Revisiting the Causes and Effects of Recurrent Floods in the Haor Region of Sunamganj, Bangladesh: Evidence from the 2022 Flash Flood

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Abstract   Bangladesh, particularly the Haor region, is well-known for its susceptibility to natural disasters. Haor locals suffer more from floods than other regional individuals. Sunamganj district, predominantly a Haor region adjacent to India's Meghalaya, was devastated by the 2022 flood. This unprecedented and catastrophic flood has broken nearly all previous flash flood records. The prime objective of this study is to explore the underlying factors and effects of recurrent flash floods in the Haor region, with a specific focus on Sunamganj, by examining the 2022 flash flood. The study employed a descriptive qualitative research approach to meet its objectives. Data was collected from 30 target individuals from diverse stakeholders based on specific inclusion criteria. An open-ended, non-structured questionnaire is used to conduct interviews with selected respondents. Riverbed siltation, heavy rainfalls, excessive water flow from upstream, and mismanagement of river and Haor, among others, are revealed as significant causes of the 2022 flash flood. On the other hand, the consequences of the flood include loss of life and property, damage to infrastructure, and adverse effects on education and social life. The study concluded by making some proposals that policymakers could consider while developing strategies to reduce losses and safeguard the Haor region from future flash floods.

Introduction

Flooding comprises 50% of global natural disasters and associated fatalities. Over the past two decades (1995-2015), floods have significantly affected 2,300 million people globally. About 89% of global flood-exposed individuals live in low- and middle-income countries, with South and East Asia being the most vulnerable (Zibulewsky, 2001; Suhr & Steinert, 2022; Rentschler et al., 2022). Floods caused 6.8 million deaths worldwide in the 20th century, and Asia alone accounted for roughly 50% of flood-related deaths in the last quarter of the 20th century (Jonkman & Kelman, 2005; Noji, 2005; Jonkman, 2005, as cited in Doocy et al., 2013). Devastating floods in developing countries lead to substantial GNP (Gross National Product) losses. For example, floods in Bangladesh in 1998 and 2004 cost roughly 7% of its GNP, while flood losses in China range between 1-3% of annual GNP (Svetlana et al., 2015). Natural and human-induced factors, including climate change, deforestation, population growth, environmental degradation, and exaggerated land-use practices, are the major catalysts of floods (Fernando et al., 2022). Bangladesh, located in South Asia, is a low-lying country in the foothills of the Himalayas. It is one of the most vulnerable countries to natural disasters. Floods are regarded as the most devastating of the natural disasters it encounters. According to a 2015 World Bank Institute report, 3.5 million Bangladeshis are at risk of floods yearly (Mahmud, 2022). From 1990 to 2021, Bangladesh suffered 90 notable flood events. These disasters caused approximately 6,279 deaths and affected around 152 million individuals. The economic damages were projected to be roughly US$ 136 million (Guha-Sapir, 2021, as cited in Hossen et al., 2022). Haor region is the most affected by natural disasters in Bangladesh. Haor (wetland) is a sizeable geological basin with a bowl-like shape. Haors in Bangladesh act as water reservoirs during the monsoon, receiving water from rivers and canals, but they dry up in the summer. The Haor region produces 18% of the country's Boro rice production and 17% of total rice production (MoDMR, 2023). However, Haor areas face flash floods almost every year with disastrous consequences. Sylhet and Mymensingh divisions contain the most Haors in Bangladesh. Sunamganj, a district of Sylhet division, is primarily a Haor region, close to India's Meghalaya border. It is prone to virtually all natural disasters, and most people rely heavily on nature for their economic lifecycle. The area is subject to flash floods during the rainy season and drought throughout the summer.

In 2022, Bangladesh was devastated by a flood that began in Sylhet and Sunamganj districts and later spread to other adjacent communities. This flood has broken nearly all previous records. The 2022 flood was the worst in the area's 120-year history of flooding (Paul & Hussain, 2022). About 80% of Sylhet and 90% of Sunamganj were flooded (Debu & Sarker, 2022). The impacts of the 2022 flood were more severe for the locals of the Haor region, especially Sunamganj. Many families lost everything- crops, cattle, and livestock. Some lost their loved ones forever. Although different stakeholders, including the government, non-government organizations, and social activists, have worked tirelessly to alleviate flood victims' suffering, experts believe a long-term sustainable policy to reduce recurring flood losses may be the best solution. This study attempts to dissect the causes of recurrent flash floods and their effects on the social ecosystem of the Haor region, particularly in Sunamganj, by analyzing the 2022 flood. In the end, specific policy proposals have been made to address the recurrent flash flood issues of the Haor region more effectively.

Methods and materials

This study employed a qualitative research design utilizing primary and secondary data to achieve its objectives. An unstructured questionnaire with open-ended questions was used to collect primary data from respondents through face-to-face interviews, and their consent was duly taken. Key informant (KI) interviews were also conducted to obtain insights into the issues. Besides interviews, the non-participant observation method is also applied to gather primary data. A total of 30 target persons representing diverse stakeholder groups were chosen as respondents from four upazilas in

Sunamganj district: Tahirpur (10), Shalla (10), Bishwambarpur (5), and Sunamganj Sadar (5). A convenience sampling technique was employed to choose 30 target respondents based on specific inclusion requirements. The inclusion criteria for study participants were as follows: (a) they had to be residents of the study area for at least the previous five years; (b) have encountered more than two flash floods (c) aged over 18 years. Diverse respondents were included to understand different perspectives on the causes, consequences, and related dynamics. Female respondents were incorporated to assess the gender-specific effects of flash floods. Responded comprise farmer (10), student (04), local government representative (03), NGO worker (02), government officer (02), local school teacher (02), social activist (03), local drivers (02) and local businessmen (02). Secondary data has been collected from newspaper notifications and reports, published articles, research reports, datasets, government and NGO census reports, etc. The descriptive qualitative formula is used for field data analysis. The reliability and validity of data are maintained via cross-checking. In most cases, the respondent's pseudonym has been used. All ethical aspects of research have been maintained and followed.

A short description of the study area

Sunamganj, a water and natural beauty region, is in northeastern Bangladesh. It has 133 Haors covering around 268,531 hectares (Kamruzzaman & Shaw, 2018). It is bordered on the north by the Indian state of Meghalaya, Habiganj, and Kishoreganj districts on the south, Sylhet district on the east, and Netrokona district on the west. There are 12 sub-districts or upazilas under Sunamganj district. The area is entirely of natural resources. Sunamganj is also essential for agriculture, fisheries, and migratory birds in Bangladesh. During the dry season (December to mid-May), this area is used for agricultural purposes, while during the wet season, it is utilized for fishery (June-November). Boro paddy is the main crop of this region, yet in some parts of Sunamganj, other crops, such as peanuts, vegetables, etc., are also produced. It alone contributes to much of Bangladesh's rice and fish production. Today, the region is a popular tourist destination where many tourists visit annually to view the scenic beauty of Haors. The area offers a range of tourist attractions, including the Hason Raja Museum, Tanguar Haor, Niladri Lake (formally known as Shaheed Siraj Lake), Cotton Garden, Jadhukhata River, Barekka Tila (Hill), and more. Nevertheless, recurrent floods and natural disasters severely threaten the lives and livelihoods of the local Haor people in the area. This study takes Sunamganj as its study area to explore the central research question: How and to what extent do recurrent floods affect the lives, livelihoods, environment, and social system of the Haor region?

History of floods in Bangladesh: Focusing on Sunamganj

Bangladesh is highly prone to floods (Brouwer et al., 2007). Bangladesh encounters four distinct types of flooding: flash floods, riverine floods, rain floods, and storm-surge floods. Flash floods are the most dangerous and impactful in Bangladesh's northeastern region (Islam et al., 2020; Mirza et al., 2003). Flash floods occur suddenly due to heavy rainfall, collapse of dams, and other reasons. This type of flood is a regular phenomenon in the Haor region, especially in Sunamganj. See the data (Table 1) for details about some of the significant previous floods in Bangladesh and their effects.

Living with extreme weather events like floods and other natural disasters is an undeniable reality for the Haor region in Bangladesh. Haor people are at considerable risk due to flash floods. The bulk of flood causalities cited above are, without a doubt, from the Haor region. Isolation, poverty, and natural disasters are the primary risk factors in this region. About 87% of Haor people are poor, and their principal sources of income and economic activities are agriculture and fishery (Sun et al., 2017). Generally, the Haor region is exposed to flash floods between March and September. Boro Dhan, the central pillar of the Haor economy, is harvested from April to May when early flash floods

strike. Late-season flash floods also affect other crops. Additionally, the Haor area's housing structure makes flash floods more deadly. Most of their houses are made from clay, bamboo, chhon (thatched roof), and wood. Approximately 87.2% of the homes are kancha, 6.9% are jhupri, 5.2% are semi-pacca, and only 0.7% is pacca (Hossain et al., 2017; Islam et al., 2010; BBS, 2011, as cited in Islam et al., 2020). Sunamganj, the most flood-affected Haor region, experienced other frequent flash floods alongside the mentioned floods. To realize how flash floods specifically affect the lives and livelihoods of the Haor people, look at the impact of the 2010 floods on Tahirpur Upazila (Table 2) and the 2017 floods on Tanguar Haor (Figure 1).

Table 1 Major Floods in Bangladesh

Year	Inundated area	Number of affected people	Number of death	Amount of economic Losses
Flood of 1974	50%	More than 13.7 million	Around 1110	$114,000,000
Flood of 1987	More than 57,000 square kilometer	-	2055	$ 1.0 billion
Flood of 1988	61%	45 million	2300	$ 1.2 billion
Flood of 1998	68%	31 million	1100	$ 2.8 billion
Flood of 2000	24%	-	-	shrimp and rice productions etc.
Flood of 2004	38%	36 million	750	$ 2.2 billion
Flood of 2017	-	No less than 8 million	145	-
Flood of 2020	20%	5.4 million	220	Over 170,000 hectors of agricultural land were affected

Source: ReliefWeb (2017); Hofer and Messerli (2006); Huq et al. (2015); USAID & icddr, b (n.d.)

Table 2 Impact of 2010 flash flood on Tahirpur Upazila

Area (Union)	Boro harvest losses and No. of family directly influenced*
Uttar Sreepur	1596 hectares and 1180 family
Dakshin Sreepur	1558 hectares and 836 family
Tahirpur Sadar	1580 hectares and 1293 family
Dakshin Baradal	1304 hectares and 1220 family
Uttar Baradal	1451 hectares and 1236 family
Balijuri	1276 hectares and 1066 family
Badaghat	1572 hectares and 1618 family

*Partial Boro harvest and other losses are not included.
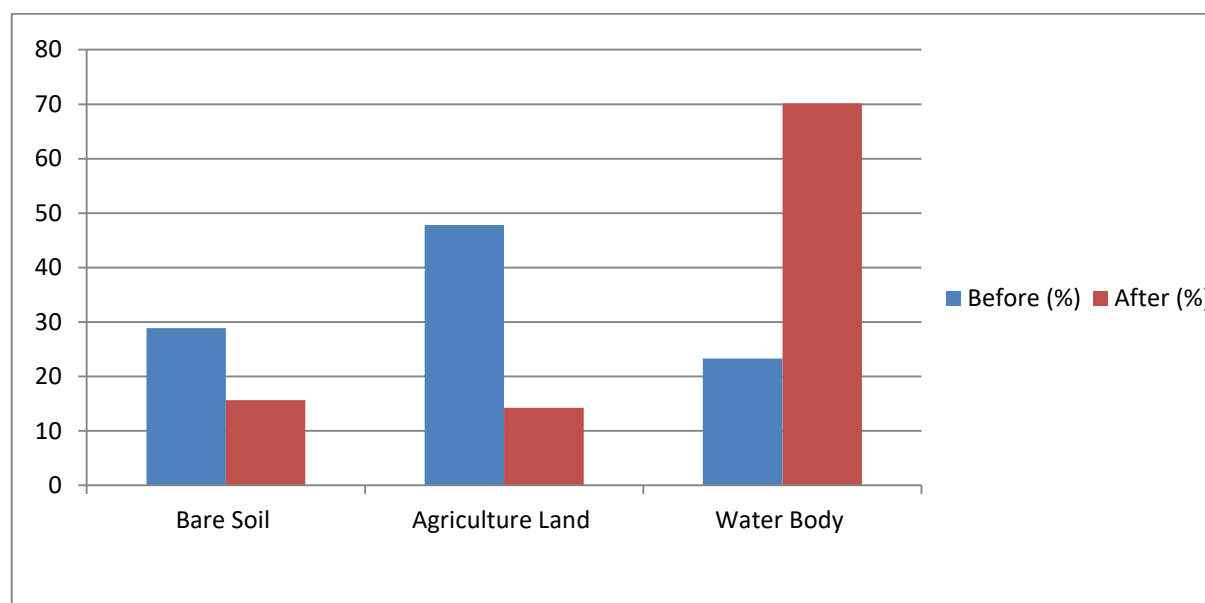
Source: Tajwar (n.d.)

Figure 1 Land covering dynamics of Tanguar Haor before and after the April 2017 flash flood
Source: Hossain et al. (2017)

The flash flood of 2022

When the economy of Bangladesh was beginning to recover from the effects of the epidemic, its northeastern region was hit by a flash flood in May of 2022. In May and June, erratic and excessive rainfall in Bangladesh and Meghalaya, India, generated a record- breaking flood in northern Bangladesh in late June. The inundation and waterlogging left nearly 9 million people isolated and without access to food, power, and fresh water. From mid-May to late August 2022, the floods caused 141 fatalities, 80 of which were in the Sylhet division alone (MoDMR, 2023). See the figures below to visualize the devastation caused by 2022 in the Sunamganj district:

☐ Between 18 and 21 June 2022, 17 million people are directly vulnerable to the flooded areas. The worst- affected districts are Sunamganj, Sylhet, Brahamanbaria, Kishoreganj, Netrokona, and Habiganj. Sunamganj has the highest number of affected people (2 million).

☐ By June 18-21, 19,500 km2 of cropland was submerged. Around 90% (2,400 km2) of the cropland in the Sunamganj district was flooded, the highest number among all. A total of 75% of the cropland in the Netrokona, Kishoreganj, Habiganj, Brahamanbaria, Maulvibazar and Sylhet districts was inundated (UNOSAT & UNITAR, 2022).

Results and discussion

Qualitative data collected from diverse respondents aims to identify the root causes and harsh effects of recurrent floods in the Hoar region. The collected data underwent editing before being categorized into themes/ codes for analysis. The findings were then analyzed descriptively and thematically based on selected themes.

Causes of the recurrent floods

The northeastern part of Bangladesh is highly vulnerable to floods because of its location. The study identifies the following reasons for the recurrence of floods in the Haor region based on respondent interviews about the causal factors of the 2022 flood.

Riverbed siltation

Rivers in Bangladesh are alluvial, and erosion and siltation are common and ongoing phenomena. The recorded average sedimentation rate in the country's coastal regions was 4.59 mm/yr. The range varied from a minimum of 1.16 mm/yr to a maximum of 8.1 mm/yr (Rashid et al., 2022). These figures indicate the extent of river siltation. Siltation is the most prominent and unavoidable phenomenon in all riverbeds of the Sylhet division. Due to riverbed siltation, major rivers and their tributaries in north-eastern Bangladesh, especially the rivers of greater Sylhet, gradually lose depth and runoff. The need for well-planned dredging on major rivers is also apparent. Thousands of chars have emerged in major rivers like Surma, Kushiyara, and Kalni and their tributaries as their flow reduced extensively. Gradual siltation of rivers and channels reduces water flow capacity and depth, posing a severe threat to life, livelihood, and the environment in the region by increasing the risk of floods. For instance, over the past 20 years, around 40–45% of the 110-kilometer stretch of the Surma River in Sylhet has transformed into chars. Insufficient excavation work has caused the Surma to become filled during the dry season. On the contrary, moderate rainfall generates flooding vulnerability in the area during the rainy season due to reduced navigability (Tarannum, 2021). Pankaj (age, 50), from Tahirpur upazila, one of the most flooded areas of Sunamganj district in the 2022 floods, said:

"In the past, even in the dry season, we used the river next to our village for our daily water-based activities, including bathing and washing clothes and ditches. However, the present scenario is quite different. The water level has depleted, so we can now walk across the river during the dry season. Furthermore, the polluted water makes it unfeasible to wash ditches, let alone take a bath."

Most of the respondents from the study area have acknowledged that recurrent floods occurred due to the rivers' limited water consumption capacity. On the way to return from Tahirpur, we found thousands of day laborers collecting sand, coal, pebble stone, wood block, etc., from the Jadukhata River, standing amid the river. A study revealed that silt buildup in the coastal Daudkhali River reduces water-carrying capability and storage. This limited capacity leads to flooding and waterlogging in the surrounding areas during the monsoon season (Ahsan et al., 2022). These findings on the Daudkhali River correspond with the remarks made by the respondents. Another respondent, Abul Basar (64), a public representative, said:

"For river erosion, the deepness of rivers is being reduced drastically day by day. Besides this, every year, particularly in the rainy season, with the wave of water, a gigantic amount of different particles, including sand, coal, and wood-block, is added to the riverbed of Bangladesh from upstream areas, especially from India. Furthermore, people in rural areas are habituated to throwing their household waste into rivers directly. All these things cause the reduced depth of rivers and are indirectly responsible for flash floods in Sunamganj."

Rivers in Sunamganj and the country have lost navigability due to poor waste management in cities and rural areas. For example, the Surma River in Sylhet city appears to be a skinny drain with shallow water and widespread waste. This river has been deeply impacted by pollution, illegal encroachment, and siltation (Das, 2022). Based on in-depth interviews, observations, and previous research findings, the study identified a lack of river dredging, river erosion, the influx of particles from upstream areas, and inadequate waste management systems as the main factors responsible for riverbed siltation. Collectively, these factors limit river depth and water storage capacity, thus raising the risk of flooding in the region during heavy rainfall.

Excessive and heavy rainfall

Geographically, the northeastern part of Bangladesh faces heavy rainfall compared to other parts. In mid-June 2022, Lourergorh in Sunamganj and Lalakhal in Sylhet received more rain than the average rainfall. Lourergorh received 1648 mm of rain against the average of normal 1495 mm, while

Lalakhal received 2129 mm of rain contrary to the long-time average of 2059 mm (Sajid, 2022). Almost all the respondents claimed that they had never witnessed such heavy and long-time rainfall. In his interview, Shafiq (43), a social worker, stated:

"I have never seen such heavy rain in my whole life. There are five people in my family. After two days of constant rain, my wife found no food to feed us. So, I had to go to the market to buy things, even though it was unpleasant to go outside in the pissing rain. I still remember it looked like a storm might hit me on my way home. Heavy rain that continues for a long time is one of the leading causes of flash floods, especially in the low basin Sunamganj area."

Heavy and record-breaking rainfall in northeastern Bangladesh and Meghalaya, India, increased the rivers' water level and shaped the 2022 flash flood. Sabitri Paul (75), the oldest respondent of the study, asserts:

"I saw several floods, including in 1974, 1998, and 2004. We stayed home during these floods since the water dissipated after a day or two. However, this time I panicked because the flood broke all previous records. For the first time, the flood persisted for more than a week. We were hopeless during those days."

Previous studies have confirmed that intense monsoon rainfall causes floods in Bangladesh and the cross-border basin in different months. For instance, floods in 1987 started at the end of June, with flash floods in Sylhet and Sunamganj due to heavy rains. An increase in rainfall events can lead to a higher frequency of floods, particularly in the northeast and northwest regions (Mirza, 2003; Shahid, 2011).

Massive water flow from India

India surrounds the northeastern part of Bangladesh, and the entire northern part of Sunamganj has a border with Meghalaya of India. Cherrapunji in Meghalaya, the highest average rainfall region in the world, is adjacent to Sunamganj. As a result, if the Indian northeast area suffers from any natural disasters, its effects also fall on Bangladesh, particularly in the northeastern region. For instance, water streams come from India when the country experiences heavy rainfall. During the monsoon, the heavy precipitation in the upstream area generates massive runoff that flows through Bangladesh and drains to the Bay of Bengal through the narrow passage (Mirza et al., 2003). Sometimes, massive water flows run over the river bank and create floods. On June 16 and 17, 2022, Cherrapunji, Meghalaya, India, witnessed record-setting rainfall of 674 mm and 972 mm. Due to the water's downstream flow characteristic, this massive water flow rapidly traverses the India-Bangladesh border and reaches Sylhet (Deshwara & Chowdhury 2022; Sajid, 2022; Paul & Shuvo, 2023). Kabita Begum (35) retorted:

"Every year during the rainy season, we are put under pressure by India's abundant water flow. It sometimes plays a vital part in flooding by raising river water levels. By causing overflow during the rainy season and drought during the dry season, Indian water flow factors make our lives more perilous."

Excessive precipitation in frontier regions and the ensuing water flow was one of the main drivers of the 2022 flood. The Himalayas and Meghalaya plateau to the north, the Rajmahal Hills to the west, and the Tripura-Chittagong Hills to the east flank Bangladesh. It is part of the GBM (Ganges, Brahmaputra, and Megna) basin. The water of surrounding areas flows through this basin. Extreme rainfall in these areas affects Bangladesh. Sometimes, it cannot withstand the additional pressure of water flow and cause floods.

Making embankments and raising infrastructure

Most respondents blame unplanned Haor development for recurrent floods and their recent devastating impact. The construction of inappropriate infrastructures in the Haor region causes floods in two ways: These initially reduce the capacity for water to disperse and subsequently obstruct the

natural channels for water to flow south rapidly. Hayder (pseudonym, 60), Chairman of a Union Parishad, indicated:

"Embankments and other unnecessary constructions in Haor regions and rivers cause floods by obstructing water movement. New infrastructure like the Itna-Mithamoin-Austagram road, bridges, buildings, and housing areas block water flow to the south, increasing the risk of 2022-like floods."

A study reveals, from 1988 to 2020, an 87% decline in wetland coverage in Bangladesh's Haor area. Haor's infrastructure has risen from approximately 1,030 sq. km in 1988 to 3,872 sq. km in 2020 (bdnews24.com, 2022). This rapid infrastructure expansion and decreased wetland areas are equally responsible for flash floods in Haor areas. Improperly constructed embankments and roadways intended to preserve agricultural land blocked water movement and exacerbated floods in Sylhet. Infrastructure such as the Itna-Mithamoin-Austagram road has damaged the fragile Haor ecology. Experts accuse negligent infrastructure adjustments and flood-prone haor damage for increased flash flood frequency and severity (Zahid, 2022). However, a government official, Mohammad Manir (49), argued:

"Government infrastructure initiatives in the Haor region aim to facilitate its people and economy's well-being. Flash floods are natural events that are beyond human control. Effective government and community partnerships can help mitigate the damages caused by floods." He added – *"Due to resource constraints and other circumstances, our efforts to support the Haor people sometimes fall short of the desired level."*

Although he refrained from providing specific reasons behind these circumstances, it underscores the shortcomings of bureaucracy. The Bangladeshi bureaucracy is marred by corruption, favoritism, inefficiency, lack of credibility, and openness. Bureaucracy often falls short of expectations, and the politicization of public institutions becomes a significant concern (Ferdous, 2016). Hence, the need for more effective government-citizen dialogue on Haor development is evident.

Demographic pressure and encroachment/ destruction of Haors and rivers

Population increase in Haor areas is exerting pressure on the land. For this rising population, more land is required for housing, roads, and highways, which often causes flooding (Khalequzzaman, 1994). Unplanned urbanization and infrastructural expansion in cities and villages leave them more susceptible to floods, especially after prolonged rainfall (Rahman et al., 2012). Bhadol Chandra (45), a high school teacher, asserts:

"Let me show you a place that was once a water body. During the wet season, this body of water helps to consume the flood water. However, due to population growth, this water body area is being refilled with sand, dirt, etc., and houses and other infrastructure are being constructed. This is why Haor's water consumption capacity is gradually declining, resulting in recurrent major flooding."

Population growth is higher in Haor areas. Most villagers think more sons will strengthen the family and bring more wealth to the family. Sayel (39), an NGO employee, says:

"I have been working here since 2012. Haor poor people believe it would be a sin to control the birth rate voluntarily. Even former union chairmen have ten children. Several of them have married. Therefore, they require additional living space, but none is available in the existing one. Now, they are constructing homes on the Haor and riverbanks. These housing developments limit wetland areas and increase the risk of flooding."

Most water bodies, including rivers, are in terrible condition in Bangladesh due to climate change and human-caused factors. A survey on the Turag River showed 51 places where 1.5 acres of riverbanks have been seized and used for trade, commerce, and residences (Hossain, 2017). In 2019, the Water Development Board found 111 invaders occupying 3.6 km of Surma River in Sylhet city

(Das, 2022). For the past thirty years, Tanguar Haor and Hakaluki Haor have similarly seen decreased water bodies and increased cropland (Haque & Basak, 2017; Uddin et al., 2013). From 1955 to 2015, Tanguar Haor witnessed a reduction in water body area from 23,230 hectares to 12,870 hectares, with an average annual loss of 1.17% (Hussain & Islam, 2017). Another study in Lakshmibaur-Nalair Haor revealed that demographic pressure and upstream dam development contributed to the decrease in the deep water area. See the figures:
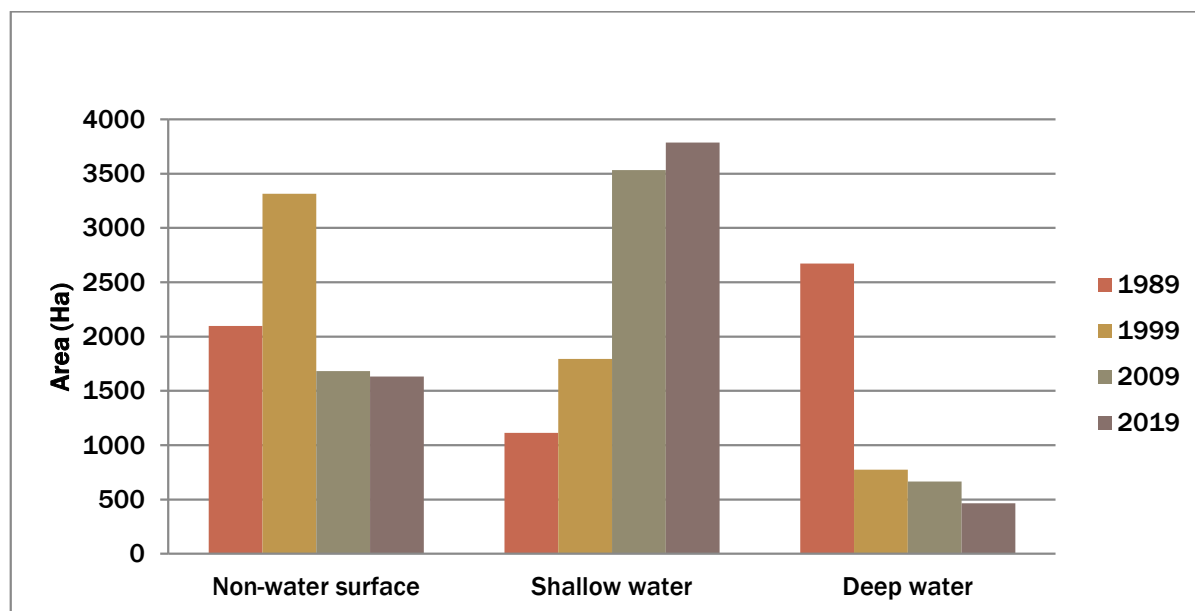

Figure 2 Lakshmibaur-Nalair Haor Land Coverage: 1989-2019
Source: Bhattacharjee et al. (2021)

On the way to data collection, we observed that houses are being constructed in open areas by filling them with soil because no space remains in their respective villages. The haphazard construction of houses raises the risk of recurrent flooding. Therefore, it is ostensible that demographic pressure and the destruction of wetlands have significant effects on Haor ecosystems.

Climate change effects

Bangladesh's coastal and northeastern areas have suffered the most from climate change. Climate change impacts in the northeastern Haor areas manifest as changing rainfall patterns, temperature fluctuations, increased frequency of natural disasters, and rise of diseases (Hossain et al., 2023). There is a concrete link between climate change and the increased severity and frequency of flooding in the Haor region. It is estimated that increasing rainfall levels will lead to more recurrent and earlier flash floods in the area (Haque, 2016; Suman et al., 2014; Nowreen, 2015, as cited in Kamruzzaman & Chowdhury, 2023). Kalek (24), a university student, said:

"In the past, we often observed that the weather predictions made by our elders regarding rain, cold, and heat were fairly accurate. However, in the present time, it has become exceedingly difficult to make weather predictions due to the shifting meteorological conditions. Early or excessive rainfall is now become a surprising and common issue. These changing climates adversely affect the living of Haor people."

Global warming, driven by the intensified greenhouse effect, is expected to significantly impact the hydrology and water supply of the GBM basins. This, in turn, can result in more severe floods in

Bangladesh (Mirza, 2002). Any sea level changes will modify the base level of all rivers. Rising sea levels are already affecting flooding. The greenhouse effect increases rainfall and storminess, thus worsening flooding problems. Therefore, global warming-induced climate change is causing an escalation in flood risks in the Haor regions of Bangladesh.

Corruption and lack of monitoring on the Haor development projects

Media reports have frequently linked flash floods to faulty dam construction, irregular repairs, corruption in Haor development projects, and inadequate monitoring. The ACC (Anti-Corruption Commission) filed a case on July 2, 2017, against contractors and BWDB (Bangladesh Water Development Board) officials. On February 10, 2019, five engineers, nine officials, and nineteen contractors were convicted, according to the FIR (Barkat et al., 2019). A respondent, Rahim (57), stated,

"Hereditarily, I reside near a dam. We complain and pressure concerned authorities to repair the dam on time yearly. Nevertheless, they do not care enough. After the crisis, public representatives and the government forgot what they promised. Because of floods, embankments break virtually every year, damaging crops. This happened due to their negligence and project errors."

Government officials and other stakeholders are frequently blamed for delayed dam repair projects. As a result, the project's completion is pushed back, leaving embankments vulnerable to flooding. This callousness is also to blame for the 2022 flood. Bijan Sen Roy, general secretary of Haor Bachao Andolon, said that the actions surrounding building crop safety dams in Sunamganj could be characterized as "looting by government officials, local politicians and influential people." Proper investigations should be carried out to examine these instances of corruption, and those involved should be held accountable. The farmers in Sunamganj rely heavily on Boro crops for their survival and often borrow money to cultivate them. Thus, the government must stand with the farmers (Roy, 2022).

Corruption in Haor areas has two forms: fraudulent practices in dam/embankment construction and repairs and systematic corruption within the Haor leasing system. Moreover, constructing unnecessary and unplanned dams also contributes to such corrupt practices. The three-tier monitoring system in high-risk zones, involving the public, mass media, and civil society, has also been considered weak (Barkat et al., 2019). So, improper Haor management and rampant corruption have made the region more vulnerable to flooding.

Cost of recurrent floods

The impacts of recurrent floods on the life and livelihood of people in Haor areas cannot be expressed in words. Flash floods' impacts include loss of lives and properties, damage to infrastructure, destruction of reserved crops, and deterioration of health conditions owing to waterborne diseases. Almost all the people of Sunamganj district were affected by the 2022 flood. People had to leave their homes and go to flood shelters to protect themselves and their children, where they faced a hard time. The study identified the following cost of recurrent floods to the Haor people by analyzing the consequences of the 2022 flood:

Losses of lives and properties

Every year, especially from May to August, Sylhet division has had to deal with flooding. Bangladeshis have seen countless floods in the past; nevertheless, the devastation caused by the flood of 2022 has surpassed all previous records. The event led to 141 deaths, infrastructure damage, housing destruction, agricultural and livestock damages, service interruptions, and employment losses. The estimated losses were BDT 67,550.84 million (MoDMR, 2023; UNDP, 2022). See the following numbers to estimate flood damages:
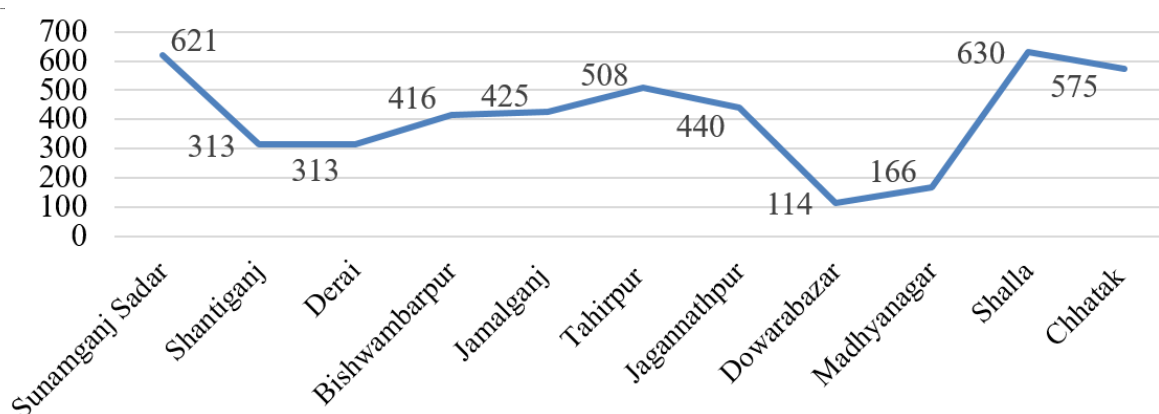
Figure 03 Number of damaged houses
Source: Field data (17-07-2022 MoDMR report collected from District Relief and Rehabilitation office, Sunamganj)

The flood damaged 186,703 houses, with 56,062 in Sunamganj and 48,066 in Sylhet. These two districts represent 45% of the total damaged or destroyed houses. In Sunamganj's Bishwambarpur Upazila, 96% of households experienced suffering, like death, disease, eviction, or loss of livelihood (UNDP, 2022; Biswas & Hoque, 2023).

According to many responders, the above list would have been more extensive if the official body had included the name correctly. Mojid and his wife, Sofia (age 64 and 47), stated:

"To save our family, we left our home soon after the flood started and moved to a flood shelter. We left the house empty-handed. The flood swept away our food reserves (Rice and Paddy). When we returned home, our home was so deplorable that we could not recognize it. The floods destroyed everything, including stock paddy, furniture, clothing, and other essentials. There was not even a pair of shoes for my children."

"The time was very miserable for us."- they added.

The effects of flooding differ according to individual factors and circumstances. A 45-year-old widow, Mariam Akther, living with two sons and an elderly mother-in-law, expressed:

"My family primarily relied on my earnings from the commercial vegetable garden in our backyard. I struggled to subsist for the next six months due to the destruction of my vegetable crops. During the most devastating days of the flood, I sought refuge in a nearby emergency shelter. However, I experienced shortages of safe water and women-friendly sanitation facilities at the center. In addition, despite being severely affected by the event, I did not receive government assistance, whereas some nearby males with fewer losses benefited."

The disastrous flood not only destroyed property but also resulted in the tragic loss of family members for some people. Drowning, lightning strikes, hill sliding, and waterborne diseases were the primary causes of these human casualties. The sufferings of the respondents vividly illustrate the extent of devastation caused by the 2022 flood. Despite criticism over delayed response, inadequate allocation, coordination issues, and corruption in relief distribution, government and NGO actions played a crucial role in minimizing losses during the flood and subsequent recovery phase.

Damages of infrastructure
Every flood has caused major destruction to the infrastructure, including roads, buildings, and bridges. Damage to rural roadways across 11 affected districts in the 2022 flood amounted to US$284.5

million. Nearly all rural roads were submerged by floodwater. More than 1,600 kilometers of road were damaged. Sunamganj, Sylhet, and Jamalpur districts witnessed the most severe damage to rural roads among the affected areas (MoDMR, 2023; Biswas & Hoque, 2023). Hundreds of bridges and culverts were either damaged or destroyed. The road has become so bad that motorbikes, three-wheelers, and even walking are difficult. Rashid Mia (27), a CNG-run auto-rickshaw driver, said:

"All roads were fully submerged during flooding, and the only way to access them was by boat rather than a three-wheeled vehicle. The flood washed the plaster and stones used on the Daukakhali-Brahmangaon-Ambari road. Like this, almost all the roads have been fully or partially damaged."

Roads between the Sadar and other upazila districts were unfit to use as most roads were severely damaged. In most Haor places in Sunamganj district, two-wheel vehicles like motorcycles are the only transportation medium. Dipankar (32), a motorcycle driver, opined:

"Sachna Bazar to Sunamganj by road used to take 40 minutes, but now it takes about two hours. Floods have tumbled down most roads. Each fiscal year, the government allocates funds to repair the damages caused by flash floods, but in reality, the roads remain highly vulnerable to even minor flash floods because of poor repair work. The government should take long-term sustainable measures in this regard."

Several respondents shared their dissatisfaction with the substandard construction and infrastructure maintenance, stating unequivocally that these are the primary causes of the flood's extensive infrastructure damage.

Losses in agriculture and business
Flash floods have profound effects on Haor agriculture. During the 2017 flood, 800,000 metric tonnes of Boro rice worth $450 million went down, while 44 metric tonnes of fish worth $52,000 died due to the disease outbreak (Kamal et al., 2018). A local newspaper reported that the 2022 flood cost the local aquaculture over BDT 140 crores. A total of 32,802 fish farmers and 5,258 hectares of carp fishery were directly impacted by heavy rain and flooding (Parvez, 2022). Moshiur (37), a small fishery owner, stated:

"Please do not make me emotional by recalling the 2022 flood. Even though there were many fish in the pond, I did not catch one since I planned on selling them a few days later for a decent price and profit. However, the flood swept away all the fish. I am still reeling from that loss."

Agriculture witnessed similar tragedies. According to the Department of Agriculture Extension (DAE), the back-to-back flash floods in north-eastern Bangladesh damaged crops worth over 11.13 billion BDT. They affected 429,401 farmers in the Sylhet division. The flood destroyed Aush, Boro, Aman, vegetable, and nut crops worth BDT 561.85 crores, 115.81 crores, 367.76 crores, and 88.56 lakhs, respectively (Hossain & Monir, 2022). The combined damage to agriculture and fisheries was estimated at US$ 196.77 million. The loss of livestock significantly affected the livelihoods of low-income people (UNDP, 2022). Many small and medium-sized businesses also experienced significant losses. A 22-year-old local businessman, Robin Paul, remarked:

"My newly built shop was higher than other shops in the market, and yet I slept in the shop that night due to fear of flooding, and in the middle of the night, I suddenly woke up feeling like my bed was wet. Within minutes, my shop filled with water, and everything was smashed by the heavy water flowing in front of my eyes. If this was my condition, imagine others!"

A similar comment was made by another respondent, Abdus Salam (65):

"I have not seen such a flood in my 65 years. This flood destroyed my shop and cost over BDT 2500000. I lost my only income source in a moment. I cannot ask relatives for money because they are also in a similar situation, and I did not get government assistance without some NGO loans."

Haor business ventures are small in terms of investment, yet these small enterprises are their only source of income. If, in any case, Haor people lose their reserved food grains, such as paddy, rice,

wheat, corn, seeds, and self-employed small enterprises. It is almost impossible for them to survive and recover from these losses without financial assistance.

Effects on education

Floods in the education sector have long-term consequences, including school closures, rising dropout rates, and increased absenteeism when schools operate as rescue centers. These consequences severely compromise children's schooling while making recovery challenging. Research examining the effects of floods on education has shown that the consequences extend beyond the school setting, impacting not only students and teachers but also parents, communities, and infrastructure (Munsaka & Mutasa, 2020; Lassa et al., 2023). The flood of 2022 had a significant impact on education. Due to the flooding, over 750 schools were closed in May and June 2022. Approximately 12% of schools in Netrokona, Sunamganj, and Sylhet districts were turned into shelters. Damage to the education sector was estimated at USD 5.9 million. Sunamganj was the most severely affected, with 195.34 million BDT in educational infrastructure losses (Paul & Shuvo, 2023; UNDP, 2022). The 2022 flood has had negative educational repercussions on both students and educators. Nalini (19), a second-time higher secondary examinee, said,

"There was no electricity for about twenty days, and we were enveloped by water. There was even water inside the house for seven to eight days. The circumstances prevented me from studying and schooling for at least three months."

Students faced different kinds of challenges. Rahul (20), a college student, described his study situation as below:

"On a flooding night, when everyone was screaming, I woke up and saw the water level rising swiftly and almost above my knees. I picked up a few books while the water swept away others. It seemed like I may not be able to take my final exams since my family's financial condition was so awful; however, the government and a few non-profit organizations helped me overcome this terrible circumstance."

Natural disasters force 169,296 students to drop out of school yearly, according to the Bangladesh Bureau of Statistics (BBS). From 2015 to 2020, 1,015,777 children had to stop schooling, and 2 60,876 dropped out due to flooding. During these years, children from the Sylhet Division accounted for 17.91% of total dropouts (the highest among all divisions). The 2022 flash floods in 17 districts of the country's north, north-eastern, and south-eastern regions caused almost 500,000 students to drop out of school (Rita & Kabir, 2022; Rahman, 2022). Teachers and students have confirmed the adverse effects of floods in interviews.

Increased internal migration

The Internal Displacement Monitoring Centre reports that annually, floods displace one million people, and cyclones uproot 110,000 individuals in Bangladesh. Every day, 2,000 people move to Dhaka, of which 70% are due to natural calamities and climate change (Illius, 2023). Thousands of people in the Sunamganj district have fled their homes as climate refugees/migrants due to flash floods over the years. Following the 2022 flood, many families moved to cities such as Dhaka and Chittagong in search of work and a better life because they had lost everything and had no choice but to move on. It was a typical scene in Sunamganj. Rashida Begum (57), a teacher, talked about the issue:

"I have been teaching here for more than a decade. This area is more vulnerable to natural disasters, and work is available only in agriculture. People who live in this area cultivate paddy and other crops. However, floods destroy their crops and homes. Due to the flash flood effect on agricultural production each year, people are forced to migrate to large cities for work. During the last 2022 flood, I saw at least three families relocate to town and change their profession."

We found several locked houses. Some families rely solely on their elderly parents to manage their property. They (elderly parents) shared their grief and loneliness with us.

Impact on social life

Floods have both short- and long-term social effects. The destruction of homes, crops, or livestock and the loss of life/injuries are the visible and direct societal impacts of floods. Floods have indirect/ silent effects, such as lower production for supply chain disruption, psychiatric disorders, and poverty-related societal anomalies (Bubeck et al., 2017). The 50-year-old Morin Ahmed's comments perfectly mirror the flood's effects.

"I have lost everything. The flood destroyed my food reserves. I am the most miserable person in the world, as I do not know how to feed my children tomorrow. My children are not attending school because I cannot pay their fees. Sometimes suicidal thoughts arise."

Most people in the Sunamganj district suffered during the massive flooding, and they now face various socioeconomic challenges. Flood's immediate costs were the loss of lives and property. People lost loved ones, crops, and cattle, among other things. People in the affected regions still suffer from several waterborne infections. Floods degrade people from poverty to extreme poverty, pushing their school-aged children to leave their books and uniforms and seek employment to survive (Rahman, 2022). Migration, child labor, malnutrition, and the early marriage of girls are among the most severe post-flood problems facing the Sunamganj Haor people (Haque, 2022). A woman respondent, Parbin Begum (35), stated:

"My husband has never been abusive, but the flood pushed us to act aggressively. He pressured me to approach my father for money for his business during and after the disaster, but I refused. Unfortunately, this led to his second marriage, where he got the money to reinvest in business. Now, quarrels have become an everyday matter in my family."

The 2022 flash flood has inflicted numerous health issues and long-lasting psychological distress on women. Reports indicate that 89% experienced severe or extremely severe depression, 88% faced anxiety, and 58% dealt with high levels of stress, primarily due to family violence during the flood (Rahman et al., 2023). Hence, the 2022 flood has had substantial social consequences, like previous floods.

Concluding remarks

Floods have become routine, especially in northeastern Bangladesh. The flash floods in Bangladesh are caused by many factors, including river bed siltation, massive water flow from India, poor embankments and infrastructure development, population pressure, river erosion, climate change-related massive rainfall, and more. The effects of recent floods are unbearable and inexpressible. The people of the Haor area, especially Sunamganj, still live in awful situations because of the 2022 flood. The 2022 flash flood nearly destroyed the socioeconomic cycle of the Haor area. A proper action framework based on sustainability may be the solution to save the economy and people of the Haor region. This study proposes measures below to mitigate and offset Haor casualties during and after flash floods:

1. Establish a scientific body responsible for forecasting flash floods through meteorological and precipitation analysis and surveillance. A simple scientific warning system may be developed in the Hoar region to keep residents informed about flooding.

2. A research body comprised of agriculturalists could be set up to explore flood-resistant crops and a new agricultural seasonal system to avoid the devastation caused by flash floods. Specialized agricultural loans and crop insurance programs can be designed to offset flash flood losses. A Haor-specific fund can be included in the budget to provide cash assistance to individuals directly impacted by floods.

3. A people-government-NGO joint action committee may be formed to build trust and coordinate large-scale projects. A quick crisis-response system like the Haor crisis management cooperative society can be established, including the people, government representatives, and non-governmental organizations.

4. A statutory task force/Haor development authority/umbrella agency might oversee all development projects in Haor areas. This body can draft a regulation regarding local housing in the Hoar areas.

5. To diversify the Haor people's livelihoods, the government can create an eco-friendly Haor tourism division under the Bangladesh Tourism Board to promote the Haor-based tourism industry.

6. The government should establish a dedicated river budget aligned with a long-term sustainable approach for river dredging. A non-bailable regulation can be introduced to prevent encroachment. The strict enforcement of mandatory social and environmental feasibility studies prior to infrastructure projects must be prioritized.

7. Bangladesh should undertake diplomatic efforts and engage in bilateral dialogue with India to address transboundary river issues, specifically dams and barrages in the northeastern zone.

*The Partial result of the paper was presented on January 7, 2023, at the 2nd International Conference on Social Work and Sustainable Development 2023, organized by the Department of Social Work, SUST, Bangladesh.

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