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Abstract: Climate change has become a major global concern, and it has severe consequences for all communities. Coastal areas of Bangladesh are vulnerable to climate change because of their geophysical condition and geographical position. Although climate change affects people's sustainable livelihood strategies in coastal regions of Bangladesh, it has gained limited attention in academic discourse. This study, hence, aimed to investigate the impact of climate change on the sustainable livelihood strategies of coastal people. Utilizing an explanatory sequential mixed research approach, including stakeholders' consultations, household surveys, in-depth interviews (IDIs), focus group discussions (FGDs), and key informant interviews (KIIs), the study was carried out in Char Kukrumukri union in Bhola District, one of the climate-vulnerable areas of the country. Our study findings revealed that climate change primarily affects natural and physical capital, which in turn impacts financial, human, social, and political capital, and in the end, creates different forms of vulnerabilities. The study also explored a significant association between increasing waterlogging areas and reducing arable lands (X^2 = 38.02; $p < 0.001$), and the reduction in fresh water sources and damages in agricultural production (X^2 = 80; $p < 0.001$). The study further highlighted that the government efforts, such as polderization, aimed at preventing salinity in coastal areas, have failed due to the lack of integration with the representation of local people. The lack of integration between the local community's voices and government actions poses additional challenges to maintaining people's sustainable livelihood strategies. Thus, the study suggests a successful integration of localized practices and government interventions to address the climate-induced livelihood challenges to coastal people.

Keywords: climate change; sustainable livelihoods; localized practices; coastal areas; Bangladesh

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1. Introduction

Global climate change, intensified by emissions of greenhouse gasses, correlates with the escalating severity and frequency of extreme events, such as global warming, sea level rise, seasonal irregularities, storms, drought cycles, and flooding incidents (Huq et al. 2023; Rajkhowa and Sarma 2021). Climate change poses serious threats to human health and well-being worldwide, causing extreme weather events, sea level rise, freshwater scarcity, drought, high temperatures, biodiversity losses, and ecological degradation (Shivanna

2022). Climate change effects are currently the major challenges for social sustainability in terms of agricultural production, employment, food and nutrition, gender equality, education, and other socio-economic activities. Smit and Wandel (2006, pp. 282–83) discussed the vulnerability of climatic change effects in human societies in terms of household, group, family, development sector, region, and country, describing the multiple forms of vulnerabilities specifying the dimension of "...vulnerability of humankind (or the global ecosystem) phenomena of interest (biological, economic, social etc.) and by time scale (instantaneous, months, years, decades, centuries) and human-environment systems, including communities: households, groups, sectors, regions, and countries". Stringer et al. (2009) describe this linkage between climate change and livelihoods in the context of the Southern Africa region, arguing climate change effects decrease livelihood opportunities. Grounded in the extreme level of climate change effects, Barnett and Adger (2007) describe these consequences as violent conflict. Climate change increases violence at micro and macro levels from household to region, which causes further social problems and non-traditional security concerns. The government adaptation approach creates differential access to local resources and affects community livelihood, which is one of the sources of economic insecurity or poverty and responsible for violent conflict. Salehyan (2008) argues along the same lines that climate change increases resource competition and forced migration, which consequently create armed conflicts and political violence.

Bangladesh is considered one of the vulnerable countries because of its topography, geographical location, and other features. The vulnerabilities of the area are heightened by hydrological, geological, and meteorological catastrophes such as droughts, cyclones, floods, river erosion, and salinity intrusion. When high population density and low socio-economic conditions are combined, these disasters lead to the significant loss of lives and economic well-being (Uddin 2022). Evidence shows that the climatic vulnerabilities of different regions appear differently. On the one hand, the northwestern region is highly susceptible to desertification due to the scarcity of water (Hossen et al. 2021), while the southwestern region is at high risk of sea level rise (Sarwar 2005) as a result of its low elevation land patterns. The coastal regions of Bangladesh account for 20% of the total land area and 30% of the agricultural land. Salinity impacts 53% of coastal regions (Haque 2006), which results in a decrease in agricultural production due to the decrease in arable lands. Regular crop production is constrained throughout the year due to the unfavorable hydrological settings and environmental conditions caused by salinity (Haque 2006). It is projected that due to a sea level rise between 12 percent and 18 percent, coastal Bangladesh will be submerged underwater by this century, as reported by the International Centre for Climate Change and Development (Huq et al. 2024). Consequently, salinity tends to increase in the upcoming days in the coastal areas of the country.

The livelihoods of the people in the coastal areas of Bangladesh are severely affected by climate change effects. As identified by Garai (2014), the effects of climate change impact agricultural productivity and food security and pose institutional challenges for coastal people which determine economic activities, employment opportunities, health conditions, and crops. Previous research in the southern regions of Bangladesh has not extensively explored this issue, despite the detrimental impact of climate-induced events on sustainable livelihood strategies, which include various livelihood assets like natural, physical, economic, human, social, and political capital. Although Islam et al. (2014) have identified the climate-induced vulnerability of fishery-based livelihoods, this lacks a comprehensive understanding of the vulnerabilities of various sustainable livelihood assets. They advocated for further research to address the existing knowledge gaps on the effects of climate-induced events on people's livelihoods. Against this backdrop, this study seeks the answer to the following question: How does climate change affect the sustainable livelihood strategies of coastal people? Therefore, this study investigated the vulnerability to sustainable livelihoods produced by climate change. We used an explanatory sequential mixed research approach, including stakeholder consultation, household surveys, focus group discussions, in-depth interviews, and key informant interviews, to assess the vulner-

abilities induced by climate change among the people of *Char Kukrimukri* union under *Char Fasson* upazila in *Bhola* District, one of the climate-vulnerable areas of Bangladesh, using a sustainable livelihood framework. The study found significant effects of climate change on the sustainable livelihoods of the people, negatively affecting livelihood assets.

The coastal people of Bangladesh, despite their extreme livelihood vulnerability, prefer to live in risk-prone areas for two reasons. Firstly, the abundance of natural resources (opportunities) is alluring and causes them to live in these areas for generations (Huq and Easher 2021); secondly, their livelihood patterns do not permit upward social mobility and relocation in a safer environment. Because of these two reasons, they have adopted sustainable livelihood strategies such as adaptive tools for surviving with all forms of difficulties and vulnerabilities. However, the Government of Bangladesh constructed a polders, a water control mechanisms, to improve the livelihoods of coastal people by reducing the impact of extreme events such as salinity intrusion, cyclones, and storm surges. Polderizations covered almost 60 percent of the country's total coastal areas (Noor 2018). Although the construction of the polder was intended to improve the livelihoods and agricultural productivity of local people and to prevent the entrance of saline water to local croplands, this adversely affects the sustainable livelihood strategies of local people, disrupting their longstanding traditional practices. Climate change further exacerbated the impact of polderization on local people's livelihood strategies. It primarily impacts natural capital, leading to freshwater scarcity, salinity intrusion, and the loss of arable lands due to increased water-logging areas, resulting in severe consequences on other livelihood assets. Huq and Easher (2021) argued that despite the extreme and violent protests against any sort of external solutions and interventions, the government has taken many projects in the name of helping coastal people without recognizing their actual needs and without considering their wisdom in coastal management. Consequently, this study suggests that localized practices should be given priority for the effective utilization of government interventions to protect coastal people's sustainable livelihood strategies and to overcome vulnerabilities in the real world.

Conceptual Framework for Understanding Climate-Induced Vulnerabilities

The analytical foundation of this study has been developed based on the Sustainable livelihood Framework (SLF). This is a thorough method for examining livelihood options in different contexts. Generally, livelihoods are a combination of skills, resources (both material and immaterial), and activities necessary to maintain one's means of survival (De Sherbinin et al. 2008). A livelihood is considered sustainable if it can demonstrate the ability to recover and adapt to different shocks and strains while maintaining or improving its innate qualities and resources, without jeopardizing the integrity of the natural resource base. Vulnerability is a trait shared by those who are unable to adjust to long-term changes in livelihood strategies or effectively deal with short-term ones. Such individuals also have a lower likelihood of realizing sustainable livelihoods (Scoones 1998; Chambers and Conway 1992).

The effects of climate change are a prominent accelerator for transformation, reducing arable lands for farming communities and altering other strategies for sustaining livelihoods (see to Figure 1). The effects of climate change on natural and physical capital have subsequent effects on other livelihood assets, such as the pursuit of varied livelihood strategies involving human, social, financial, and political capital.

McLeod (2001) summarized the sustainable livelihood strategies as follows:

Natural (Environmental) Capital: Natural resources (land, water, wildlife, biodiversity, environmental resources).

Physical Capital: Basic infrastructure (water, sanitation, energy, transport, communications), housing, and the means and equipment of production.

Human Capital: Health, knowledge, skills, information, ability to labor.

Social Capital: Social resources (relationships of trust, membership of groups, networks, access to wider institutions).

Financial Capital: Financial resources available (regular remittances or pensions, savings, and supplies of credit).

Political capital: Access to rights, empowerment, access to justice, access to decision-making processes, equal access to government provisions (Rahman and Huq 2023).

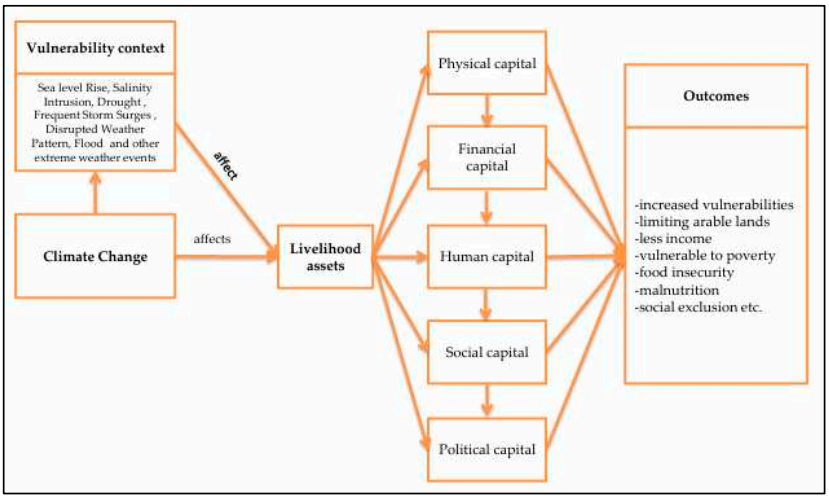

Figure 1. Sustainable Livelihood Framework modified from DFID (2001), and Rahman and Huq (2023).

2. Materials and Methods

2.1. Research Design

This study utilized an explanatory sequential mixed research method, referring to the collection and analyzing of quantitative and then qualitative data in two consecutive phases within one study (Rahman et al. 2023; Alexander et al. 2008; Ivankova et al. 2006; Kelle 2001), to understand the effects of climate change on the sustainable livelihood strategies of coastal people. The study initially focused on stakeholders' consultations and household surveys, and subsequently conducted focus group discussions (FGDs), in-depth interviews (IDIs), and key informant interviews (KIIs). These methods are suitable for comprehending a particular phenomenon from the viewpoint of the respondents. These methods also help to improve the accuracy and to increase the level of confidence of our research. Additionally, mixed method research enables researchers to integrate different approaches, adding a concrete methodological foundation and creating a holistic approach to address complex practical problems (Ivankova and Wingo 2018).

2.2. Study Area

This study was conducted in the coastal area of Bangladesh which has been significantly impacted by intense and frequent climatic hazards over the recent decades (Sultana and Luetz 2022). The study was carried out in *Ayeshabag* village, located in *Char Kukrumukri* under the *Char Fasson* upazila in *Bhola* (see Figure 2). In *Char Kukrumukri* union, the total population is 20,383, and the literacy rate is only 27 percent (Banglapedia 2024; GoB 2024). The total cropland in this union is 3064 hectares. This area exhibits a high poverty rate, with 60 percent of the population living in poverty and 55 percent being landless (GoB 2024).

The residents of this area face challenges such as wind and tidal surges, erosion, cyclones, drought, and salinity intrusion, which significantly slow down their ability to sustain their livelihoods (Daily Observer 2021).

Bhola is the largest island in Bangladesh and is positioned in the coastal part, being mostly surrounded by bodies of water. This district is a distinctly coastal area, characterized by its geographic location, natural environment, and resources on the one hand, as well as the occurrence of natural disasters on the other. It is subject to a variety of vulnerabilities including cyclones, storm surges, and coastal erosion, which occur on a frequent and severe basis (Sultana and Luetz 2022).

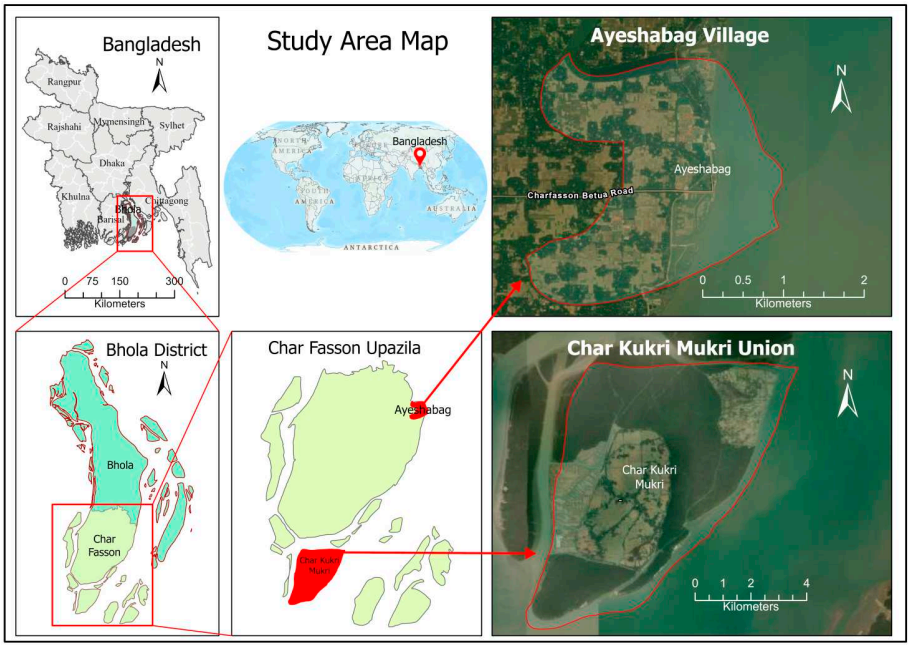

Figure 2. Locational map of *Ayeshabag* Village in *Char Fassion* Upzilla under *Bhola* District in Bangladesh.

2.3. Data Collection and Analysis

To understand the impact of climate change on livelihoods, people's perceptions were assessed, primarily through stakeholders' consultations in a group. The primary objective of the stakeholders' consultation was to organize and finalize a questionnaire for household surveys and to develop the checklists into different thematic dimensions for focus group discussions (FGDs), in-depth interviews (IDIs), and key informant interviews (KIIs). We collected household data (n = 40) using a semi-structured questionnaire which helped us comprehend the practical aspects of our research (Catterall 2000). We conducted a household survey among 40 households, only because of time constraints and financial limitations. The survey data mainly covered the people's perceptions and experiences about the severity of freshwater scarcity, increasing patterns of waterlogging areas and land salinity, reduction in arable lands, and severity of agricultural production damages in the study areas. We followed a random sampling technique to conduct household surveys. After collecting the household data, we deployed IDIs (n = 15) to learn more about individuals' perspectives, based on narrowly defined themes, to assess the impact of climate change on the sustainable livelihood strategies of coastal people. Additionally, we conducted four FGDs (two with male respondents and the other two with female respondents) in the area, consisting of 8–9 respondents, to validate the data obtained through household surveys and IDIs. Moreover, the FGD aimed to explore the diversities and dimensions of the climate-induced vulnerabilities of the local people by considering their sustainable livelihood strategies. The participants in the focus group discussions (FGD), IDIs, and household surveys were selected based on their age group, particularly targeting individuals who were aged above 35 years and aware of climate change and its impacts over the last 20 to 25 years. While both IDIs and FGDs can be used on their own, they can also be used to complement each other in order to gain a better understanding of the research problem, and they can be used to support other methods, like survey-based research (Johnstone 2017). Household and IDI data were collected by five of our authors, and each FGD was conducted by a facilitator with an assistant for collecting notes and recording the FGD sessions which were later transcribed into text form. At the end of data collection, as part of supplementing other research tools, including focus group discussions (FGDs) and in-depth interviews, we conducted KIIs (n = 4). KII respondents represent government officials, including representatives of the Bangladesh Water Development Board, Agriculture Extension Department and Fisheries Department, and university professors.

We followed the standard ethical protocol utilized in other research (see Hossen et al. 2021; Rahman et al. 2023) and we received ethical approval from the Institutional Research Ethics Board (IREB) of United International University (IREB Reference No.: IREB-2024-015). Like other studies, all the respondents were up-to-date about the study objectives, and we also obtained verbal and written consent from the respondents before interviewing them (Hossen et al. 2021).

Each of the datasets, including stakeholders' consultations, household surveys, IDIs, FGDs, and KIIs, covers the respondent's perceptions about climate change in the study area as well as the vulnerabilities they have been experiencing. We used descriptive statistics to interpret the data. To deduce the impact of climate change from people's perspectives, specifically for measuring the relationship between increasing waterlogging areas and decreased arable lands, people's perspectives were assessed into different levels of change (e.g., "increased, moderately increased, significantly increased, decreased, moderately decreased, and significantly decreased"). Additionally, to assess the implications of climate change on freshwater scarcity and crop productivity damage from people's experiences, people's viewpoints were measured into different levels of increase and decrease (e.g., "increased, moderately increased, significantly increased and damaged, moderately damaged, and significantly damaged"). The data gathered from the household surveys in different categories were analyzed using the chi-square (X^2) test to determine the statistical significance.

While household survey datasets were analyzed through R statistical software (Version 4.3.1), qualitative datasets including IDIs, FGDs, and KIIs were collected in text and transcribed forms and analyzed using traditional qualitative data analysis software (N-Vivo, Version 20, Melbourne, Australia) to inductively discover important emergent themes from the data from each FGD.

3. Results

3.1. Socio-Economic Characteristics of the Respondents

Table 1 indicates that 48 percent of the respondents are female, while the remaining 52 percent are male. The age range of the respondents spans from 35 to 70 years. The table also indicates that almost 68 percent of the respondents have either received no education or education up to grade 5, while 24 percent have received education up to grade 10, and only 8 (approximately) percent of the respondents have received graduate or post-graduate education. In terms of family structure, 57 percent of respondents possess nuclear family status. Male members are mostly engaged in agriculture, and female members are housewives.

Table 1. Demographic characteristics of the respondents of household surveys, focus group discussions, in-depth interviews, and key informant interviews.

Parameter	Variable	Frequency	Percentage (%)
Gender	Male	47	51.65
	Female	44	48.35
Religion	Islam	91	100.00
Education	No Education/Illiterate	23	25.27
	Primary	39	42.86
	Secondary/SSC/HSC	22	24.18
	Graduate/Postgraduate	7	7.69
Family Type	Nuclear	52	57.14
	Joint	20	21.98
	Extended	19	20.88
Occupation	Farming/Agriculture	27	29.67
	Business	19	20.88
	Housewife	28	30.77
	Service/Professional	4	4.40
	Unemployed	13	14.29

3.2. People's Perceptions About the Impacts of Climate Change on Livelihoods

The findings of our study demonstrate that climate change-induced hazards such as floods, storms, salinity intrusion, sea-level rise along with disrupted weather patterns pose significant threats to physical capital, including lands and houses, claimed by 85 percent of the respondents. They further asserted that the impacts of climate change on physical capital extend to other dimensions, including financial, social, human, and political capital, and create ripple effects for this population (see Figure 3).

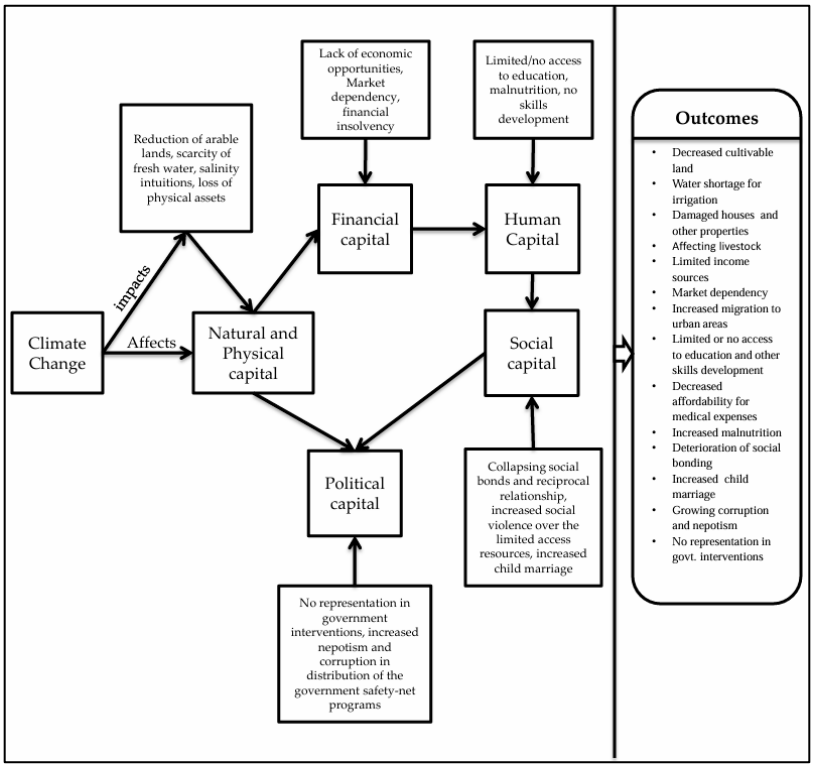

Figure 3. The impact of climate change on the sustainable livelihood strategies of coastal people.

3.2.1. Climate Change Affects Natural and Physical Capital

The findings of the study indicate that climate change has direct impacts on natural (freshwater scarcity, limiting croplands) and physical capital (loss of houses and physical or tangible assets) (see Figure 3). Respondents asserted that due to climate change, a significant portion of arable lands has decreased with the increase in waterlogging areas. On the other hand, freshwater availability and freshwater sources have significantly decreased in the study areas according to the respondents.

The study found a significant association between the increased volume of waterlogging areas and arable land decrease through the chi-square test (see Table 2A). In the same way, this study also found a significant relationship between the reduction in freshwater availability and damages in agricultural productivity (see Table 2B).

In the study area, agriculture and livestock constitute the main sources of livelihood. However, a significant portion of agricultural land remains uncultivable for a certain period of the year due to salinity intrusion and waterlogging issues from the Bay of Bengal, caused by tidal surges resulting from environmental and natural disasters, and tidal flooding events every year. All the respondents claimed that when cyclones happen, lower lands are affected by tidal surges and water stays for a long period. Furthermore, the sea level rise contributes to sinking the lands, comparatively situated in low elevations, underwater.

Table 2. (**A**) Pearson's chi-squared test for the relationship between the reduction in arable lands and increasing waterlogging area. (**B**) Pearson's Chi-squared test of the relationship between freshwater scarcity and crop productivity damage.

(**A**)

Increasing Waterlogging Areas	Decreasing Arable Lands			Total Frequency	Df	X^2	*p* Value
	Significantly decreased	Moderately decreased	Decreased				
Increased	2	1	6	9	4	38.02	<0.001
Moderately increased	4	15	0	19			
Significantly increased	10	2	0	12			
Total	16	18	6	40			

(**B**)

Freshwater Scarcity	Crop Productivity Damage			Total Frequency	Df	X^2	*p* Value
	Damaged	Moderately damaged	Significantly damaged				
Significantly increased	0	0	22	22	4	80	<0.001
Moderately increased	0	17	0	17			
Increased	10	1	0	1			
Total	16	18	22	40			

Furthermore, according to all respondents, freshwater, which is a prerequisite for irrigation in agricultural activities, is scarce in this area. Thus, agrarian production is severely affected by the scarcity of freshwater. In some cases, agricultural production is in no way possible. Side by side, climate change is affecting water, irrigation, and lands, while houses and other infrastructure are being damaged by cyclones, tidal surges, etc. As one KII respondent stated,

> *Over the past year, a cyclone damaged many people's residences here. They either required repairing them or reconstruction after cyclones and tidal surges.*

Additionally, saline water and waterlogging produced by cyclones and tidal surges caused agricultural land loss with the introduction of salinity in the soil. Thus, the only means of livelihood for the people, which depends on nature, is being affected. In these ways, the marginalization of people has been intensified.

As financial pressure mounts due to reduced agricultural productivity, farmers often need to sell their cropland to meet basic needs. However, people show less interest in buying these saline-affected lands as they provide minimal benefits to the owner, resulting in significantly lower prices. Moreover, when natural disasters like cyclones happen, farmers cannot afford to take their livestock to cyclone shelters, which leads to further physical capital losses. On the other hand, cattle like cows and goats require grazing. Having limited land or no land leads to reduced or low rates of cattle-rearing practices in the study area.

3.2.2. Impacts of Climate Change on Financial Capital

Climate change has a severe impact on the sources of income of various socio-economic classes, with farmers being the most vulnerable. According to the field data, 90 percent of farmers have been significantly affected by climate change, suffering from severe economic losses (see Figure 3). Crop damage caused by salinity intrusion, and natural disasters (tidal surges, coastal flooding) which are induced by climate change have a significant impact on the economic position of local people across various dimensions. Firstly, it has direct consequences on landowners, involving a decrease in crop cultivation and farming activities. The impacts of climate change on agriculture, including crop damage and crop loss, and the low productivity of the lands discourage landowners from producing crops on their lands. The owners then become dependent on the market for ensuring food security for their families. Secondly, a group of farmers who work as day laborers in the crop

fields are dependent on agriculture for their livelihoods. The individuals who depend on salaried farming are directly impacted by the limited agricultural activities opted by the landowners. Many of them have relocated and migrated to urban areas of the country in search of alternative sources of income. Thirdly, climate change increases inequality and the poverty rate among people, further marginalizing the people. One of the IDI respondents claimed that,

> *I have 2 hectares of agricultural land to produce paddy, but the intense heat during the summer has posed a challenge by causing the water in the pond to evaporate. Due to saline water, we are unable to utilize canals or rivers. Instead, we rely on rainwater, which we collect and store in ponds. However, the occurrence of reduced rainfall and intense heat waves together might result in significant losses in paddy farming. In winter, freshwater crises reach extreme and I cannot grow many crops. This year, I took a loan of 1.5 lakh taka from an NGO with a 12% interest rate to conduct agricultural activities. I planned to pay for it by selling my produced crops. However, this year I am unable to sell my paddy crop to cover even the cost of my fertilizer, moreover, I have to repay the loan. I am uncertain about how I will manage my family's expenses this year and how I will return my debt. I intend to resolve the situation by selling my land. In addition, several locals were employed on my property, performing tasks ranging from soil preparation to threshing the crops. I have departed from a significant number of individuals and most of them are not currently employed in this location; instead, they have relocated to urban areas in search of new employment opportunities as the agricultural sector is characterized by unpredictability.*

3.2.3. Impacts of Climate Change on Human Capital

Being impacted by climate change, human capital becomes affected by financial constraints. Farmers cannot afford to give proper education to their children due to financial losses. Instead, they encourage their children to support them by either having them work in the crop fields or by sending them to urban or peri-urban areas to find jobs to support their families (see Figure 3). One of the FGD respondents responded,

> *There are a few youths who enrolled in college in this area. Typically, children of the families must dedicate a significant amount of time to engage in agricultural chores to assist their parents. Furthermore, during storms, tidal surges or other natural disasters, schools, and colleges remain closed for an extended period of many months. Consequently, students lose their enthusiasm to study, and many of them engage in activities to make money in order to support their families. Even many youths tend to move to the cities for searching the jobs to support their families.*

A total of 10 IDI respondents and 15 FGD respondents explained the situation in a similar manner. Additionally, all the respondents of this study claimed that people in this area have been suffering from different diseases due to salty water and the scarcity of freshwater. Furthermore, people cannot receive medical support and treatments due to financial constraints.

3.2.4. Impacts of Climate Change on Social Capital

Our field data show that climate change transforms the survival strategies of the people, resulting in a reduction in financial and natural resources. This leads to vulnerable economic conditions, which in turn weaken family bonds and social connections. Consequently, nuclear family practices are on the rise. Moreover, there existed strong social bonds among the members of the community, characterized by activities such as the sharing of food and resources as well as collaborative efforts during times of hardship. However, these bonds follow a downward trajectory, primarily as a result of constraints in both natural and financial resources (see Figure 3). The limited availability of resources has also led to a rise in child marriage and interpersonal violence in the community. Hence, mutual trust and dependency (social capital) are absent among the members of this area. As one IDI said,

When I am unable to meet my family's essential needs, I seldom find myself inclined to engage in communal activities or assist others due to my low financial capacity. I have a loss of self-esteem when I am with people due to the financial strain caused by a low income and heavy debt obligations. In order to participate in the family event, it is expected that we contribute either a gift or a monetary donation. However, I am now unable to afford this expense. Therefore, I made the deliberate choice to refrain from maintaining effective connections with both my relatives and neighbors.

Another participant in the FGD 3 added,

I have a total of 5 offspring, specifically 3 daughters and 2 sons. I have successfully arranged marriages for all of my daughters, providing a dowry. I need to obtain a loan in order to cover the expenses associated with a dowry. Prior to turning 18, I orchestrated their marriage due to my inability to afford the financial burden of supporting the family. My boys are employed in agricultural fields.

3.2.5. Impacts of Climate Change on Political Capital

The results of this study indicate that vulnerabilities in financial, social, and human capital amplify vulnerabilities to political capital. Adversely climate-affected marginalized people in this area are also underprivileged in the political sphere (see Figure 3). Government safety net programs and relief distribution are unequally and inefficiently distributed to the people in this area. Although the government made numerous promises, it was unable to improve the resilience of these communities to climate change. This was due to the limited participation of marginalized people in the policy formulation process and implementation processes. All the respondents claimed that their problems related to climate change were not solved, after hearing their perspectives. Even non-government organizations (NGOs) are providing external support without considering the local context, as was asserted by the respondents of household surveys, IDIs, and FGDs.

3.3. Polderization Aggravates the Impacts of Climate Change

The findings of this study highlight the government-initiated polderization (an initiative of the coastal embankment process) has aggravated the impacts of climate change, including increasing waterlogging areas, creating freshwater scarcity, and prompting salinity intrusion in the study area. Although it was established to control floods, salinity, cyclones, and tidal surges to improve coastal people's livelihoods, according to the representatives of the Government of Bangladesh, it had the reverse effects on the local livelihood vulnerabilities, as asserted by the respondents of this study. The people of this area were not aware of the polderization process, and the GoB representatives did not consult them on any aspect of the polderization process. The people in this area face a double burden, including the adverse consequences of the polder and climate change. Together, they have caused severe challenges to the survival and sustainable livelihood strategies of the people.

4. Discussion

The research findings highlighted the significant impact of climate change on the sustainable livelihood strategies of coastal people in south-central Bangladesh. The results of this research align with the prior studies of Islam et al. (2015), Huq et al. (2015), and Amin et al. (2018), which have investigated the effect of climate change on the livelihoods in coastal areas. However, while existing studies only focus on the effects of climatic events on specific aspects of people's livelihoods, they overlook the implications of climate change on sustainable livelihood assets. This study, in contrast, identified how climate change influences coastal people and the strategies they adopt to sustain their livelihoods, providing holistic views on this critical issue.

According to our study, climatic disasters have an immediate impact on natural capital, such as freshwater scarcity and the limitation of arable lands, and natural capital, including houses, livestock, and some tangible assets. This study highlights the findings of other studies, e.g., the study conducted by Machado and Serralheiro (2017), which

revealed that land infertility due to salinity impedes cultivation and reduces agricultural productivity. Furthermore, Nguyen et al. (2020) describe that salinity intrusion adversely affects agricultural production and food security resulting in economic losses owing to its influence on agricultural land. Our study validates the arguments that climate-induced salinity intrusions affect coastal people's economic position. This study further validates the findings of Haider and Hossain (2013), which highlighted how salinity intrusion imposes adverse effects on the income, spending, and employment prospects of farmers. Peal et al. (2020) found an indirect connection between climate change and farmers' poverty. Our findings differ from others in the context of how climate change-induced events affect social classes differently. The field data also revealed that farmers' heavy reliance on loans with high interest to pursue agricultural inputs puts further pressure on their shoulders to repay those loans, especially when crop production is disrupted by climate change, which is supported by the statement of Panwar and Khan (2019) that the adverse effects of climate change on Indian agriculture result in cultivators falling into debt traps and, in extreme cases, committing suicide. Addressing these financial challenges, a KII respondent suggested that adaptive agricultural practices, such as drought-resistant crop variants, and rainwater harvesting techniques are necessary. Further, providing access to interest-free loans or low-interest rate loans could help farmers manage their finances and overcome difficulties.

Fragile economic conditions with limited physical capital further weaken family ties and communal relationships and undermine collective resilience to adapt to climate change. As stated by the FDG respondent, during a financial crisis, everyone becomes self-centered, paying less focus on communal activities and social bonding. This finding is supported by Clayton (2020), explaining that climate change imposes negative impacts on hazard-affected people that deteriorate their social relations. Further, Di Giorgi et al. (2020) stated that climate change has a detrimental effect on social bonding, reducing social capital and impacting emotional stability. As suggested by KIIs, rebuilding social bonds and collective resilience requires initiatives such as community savings groups, cooperative farming, and communal disaster preparedness programs. On the other hand, local people claimed that one of the reasons for the collapsing social bonds in the community is inappropriate external support. They argued that when no external support was available, people built a strong community bonding as an adaptive mechanism. When support is provided by external sources, such as GOs and NGOs, it makes people less committed to the community.

The study revealed that climate change-induced social and financial issues are hindering the progress of education and skills development. The necessity for children to work in their parents' agricultural fields because of financial constraints impairs their long-term prospects and forces them to stay in a cycle of poverty. The findings highlighted that school dropout is a very common phenomenon in coastal areas, where girls are rarely allowed to study after the completion of primary education due to cultural and religious pressure. These findings align with the previous research of Muurlink and Poyatos Matas (2010), who found that climate change affects the students' capacity to attend school, especially poor, rural, and female pupils. So, enhancing educational infrastructure and integrating climate change adaptation and agricultural skills training into the educational curriculum can equip the younger generation with the knowledge and skills needed to thrive in a changing environment.

The study found that the cascading effects of climate change are causing people to become more marginalized, weakening political capital, including their representation in the political sphere, local policy implications, access to public resources, and access to resource allocation and distribution. It increases corruption, nepotism, and the unequal and insufficient distribution of government-supported resources. Rahman (2018) highlighted the negative impact of poor governance and the political system on community resilience, which aligns with our findings.

Local Problems Need Localized Solutions

The Government of Bangladesh (GoB) places a huge emphasis on adopting different initiatives, strategies, and policies for climate change adaptation to reduce the adverse impact of climate change. In 2009, the Ministry of Environment, Forest, and Climate Change (MoEFCC) prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) by integrating six thematic areas, where five focused on adaptation and the sixth on mitigation. The GoB also accounted for the context and implications of climate change in the preparation of the Bangladesh Delta Plan 2100. Currently, the government is in the process of the advancement and formulation of the National Adaptation Plan (NAP) that will significantly enhance our adaptation ambitions (MoEFCC 2024; MoEF 2009; GED 2018). Despite the number of policy implications of the GoB, contemporary policies have limited inclusiveness of the localized context of climate change issues. The policies lack the participation of marginalized, informal, and excluded communities. They also ignore the local social and cultural aspects of adaptability, introducing outsiders' inventions (Chowdhury et al. 2022). The study's findings are not beyond this evidence. The findings highlight that the voices of marginalized and climate-affected communities are not heard in policy-making and execution processes. Even external project developments and implementations do not consider the local people's practices. One of the external interventions taken by the government is polderization in the coastal zone of southern Bangladesh. The KII respondents, who represent the Local Agricultural Extension Department and the Bangladesh Water Development Board, mentioned that the polders were created to prevent the entrance of saline water into the locality and local agricultural lands on the one hand, and they also aimed to store fresh water during rainy seasons on the other. The objectives of the polder are to increase agricultural productivity and to make the land arable year-round. However, local people claimed that polderization has the reverse effect on local land management and agricultural activities. It increases the chance of saline water intrusion and increases salinity in the soil. Water logging is another issue claimed by the respondents. Without utilizing the polder's water (as it contains salinity), farmers rely on big ponds (created by their initiative) to store rainwater to irrigate their croplands, particularly paddy fields. The field data revealed that the polderization system in the coastal area significantly affected the sustainable and long-standing livelihood strategies of local people. When questioned about the government's inability to protect their livelihoods, 70% of the respondents asserted that from the inception to the implementation of the polderization process, local perspectives and people's experiences have not been taken into account. We are the people who have been living there for generations and know how to deal with these adversities. Government agents are the outsiders who suggested the polder system be implemented without our representation. Even today, solutions to the problems associated with polderization are carried out with experts' opinions, ignoring our experiences and voices. Without our representation, how can they understand our problems? They (respondents) suggested that government initiatives should be based on the local people's needs and hear their voices.

Although coastal areas represent livelihood vulnerabilities, they also provide plenty of opportunities for the people living in the coastal regions (Huq and Easher 2021). The people of these areas deal with the vulnerabilities by seizing opportunities with their traditional mechanisms and wisdom. Government interventions in this regard should be based on the traditional and localized practices of the coastal people to protect their sustainable livelihood strategies. This study suggests that localized practices should be considered in external interventions based on the work of Moran (2022), who posits that livelihood strategies are different based on geographical and geophysical conditions, including water resources availability, temperature, rainfall patterns, position of the land relative to the sea-level (elevations), resource availability, biological productivity, etc. Otherwise, any interventions could be ineffective and potentially lead to new problems for the local people, as evident in the study by Huq and Easher's (2021).

5. Conclusions

This paper revealed that climate change has severe implications on the sustainable livelihood strategies of coastal people, limiting their access to natural capital and damaging physical capital, which further affects financial, human, social, and political capital. Despite the GoB making serious efforts to reduce the adverse impact of climate change by taking adaptation and mitigation initiatives and policies, they have not been effective due to the lack of integrating socially and culturally driven, longstanding, localized practices into the policy level. While the GoB claims that they have been considering the local context of climate issues and their adaptive and mitigative measures, this is indeed not seen in practice in local areas. Again, the government has implemented some interventions, like polderization, to prevent salinity intrusions in the coastal croplands. These interventions do not work effectively as they ignore the local people's representation. The gap between local people and government interventions creates more challenges for sustaining people's livelihood strategies in the era of climate change. Integration between local people and government stands out as an urgent need to confront climate change challenges for people's sustainable livelihood strategies.

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