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VULNERABILITY ENFORCED BY THE TEESTA RIVER FLOW AND COPING STRATEGIES OF LOCAL COMMUNITIES IN BANGLADESH

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ABSTRACT

The sharing of Teesta water has long been a contentious issue between India and Bangladesh. The substantial flow of water during the monsoon season, coupled with considerable withdrawals in the dry season, has precipitated a range of socio-economic and environmental challenges. These challenges manifest as desertification, flooding, river erosion, and alterations in the social and economic landscape of Bangladesh. In this context, this study examines the socio-economic transformations occurring within the communities along the Teesta riverbank, in relation to the dynamics of its water flow. To this end, a qualitative approach, which included in-depth interviews, case study interviews, and key informant interviews, was followed. A few communities in Gangachora Upazila, Rangpur District, Bangladesh, were selected as the study sites. This study argues that the dynamics of water flow exert a significant influence on various

social institutions, including family structures, marital practices, settlements, and social networks. The dissolution of joint families, the transition from clustered to dispersed settlements, the transformation of social networks into conflicts, and the persistence of child marriage have all emerged as consequences of the flow of the Teesta River. Nevertheless, the communities have exhibited remarkable ingenuity by embracing adaptive strategies, including migration, alterations to their livelihoods, and refinements in agricultural practices. Moreover, the appearance of new sandbars and dunes has led to new economic dynamics, utilising the new territories for farming and harnessing alternative crop production. The study contends that acknowledging and assessing these coping mechanisms, stemming from the varied livelihoods along the Teesta riverbank, is intrinsically linked to vulnerability. This necessitates a shift from conventional adaptation to local community-driven coping strategies.

Keywords: Flood, social change, vulnerability, crop diversification, coping strategies

INTRODUCTION

Rivers are inherent demarcations between neighbouring land masses, defining a nation's geographical limits (Krause 2016; Leisher et al. 2022). The main rivers in South Asia are linked together, working in a way that can be thought of as a network of rivers that share many important historical, social, and cultural features. Espousing this view, it is apparent that Teesta is one of the significant transboundary rivers (Zannah et al. 2020; Basu 2022), demarcating the boundaries between India and Bangladesh (Bari and Haque 2016). This study has examined how the river's transboundary nature has resulted in tensions and conflicts (Mirchandani 2016), and the construction of a barrage upstream (Ghosh 2014) has significantly reduced the water flow within the northern part of Bangladesh (Islam and Higano 2002). Therefore, the inter-state water sharing dispute between Bangladesh and India causes a limited water influx in the Teesta River located in Bangladesh, resulting in a detrimental effect on the community people in terms of economy, agriculture, and their daily lives. Specifically, this study shows how the Teesta Barrage Project has seriously disrupted water distribution during the dry season when Bangladesh receives less water from the Teesta River since India uses a significant amount of its water for internal use. This impacts agriculture, resulting in crop failures and jeopardising food security for community people who are residing beside the Teesta River. Furthermore, during the monsoon season, when India releases water from the barrage, Bangladesh experiences an abrupt and excessive water flow, leading to severe floods and river erosion. This results in the destruction of houses, infrastructure, and farmland, forcing thousands of people to flee their homes. In this context, this study focusses on externalities, considers complex issues, and seeks to shed light on how the community members in the Teesta riverbank area are negatively impacted.

Among other contributing factors, Bangladesh's disaster-prone geographical location (Alam et al. 2020) and its high vulnerability to climate change (Azam and Rahman 2022) significantly impact the lives of local inhabitants. Additionally, the unequal distribution of resources further marginalises certain groups of people (Parvin et al. 2024). As the intricacy of rivers and water continues, reflecting the natural connectivity, simultaneously, the portrayal of water from its social context has come under heightened scrutiny underpinning cultural, religious, and political aspects (Wantzen et al. 2016; Magdaleno 2018; Anderson et al. 2019).

In the current socio-economic context, vulnerability results from social construction as a precondition or outcome with a broad interdisciplinary emphasis (McFadden and Green 2007; Biswas and Nautiyal 2023). The idea of vulnerability is not an absolute measure of deprivation but rather one that suggests consequences and distinguishes across socioeconomic groups or locations (Adger and Kelly 1999). Hoque et al. (2022) demonstrated that the vulnerability

arises from three perspectives: (1) social; (2) economic; and 3) environmental with some unsurmountable consequences (Sneddon 2002; Cao et al. 2022; Xi et al. 2022), resulting in social conflict, economic insolvency, and ecological degradation (Souza et al. 2015; Xie et al. 2021; Calderón et al. 2022). Furthermore, Rufat (2024) characterises vulnerability as a complex and multifaceted social space constructed on the premise of political, economic, and institutional capabilities (Bohle et al. 1994). In line with this remark, the study focuses on Teesta and its periphery areas as a diverse and multilayered social space with direct and indirect repercussions on social institutions and climate-related changes, including desertification, floods, and river erosion.

As such, sequestering vulnerability from coping strategies would be irrelevant, as both terms are interrelated. Blaikie et al. (2004) support this argument by describing vulnerability as the ability of an individual or group to foresee and adapt to a vulnerable circumstance. In addition, Burkett and Davidson (2012) contend that coping is a behavioural response to exposure to extreme or persistent natural events that inversely correlates with vulnerability. In other words, the more the coping capability of a system, area, community, or individual, the less vulnerable it is. Bhuiyan et al. (2017) studied the impacts and livelihood vulnerability along the Padma River in greater detail. They observed the lack of industrial or developmental infrastructure due to riverbank erosion, followed by damage to the local market and the relocation of educational institutions. Another observation was attributed to the disappearance of indigenous or homestead trees due to erosion. Uddin and Rahman (2011) argue that riverbank erosion has a detrimental impact on agriculture and results in variations in cropping patterns, production loss, variability in cropping intensity, and crop damage. Similarly, due to riverbank erosion in the Teesta River area coupled with floods, groundwater becomes contaminated, and freshwater is hard to come by. Therefore, several waterborne diseases spread among community members, which brought another massive epidemic in the Teesta River zone (Sultana 2020).

Against the backdrop, this study explores: (1) How socio-economic changes and vulnerability are interconnected to the Teesta water flow?; (2) What are the coping mechanisms available to local people?; and (3) How coping mechanisms are leading to particular socio-natural forms that facilitate the overarching principles of sustainable livelihood management?

LITERARURE REVIEW

The Teesta River flows by connecting people, places, and other life forms, impinging and intersecting values, norms, and culture; nevertheless, water disputes and the dynamic climate change phenomenon have facilitated forced migration, riverbank erosion, and loss of agricultural land, eventually manifesting in economic, social, and psychological suffering (Mamun et al. 2022). Following the drastic change in the domain of the study area, this research will try to explore two strands of literature in the context of Bangladesh, namely vulnerability and adaptation.

The first strand will examine the literature on vulnerability in the context of relative changes in social conditions, environmental change, and climate. Concerning vulnerability, Islam (2018) stated that river erosions in the Bhola District decreased people's livelihood options. Similarly, Alam et al. (2018) found that the Jamuna River erosions contributed to the loss of land and employment opportunities. In terms of migration, a vast array of literature underscores migration as a dominating factor as it contributes to rural household's decision to migrate temporarily or permanently in terms of internal and external parameters (Paul and Islam 2015;

Islam and Hasan 2016; Islam and Shamsuddoha 2017; Islam 2018; Islam and Khan 2018; Alam et al. 2020). For example, Islam (2018) studied twenty-eight char lands (sand lands) in the three northern districts and found that people living on these chars are compelled to migrate from one char to another due to the complex interactions between climate change, natural disasters, and socio-economic vulnerabilities. Sultana (2022) observed that both men and women look for alternate livelihoods to deal with the situation and boost resistance to riverine risks. In contrast, vulnerability also induces urban migration in vast urban slums due to abrupt economic shifts and lacking fundamental amenities (Islam and Hasan 2016; Islam and Shamsuddoha 2017). Through the cross-sectional lens of vulnerability, this study explored every angle of challenge prevailing among the community people of the Teesta River area. For example, settlements, crops, and grazing fields near the riverbanks are more susceptible to this climate vulnerability, making community people more disappointed and having nothing left for survival. Moreover, the community notably reported that flood water facilitates the perilous insects to come out, and mosquito bites are more common during this season. Furthermore, another crisis arises when new land emerges in the river channel after floods, raising social conflict and violence in claiming ownership of the char (new land). However, researchers ignored how social detachment, like temporary or permanent migration, causes a long-term impact on their social bonding, which they have been practicing for decades. This study found that the joined families are dispersed due to the inevitable consequences of environmental vulnerability and migrated to the feasible zone to find new job opportunities and permanent settlements; this is how their social norms, cultural authenticity, and structure have collapsed.

In the domain of social dynamics, Islam (2018), Islam and Shamsuddoha (2017), and Islam and Hasan (2016) have stated that pregnant women, aged individuals, and disabled individuals are susceptible to river erosion. Furthermore, social detachment (Long et al. 2007), health issues (Cheng et al. 2018), poverty (Najmuddin et al. 2017), and violence toward women (Jin et al. 2018) are the foreseen consequences that exacerbate their livelihood patterns during the river erosion and flood season. For children and elderly persons, for instance, child marriage becomes a more inexorable event to relieve the burden of a female child (Sultana 2022). Similarly, Ferdous and Mallick (2019) revealed that women are the most sufferer of all the vulnerable groups, not just because of their gender roles and responsibilities but also because of discriminatory social norms and practices that further impede women's economic empowerment and mobility, such as the dowry system (Mou et al. 2022), early marriage (Sultana 2021), lack of education, and acceptance of domestic violence against women (Rahim at al. 2024). Additionally, women encounter internal violence once they fail to give birth to male children, who are expected to be more capable enough to provide financial assistance during their emergency (Das et al. 2022).

The second strand elucidates coping strategies through investigation of existing literature. Ferdous et al. (2020) examined how the Teesta River brings into people's lives that community members are progressively altering their precarious circumstances and acquiring new survival and living skills to become more resilient against challenges. Moreover, the passive and marginalised women are reinvigorating the local economy by conserving money and making pre-disaster plans to protect their families during a crisis (Ferdous and Mallick 2019). In another study, Keya and Harun (2007) looked at riverbank erosion's psychological stress on women in Bangladesh. They found that displaced women engage in various coping strategies, such as a more positive reassessment of their circumstances and seeking social assistance. Al-Maruf et al. (2023) discovered the various resources that influence the ability to withstand windstorms in coastal Bangladesh's extremely susceptible ecological setting. In this case, human capital is a crucial and essential resource that permits and promotes the utilisation of additional resources in

households' actions after floods, storm surges, and other cyclone-related destruction. According to Al Mamun and Al Pavel (2014), indigenous knowledge systems can be developed by the flood-affected people of Bangladesh to respond to changes in the climate in their farming methods. These systems can involve various strategies for adapting to climate change, such as growing common crops and assessing their economic viability.

Regarding coping mechanisms, Rahman et al. (2013) proposed that the most effective approach to expanding tree canopy cover while promoting a sustainable environment is to encourage the adoption of non-conventional agroforestry methods in the riverbank area. Another study by Rahman and Gain (2020) on adaptation strategies to riverbank erosion in Koyra Upazila in Bangladesh found that the majority of people adjusted or coped by cutting back on meals while maintaining food security, while others used low- or no-interest loans from family, neighbours, and donation organisations to offset the effects of river erosion. Chassiot et al. (2020) argued that families adapted by having fewer school-age children or by having their children drop out of formal education.

This study is unique under the critical paradigm because it includes and assesses new factors that arise from social challenges linked to continuing vulnerability. This necessitates a shift from conventional adaptation to creative coping techniques. Previous studies have addressed one or two aspects in the micro lens setting but have not delineated the contextual connection between environmental impacts, vulnerability, and adaptation strategies of riverbank communities over the years. Therefore, in the opinion of the researchers, this study is novel since the implications are applied and integrated with the critical research paradigm. Moreover, this pioneering study demonstrated a conceptual framework where vulnerability measures and coping strategies are discussed, adding more conceptual ideas to the existing literature.

CONCEPTUAL FRAMEWORK

Mekonen and Berlie (2021) provided a conceptual model that explained livelihood vulnerability in terms of exposure, sensitivity, and adaptive capacity, evaluating the fundamental methods for comprehending the influences of climate change and development difficulties in many contexts. On the other hand, Tran et al. (2021) examined the fact that the inhabitants of the coastal area are more susceptible to climate vulnerability and provided a clear understanding of what strategies and policies should be utilised to adapt to climate change. Hoque et al. (2022) highlighted an inclusive vulnerability model by examining the absolute challenges and how the community people should react and change their livelihood patterns during environmental hazards. After the conceptualisation of this study, vulnerability theory is the most relevant theory that could be incorporated into this study. Therefore, the researchers designed a holistic conceptual model based on inclusive vulnerability theory, where risk perception, vulnerability level, and adaptive measures were considered for this study. Moreover, some indispensable issues and sustainable recommendations have been added that generate a broader view of livelihood vulnerability and provide a sustainable solution for the community in the Teesta riverbank area.

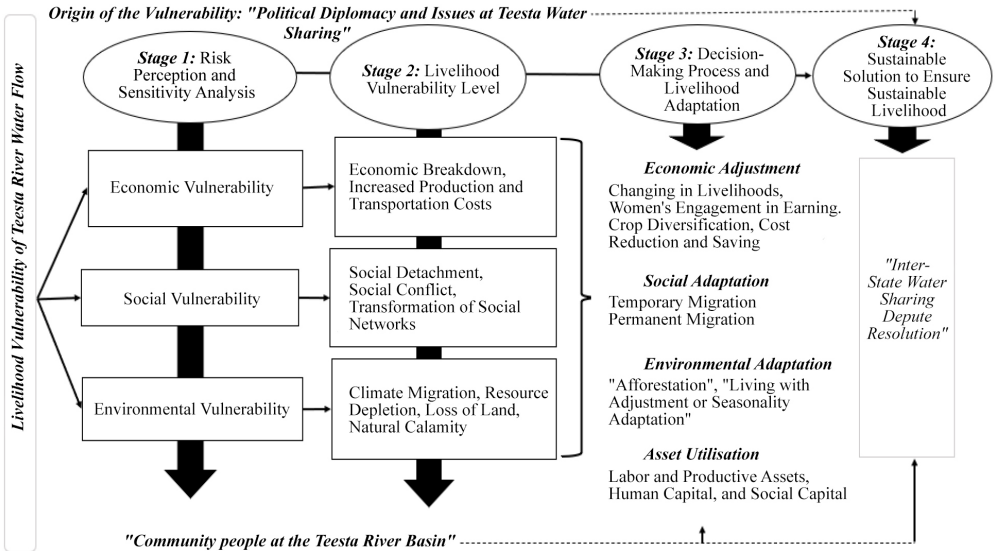

Figure 1: Conceptual framework of livelihood vulnerability and adaptation at Teesta River area.

The origin of the vulnerability derives from the inter-state water-sharing dispute between Bangladesh and India that has lasted for decades. Therefore, the arrow goes down from the political issue to the community level, demonstrating the Teesta River's detrimental effect (see: Stage 1 and Stage 2). The conceptual figure draws multiple facets of the livelihood vulnerability in the Teesta River area, covering four rudimentary stages: (1) risk perception and sensitivity analysis; (2) livelihood vulnerability level; (3) decision-making process and livelihood adaptation; and (4) sustainable solutions to ensure sustainable lifestyle. The first three stages describe how the community encounters challenges concatenated into three subcategories, including economic, social, and environmental vulnerability. After that, these challenges trigger the upshots of livelihood vulnerability level with several inevitable consequences, covering economic breakdown, social detachment, and climate migration at the Teesta riverbank area. The later stage gives ample insinuations on how the community can adapt to challenges by embracing several strategies and changing their livelihood patterns, including economic adjustment, social adaptation, environmental adaptation, and asset utility. Most significantly, the last stage provides a sustainable solution that emphasises the inter-state water-sharing dispute resolution between Bangladesh and India. Therefore, political diplomacy and community involvement are essential to come up with a reasoned conclusion on how these challenges can be annihilated.

Concerning the macroscopic picture, this framework (as shown in Figure 1) can be utilised in various ways, as the purview of a holistic theme is brought to mitigate the gaps. This scholarship argues that the magnitudes of these stages are inherently unique; congregating and synchronising all these steps will lead to tackling the livelihood vulnerability of Teesta inhabitants. This article also contends that leveraging this conceptual framework can be directed towards other major rivers in Bangladesh, such as Meghna, Padma, Jamuna, etc. Not to mention, these rivers also experience constant flash flooding and damage to the river-based ecosystem, including socio-economic disparities, shifting cultivation patterns, deforestation, soil degradation, sedimentation, and, most significantly, climate change. Each of the rivers has a unique geographical boundary (transboundary) as well as complex navigation, coupled with dynamic relationships associated with socio-economic and political caveats; hence, comparing and justifying the different parameters of Teesta and other rivers can have substantial outcomes

to mitigate the negative effects for a longer period. On the contrary, the Teesta water sharing has been a contentious issue for several decades, lacking concerted effort between the two countries. In light of this issue, the framework suggests that owing to sustainable practice incorporated with livelihood vulnerability and political diplomacy can render a win-win situation for both countries. As the discerning conflicts become tighter, the flexibility of the corresponding framework can provide the leeway for further institutionalisation of this problem.

RESEARCH APPROACH

This research has adopted a qualitative approach due to its ability to provide comprehensive and detailed insights into the social processes and human behaviour that arise from environmental concerns. Subsequently, a narrative inquiry methodology was used. Hara (1995) asserts that qualitative research has a level of sophistication and can investigate intricate social issues. The primary focus of this research is to ascertain the variables and gain insights into the socio-economic transformations occurring in the communities residing along the Teesta riverbank, specifically about its water flow. In this context, narrative research seems most suitable due to its interpretative capacity to extract significance from narratives, therefore, revealing human cognition via storytelling that links different events through sequential plot development (Sarbin 1986). From an epistemological standpoint, narrative research acknowledges and values the subjective nature and many interpretations of reality (Wertz et al. 2011). According to the Personal Narratives Group (1989), people's narratives are increasingly recognised as being rich and thought-provoking. These narratives have the potential to provide fresh insights and foster a deeper understanding of the diverse and intricate nature of a particular phenomenon within a specific context. In recent years, there has been a notable surge in scholarly interest in stories as a research tool (Trahar 2011). According to Franzosi (1998), narrative texts include significant sociological information, and a substantial portion of empirical data is presented as narratives. Nevertheless, a limited amount of scholarly research has been dedicated to examining the narratives of individuals belonging to the communities living along the Teesta riverbank in the northern region of Bangladesh. This research aims to assess the influence of the water flow in the Teesta River by examining participants' personal experiences and exploring their perspectives to elucidate the significance of their lived experiences.

The Teesta River enters Bangladesh through Domar Upazila in the Nilphamari District after flowing through the southern portion of the Jalpaiguri District in West Bengal, India. However, India, specifically Malbazar Town in Jalpaiguri, has constructed an irrigation barrage on the Indian side of the Teesta. The Teesta Barrage acts as a blockade and diverts the water flow. For collecting primary data, fieldwork has been conducted on the communities of Lakshmitary, Mohishkhocha, and Khuniagaach in the Gangachora Upazila of the Rangpur District in Bangladesh, next to Nilphamari District, whose socio-economic patterns, the natural biodiversity, and the ecosystem of the area are the significant issues to research. The area was chosen because locals are frequently affected by the flow of Teesta water; however, not much in-depth research has been conducted about this part of Bangladesh (as shown in Figure 2).

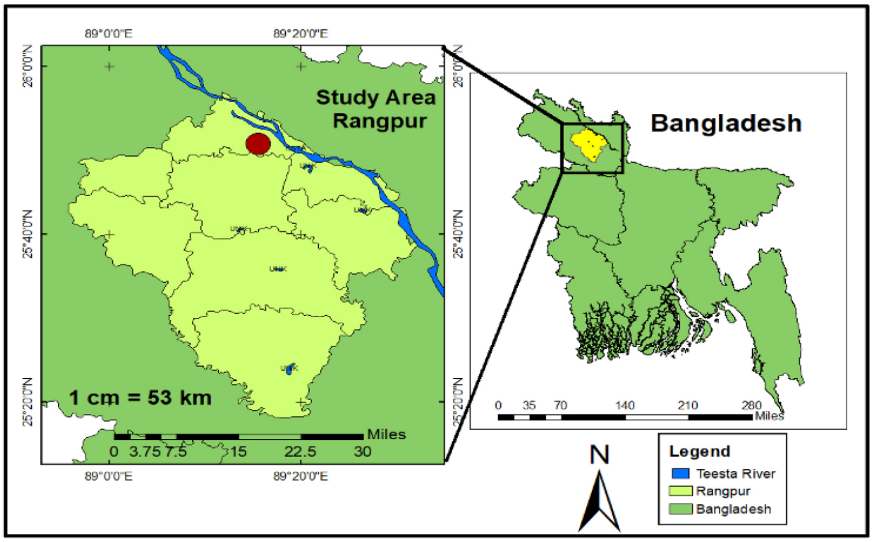

Figure 2: Map of the study area.

It is also important to illustrate the rainy season and lean season in the northern part of Bangladesh. A monthly rainfall outlook for the study area and nearby district is extracted from the Bangladesh Meteorological Department (BMD 2023). The monthly rainfall drastically drops after the expulsion of precious monsoon days. The study area communities experience good rainfall during June, July, August, and September, as the monsoons are active all over the country. Hence, November, December, January, February and March are considered the dry season in Bangladesh (as shown in Figure 3).

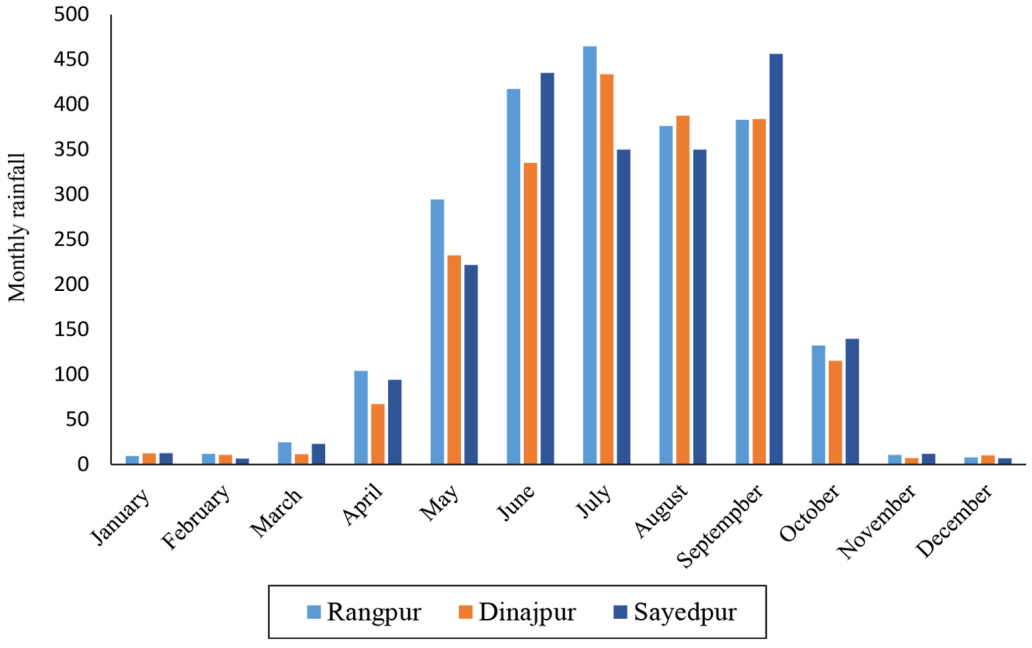

Figure 3: Monthly rainfall outlook.
Source: BMD (2023).

Data were collected from both primary and secondary sources for this study. To collect primary data, in-depth interview (II), case study interview (CSI), key informant interview (KII), and expert conversation (EC) were used as narrative inquiries. The sample size was thirty-four, and the possible respondents were contacted following snowball sampling. The utilisation of II as a qualitative research method proves to be highly effective in situations where the scope of investigation is limited, the participants are representative of a well-defined and homogeneous group with a known context, the participants are accustomed to and familiar with interviews as a mode of communication, and the objective is to generate themes and narratives (Crabtree and Miller 2023). The method was utilised in this research to identify and compare the living experiences of six residents who live in the study communities and are affected by the Teesta river water flow. Besides, this study included an interview of eighteen cases involving various community members, such as farmers, fishermen, carpenters, and small merchants. A guideline was used to facilitate the interviews, with the aim of comprehending the underlying dynamics within these particular contexts. The case studies address a condition characterised by a higher number of variables of interest compared to the available data points, presenting a practically distinctive scenario. Consequently, this not only generates theoretical assumptions but also produces proof derived from many sources, ensuring that the data converges in a triangulating manner (Yin 2018). In addition, this study has undertaken six KIIs to investigate the historical context and broader implications, both locally and nationally, of the water flow of Teesta River. The research aims to examine the coping mechanisms used by community members living in the vicinity of the river. The key informants include individuals such as local leaders, representatives, school teachers, and senior members of the community. The informants distinguish themselves from others by their unique position within the given culture, their profound connection to the study issue, and their possession of specialised expertise, social status, and exceptional communication skills (Crabtree and Miller 2023). To provide a comprehensive analysis of the data gathered from the study communities, a series of ECs was held with officials from the Bangladesh Water Development Board. In this particular instance, a predetermined framework was developed, with a specific emphasis on the six key domains proposed by Timperley (2015), namely, process, knowledge, culture, resources, context, and connections.

Following the completion of fieldwork, the data was transcribed and then subjected to coding. In this particular instance, a mix of alpha-numerical combinations was used for the purpose of encoding the data. An instance of LT/KII-3 denotes a KII conducted with participant number 3 belonging to the Lakshmitary community. The same coding method was used on other participants (see Table 1). Subsequently, the tales provided by the participants were subjected to a thematic analysis, since it is a frequently used method of analysis in the field of narrative research (Wertz et al. 2011). To effectively record and examine life experiences, the narratives provided by the respondents were presented into several themes that possess distinct interpretations. To ensure the validity of the data, triangulation was done. In this instance, the data collected from IIs and CSIs have been juxtaposed with KIIs and expert dialogues. The data analysis incorporates verbatim quotations to enhance data quality and provide a comprehensive understanding of the research populations' actual circumstances. Subsequently, inductive reasoning was followed to explore potential patterns that more accurately depict the impact of Teesta River flow and coping strategies when applied to a broader range of theoretical assumptions.

Table 1: Sample distribution

Community/Institution	Region code	CSI	KII	II	EC	Total
Laksmitary	LT	6	3	2	1	12
Mohishkhocha	MK	8	2	2	–	12
Khunigaach	KG	4	1	2	–	7
Water Development Board Office (WDBO)	WDBO	–	–	–	3	3
Total		18	6	6	4	34

RESULTS AND ANALYSIS

Teesta River Inciting New Family Composition and Cyclic Displacement

Families living along the riverbed face unthinkable hardship and are isolated from their loved ones (Alam et al. 2020), signifying social institution disintegration. Teesta has a detrimental influence on this social institution since the inconsistency of water supply aggravates the lives of family members, destroying the traditional joint family arrangement. Furthermore, regular floods and erosion push residents to devise new survival strategies, separating them from families and limiting them to the community. Within the research site, Bashir Ali was living with his married offspring and grandchildren in a joint family. However, due to the detrimental effects of river erosion, the sons were driven to establish new dwellings on distinct sandbars. The management of space in sandbars posed significant challenges for the displaced people. The potential hazards of violence and intrusion were considerable in scale and could not be easily dismissed. Moreover, the concept of char land exhibits a notable degree of flexibility, hence, facilitating the mobility of its residents. In addition, the relocation of char residents is an intrinsic component of the cyclical process (Islam and Higano 1999). This cyclic process is reflected in the narration of Bashir Ali's eldest son:

> We used to live as a joint family, but as a consequence of river erosion, our dwelling was destroyed in 2009. Consequently, my whole family, together with my three uncles, sought refuge in dams. When things got better, my two uncles proceeded to construct new residences on sandbars, therefore, leading to our relocation to the present village. (KII/MK-1)

Unfolding the Unlocked Insights on Child Marriage

Natural disasters typically cause anxiety and depression in women and children (Bhuiyan et al. 2017). Schafer et al. (2018) examined the relationship between early marriage and natural disasters and determined that economic destruction increased the likelihood of child marriage. It is noteworthy that the majority of community guardians expressed their decision to arrange early marriages for their daughters as a response to the vulnerability and instability experienced during the period of flooding and river erosion (as shown in Figure 4). This is reflected in the following statement from the father of a married daughter:

> Teesta engulfed my farming land and house three years ago. When I lost my home, my family and I sought refuge on local roads. My wife and children heard foul words from bystanders during our midnight stay on the roadways. They would sometimes scare my wife with kidnapping my children. As a result, all the houses of Khuniagaach char marry off their unmarried daughters before the flood season. (CSI/KG-2)

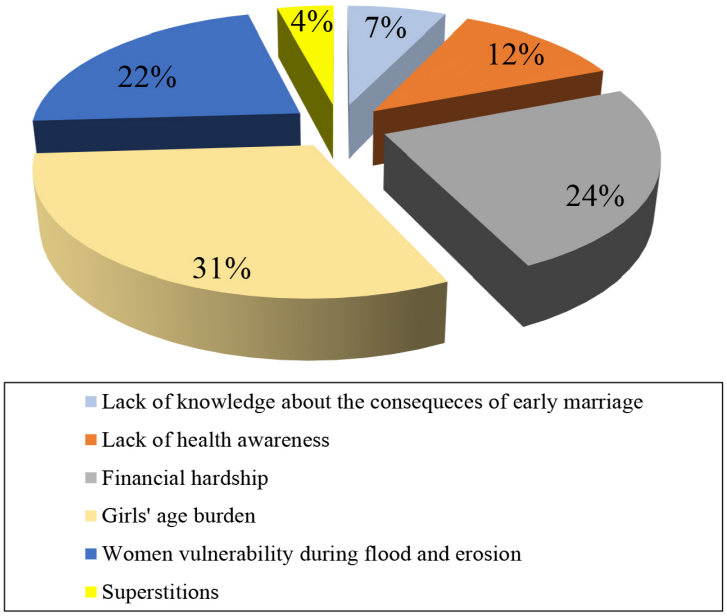

Figure 4: Community perceptions about child marriage.

It appears that households practice child marriage as a coping mechanism because they are more vulnerable to natural disasters. Some respondents who have daughters desire to postpone their daughters' marriages due to the prevalent experience that the older a female is, the higher her dowry will be. Thus, this dowry will be a significant burden for these families. Because of this reality, even if a family has the financial means to provide their daughter with a better level of education, the dowry system restricts the girls' educational opportunities. This is reflected in the case of a 29-year-old mother:

> Despite our utmost efforts, we are unable to provide our daughter with education due to dowry. She is becoming older. It is crucial to expedite the arrangement of an early marriage for her, as any delay may result in a significant dowry burden for our family. (CSI/MK-8)

Women are the Primary Absorbers of the Teesta Effect

Migrant women may give up their morality and dignity (Stacey 2005). For example, women in urban areas work in the ready-made garment industry, vend rice cakes, break bricks, sew, make jute bags, sell ash, and serve as domestic assistance (Akter et al. 2019). This study found that both men and women members of a household were affected negatively by the Teesta River water flow, resulting in a greater work load for both. To support the family, both work as earning members of the family, while women were formerly primarily engaged in home tasks. During the dry season, the women residing in the village of Mohishkhocha undertake the responsibility

of procuring water for the purposes of drinking and cooking. In contrast, the male inhabitants choose to travel to larger urban centres, such as Dhaka, the capital city of Bangladesh, in pursuit of greater earning opportunities or engage in seasonal activities. According to respondent CSI/MK-7:

> Previously, my husband's income was adequate enough to bear the cost of the whole family. But now, it is obvious that floods and river erosion are frequently appearing; so, we are trying to earn extra money to save some amount for the future.

The empowerment of some women has been seen as a consequence of engaging in various income-generating endeavours, participating in decision-making processes, and experiencing enhanced physical mobility. However, it is important to note that these women also face an augmented burden due to the unequal division of family labour (Brown et al. 2020). A respondent (KII/MK-2) disclosed that male individuals engaged in the exploitation of their spouses, taking advantage of their labour and efforts to get control over their financial resources. Moreover, it was found that when efforts were made to curtail family expenses, a significant proportion of the burden fell onto the education and health of girls and their food intake. A mother (CSI/KG-2) expressed distress and reported that her 10-year-old daughter had been experiencing illness attributed to a deficiency in electrolytes and iron.

Transition from Social Harmony to Social Conflict

When erosion and flooding dwindle, the appearance of chars in affected areas generates intergroup conflict vying for ownership or authoritative control over the new territory (Kabir and Kamruzzaman 2022). These clashes cost money, harm social standing, and strain social relations between groups (Vietz et al. 2018). Lakshmitary community, for example, has more grouped settlements than the other two, Mohishkhocha and Khunigaach communities. An informant of Lakshmitary said:

> The inhabitants from Mohishkhocha and Khunigaach had previously resided with us. However, due to river erosion and floods, certain areas of this village (Lakshmitary) were submerged, causing the population to migrate to Mohishkhocha and Khunigaach. This also created social conflict between the two groups regarding land ownership. (KII/LT-03)

Sultana (2022) argued that land ownership conflict is a growing concern among the bank erosion displaces, and the majority of people handled different types of land proprietorship clashes. Previously, those people lived in harmony in the same village. However, they clash to encroach char now, resulting in social conflict as a new survival strategy, transforming cluster settlements into scattered settlements and weakening the fabric of the social network.

Water Scarcity, Flood and Increasing Crop Production Igniting Crop Diversification

Flooding and drought are often induced by contaminated water supplies and rapid soil deterioration, resulting in biological catastrophes such as disease outbreaks and insect infestations (Gierszewski et al. 2020). In response to the multiple challenges posed by floods, droughts and erosion, communities alter their lives and agricultural practices (Bordoloi et al. 2020). Floods and river erosion are also common in the Mohishkhocha and Khunigaach settlements. Due to the unpredictable flow of the Teesta River, the grounds of these two

settlements are left barren. Case studies from these two villages indicate that farmers are aware of Teesta's unpredictable qualities, which impede productivity and contribute to income and food instability. A 62-year-old landowner commented:

> Three years ago, it was fall, and the Bengali month was *Vadra*. We were facing a water crisis due to a lack of rain. However, the water level quickly rose in the afternoon. The flood was caused by severe rain upstream, and my 1.5 bighas of paddy land was completely submerged. Did anybody compensate me or take any efforts to put a stop to it? No one. (KII/LT-3)

Another farmer (CSI/MK-4) narrated: "Cultivating crops in the rainy season will not generate any income; rather, the cost of sowing seeds will be listed in debt. I have lost half of my land due to river erosion". When evaluating the crop production scenario during the period of low agricultural activity, it becomes evident that the Teesta River's water constraint has presented additional intricacies. According to EC/WDBO-2, a minimum flow rate of 8,000–10,000 cubic feet per second (cusecs) is required in Bangladesh to sustain the operational functionality of the barrage during the dry season. However, the mean flow ranges from 3,000–4,000 cusecs constituting just 10%–15% of the whole flow of 35,000 cusecs inside the borders of India. The substantial deficiency renders these territories unsuitable for the cultivation of rice. Due to the high-water requirements of agriculture, the expenditures incurred by the eight farmers who owned land may be represented in Figure 5.

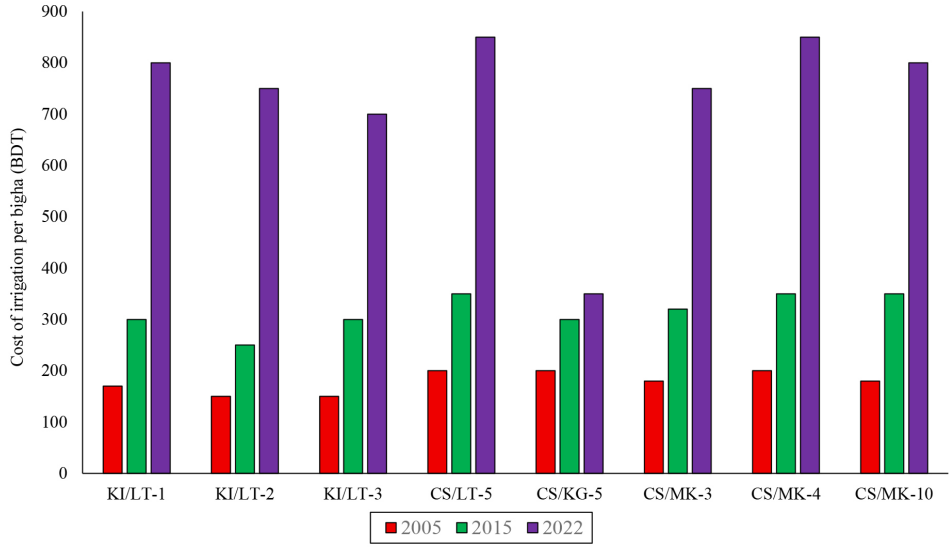

Figure 5: Irrigation cost of paddy production.

Figure 5 illustrates the upward trajectory of irrigation expenses. During the lean season, farmers in the Teesta River region are compelled to use groundwater for irrigation of their paddy crops due to the limited supply of water. This is done by the use of deep shallow machines. Consequently, the additional expenses they incur for fuel and electricity are a financial strain for them. According to Kolas et al. (2013), the water sourced from the barrage is priced at BDT250 per bigha; however, the water extracted using a shallow machine is much more expensive, costing BDT1,500 per bigha. For example, according to a report by Xie et al. (2021), an estimated amount of BDT15,000 (BDT115 equivalent to USD1) is required for the purpose of irrigating one acre of

land. This increased production cost changes the landscape of agricultural production. Farmers in such areas have started to shift agricultural production away from water-intensive crops and towards water-saving crops such as maize, tobacco, onions, vegetables (potatoes), and fruits.

Figure 6 depicts how crop diversity is being shaped by water shortages and increased production costs. Farmers who live far away from the river or on sandbars focus their efforts on maize, tobacco, onion, and vegetable cultivation. Those who live along river and sandbars, on the other hand, continue to produce paddy because they have greater access to water.

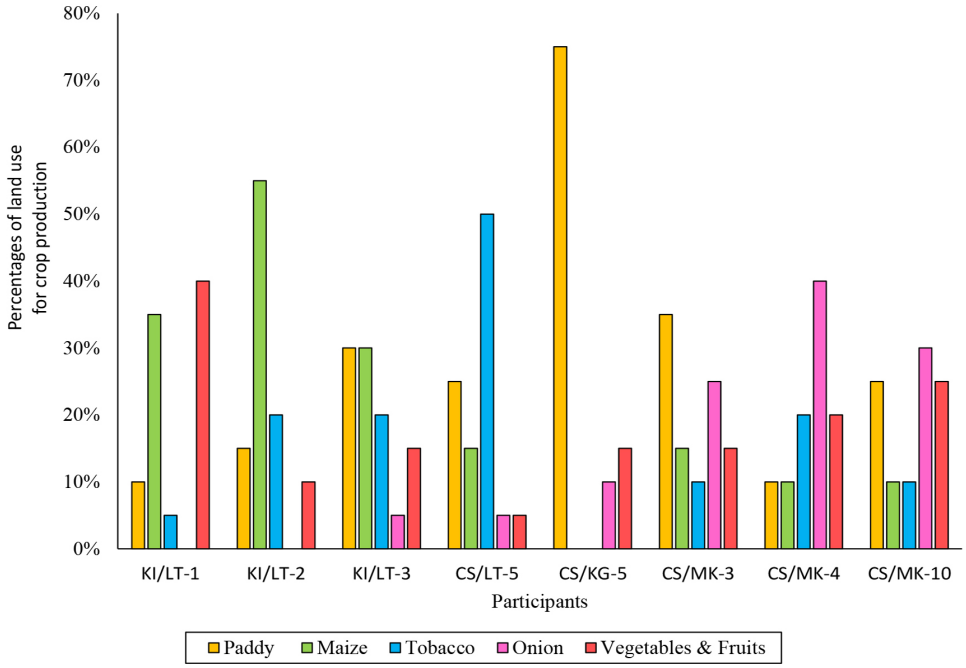

Figure 6: Crop production patterns.

Hopes of Ancestral Fishermen and Boatmen Fading Away

The flow of the river influence fish output. Any attempt to make a little alteration has a significant influence on the fish population. This research finds that fish production is dependent on rivers, and fishermen lack the expertise to boost fish output. They feel depressed because of the number of fish produced throughout both the rainy and dry seasons. From *Chaitra* to *Joistha* (mid-March to mid-June), fisherman catch practically no fish; moreover, during the months of *Ashar* and *Shrabon* (mid-June to mid-August), the presence of strong currents renders the area unfavourable for fish habitation due to the absence of ideal reproductive environments. A respondent, aged 62 years old, said:

> My father was the family's only breadwinner who provided for the family's necessities by selling fish. However, it is now very difficult to catch fish during the dry season. Currently, I have three working members, but their incomes are insufficient to cover the family's demand. Consequently, my two sons migrated to the city to work as day labourers, and I transitioned from fisherman to rickshaw puller. (II/MK-2)

The statement suggests that fishermen are now employing alternative survival strategies. Nonetheless, some fishermen cast nets in the aim of making a living as fishermen, as it is their ancestry (as shown in Figure 7).

Figure 7: Landless farmers, victims of river erosion, live off fishing in the shallow, stagnant waters in the immediate downstream of Teesta barrage.

Source: Photo by Vishwa Ranjan Sinha in Chandan (2019).

The navigability of Teesta is important in the economic lives of the studied communities. A Mohishkhocha respondent (CS/MK-4) said that the transportation cost of their produced products, such as maize and onion, has increased since truck drivers demanded excessive payment for the shipping during the dry season, notably in February and March. As the water level starts to rise in May and June, the socioeconomic condition and visitor movement change. The majority of the male members work as boatmen on tourist boats, while young male members sell street foods near the Teesta Bridge.

Coping Strategies with Asset Vulnerabilities

Based on the field data, an attempt was made to examine the coping mechanisms of Lakshmitary, Khunigaach, and Mohishkhocha communities, taking into account the asset vulnerabilities of the individuals in those areas. Temporary migration, permanent migration, change in livelihood, change in crop production, and living in the same place with adjustments are the five categories of coping strategies. Asset vulnerabilities, on the other hand, are divided into four categories, namely, ability to work, human capital such as knowledge and education, productive assets, and social capital.

Figure 8 shows that of the 34 respondents from three communities who were able to work, some migrated to cities like Rangpur and Niphamari for better opportunities, while others chose temporary migration. Those with human capital, such as a minimum secondary school level of education and expertise, are attempting to either leave or alter their livelihoods from these vulnerable places. Families with productive assets like land, livestock, or other assets, on the other hand, are attempting to survive in the villages by shifting agricultural output and adapting their lifestyles.

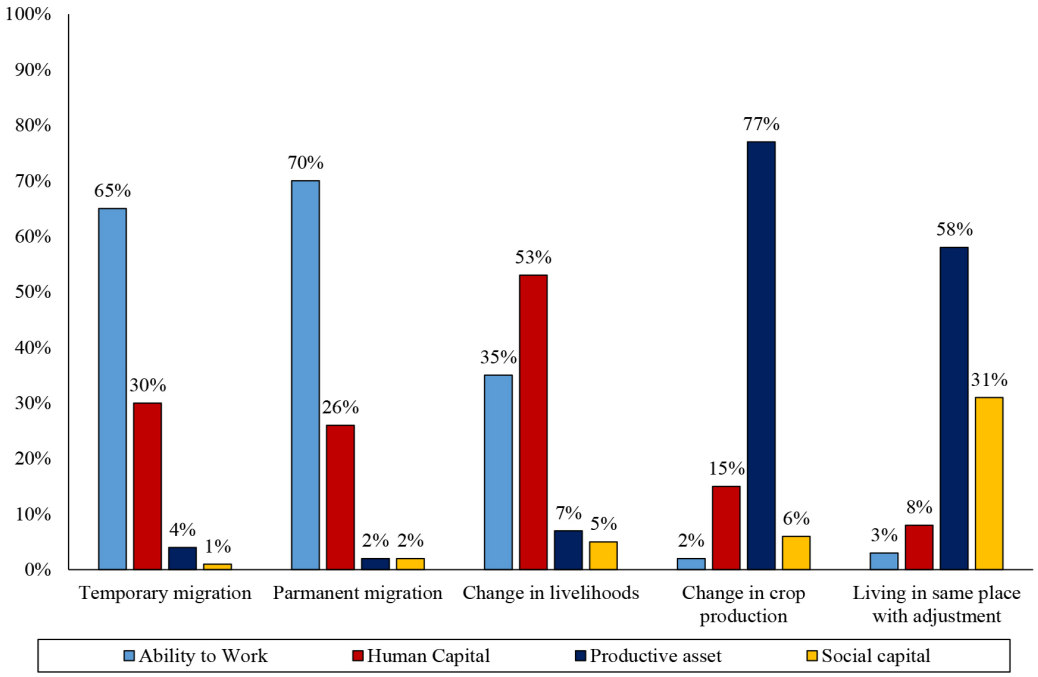

Figure 8: Coping strategies and asset vulnerabilities.

Poverty Trajectory Patterns from IIs

In the context of poverty dynamics, relying just on economic indicators is inadequate for assessing the poverty levels of a particular community. In addition to the quantitative indicators of poverty, there are intricate narratives around communities or families that perpetuate the cycle of poverty. It is essential to disseminate these narratives and concealed revelations to the wider public, since doing so may enable the mainstream to comprehend the veracity and challenges faced by a particular group (Addison et al. 2009). The impoverished nature of study communities may be attributed to their susceptibility to natural disasters. However, these individuals are unable to extricate themselves from the cycle of poverty, since they have gotten entrenched inside its confines. The justification for addressing these crucial topics is substantiated via the examination of the life histories of four individuals. The narrative starts with the life trajectory of Sharifullah, a 67-year-old farmer (as shown in Figure 9).

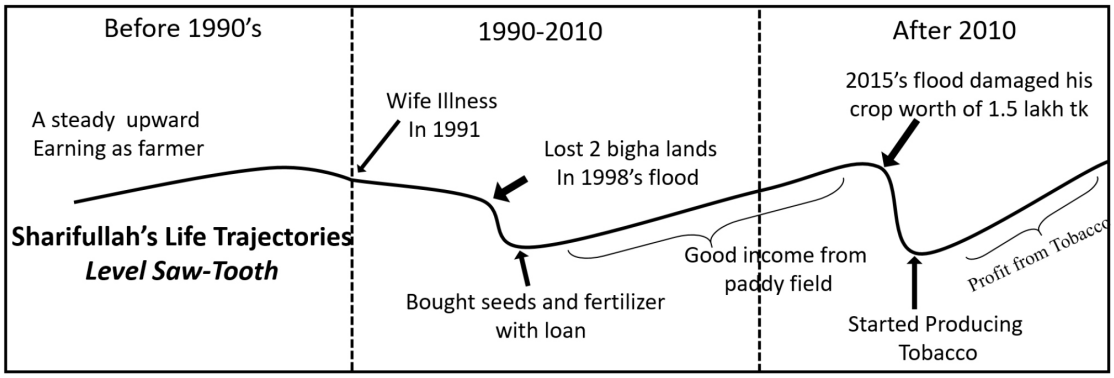

Figure 9: Life trajectory of Sharifullah.

Sharifullah is a resident of the Mohiskhocha community. When he was eight years old, he began working in the paddy field alongside his father. However, soon after his father passed away, he and his two brothers took over the management of the farming land. Everything was going smoothly until his wife had complications after the delivery of their fourth child in 1991, which came as a surprise shock. To help pay for the treatment, he sold his cattle and a portion of the farming land. In 1998, he had yet another shock as he lost two bighas of land due to Teesta erosion, leading to an economic crisis. After that, he attempted to improve the family's financial situation by taking out loans from neighbours. Then his family started to see an increase in the amount of money they were making from the paddy field. His family did not have any serious crises between 2000 and 2015. However, as the year went on, the cost of irrigation went up, and the price of paddy dropped, their revenue from the paddy field started to decline. Moreover, the flood of 2015 altered the whole condition. Once again, he lost BDT1.5 lakh because his ripe crop was damaged just before harvesting due to flood. He no longer grows paddy since it is not as lucrative for him. Instead, he grows solely winter crops during a dry season, like tobacco.

Delwar is a farmer and more suited to deal with ups and downs, as seen by the life trajectory pattern in Figure 10. A 2.5 bigha paddy field belonged to his father. The family also had a sizable herd of cattle. Prior to the flood of 1998, his father had passed away. The family had another terrible shock just after this loss. That year, Delwar's family lost 0.5 bigha of land due to river erosion. Following that, his family made the decision to apply for a non-governmental organisation's (NGO) loan. However, they were unable to use it. Because the family experienced another shock wave prior to reaping the advantages of the loan. It was due to the flood of 2004 that caused a great damage to the harvest. Delwar married off his two daughters that year. Crop damage and dowry for daughters' marriage caused an enormous economic crisis for the family. However, his two sons entered the garment industry after that, and the family started earning some money. But once again, the flood of 2017 struck, damaging the harvest. He has now made every effort to put his family back in a secure condition but he is unable.

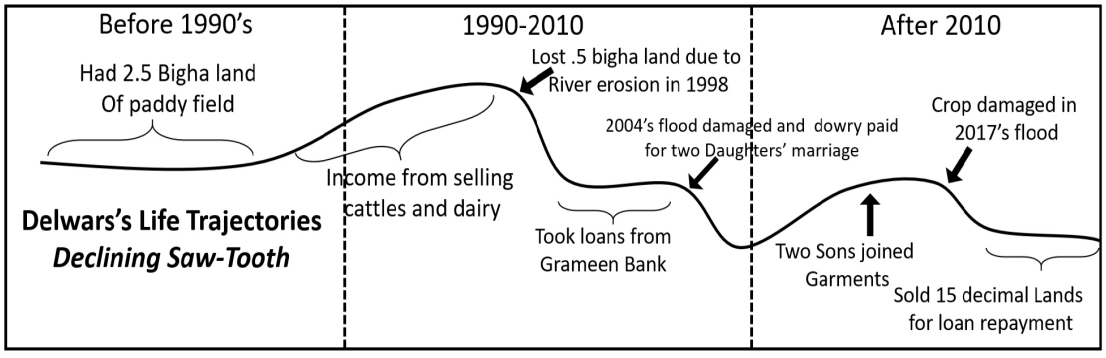

Figure 10: Life trajectory of Delwar.

The life experiences of fisherman may be reasonably predicted by tracking Ajgor's trajectory (as shown in Figure 11). The income of Ajgor Ali's family, who were engaged in fishing, saw a decline prior to the 1990s. As to his assertion, the current fish population in the Teesta River is lower compared to that of two decades ago. As a result, he started to earn by engaging in sharecropping. However, Ajgor had significant challenges in supporting the family with the limited income received. In the year 2004, he subsequently acquired loans once again, using the money to establish a tea stall inside the nearby market. Currently, the circumstances have improved for his family.

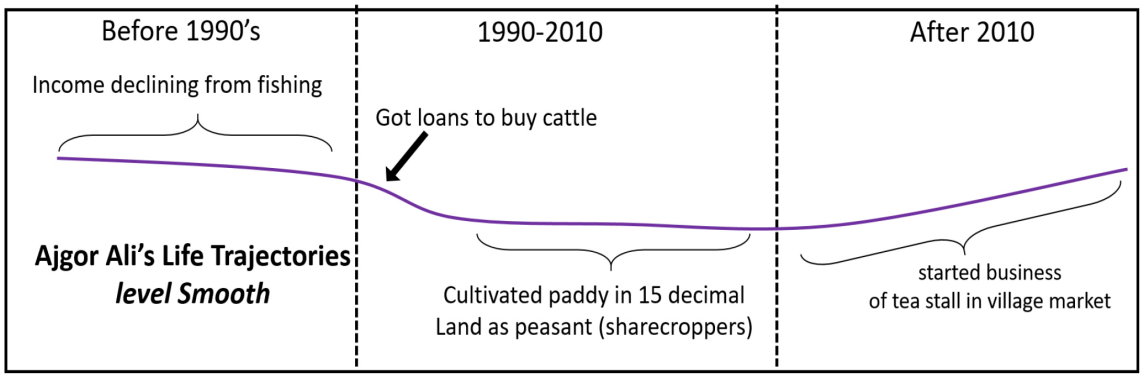

Figure 11: Life trajectory of Ajgor Ali.

The final life trajectory (as shown in Figure 12) illustrates the temporal framework of a boatman residing in Khuniagaach. Vulu Mia, a boatman, had consistent earnings during the 1980s when the flow of the Teesta River was enough to allow year-round navigation of boats. The single mode of transportation available was a boat. Throughout the year, people embarked on journeys to see their kin, traversing riverbanks, moving from one village to another, and even attending marriage ceremonies. Therefore, the income of Vulu Mia is deemed satisfactory. In 1994, Vulu Mia's spouse became afflicted with cholera. Consequently, a substantial portion of his savings was allocated towards her medical care, a financial endeavour facilitated via the sale of livestock. Subsequently, with the reduction in river water levels during the period of dry season, there was a significant decline in his earnings. Subsequently, he made the decision to pursue employment as a day labourer in the paddy field. Based on this earning, he successfully handled the expenses associated with his daughter's wedding including dowry. Daily wage workers had seen significant financial gains throughout the periods of harvesting and seed planting. However, in 2010, his family including all community members experienced displacement. Following the incident, subsequent to the amelioration of the circumstances, the affected families proceeded to construct their houses in a settlement characterised by the presence of sandbars, known as Khuniagaach. Presently, he engages in the occupation of carpentry and assumes the role of a boatman throughout the inclement rainy season. He represents the only source of hope for the survival of his family.

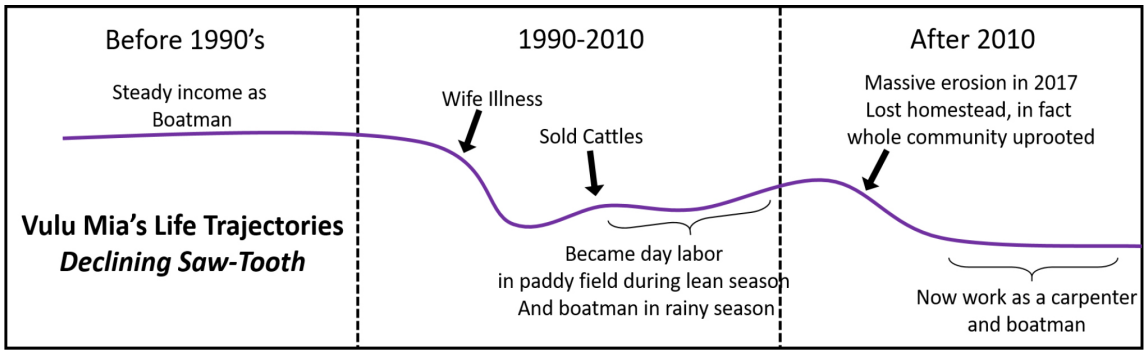

Figure 12: Life trajectory of Vulu Mia.

DISCUSSION

This research aimed to analyse the socio-economic impact of Teesta River water flow and the coping strategies of affected communities. The results indicate that the adverse impacts of river erosion, floods, and drought have detrimental effects on the social, economic, psychological, and cultural well-being of communities. Consequently, a significant proportion of households within these communities choose to adapt by reducing their spending patterns, a phenomenon often known as living in the same place with modifications. However, this study explored that Lakshmitary communities were singled out because their residents experienced flooding but not river erosion. Their members were willing to work, some families decided to modify their way of life during the flood. To earn money, members of other homes had decided to temporarily relocate to other places like Rangpur, Bogra, or Dhaka. For example, in the Ganga River flow area, some of the fishermen frequently left their homes during the dry season and travelled to the reservoir upstream during the beginning of the rains to fish (Singha et al. 2020). This study found that those households with male wage earners choose to remain in the village rather than move permanently to better locations. Few people had decided to migrate permanently.

However, no families in the village of Mohishkhocha and Khunigaach decided to leave because it was difficult for them to leave their homes, families, and lands behind. In contrast, at Yangtze River Basin in China, where communities were affected by riverbank erosion, they had been permanently sifted to a newer location as a result of climate refugees (Li et al. 2021). This study argues that the communities of the Teesta riverbank were not willing to move permanently because they were living in their place from generation to generation, which built a strong emotional attachment to the place. Instead, they made an effort to cope by altering agricultural production, means of subsistence, or adjusting to the present situation. For instance, the majority of households, whether they had assets or not, moved temporarily to the Teesta River's north bank to find shelter during a flood, and they were prepared to work there to generate revenue. Moreover, they had previously grown paddy, but they have now been growing tobacco, maize, and watermelons for three to four years. Finally, communities in the Teesta riverbank area develop a variety of coping mechanisms as a result of their diverse livelihoods.

CONCLUSION

This study focuses on how river erosion, flooding, and drought negatively impact communities along the Teesta River, coupled with their adaptation strategies. Findings indicate the loss of their habitat, farmland, forests, and other tangible assets, and subsequently, the application of their local knowledge and skills to adapt to the situation. Therefore, instrumentalising required steps to tackle river erosion, flooding, and drought, along with overarching principles of sustainable livelihood management, needs to be facilitated.

Although the socioeconomic effects of rivers have been researched across different disciplines, this area of study and the strategies for adapting are still in their infancy. To fill this gap, the current study utilises a substantial contribution to the body of literature because the qualitative methods used to examine a comprehensive research model in the Teesta riverbank contemplate several dominant socioeconomic and adaptation factors. This study has two extended theoretical implications. First, the current research has identified the socioeconomic conditions of the Teesta riverbank area and second, suggested the community's adaptation strategies. Lastly, this research identified six major coping strategies, including temporary migration, permanent migration, building houses in the highlands, change in livelihoods, change in crop production, and living in the same place with adjustment.

This research sketched practical implications for the researchers, governments, communities, and other stakeholders. The practitioners may understand the main factors that influence or affect the socioeconomic condition of the riverbank area. Moreover, this study indicates the use of local knowledge and improving strategy to adapt to a crisis moment. Besides, this research highlighted numerous proactive and reactive measures taken by the community people at the Teesta riverbank area at Rangpur, which can be beneficial to inhabitants residing in a similar predicament in the region.

This research's primary limitation is the absence of global comparisons from diverse dynamics. Furthermore, the interregional assessment of other rivers in Bangladesh, along with the marginalised communities, can provide better insight into the effectiveness of rivers considering the macro-level scale. The research has been conducted from a socioeconomic viewpoint. Hence, it is suggested that future researchers may evaluate the political, environmental, and economic impact of Teesta River water flow and coping strategies of affected communities. This study has been conducted by following qualitative approach. Thus, future scholars may use longitudinal and quantitative analysis for conducting their studies to get a better insight. In conclusion, this research has been conducted on Lakshmitary, Mohishkhocha, and Khuniagaach communities in the Gangachora Upazila at Rangpur. Other regions in the Rangpur District are also affected by Teesta water flow; therefore, there is a tremendous opportunity to collaborate with community members who do not fall under the purview of research.

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COMPLIANCE WITH ETHICAL STANDARDS

As per international standards or university standards, participants' oral permission has been obtained by the researchers.

DISCLAIMER

This article is a revised part of a post-graduate thesis which was submitted by the first author to the Department of Development Studies, University of Dhaka.

NOTES

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