livelihoods assessment qualitative or quantitative data collection, and community viewpoints to comprehend the vulnerabilities in the district. The findings show that most of the Unions of Itna and Mithamoin area are vulnerable to various dangers due to their geographical location, topography, and socio-economic variables. The disaster frequency is gradually increasing. Riverine and flash floods inundate extensive agricultural lands regularly, disrupting livelihoods and increasing food insecurity. Riverbank erosion, hailstorms, increasing trend heat waves, and cold waves

endanger settlements, resulting in population displacement. Moreover, these risks not only have an impact on livelihoods but can worsen disease and reduce the availability of drinking water.

The assessment also highlights how vulnerable populations, including women, children, and members of disadvantaged communities, are disproportionately affected by hazards. It emphasizes the need for inclusive and targeted interventions to address their specific vulnerabilities and boost resilience.

Keywords: Vulnerability Assessment, livelihood, Gender, Health, Was

Introduction:

Bangladesh's geographic and geophysical location makes it one of the most vulnerable countries affected by climate change.

South Asia's climate is changing, and the impacts are already being felt. (IPCC, 2022). Based on data from 2000 to 2019, the Climate Risk Index (GCRI) reports that Bangladesh lost 11,450 people, suffered economic losses worth \$3.72 billion, and witnessed 185 extreme weather events from 2000-2019 due to climate change (GCRI, 2021). The country is experiencing the effects of climate change through a variety of disasters, including frequent floods, cyclones (including frequency, intensity, and seasonality) thunderstorms, torrential rain, salinity intrusion, rising temperature, erratic precipitation, sea level rise (Sattar et al., 2020). This Haor region is also a very endangered area with diversified problems shortage of food, and damage due to floods, erosion, excess rain, and loss of land (Islam et al., 2020). In the Kishoreganj haor region, natural disasters have increased due to climate change such as flash floods, soil erosion, heavy rainfall, drought, storm surges, etc. Large, spherical

floodplain depressions known as haor areas frequently experience floods because of extreme events like heavy upstream rainfall. Because of changes in rainfall and temperature patterns, regions are anticipated to undergo more stress increases in the years to come. (Nowreen et al., 2014). Pre-monsoon flooding in April and May raises the risks within the region's economic, social, and environmental sectors and results in the loss of crops during the entire year (Suman & Bhattacharya, 2015). The main objective of this study is to explore hazard multi-hazard vulnerability and the impact of climate change on the livelihoods of the communities in Itna and Mithamain Upazila.

Methodology:

2.1. Study Design

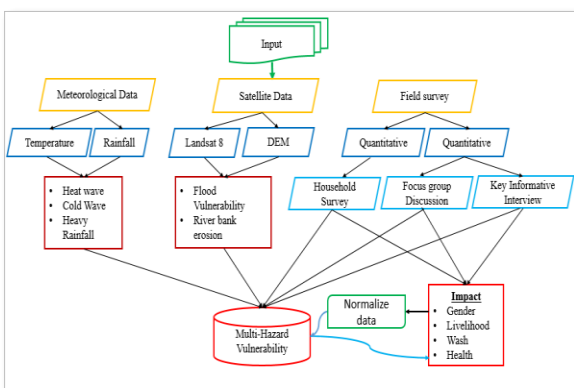
The study employed a participatory, multi-disciplinary approach, utilizing mixed methods encompassing both qualitative and quantitative data. Data collection methods included Household Surveys (HHS), Focus Group Discussions (FGD), and Key Informant Interviews (KII). Quantitative data was gathered from 399 households across two districts through HHS, comprising 150 male-led households, 150 female-led households, 75 youth-led households, and 24 households led by People with Disabilities (PWD). In addition, 30 community members—15 men and 15 women—participated in 12 focus group discussions (FGDs) that included farmers, fishermen, boatmen, small traders, and livestock farmers. Two FGDs were held in each Upazila.

Furthermore, the study employed multi-hazard risk assessment and resource mapping using GIS, with Landsat satellite images obtained from the U.S. Geological Survey Earth Explorer interface for land

cover mapping in 2022. A Multi-Disaster Vulnerability Index was developed, categorizing respondents' perceptions into high, medium, and low vulnerability, validated against the national disaster vulnerability database. Based on participant perceptions, a Composite Disaster Impact Matrix was constructed, normalizing responses across various factors such as domestic violence, gender discrimination, agricultural production loss, employment opportunities, water quality, reproductive and physical health, disability, and agricultural land loss, categorized into four impact sectors: Gender, Livelihood, WASH (Water, Sanitation, and Hygiene), and Health.

In addition to primary data collection, the study utilized secondary data obtained from sources including the Bangladesh Meteorological Department (BMD), and the Department of Disaster Management (DDM). The secondary data was gathered to supplement the original data and offer more background information for disaster management and hazard analysis.

Figure 1: Approaches and Methodology



2.2 Study Area:

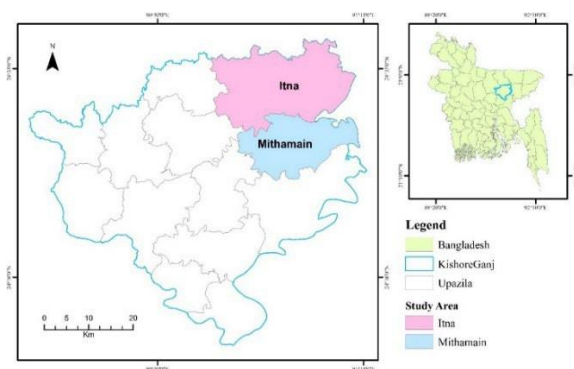
There are 423 haors in Bangladesh, spread over seven districts, including the north-central Kishoreganj district, which is impacted by climate change (Islam et al., 2020; Nath et al., 2010).

Agriculture is the main source of income for the people living in the district, employing 61.47% of the workforce (BBS, 2021) compared to 53.67% of the total haor area's population.

Generally, the population in Kishoreganj is mainly dependent on natural resources such as agricultural land for livelihoods. However, this district is a disaster vulnerable area characterized by problems like reduced crop production and livelihood opportunities, food shortage, and economic damage from water, sanitation, and housing infrastructures due to floods, erosion, and loss of land.

In the Kishoreganj district, the effects of climate change are directly felt on livelihood, fishery resources, crop output, and fish habitat (Ahmed, 2012). Rising temperatures, storm surge damage, wetlands loss, altered crops and livelihood patterns, decreased agricultural production, decreased biodiversity, and harm to community infrastructure are all results of climate change in the Kishoreganj district (Adger et al., 2005; Westlund, 2007).

Figure 2: Study Area



2.3 Qualitative Method

The study incorporated FGD with the local vulnerable community to identify and assess the Multi-Hazard Vulnerability.

Table 1: Quantitative Method of Data Collection

Participant Group	Number of FGDs
Farmers	2
Fisherfolk	2
Boatmen	2
Small Traders	2
Livestock Rearers	2
Total	12

Twenty Key Informant Interviews (KIIs) with representatives from the Department of Agriculture Extension (DAE), Department of Public Health Engineering (DPHE), District Relief and Rehabilitation Officer (DRRO), Project Implementation Officer (PIO), BDRCS NHQ, Department of Social Service (DSS), and Department of Women and Children Affairs (DWCA) were conducted to obtain information about current

climate vulnerability scenarios and significant issues of community resilience for the residents of the studied area.

2.4 Quantitative Method

The study's quantitative methodology is covered in this section. To choose participants for a household survey, a non-probability sampling technique called convenience sampling was employed. Two areas and 399 participants in total were surveyed.

2.4.1 Sample Design

Numerous sampling strategies, such as convenience, purposive, and non-probability sampling, were used in the study. The researcher used convenience sampling, a type of non-probability sampling, to choose units for the sample based on how easily accessible they were (Rahman et al., 2023). Cochran sample size formula was used to calculate the sample size (Cochran, 1977):

$$n_0 = \frac{Z^2 p q}{e^2}$$

Where,

- e is the desired level of precision (i.e. the margin of error),
- p is the (estimated) proportion of the population that has the attribute in question,
- q is 1 – p.

$$n_0 = \frac{(1.96)^2 \times 0.5 \times 0.5}{0.05^2}$$

$$n_0 = 385$$

Considering a non-response rate of 3.5% the sample size was determined. So, the non-response was found as,

$$n = 385 \times 3.5\%$$

$$n = 14$$

So, the new sample size would be,

$$NN = n_0 + n$$

$$NN = 385 + 14$$

$$NN = 399$$

2.4.2 Sample Size and Data Collection

About household leadership types, the quantitative sample size distribution table offers a succinct summary of the households that were surveyed for the study. The sample consisted of 399 households in total, evenly distributed among the different leadership categories. There were 24 households headed by people with disabilities (PWD), 150 households led by females, 75 households led by youth, and 150 households led by males. A thorough examination of the research objectives across various demographic groups is made possible by this systematic distribution, which guarantees a thorough representation of a wide range of household compositions.

Table 2: Sample Size of Data Collection

Household Type	Number of Households
Male-led	150
Female-led	150
Youth-led	75
People with Disabilities (PWD)-led	24
Total	399

2.5 Data Analysis

Data analysis employs a comprehensive and multidisciplinary methodology to derive significant insights from the collected data. Quantitative data from household surveys is first statistically evaluated to find patterns, trends, and connections among various demographic factors like household leadership, socioeconomic status, and vulnerability indicators.

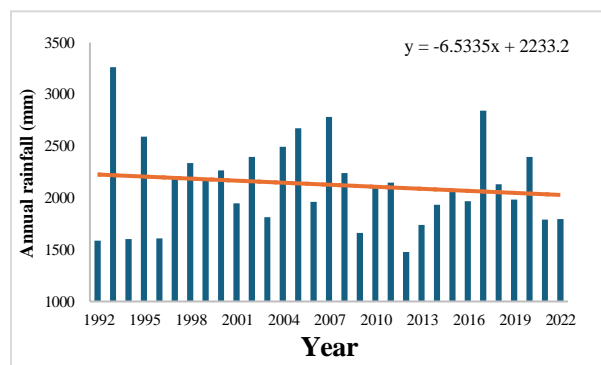
Descriptive statistics approaches are used to summarize and show the quantitative data in an intelligible manner. Thematic analysis is carried out concurrently on the

qualitative information gathered from key informant interviews and focus groups. To improve the quantitative results and provide context, this technique finds and analyzes recurring themes, viewpoints, and storylines. Furthermore, the distribution of resources, vulnerabilities, and hazards in the research region is depicted and evaluated geographically using spatial analytic tools like GIS mapping. The research aims to provide a comprehensive knowledge of the complex interactions between gender, the environment, and socioeconomic factors by utilizing this multidisciplinary analytical approach. This will make it possible for it to support initiatives and evidence-based policy recommendations that enhance community resilience and well-being.

1. Climate Change in Kishoreganj District

During the monsoon season, approximately 80% of the 5,900 mm of total rainfall happens. (BMD, 2021). However, the district's time series analysis of annual rainfall patterns over the years 1992–2022 revealed that both of these metrics exhibit a decreasing trend in Kishoreganj (**Figure 3**).

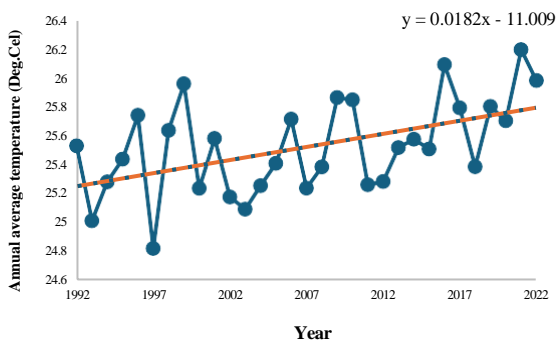
Figure 3: Annual Rainfall (mm) Distribution (1992-2022)



1.1. Temperature:

The average maximum temperature and average minimum temperature also showed increasing trends last 30 years (**Figure 4**).

Figure 4: Average Temperature (Deg. Cel) 1992-2022



1.2. Climate Extreme Components Vulnerability in Kishoreganj District

1.2.1. Heavy Rainfall

The data analysis indicates that the number of days with heavy rainfall is increasing in the Kishoreganj district, although there has been significant variation in this number from year to year.

Over the years, the frequency of heavy rainfall days has fluctuated. In 1990, there were approximately 37 heavy rainfall days. By 1995, this number had decreased to about 23 days. However, in 2007, the frequency increased significantly to around 43 heavy rainfall days. More recently, in 2021, the number stabilized at approximately 38 heavy rainfall days (**Figure 5**). In the Kishoreganj district, the seasonal distribution of rainfall has also altered over time.

Figure 5: Number of Heavy Rainfall Days 1990-2020

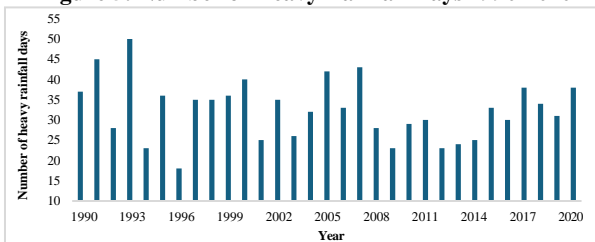
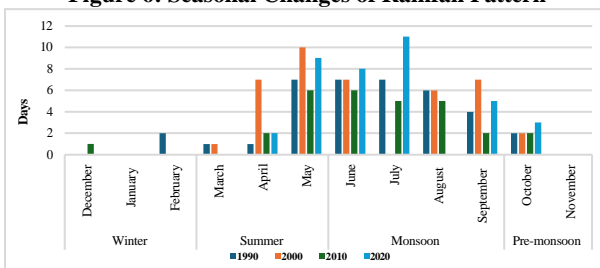


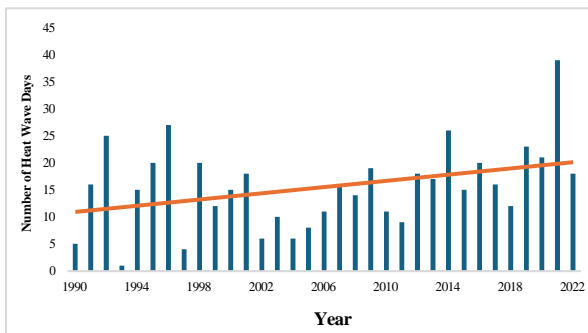
Figure 6: Seasonal Changes of Rainfall Pattern



1.2.2. Heatwave:

Heat waves increased in the Kishoreganj district (**Figure 7**) during 1990-2022. Two days of sudden, intensely hot air that swept across the country for two consecutive days in early April 2021 disrupted the rice's growth and destroyed the crop (Thomson Reuters Foundation, 2021).

Figure 7: Number of Heat Wave Days (1990-2022)

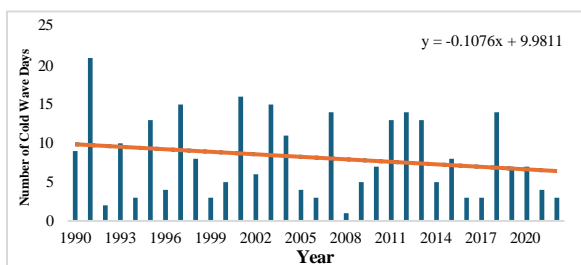


1.2.3. Cold wave:

Historically, Bangladesh has experienced many cold waves that have severely damaged agriculture, interfered with communications, and caused extensive suffering and deaths among impoverished and marginalized groups from illnesses related to the cold.

(Hasan et al., 2024). According to Health Directorate sources, 14 children died in 2006 in the northern Kishoreganj district. (Relief Web, 2006). According to the FGD, a mild cold wave is now a common scenario in the Kishoreganj district. However, **Figure 8** represents the decreasing trend of cold waves in Kishoreganj district

Figure 8: Number of Cold Wave Days (1990-2022)

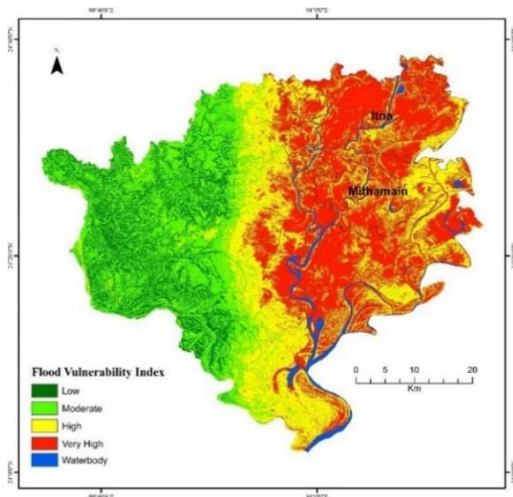


1.2.4. Flood vulnerability:

Flooding is a common phenomenon in the haor areas, and almost every year, people experience seasonal and flash floods. The Haors areas are suitable for *boro* rice cultivation, but early flash floods often wash away standing crops, and people lose their harvest. Early floods, hailstorms, and drought are the main constraints to growing modern *boro* rice (Kamruzzaman & Shaw, 2018). Early flash floods in Haor areas result from climate change, which has a destructive impact on agricultural productivity, natural fish breeding, land use practices, lifestyles, and livelihoods (Azizul & Kabir,

2022). The agricultural damage is causing a serious impact on the country's national economy. The flood vulnerability map (**Figure 9**) illustrated that Itna and Mithamain upazilas fall in a very high-risk flood-vulnerable zone. The red color represents the high-risk zone and the green color represents the low-risk zone.

Figure 9: Flood Vulnerability



1.2.5. River bank erosion

Seasonal monsoons, flash floods, and heavy rainfall are natural phenomena that significantly contribute to river swelling. These events increase water flow and accelerate erosion along vulnerable riverbanks. Approximately 1,000,000 people are affected by river erosion and 9,000 hectares of cultivable land are lost (Government of Bangladesh, 2014). Around 47 sq. km. of erosion occurred in the Kishoreganj district during the past 30 years. (**Figure 10 & Figure 11**).

Figure 10: Erosion and Accretion of Kishoreganj district

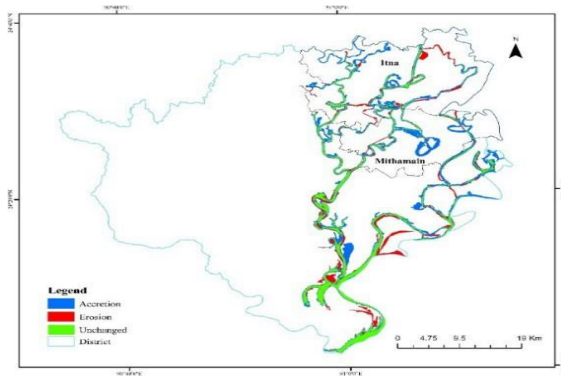
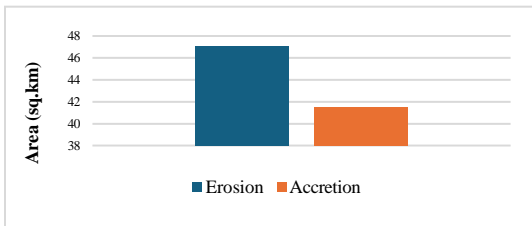


Figure 11: Erosion and Accretion Trend (1992-2022)

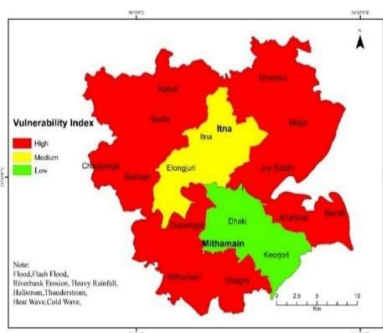


Result & Discussion

1.3. Multi-Disaster Vulnerability Analysis of the Study Area

Based on the **Multi-Disaster Vulnerability Index** assessment (**Figure 12**); Chauganga, Joysiddhi, Dhanpurn, Badla, Baribari, Mriga, Raituti, Khatkha, Gopedighi, Ghagra, Bairati, Dhaki, Mithamain unions of the study area are highly vulnerable to various hazards. Meanwhile, Itna and Elongjuri unions are medium-vulnerable. The rest of the unions like keorjori and Dhaki in the study area are low vulnerable. To consider resilient interventions, highly vulnerable unions based on multi-hazard exposure should be the top priority.

Figure 12: Multi-Disaster Vulnerability



According to the respondents' perceptions, this study observes a discernible trend over the past five years within the study area. Floods, flash floods, heatwaves, riverbank erosion, and thunderstorms have exhibited an increasing occurrence, while incidences of waterlogging, drought, wave erosion, and hailstorms have shown a decreasing tendency (**Table 3**). The District Relief and Rehabilitation Officer (DRRO) of the Kishoreganj district also noted that thunderstorms are becoming a threatening hazard for the Haor area, including Kishoreganj.

Table 3: Disaster Trends in the Study Area

Disaster	The trend in 2018-2022
Flood	High (Red)
Riverbank erosion	High (Red)
Waterlogging	Low (Green)
Heavy Rainfall	High (Red)
Drought	Low (Green)
Flash Flood	High (Red)
Wave erosion	Low (Green)
Cold wave	High (Red)
Heat wave	High (Red)
Thunderstorm	High (Red)
Hailstorm	Low (Green)

Increased	High (Red)
Decreased	Low (Green)

Almost all year, the study area is vulnerable to different disasters. In general, the Haor region is flooded from June-August. But according to FGD participants they mentioned that in recent years, flash floods start in late March and have prolonged up to May. On the other hand, during the dry and summer season (November, December and January, February), haor people suffer from drought (Figure 13) The FGD participants from three Upazilas noted drought hampers water availability and agricultural production during summer and winter seasons. For example, they mentioned that they could not irrigate their cropland or extract water from tubewell for drinking and domestic purposes.

Figure 13: Hazard calendar in the study area

Disasters	Names of month											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Flood												
Flash Flood												
Waterlogging												
Heavy Rainfall												
Drought												
Riverbank Erosion												
Wave Erosion												
Heatwave												
Cold wave												
Thunderstorm												
Hailstorm												

Climate Impact and vulnerability of climate change

The effects of natural disasters and climate change have environmental and socio-economic impacts on the people living in the affected areas. Based on the perception of respondents, a Composite Disaster Impact Matrix was developed by normalizing the participants' responses into Four impact sectors, including Gender (domestic violence, abandoned women, gender discrimination); livelihood (agriculture production loss, land loss, employment opportunity,); WASH (water availability, water infrastructure, sanitation infrastructure); health (reproductive health, physical health, disability, death, mental health) (Table: 4).

Table 4: Disaster Impact Metrix

Upazila	Gender	Livelihood	WASH	Health
Itna				
Mithamain				
Index	Vulnerability			
	Low			
	Medium			
	High			

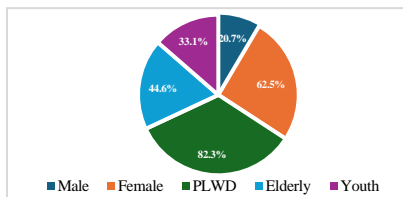
Climate Change Impact on Gender

Looking first at the findings on gender, FGD participants reported that domestic violence, abandoned women, and gender discrimination have increased. Women are facing many deprivations and inequities. Climate change was seen to affect women disproportionately due to their already weak position in society and limited or lack of earning capacity, physical and biological barriers, and religious barriers, lack of control of resources and property rights, leaving women to face more severe issues of food insecurity, water, and health problems, injury and death due to climate disasters. Women don't leave their houses during catastrophes because it is culturally and religiously inappropriate. As a result, during floods, the women's death toll is higher than men. Poor women, who control homestead-based livelihoods, lose income and suffer from chronic malnutrition when homestead vegetable production beds and livestock houses are washed away. Not only so, but also climate-induced disasters increase the malnutrition of women because disasters reduce food availability. As a result, women have limited access to food because they have the liability to feed male counters and children. Floods also increase women's workload regarding repairing homesteads and collecting drinking water. Floods destroy drinking water sources, so women must collect drinking water from long distances. Sometimes, women face gender-based violence to collect water from a far distance.

The climate change impacts also enhance human displacement and migration, where women and children suffer the most. Most female-headed households resulted from women becoming widowers or being left by their husbands. Families headed by women and single mothers were seen as more vulnerable than male-headed families. 88.5% of the respondents believed that female-headed families suffer more from climate extremes because they cannot quickly move to safe places during the flood. The FGD participants reported that because of limited income, they could not preserve food medicine and didn't have savings for emergency risk recovery. Most of the women migrate to brick field to work as cooking staff. In the brick fields, the migrated women face sexual violence.

(Figure 14) represents a breakdown of different vulnerable groups at the household level: PLWDs, male, female, youth, and elderly, based on the perceptions of the community members who participated in the household survey. PLWDs were believed to be the most vulnerable group at the household level (82,3% of respondents answered that they viewed the group as susceptible to climate changes), followed by women (62,5%) and the elderly (44,6%).

Figure 14: Household-level climate vulnerable group

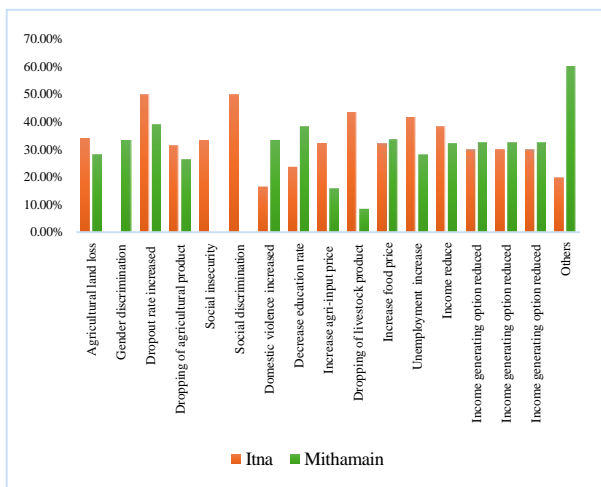


Climate change Impact on Agriculture and livelihoods

Climate-related disasters, lower crop yields, degradation of arable land, and deterioration of public resources such as water and fisheries drive smallholder and subsistence

farmers to work as day laborers and experience a sharp decline in income. **(Figure 15)** illustrates that the primary causes of the destruction of livelihood opportunities are land loss, shrinking employment opportunities, loss of agricultural production, and a decrease in the availability of livelihood options as a result of climate-induced hazards like heavy rains, floods, water logging, and land erosion. Nearly every respondent in the HHS and FGD raised this issue, emphasizing the yearly harm that crops and homestead farming sustain from monsoons and floods. Conversely, sources also clarified that inadequate irrigation water poses a problem to crop productivity in the summer.

Figure 15: Disaster Impact on Livelihoods



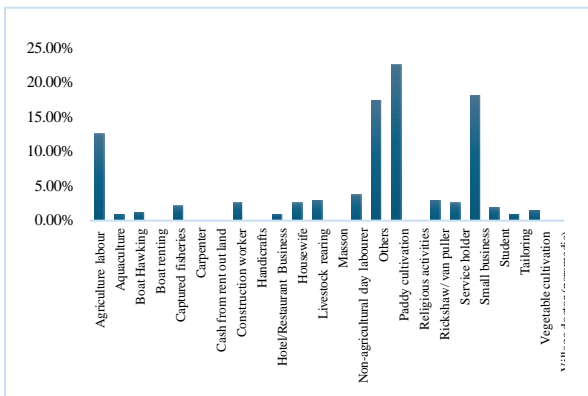
Occupation

Climate-related disasters raise health risks, significantly lower income, diminish crop yield, degrade agricultural land, and limit access to natural resources like fish and groundwater due to their depletion. The majority of the time, PLWDs and poorer women suffer greatly. People who are underprivileged, particularly those who work

directly in agriculture and crop production, frequently face dangerous circumstances that endanger their lives. The respondents claim that because they are unable to extract groundwater to irrigate their crops during this time, crop productivity is limited by increased soil dryness and fewer irrigation opportunities in the winter and summer. Farmers' livelihoods are hence unsecured.

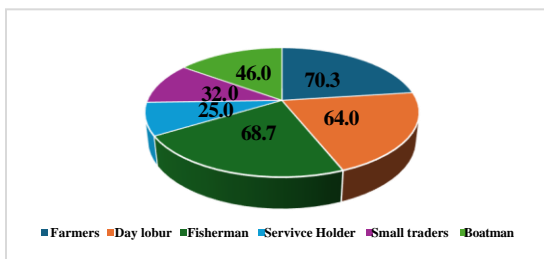
More than 40% of the crops are damaged during the monsoon because there are no fields for processing and drying collected products, according to the farmer FGD participants from two Upazilas. Because they happen before crop harvesting, early floods also reduce crop productivity. Furthermore, due to the delayed planting caused by late floods, crop productivity is also hampered. The respondents also raised the issue of people having to plant paddy at the appropriate time due to flood-related inability to buy seedlings. Because of this, most of the year, even though September is the ideal time to plant—they are unable to do so due to flooding, and the delay continues until November. Delays in the planting phase cause cold waves that hinder paddy development and reduce yield. However, during this period, heavy rain, flooding, and attacks by insects referred to as "current insects" in the area impede productivity.

Figure 16: Sources of Occupation



Based on the questionnaire responses, the study also identified various occupational groups that were considered vulnerable. It was discovered that farmers (70.3%) were considered the most vulnerable group because their work and income are constantly impacted by various types of climate extremes, such as heat waves, droughts, floods, and droughts. While 64% of respondents said that day laborers were vulnerable to climate change, 68.7% of respondents said that fishermen were especially vulnerable. In keeping with this, FGD participants from the fisherman group mentioned that they don't have any opportunity to fish during the dry season. They do have the chance to fish during the rainy season, but their options are restricted because of haor leasing. However, their ability to fish is limited by floods and high winds. Service holders were deemed the least vulnerable occupational group due to their fixed income and consequent year-round ability to purchase food.

Figure 17: Occupational vulnerable group



Agriculture

The study also demonstrates climate-induced calamities, including cold waves and fog, groundwater depletion, floods, severe rainfall downright damaging agriculture, homestead farming, etc. **Table 5** is developed based on the opinion of the studied people and finds that in the study area homestead vegetables and rabi crops (winter crops) are vulnerable because of cold waves and fog.

Groundwater depletion restricts homestead vegetable farming though rabi crops are under threat because of groundwater depletion. Homestead vegetables are fully vulnerable to flooding. Rabi crops (winter crops) are moderately vulnerable to floods (in terms of flash and late floods).

Table 5: Impact of climate-induced disasters on agriculture

Vulnerable sectors	Cold waves & fog	Groundwater depletion	Flood	Heavy rainfall
Homestead vegetable	High	High	High	Medium
Rabi crops	High	Medium	Medium	Medium
Livestock	Medium	Low	Medium	Low
High	High			
Medium	Medium			
Low	Low			

The increasing trend of temperature increases the rate of dryness in soil. It decreases water availability for irrigation, livestock, and drinking during the dry season and restricts crop production during summer and winter. The information provided by the study participants in the household survey and focus group discussion (FGD) shows that early floods damage crop fields and destroy crop production. In addition, late downpours also hamper farming. Usually, October is the month of planting the main crop (paddy) in the study area, but late flood delays planting. As a result, pests and diseases attack crops, reducing production yield. The damage is sometimes reinforced by heavy fog and cold waves. Cold waves and heat waves also increase diseases in livestock and poultry. During summer and winter, the informants cited that many livestock (cattle, goat) and poultry (hen, duck) die from diseases. However, there is no specialized veterinary support from the government or non-government sector. As a result, most livestock farmers

depend on local unskilled veterinary medicine sellers, which causes more livestock death toll. Consecutive crop and livestock production failure has decreased the employment rate amongst smallholders who experience limited access to food and suffer from seasonal hunger. Reduction of livelihood options and food insecurity causes poor nutrient intake for climate-vulnerable people, which leads to poor health and lessened immunity.

Migration

Day by day, livelihood options are shrinking, and as a result, seasonal migration is on the rise as people search for new livelihood opportunities. The study found that the seasonal migration from the study area is 12% (out of 399 respondents) which is highest in Mithamain and 6.50% from Itna upazila. (**Figure 18**). The participants of FGD in Mithamain mentioned that mainly male family members undertake migration to primarily urban areas, especially Dhaka and Chittagong, to secure livelihoods in the informal sector like rickshaw pulling, hawking, vendor, van pulling, etc. However, the male FGD participants from all three Upazilas noted that they could not afford household expenses with this income. Because they work hard with low income and also need to pay for their purpose, they cannot send enough money for their household expenses.

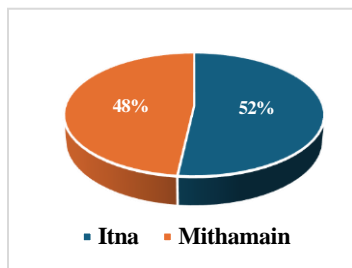
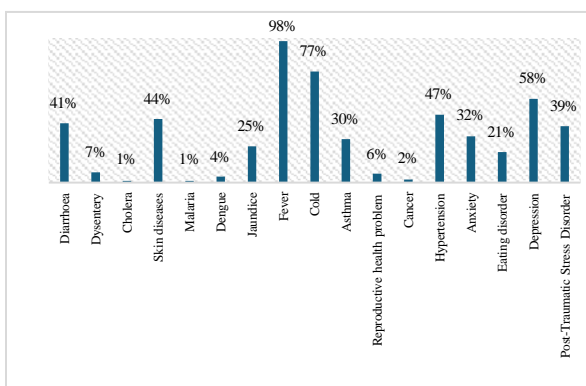
Figure 18: Migration Pattern



Impact of Climate Change on Health

Climate change-induced hazards are not just about flash floods, river floods, cyclones, and riverbank erosion; changing and erratic weather patterns have also affected the people in the study area's physical and mental health. The evolving climatic conditions have had detrimental effects on people's physical and psychological health, increasing the prevalence and variation of infectious diseases and mental health issues such as depression and anxiety disorders. The study reveals that diseases, especially waterborne diseases, malnutrition, and neglected health and sanitary systems in the study area, are common phenomena. Due to drinking and bathing in polluted water, most women and adolescents

suffer from reproductive health problems. During the dry season, most women don't wash (or wash in contaminated water) their clothes used for menstruation because they lack fresh water. Heat stress and cold waves also increase hypertension among community members, especially newborn babies and the elderly. About 98% of respondents suffered from fever and 77% from cold, followed by 47% and 41%, respectively, from hypertension and diarrhea. 6% of women and adolescents suffer from reproductive health problems, which the respondents mentioned (**Figure 20**). During the Focus Group Discussion with women and Key Informant Interview with UHC, it was found that Early or delayed menarche, Infertility or compromised fertility (pregnancy), recurrent pregnancy loss, pregnancy compromise, congenital disabilities, congenital abnormalities, and low birth weight babies, premature delivery, Leucorrhea, Pelvic Inflammatory Disease (PID), Urinary tract infection (UTI), Abdominal Discomfort, are a major reproductive health problem.

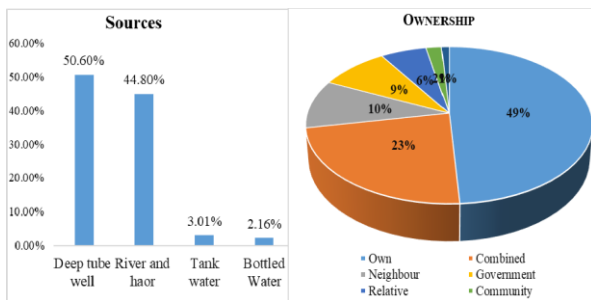
Figure 19: Suffer from Diseases**Figure 20: Disease Types Suffered by Respondents**

Impact of climate change on WASH

WASH infrastructure damage is a common scenario in the study area, making this sector the most vulnerable. Floods and erosion are mainly liable for WASH infrastructure damage because floods wash away and submerge the infrastructure. Also, water pollution is a usual scenario in the haor area; almost all toilets become submerged during floods, causing water pollution. Floods and flash floods, the regular occurrences in the study area, mainly affect the safe water availability and sanitary system. During monsoons, an increase in infectious diseases is usually associated with severe flooding and a breakdown in the sanitation system. On the other hand,

during the dry season (summer and monsoon), people don't have access to drinking water due to groundwater depletion and drying up Haor. About 50% of respondents depend on deep tubewell for drinking water, but 44.80% get drinking water from the river and Haor. Other sources, like reserved tank water (rainwater harvesting) and bottled water, are drinking water sources (**Figure 21**). The participants of the FGD in all three Upazilas mentioned that the people with the financial capacity drink bottled water around the water. As a result, those people don't suffer from waterborne diseases. Only 49% of the respondents have their drinking water sources like deep tubewell, rainwater, and harvesting systems. The remaining respondents (51%) depend on neighbors and public and relative drinking water sources to meet their demands (**Figure 21**).

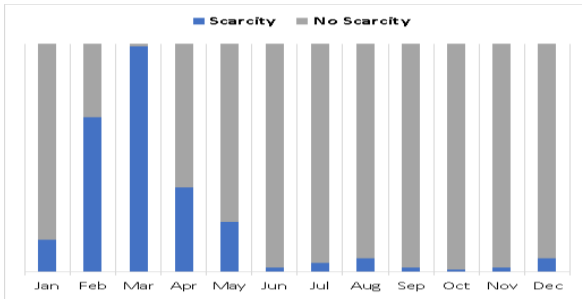
Figure 21: Sources and Owner of Drinking Water



The study revealed that from January to May, there remains water scarcity, and it reaches a peak in March (**Figure 22**). From June the water table increases and stays saturated. During the rainy season, most people get drinking water from the tube well. However, in the Key Informant Interview with the Department of Public Health Engineering (DPHE), it was found that during the flood period, most of the people suffered from a drinking water problem because of water pollution. DPHE

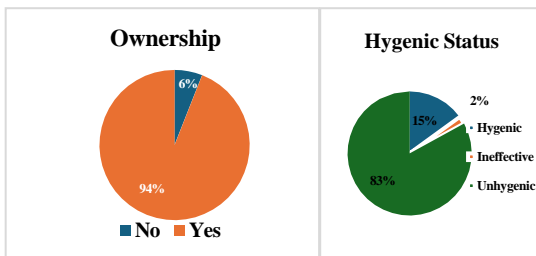
provides bottled water and water purification tablets during each flood, but it is insufficient.

Figure 22: Drinking Water Crisis Months



The FGD participants of Itna and Mithamain mentioned that the tubewells installed above 800 feet depth provide saline water. They also utter that in some tubewells, water does not taste good. Though 94% of respondents have latrines, only 15% are hygienic (Pit latrines consist of a pit, slab, and water seal) (Figure 23). About 83% of respondents noted that their latrines are not hygienic, which reveals that most households live in unhygienic conditions and pollute the environment. Some community people also defecate in open spaces found in FGD. DPHE mentioned that, though they provide sanitary latrines in the haor area, most toilets were damaged during the floods.

Figure 23: Latrine Ownership and Hygienic Status of Latrine



Conclusion:

The assessment of multi-threat vulnerability and impacts in Kishoreganj district exhibits a complex interaction of things that contribute to the region's susceptibility to numerous dangers. The analysis considered quite several natural and anthropogenic threats, such as but no longer constrained to floods, heatwaves, bloodless waves, and socio-financial vulnerabilities. The findings underscore the pressing want for comprehensive and context-specific techniques to beautify the district's resilience. A one-length-suits-all approach will not suffice, given the particular geographical, socio-economic, and environmental traits of Kishoreganj. Tailored interventions should be developed to address the unique vulnerabilities diagnosed throughout the take a look at. Furthermore, the influences of those dangers on the network are profound and multifaceted. The vulnerability evaluation indicates that inclined populations, which include low-income households and marginalized communities, bear a disproportionate burden throughout and after hazard activities. As such, any mitigation and edition strategies should prioritize inclusivity and fairness, making sure that the maximum inclined companies are actively worried in choice-making strategies. A holistic and collaborative technique related to government groups, non-governmental businesses, nearby groups, and different stakeholders is crucial for powerful chance reduction and sustainable development. The creation of early warning structures, infrastructure upgrades, and network-based catastrophe preparedness initiatives need to be included in the district's improvement plans.

In conclusion, addressing the multi-danger vulnerability of the Kishoreganj district calls for a proactive and integrated technique that combines scientific understanding, network engagement, and policy

implementation. The insights received from this evaluation should serve as a basis for knowledgeable selection-making, fostering resilience, and in the end, developing a more secure and more sustainable destiny for the citizens of Kishoreganj.

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