



Understanding the challenges of climate change adaptation in rural Bangladesh: Qualitative insights of geographical obstacles

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Abstract

This research delves into the challenges of climate change adaptation in rural Bangladesh, particularly in coastal and riverine areas, through qualitative insights on geographical obstacles. It reveals the vulnerability of low-income communities heavily reliant on agriculture, facing threats to food production and security due to climate-induced disasters and land pressure. The study underscores the multifaceted impacts of climate change, including freshwater scarcity, gender inequalities, and forced migration, exacerbating socio-economic vulnerabilities. While indigenous adaptation practices like salinity-resilient agriculture and integrated farming techniques are employed by coastal farmers, the research highlights the inadequacy of current measures to address escalating salinity levels and extreme events, leading to significant losses and livelihood challenges. Additionally, it explores the role of indigenous knowledge systems in disaster risk reduction, advocating for their integration with modern scientific approaches to enhance resilience effectively. The study emphasizes the urgent need for targeted interventions and policy measures to enhance climate resilience in vulnerable regions, advocating for essential infrastructure development, improved resource access, and community-based adaptation strategies to empower local communities in decision-making processes.

Keywords

Climate change adaptation, Rural Bangladesh, Indigenous knowledge, Salinity-resilient agriculture, Community-based adaptation



Significance Statement

This research sheds light on the critical challenges faced by rural communities in coastal and riverine areas of Bangladesh due to climate change. By exploring into the geographical obstacles hindering effective adaptation efforts, the study emphasizes the urgent need for tailored strategies to address these vulnerabilities. The findings underscore the disproportionate impact of climate-related disasters on agriculture, livelihoods, and food security, exacerbating poverty and hunger among local populations. By advocating for proactive adaptation measures and community engagement, the study emphasizes the importance of context-specific approaches to climate resilience. The research underscores the significance of geographic considerations in crafting effective adaptation policies, urging policymakers to prioritize climate-resilient infrastructure and community-based solutions to safeguard vulnerable communities in Bangladesh and beyond.

Introduction

The global phenomenon of climate change, notably influenced by human actions, holds significant socioeconomic and ecological significance. Nonetheless, it is the localized consequences of this global shift that apply the greatest impact on individual lives, primarily due to the complicated nature of how local areas respond to this worldwide phenomenon (Report, 1993). Climate change pretenses severe threats to LMICs and underdeveloped countries, and Bangladesh is particularly vulnerable due to its topography and socio-economic conditions. This paper focuses on rural coastal and riverine areas, highly susceptible to multiple climatic hazards, leading to prolonged waterlogging and adverse impacts on agriculture and livelihoods. Lower middle-income countries (LMICs) are at high risk of being vulnerable to the adverse effects of natural climatic hazards due to their topographical locations (Details, 2023; Barua et al., 2023; Barua et al., 2022). Low-income countries heavily depend on agriculture for rural livelihoods and development. However, agricultural systems in these developing nations face significant challenges due to land pressure and climate change. Both factors pose threats to food production, putting the livelihoods and food security of vulnerable communities at risk (Saha and Barua, 2023; Mbow et al., 2014). Climate change is a worldwide problem that has affected various economic sectors, including agriculture. Among those most vulnerable are existence and smallholder farmers in low-income countries, who heavily depend on nature and often lack sufficient adaptation capacity (Karki et al., 2020). Climate change has become an undeniable reality, bringing about shifts in weather patterns with significant consequences for everyone. These changes disrupt seasonal cycles, harm ecosystems and threaten water supplies.



Moreover, they have adverse effects on agricultural farming systems and food production, while also contributing to rising sea levels. The consequences of climate change encompass floods, landslides, droughts and even famine (Barua et al., 2020; Barua et al., 2021; Barua and Rahman, 2017). Extreme events comprise a range of occurrences, such as floods, deficits in soil moisture, tropical and other types of storms, unusual temperature fluctuations and wildfires. The consequences of these extreme events tend to have momentous local impact and can utilize a strong influence on specific sectors and regions (Smith et al., 2001). The frequency and intensity of storms may escalate, leading to heightened risks, including more intense rainfall, greater agricultural losses, increased likelihood of landslides, a rise in tropical cyclones and an elevated number of fatalities (Gakpey, 2022). Among the respondents, the most significant risk reported was flooding, closely followed by cyclones. Additionally, nor'westers, heavy rainfall, and tidal surges also had severe adverse effects on the lives of many people, causing damage to existing infrastructure, disrupting crop production, poultry farming, cattle rearing, shrimp cultivation, crab fattening, homestead gardening and other aspects of their normal daily lives (Strategic et al., 2021). Drought stress pretenses a significant abiotic challenge that hampers nutrient uptake by roots, thereby restricting cereal crop production in Asian Least Developed Countries (LDCs) (Karim & Rahman, 2015). Health adaptation focuses on lessening the impact of climate-sensitive health issues. To assess its effectiveness, indicators might be used to monitor alterations in the geographic range, seasonality and occurrence of such climate-sensitive outcomes (Ebi et al., 2018). In Bangladesh, periodic droughts cause destruction on crops, leading to hardships for underprivileged agricultural laborers and others struggling to find employment. In such regions, the issue of Monga, characterized by seasonal hunger due to unemployment, is particularly acute, especially in the months preceding the November-December rice harvest (Govoni, 2012). Drought represents a distinctive natural hazard, possessing multifaceted characteristics that impose harm upon both ecology and economy. Effectively addressing drought necessitates a dedicated policy covering precautionary and proactive measures (Bandyopadhyay et al., 2020). The majority of respondents chose not to seek shelter during the disaster for several reasons. Firstly, they believed it was unnecessary. Secondly, they prioritized protecting their property by staying at home. Thirdly, the shelters were located far away, making it inconvenient for them to reach. Fourthly, they considered the disaster to be a common occurrence and were familiarized to dealing with it. Finally, they determined to protect their household and cattle themselves as a coping mechanism for dealing with undesirable natural disasters (Strategic et al., 2021). Communities worldwide, which are vulnerable and



exposed to climate change, are already experiencing its impacts and implementing various adaptation strategies to ensure their survival and sustain their livelihoods (Details, 2023). Incorporating the community in Early Warning Systems (EWSs) is of utmost importance as it plays a critical role in saving lives, reducing injuries, and mitigating environmental damage caused by disaster events (Sufri et al., 2020). In urban communities, the majority of people are typically involved in the dissemination and communication aspect of Early Warning Systems (EWSs), utilizing advanced information and communication technologies (ICTs) readily available in cities. These technologies facilitate efficient one and two-way communication processes, enabling better dissemination of critical information during disaster events (Sufri et al., 2020). The research results revealed that the majority of documents originated from developing countries, predominantly in Asia and Africa. These documents highlighted community involvement in the design and implementation of Early Warning Systems (EWSs), with a specific focus on addressing individual hazards like floods, landslides, droughts, cyclones and volcanic eruptions (Sufri et al., 2020). Climate change directly affects various aspects of the environment, including biodiversity, agriculture, water resources, forests and coastal areas (Nzeh, n.d.). Agricultural crop production in Asian Least Developed Countries (LDCs) is seriously impacted by drought stress experienced during crop growth. Drought stands as the primary environmental limitation to plant survival, distribution and crop productivity, resulting in considerable economic losses (Karim & Rahman, 2015). The farming communities relying on rain-fed agriculture for their livelihoods are particularly susceptible to the detrimental effects of climate change, which can lead to substantial hazards and risks for their well-being (Karki et al., 2020). Climate change has the potential to exacerbate both climate vulnerability and gender inequality. As a result, women may encounter specific conditions of vulnerability in society and their daily livelihoods (Md et al., 2022). Food production for both humans and animals has been adversely affected by the rise in floods and heavy rainfall. The respondents have raised concerns about the escalating crisis in animal food availability over the past few years (Change et al., 2022). Agroforestry offers multiple benefits, including assets and income generation from carbon sequestration, wood energy production, improved soil fertility, and the enhancement of local climate conditions. Additionally, it provides valuable ecosystem services while reducing human impacts on natural forests (Mbow et al., 2014). The vulnerabilities to climate change and the actions taken to adapt vary depending on social differences, which are entangled with complex power dynamics within specific places, cultures and contexts (Garcia et al., 2020). The impact of climate change on human mobility and health outcomes is a topic that



predominantly revolves around quantitative predictions and debates on whether migration is adaptive or maladaptive. However, insufficient attention has been given to the perspectives of the individuals who are moving due to climate change, particularly concerning their health and overall well-being (Schwerdtle et al., 2021). Forced migration poses a hindrance to development through several channels. It intensifies the strain on urban infrastructure and services, undermines economic expansion, elevates the potential for conflicts and contributes to deteriorating health, education and social indicators within the migrant population (Piguet, 2008). Annually, a significant number of people are internally displaced in Bangladesh, with coastal areas being the most vulnerable to the impacts of climate change (Chowdhury et al., 2020). When individuals, households and communities decide to migrate, they engage in a risk exchange, which results in a range of positive and negative consequences for their health and well-being. As they move, various health determinants undergo changes and migrants encounter a different healthcare environment characterized by varied choices, barriers and quality of care (Schwerdtle et al., 2021). Every year, a large number of people in the coastal areas of Bangladesh are forced to relocate due to climate change-related natural disasters, leading to the emergence of Internally Displaced Persons (IDPs) (Chowdhury et al., 2020). Climate-induced disasters have a significant impact on croplands and exacerbate the vulnerability of smallholder farmers (Al-Maruf et al., 2021). Bangladesh, as a nation defined by its extensive network of rivers and proximity to the sea, appearances a coastline that stretches for 710 kilometers, characterized by numerous indentations, situated at the apex of the Bay of Bengal (Iqbal et al., 2021). Bangladesh includes 230 rivers, with 57 of them being transboundary (54 originating from India and 3 from Myanmar). The country takes pride in its rivers, which collectively expanse approximately 24,140 kilometers. This diverse network contains small hilly streams, meandering seasonal creeks, muddy canals (khals), as well as majestic rivers and their tributaries and distributaries (Rahaman, 2005). Water is a vital, life-preserving essential for all forms of animal and human existence (Govoni, 2012). Freshwater plays diverse and crucial roles in various aspects of life. Ecologically, it is the defining factor that distinguishes a river from other water bodies like lakes. Water is an essential component of ecosystems, supporting the existence of life and contributing to the functioning of various natural processes (Hunter, 2005). Out of the total water available, 97% is salt water, which is largely unsuitable for human consumption (Hunter, 2005). Approximately 70% of the world's fresh water is utilized for food production, with developing countries accounting for about 82% of this usage (USAID, 2009). Water scarcity is demonstrated through various scenarios, such as individuals having to transport heavy containers of



water over long distances daily to fulfill their domestic requirements, farmers facing hardship as they lose their lands or livelihoods due to insufficient irrigation water, wetlands or creeks disappearing due to water depletion upstream, and a rise in health issues attributed to water pollution and the spread of waterborne diseases (Barker et al., 2000). Climate change is leading to the uninhabitability of certain lands and disrupting water supplies, posing a threat to people's fundamental needs. It has adverse effects on agricultural farming systems and is also a driving factor behind displacement (Nzeh, n.d.). Indeed, water not only defines landscapes but also actively shapes the land through processes like flooding and erosion. Moreover, it plays a significant role in providing essential nutrients to coastal areas and oceans, influencing the health and productivity of marine ecosystems (Hunter, 2005). The level of investment a company makes in addressing water risks serves as an indicator of its commitment to the issue. However, the specific allocation of that investment exposes the company's true dedication to genuinely reducing water-related impacts, enhancing resilience and augmenting brand value (CDP, 2020). Climatic events can make it challenging for people to access deep tube wells, leaving them without access to safe drinking water. As a result, they are compelled to consume unhygienic water, posing a threat to their health (Change et al., 2022). The private sector plays a crucial role in attaining the water-secure world necessary for our collective well-being. Amidst challenges such as nature loss, climate change and a global pandemic, all of which intersect with water, there remains significant unused potential for companies to take further actions to address these issues effectively (CDP, 2020). Approximately 3.26 million rural households in Bangladesh are landless. Typically, these landless households represent the poorest and most vulnerable segments of the population in the country and are often the first to be affected by climatic hazards (Morsalin & Islam, 2023). Bangladesh stands out as one of the world's most disaster-prone nations, facing heightened vulnerability to the impacts of climate change. This vulnerability is evident in the escalating frequency and severity of river erosion, leading to substantial human and economic tolls (Rahman & Gain, 2020). Bangladesh's north, north-western and north-eastern regions frequently experience seasonal floods and flash floods as common natural phenomena (Al-Maruf et al., 2021). Bangladesh continues to grapple with high poverty and unemployment rates, acute economic and social inequalities, weak physical infrastructures, and fragile and ineffective governance systems. These factors collectively increase the vulnerability of the population and create obstacles for their efforts to adapt to the challenges posed by climate change (Morsalin & Islam, 2023). Ecosystems play a critical role in coastal communities, particularly in rural areas, where livelihoods heavily rely on industries such as fisheries, agriculture,



livestock and forestry (Nurzaman et al., 2020). Cyclone Sidr in 2007 and Aila in 2009 resulted in the destruction of approximately 95% and 46% of standing croplands in the coastal areas, respectively (Al-Maruf et al., 2021). In coastal regions, the majority of women heavily rely on natural resources to generate income and sustain their livelihoods. According to the respondents, women in the study area earn money through various agro-based activities such as transplanting, harvesting crops, boiling and drying cereals. Additionally, they engage in activities like collecting fish and prawns from the river, as well as raising hens and goats (Md et al., 2022). The study aims to identify the specific challenges faced by these vulnerable areas in adapting to the effects of climate change, particularly in relation to climatic hazards such as heavy rainfall, river bank erosion, floods, storm surge, cyclones, high and low tide and waterlogging. By focusing on the geographic context, the study seeks to shed light on the unique and localized issues that rural communities in these regions encounter and how these obstacles hinder their ability to adapt to changing climatic conditions.

This research sheds light on the critical challenges faced by rural communities in coastal and riverine areas of Bangladesh due to climate change. By exploring into the geographical obstacles hindering effective adaptation efforts, the study emphasizes the urgent need for tailored strategies to address these vulnerabilities. The findings underscore the disproportionate impact of climate-related disasters on agriculture, livelihoods, and food security, exacerbating poverty and hunger among local populations. By advocating for proactive adaptation measures and community engagement, the study emphasizes the importance of context-specific approaches to climate resilience. The research underscores the significance of geographic considerations in crafting effective adaptation policies, urging policymakers to prioritize climate-resilient infrastructure and community-based solutions to safeguard vulnerable communities in Bangladesh and beyond.

Rationale of the Study

The objective of this qualitative study is to explore and understand the geographical obstacles hampering climate change adaptation efforts in rural areas of southern coastal and riverine regions of Bangladesh.

- a) **Climate Vulnerability:** Bangladesh is highly vulnerable to climate change impacts and the southern coastal and riverine areas are particularly exposed to multiple climatic hazards. Understanding the specific challenges faced by rural communities in these regions is crucial to developing effective and targeted adaptation strategies.



- b) **Limited Access to Resources:** Rural areas often have limited access to resources and infrastructure, making them more susceptible to the adverse effects of climate change. The study aims to highlight how the lack of climate-resilient infrastructure, such as cyclone and flood shelters, impacts the ability of rural communities to cope with and recover from climatic disasters.
- c) **Impacts on Agriculture and Livelihoods:** Agriculture is a significant livelihood source in rural Bangladesh. The study seeks to explore how recurrent natural disasters and climate variations affect agricultural production, leading to food uncertainty, increased costs of cattle rearing and overall poverty and hunger among affected communities.
- d) **Need for Adaptation Mechanisms:** Understanding the challenges and barriers to implementing climate change adaptation is essential for designing effective strategies. The study aims to identify the obstacles faced by rural communities in adopting proactive adaptation tactics and the importance of considering geographic contexts while planning and implementing such measures.
- e) **Policy Implications:** The research intends to provide valuable insights to policymakers and governmental bodies, emphasizing the importance of developing climate-resilient rural infrastructure and promoting community-based adaptation strategies. By involving local communities in decision-making processes, building resilience and enhancing access to information and resources, the study seeks to contribute to more effective climate change adaptation efforts in vulnerable regions.
- f) **Qualitative Insights:** The study adopts a qualitative approach to gain in-depth understanding and explore the perspectives and experiences of rural communities directly affected by climate change. Qualitative research allows for rich and contextual information that can inform more comprehensive and nuanced climate change adaptation strategies.

Overall, the objective and rationale of the study aim to contribute to the existing knowledge on climate change adaptation challenges in rural Bangladesh, with a specific focus on the geographical obstacles faced in the coastal and riverine areas. By highlighting these challenges, the study intends to advocate for targeted interventions and policy measures to enhance climate resilience and improve the well-being of vulnerable communities in the region.



Methodology

This qualitative study employed in-depth interviews, focus group discussions and field observations to understand the geographical obstacles hindering climate change adaptation in rural Bangladesh. Nine Key Informant Interviews (KIIs) and six Focus Group Discussions (FGDs) were conducted in coastal, in-land and riverine areas from January to December, 2023. Participants provided verbal and written consent and data collection continued until data saturation. Field notes were taken during interviews and discussions.

Results

The study identified several significant climatic hazards in the southern coastal and riverine regions of rural Bangladesh, including heavy rainfall, river bank erosion, floods, storm surges, cyclones, high and low tides and waterlogging. These hazards have profound effects on the communities living in these areas, leading to adverse consequences for agriculture, livelihoods, and overall well-being. The impact on agricultural production was particularly pronounced, resulting in submerged croplands and increased costs for cattle rearing feeds. This economic strain further contributed to food uncertainty, hunger and poverty among affected communities. A key finding was the limited access to resources and climate-resilient infrastructure in these rural areas. The lack of disaster awareness and preparedness exacerbated the vulnerability of these communities. Many regions lacked adequate cyclone and flood shelters, making it challenging for rural communities to cope with and recover from climatic disasters. These challenges underscore the urgent need for targeted interventions and policy measures to enhance climate resilience in vulnerable regions.

The paper emphasizes the significance of proactive adaptation tactics to mitigate the adverse effects of climate change. The government should focus on developing climate resilient rural infrastructure, including roads, bridges and communication networks, to enhance access to information and resources. Community-based adaptation strategies are crucial in involving local communities in decision-making processes and empowering them to build resilience to climate change. The study's findings indicate that rural areas in the southern coastal and riverine regions of Bangladesh are indeed highly vulnerable to climate change impacts. Submerged croplands and livestock farming areas result in increased costs of cattle rearing feeds, leading to economic strain and poverty among the affected communities. Food uncertainty and hunger are also predominant due to the vulnerability of agricultural production to climate hazards. Challenges hindering effective climate change adaptation in these rural areas include limited



access to resources and climate-resilient infrastructure. The lack of disaster awareness and preparedness further exacerbates the communities' vulnerability. Many of the affected regions lack adequate cyclone and flood shelters, making it difficult for rural communities to cope with and recover from climatic disasters.

The respondents of the south-western coast of Bangladesh are people from Stakhira and Khulna. These districts are protected by the large mangrove forest –the Sundarbans. This region is frequently battered by tropical cyclones: the most notable of them in recent years was the severe cyclonic storm Sidr in 2007. Due to the disaster-prone nature of the region and the memories of recent disasters, most people are very much aware of the vulnerability and the threats. They were also found to be highly aware of the protective adaptation options. The authors found that women who live near the seaside are more susceptible due of in a very dynamic setting with several natural hazards. In addition, there are risks from upstream water and land uses as well as climate change. These dangers have an impact on practically every element of life and restrict people's options for a living. In addition, women are involved in activities outside of their typical home duties. Coastal people's process of communal adaptation is more successful. The community has now been able to determine which tree species are best for their altered conditions, and they are beginning to plant three different kinds of trees: sour, bitter and tan trees, which grow fruit and thrive in saltwater environments. Having alternate sources of income could lessen financial vulnerability. NGOs assist people in improving their standard of living by working with the local community to plan improvements and engage in activities that lower disaster risks and help people adapt to climate change. Besides, the authors explored that women experience poverty, starvation, malnutrition, economic crises, environmental degradation, health issues, insecurity and becoming victims of violence and political unrest more frequently than males do during and after disasters. Gender becomes a crucial factor in the gendered division of labor. Because of the extra work and environmental changes brought on by a disaster, roles are frequently reinforced, if not increased. Residents of coastal areas have been residing in homes with mud walls and palm leaf-like structure known as the golpata roof. Golpata houses are not resistant to cyclones. When the storm People frequently did not want to go to shelters unless there were strong storm warnings because they are far away. Many people perished during Aila while residing in their homes since the mud walls were not sturdy enough resistant to cyclones. The majority of people used a new approach to build buildings after Aila. They produced sticks from bamboo or Goran trees and they were used to make fences. The mud layer was then spread over the fence to construct



their homes' walls. The usual muddy house is not as sturdy as this one. From the focus group discussion with women groups in the different geographical region found that *“Bangladeshi women's social, economic, cultural and political circumstances force them more susceptible overall to global warming and climate change. Various kinds of local Adaptation strategies include raising chickens, conventional farming, earning a living and using rainwater. Women are the ones who take collections, etc. Less wealthy women save money, stockpile food, and eat less foods, give up their personal resources in order to support their husbands and kids. Certain ones were being moved from one to another for financial gain, safety and other reasons. Women also began to diversify their crops and fish, day labor and farming as a coping mechanism after losing one's job and money. The populace also shrank eating as a coping mechanism for a lack of food. Southern women deal with a variety of violence and discrimination both during and after a crisis. The majority of responders occasionally experience gender discrimination at work spot. Not only do the respondents experience gender discrimination in the workplace on occasion, but they also witness it all the time. Most family members don't relocate as a result of a tragedy”*.

The primary rice-growing region in Bangladesh, the haor wetlands, which are located in the country's northeast, account for roughly 18% of the country's total rice production. Physically, these haor wetlands are a sizable tectonic depression in the form of a bowl or saucer, with a subtropical monsoon climate prevailing. A multitude of livelihood choices and rich crop production have been made possible by the distinct physical environment and hydrology of the haor regions. Sadly, there are serious climate hazards in this area as well, most notably the possibility of early flash floods. The main worry these days is that floods in these northeastern haor wetlands are predicted to increase further in the near future as a result of climate change, which will further increase the uncertainty surrounding the sustainability of the farming and production system. Regrettably, these marginal and smallholder farmers in haor wetlands typically have inadequate adaptive capacities and are more susceptible to crop loss risk. Additionally, they don't have as much access to other production methods. Thus, there is a serious risk of acute food insecurity as a result of climate change's severe threat to their farming system, food supply, and productivity.

In order to address climate hazards and the resulting crop loss, production system adaptation has emerged as a critical policy response that reduces climate vulnerability while safeguarding the agri-food system and means of subsistence for impoverished farmers, particularly those from those developing nations. During the discussion with local communities of Hoar area, they said tha *“There are several*



obstacles to flash flooding adaptation which include lack of submergence-tolerant rice varieties, market and input access issues, ignorance of available choices for adaptation, and a labor scarcity during pick-and-plant operations. Farmers' behaviors related to problem-solving and resistance to change were also associated with their socioeconomic characteristics. The annual family income, media exposure, and sense of climate change are examples of socioeconomic features. However, farmer's resource limitations to adjust to climatic shocks and traditional, nature-dependent boro rice production system limit the policy alternatives available to them. Thus, additional financial and logistical assistance for farmers as well as efficient coordination and governance between extension agents and legislators are required for the successful adaption of strategic interventions".

From the finding of Key informant interviews with stakeholders for necessary adaptation options for haor region the authors found that future studies should concentrate on farmers' cognitive capacities and aptitudes for acting in a risk-averse manner, as this was not addressed in the study. In the haor wetland region, these actions would help ensure a sustainable farming system while also efficiently managing the uncertainties associated with climate change. The current status of adaptation barriers to climate vulnerability and many socioecological system elements that both directly and indirectly affect the haor community's ability to adapt to flash flood events were covered in detail in our study. Furthermore, no "one-size-fits-all" solution exists for all areas or populations. There are differences in farming practices, geographic locations, climate hazards, and demands and demands for care among the various regions. These target areas include establishing an early warning system to help farmers prepare before the onset of climate hazards, managing water resources to address local environmental issues like flood control and irrigation management for rice production, providing farmers with support after flooding occurs, encouraging alternative income-generating activities as a supplementary source of income for rice growers, and establishing a mechanism for coordination between various actors and stakeholders at the local, regional and national levels. In order to increase the vulnerable communities' ability to adapt to climate change vulnerabilities, the government and policy makers may find it necessary to allocate more resources, create efficient channels of communication between the government and local actors and offer logistical and technical support to these communities.

Bangladesh's government structure places less emphasis on locally contextualised natural resource governance for climate change adaptation. wetlands in floodplains thus in this governance viewpoint,



agro-ecological ecosystems are disregarded. Following the Ganges-Kobodak irrigation canal's construction, local Wetlands dried up, making it difficult for poor farmers to manage livelihoods. Infrastructure spending related to water disregard the ecosystem's perspective, which leads to water concerns about adaptability, local disputes and insecurity for the majority of residents in the area. In regulations like the National Adaptation Plan (NAP) 2022, the administration neglected to acknowledge numerous issues, including the loss of assets and welfare brought on by climate change. No significant players, like non-governmental organizations (NGOs), civil society groups, or regional administrations think about using adaption strategies. NGOs, or non-governmental organizations abide by the planning recommendations of bilateral and multilateral donors and carrying out their community empowerment initiatives. Organisations encourage neoliberalism and globalisation by taking advantage of the weakest Bangladeshi people. Particularly, the current microcredit as a development buzzword for women's empowerment supports Multinational Corporations' (MNCs') capitalist interests. Because of the top-down, RALA viewpoint, NGO activities don't effectively advance sustainable adaption strategies and social. For instance, microloans leads to debt that is the cause of hunger, asset loss and debt default.

One of the respondent of KII from Chittagong University, noted that the top-down strategy for adaption initiatives is one of the main barriers to aiding victims of climate change in Bengal. He clarified, saying that when a senior government official contains a goal, and the government is required by law to establish and uphold policies. There's no need to comprehend in this situation the needs of nearby communities. A lot of adaption techniques constructing a shelter for a cyclone or dredging a river can produce adverse effects on the affected communities. When a cyclone, the shelter needs upkeep and lacks road access, issues, or is ruled by the wealthy, locals fall short in providing refugee assistance. Likewise, the government's initiative to dredge rivers is ineffectual when it doesn't guarantee community involvement and sound governance as well as portrayal. When it comes to public policy in general, adaptation politics is important. Coordinating with their international allies, a ruling administration oversees policy formulation and decision-making.

The water problem has a detrimental impact on other sources of income, including agriculture. The government should create water policy in tandem with climate change adaptation to lessen the effects of the water problem. Locals are currently looking for alternative water sources in order to preserve freshwater ecosystems, sustain vegetation and food production and assist marginalised groups of people



in supporting their way of life. To create more effective policies to deal with climatic catastrophes like flooding and landslides at the individual, community and governmental levels, local adaptation expertise is crucial. Other groups of individuals also experience the income insecurity that communities faces as a result of climate change factors. To guarantee that people have the right institutional support, future legislation should avoid generational consequences. Data collecting on the knowledge of the local community is a crucial element of this governance perspective. As was previously said, in order to enhance the link between government and local communities, adaptation policies related to a particular climate issue must take into account both the social and technical aspects of local community knowledge. If not, the coastal region will progressively become deserted, leading to increased population displacement, emigration and social unrest throughout Bangladesh and abroad.

The National Adaptation Plan (NAP) must take into account the fact that the regular agricultural losses brought on by salinity issues lead to unemployment, which in turn promotes violence against women, relocation and exploitation. Because of their socioeconomic and geographic backgrounds, the locals are knowledgeable about climate issues and adaptation strategies in their own right. Class status, work habits and environmental factors are among the factors that the Proactive Approach To Adaptation (PATA) can help to alleviate. It is imperative to integrate particularised information into the policy formulation and implementation process to ensure that initiatives and programmes effectively tackle issues. Shudhirpur's for instance, requested immediate assistance from the government because the city lacks a pond and requires a deep tube-well for drinking water. Additionally, they require more well-managed cyclone shelters for the populace that are connected to road networks and guarantee locals' correct accessibility regardless of their social or political identification. Many individuals have lost land as a result of cyclone activity because of erosion and other associated problems. Another KII respondent from CEGIS, a quasi-governmental organisation, discussed the significance of relocation in this setting and noted that the government is not addressing it. For instance, the government purchases property to develop hospitals, exclusive industrial zones and roads. Moreover, the government does not assist refugees from climate change. KAJ maintained that the government only provided assistance for floods and storms and did nothing else in relation to resettlement. Governments must involve the community in decision-making processes in order to meet their requirements. When locals are involved in governance, there is greater room to support local customs and culture, where decisions are made by and for the community. For crucial responses to occurrences like climate change, a flexible governance strategy facilitates co-



management decision-making among diverse stakeholders, including domestic, national and transboundary governments.

One way to create an effective adaptive policy to deal with environmental changes is to incorporate local practises. Documenting the many losses and forms of damage from a past climate catastrophe, such as Cyclone Aila, can aid in the creation of future policy that works. Institutions, civilizations and cultures may be better prepared in this situation if the various components and the degree of sensitivity and resilience are categorised. The characteristics that form a category include things like the types and extent of damage and loss experienced by vulnerable groups of individuals, as well as their resiliency and sensitivity to cyclone effects. Furthermore, according to focus group discussion, local governments require more efficient financial contributions to support their adaptation efforts. The government of Bangladesh's KB-2 endorsed for additional funding and brought up the necessity to address the regional differences in budget allocations in order to create practical financial strategies for climate change adaptation. In the process of adaptation, this multi-level financing strategy for public policy (Clar et al., 2013) may prove to be more successful. A wide range of local interventions with coordinated effort, creative management, and related shifts in resource use and institutional roles can be achieved through the coordination of the various policies and their implementation, giving the local people the results they need. For instance, land policy can have a significant role in resolving issues with unemployment. Land ownership is important for jobs, revenue and livelihoods, but in Bangladesh, locals are dealing with rising land inequality and related unemployment. The percentage of the population without land rose from 17.5% in 1962 to 33% in 1982 (Rahman, 1985). Land reform can advance social justice, which may lead to land equality and related employment possibilities. Every individual should own a piece of land that they may use for agriculture in order to sustain domestic animals, money, work possibilities and housing facilities—all essential elements of successful adaptation. Land policy must address the issues of land erosion and displacement, land reclamation and redistribution in the framework of resilient adaption methods.

In order to ensure coordination among various government levels and organisations for transportation and communication, embankment protection, functional markets, livelihood activities like income generation, water and sanitation, health and education and funding sources like micro-credit, significance of an integrated approach to climate change adaptation. When creating policy, it is important to consider both community and scientific information in order to fully grasp all of the variables. The relevance of



adaption innovation based on the involvement of numerous stakeholders, such as scientists, farmers, fishermen, and local governments, was highlighted by KSI from the UNDP. Given how the environment, livelihoods and society are changing, this innovation is crucial. The traditional viewpoint is ignored when addressing the requirements of the local population to deal with climate vulnerability because of the top-down government's dominance over innovation. The government must guarantee the independence of researchers to contribute and supply funding for study in order to achieve this goal. Bangladesh's adaptation policy must build a multi-level governance collaborative approach among stakeholders to promote social and cultural transform.

Creating a successful adaptive policy to deal with environmental changes may also involve incorporating local practises. Effective policy-making for the future can be aided by documenting the various losses and forms of damage from past climate events, such as Cyclone Aila. The classification of the many components and the degree of sensitivity and resilience in this context can open up opportunities for organisations, civilizations and cultures to better prepare. Groups of vulnerable individuals, their degree and types of loss and destruction and their sensitivity and resilience to deal with cyclone consequences are some of the aspects that characterise categorization. Additionally, local government needs to get more substantial financial support for its adaption plans. The Government of Banglades endorsed additional funding and pointed out that in order to create successful financial plans for climate change adaptation, there must be a correction to the regional imbalance in budgetary distribution. In addition to a wide range of local interventions with coordinated effort, creative management and related shifts in resource use and institutional roles, coordination between the various policies and their implementation can produce the results that the local people require. One key element in addressing unemployment issues, for instance, may be land policy. Ownership of land is important for livelihoods, jobs and income, but in Bangladesh, locals are struggling with rising land inequality and related unemployment. In order to achieve land equity and the related livelihood prospects, land reform can advance social justice. To sustain domestic animals, money, work possibilities and housing facilities—all crucial elements for successful adaptation—everyone should own a piece of land that they can cultivate for agriculture. Concerns about land erosion and displacement, land reclamation and redistribution must be addressed through land policy in the framework of resilient adaption methods. According to the statement of focus group discssuion in the local level these elements are referred to as "sectorial coordination." One further significant issue in these areas is land inequality: 75% of rural residents are either landless or own less



than 0.5 acres of land and the percentage is rising as a result of poverty, unsuitable development projects and the effects of climate change. When it comes to transportation and communication, protecting embankments, functional markets, livelihood activities like generating income, water and sanitation, health and education, as well as funding sources like microcredit, Policy should be formulated after consulting both scientific and community knowledge to fully grasp all of the elements involved. Scientists, farmers, fishermen, and local governments are just a few of the stakeholders that KSI from the UNDP highlighted as part of the significance of adaptation innovation. Considering how the environment, means of subsistence and society are evolving, this innovation is crucial. In order to address the requirements of the local population in coping with climate vulnerability, the traditional perspective is precluded because of top-down government dominance over innovation. The government must support research funding and guarantee the independence of researchers in order to achieve this goal. In order to encourage social and cultural transformation, Bangladesh's adaptation policy must establish a multi-level governance collaborative approach.

The residents of the town are making an effort to use their local resources, expertise and experience to deal with the difficult circumstances surrounding the water crisis and sanitation issues. Although coping has its limitations, they are crucial in lowering risks and a person's degree of vulnerability. Ecosystems have both common and unique coping mechanisms and reactions. Putting the tube well on high ground has been a standard response in flood and water logging situations. Throughout the project regions, a frequent solution to flooding is to use banana rafts for defecation. In order to make these kinds of local coping mechanisms more effective in the present and future climate crises, scientific and technical inputs must be added. To effectively transition the chosen coping strategy to planned and successful adaptation—and hence significantly lower the community's risks and vulnerability—further participatory research and local innovation would be needed.

Many adaption options have been proposed by the community members for WATSAN, taking into account their local contexts, dangers associated with the environment and climate and vulnerability. Based on their requirements, priorities and existing coping mechanisms, the technology and adaptation choices should be recognized and promoted. DTWs and piped water supplies for the neighborhood are frequent tactics and choices. In coastal areas, collecting and purifying rainwater. The local community and stakeholders have also proposed better pond management and saving fresh water for home use.



Numerous solutions, including communal latrines, flood and cyclone-resistant sanitation systems, were proposed in relation to sanitation. Along with widespread knowledge of WATSAN, they also sought increased community access to government subsidies and health services. Additionally, the community members in the southwest coastal ecosystem have recognized the following adaptation needs and strategies for improved climate resilient WATSAN and health management:

- Provide accessible and readily available potable water from deep tube wells
- Educate people about the need to boil pond water and then purify it with fitkari (alum) before using it
- Lift the shallow tube-well platform
- Educate the public about the need of healthy drinking water
- Raise the ponds' banks
- The necessity to dig the ponds again
- Plants that can store rainwater should be created, and rainwater harvesting should be implemented.

The residents in the central coastal area believe that constructing an embankment and sluice-gate would be beneficial.

To lessen the detrimental effects of climate change on southern coastal communities' sanitization infrastructure and public health, the following actions should be encouraged:

- Maintain hygienic restrooms
- Spread knowledge about the negative effects that unclean litter and unhygienic latrines have on the environment and human health
- Offer hygienic education
- Raise the proportion of educated and literate people
- Ascertain that the standard is upheld when building latrines
- Use methods for maintaining hygienic latrines and disposing of waste appropriately.

The following actions could be performed to lessen the dangers to health that climate change brings about:



- Increase public knowledge of the advantages of maintaining good personal, family and social hygiene;
- Ensuring that impoverished and extremely disadvantaged communities have access to more WATSAN services; and

Government agencies, non-governmental organizations and other interested parties must step up to help the communities.

Discussions

Bangladesh, with its topography and socio-economic conditions, is highly vulnerable to climate change, especially in rural coastal and riverine areas. Low-income countries, where agriculture is a critical source of livelihood, face significant challenges due to climate change and land pressure, posing threats to food production and security. Climate-induced disasters force migration, leading to challenges in health, livelihoods and urban infrastructure. Freshwater scarcity, exacerbated by climate change, affects access to safe drinking water and has adverse effects on ecosystems and coastal areas. Climate change exacerbates gender inequalities, particularly in vulnerable communities, where women play significant roles in natural resource-based activities.

Farmers of the coastal areas of Bangladesh are practicing salinity resilient rice production, cage fishing, production of mele (reed), production through floating dhap, changing the time of plantation, high yielding short duration rice production, methods of Sorjan, plum production, production of sunflower, floating bed vegetables production, organic fertilizers, urea deep placement, integrated cultivation, fattening of the crabs and small indigenous fishes, platform shed goat, duck and chicken rearing, production nearby the dyke, net fishing, different salt resilience wheat production such as Bijoy, BAU-1059 line, BARI Gom-25, production of salt resilient potato, salt resilient sweet potato, heat and salt resilient pulses, salt resilient short time tolerant oilseeds, salt and heat resilience tomato production, salt resilient jute cultivation, high yielding salt resilient sugarcane production, platform shed or semi-scavenger rearing process of livestock such as goat, sheep, duck and chicken, salinity resilience fish culture, short duration fish production, fish and vegetables integrated farming, crab farming etc as the climate change adaptation practices by the coastal communities.

This is also noteworthy because farmers in coastal areas grow vegetables in crop fields year-round, overcoming challenges like salt resilience, short growing seasons and small spaces. They do this with the



help of governmental and non-governmental organizations through practices like homestead cultivation, roadside, embankment side and dyke farming, dhap/gher cultivation, pesticide-free cultivation, increasing the amount of paddy seed stored in storage, applying guti uria in rice fields, organic biocomposting, or integrated farming. This assessment also indicates that the country's coastal areas do not have the capacity for large-scale vegetable or crop production; instead, farmers there only cultivate small-scale food for their own households.

The study areas' findings indicate that there is a relationship between per capita food expenses and climate-smart agriculture practices. The most important options identified are crop species that are resilient to salt and floods, vegetable husbandry beside ponds and roads, and various water harvesting techniques that could improve the food security of coastal farmers' households. The results of this book chapter seem consistent, taking into account the location on Bangladesh's southeast coast, where saline intrusion poses a serious threat to the country's coastal towns. Long-term flooding of agricultural fields necessitates the expansion of pond areas in order to facilitate the production of various vegetables with short growing seasons and large yields, particularly during the rainy season. Crop producers could use water they had stored in ponds or canals during the rainy season, which lasted from July to September, to supply water to their crops and vegetable production fields during the dry season (November to February). It was discovered that, in coastal Bangladesh, per capita food expenses were strongly connected with salinity and flood resilience of various crop products, vegetable production on roads and ponds, and choices for various water collection processes.

The authors noted that, based on per capita annual food expenses, there is a poor correlation between the climate smart agriculture coping technique and food security of agriculture households in coastal Bangladesh. The current adaptation measures employed by farmers are unable to handle the increasing salinity levels, particularly those resulting from extreme events. In addition to these risks associated with climate change, the degree of poverty, low resilience, and absence of substitute means of subsistence lead to major losses for the people living along the shore as a whole as well as the study communities. More people are moving away from the coast, primarily because their job opportunities have diminished. Extreme weather events become more frequent as sea levels rise, and this internal mobility (rural-urban, coastal-central) will intensify if adaptation options are inadequate. An urban slum serves as the last resting place for these impoverished families. Enough utilities and other services for both old and new city



dwellers would be harder to come by in the capital and other surrounding cities and villages due to this migration caused by a variety of climate factors, such as saline intrusion.

The adaptation of climate change and its effects urgently requires ongoing research studies, field observation, monitoring, crop and weather knowledge management and technology-related novel idea and application. To improve the population's capacity to adapt to new circumstances, a comprehensive training program is required. As evidence of global warming has accumulated, the climate change issue has taken on particular relevance, and it is now posing a significant challenge to the entire world. Nearly every country is affected, and this poses a serious threat to global development and food insecurity because of low agricultural output and land that becomes unfertile due to saline intrusion. One of the most proactive developing countries in the world to address challenges brought on by climate change is Bangladesh. All efforts to lessen the effects of the country's poverty situation and to achieve the Sustainable Development Goals (MDG) have been hindered by climate change and its considerable effects. Additionally, a cooperative land execution management process should be established, with coastal aquaculture production being conducted under community-based management techniques that will grant minor landholder authorization through the weakening of the powerful and bulky landholders' political ties. The use of salinity resilience in rice diversities, along with other vegetables, crops, floating gardening and integrated cultivating systems (shrimp/prawn+ rice), could potentially mitigate climate change and economic weaknesses in Bangladesh's coastal districts. The government of Bangladesh should also implement initiatives to build and strengthen coastal embankments, which will lessen coastal areas' susceptibility to deficiencies and allow marginalized groups to revert to their own cultural technologies.

Catastrophe risk discount scholars and other proponents of indigenous expertise structures have frequently disputed that indigenous knowledge of local communities can significantly contribute to preventing harm to people and property from mistakes (Hiwasaki et al., 2014; McAdoo et al., 2006). Local people possess certain abilities that have developed through millennia. These abilities and knowledge have been put to the test and proven to be durable and useful in both avoiding mistakes and averting dangers (Shaw et al., 2008).

The utilization of indigenous knowledge systems in expertise and disaster management, as well as an understanding of the version practices of the communities within the study areas, became the main emphasis of this research. In this chapter of the e-book, the writers investigate how local communities'



indigenous knowledge systems might be effectively used to the management of different types of failures in Bangladesh's South Japan Sea region, namely in Kutubdia, Maheshkhali and Sandwip. The study's objectives were to investigate the role that indigenous knowledge plays in climate change-related disaster threat reduction interventions; to identify indigenous knowledge networks for managing natural disasters that are accessible to nearby communities in the study regions; to investigate the benefits that nearby communities within the study areas can reap from employing indigenous knowledge in disaster hazard reduction; to discuss how practitioners can benefit from the indigenous knowledge of nearby groups when managing flood disasters; and to investigate the reasons why practitioners are dubious about the indigenous knowledge of local agencies in handling flood disasters.

The landless residents of Maheshkhali, Kutubdia and Sandwip who live along the embankment are coastal and island inhabitants (occupants) and they frequently lose their homes due to coastal erosion. The landless people of Bangladesh have peacefully assembled in settlements alongside this public embankment area, which the government of Bangladesh constructed and is responsible for preserving. In Tabelar Char of Kutubdia, the number of landless people increased and at some point in their lives, they moved five or six times. According to people living in the neighborhood, roughly 950 households moved from Kutubdia to Tabelar Char at some point in the early 1980s. They all formed isolated communities in Tabelar Char and were landless in Kutubdia. Through the land control apparatus of the authorities, the isolated villages that currently exist on this little island have subsequently created another element of vulnerability to storm disasters. After a series of procedural processes, the office of the Deputy Commissioner (the leader of district-level administration) eventually allowed all allocation and agreement matters with the passage of the 1984 Land Reform Ordinance. Following intense pressure, the Bangladeshi government granted each of the landless people 6 two acres of land for agricultural and settlement purposes. For their part, those wretched individuals settled in the center of their designated allotment. As thus, the entire island was fashioned as a dispersed agreement. However, several impoverished settlers are currently unable to use their land for anything other than their primary house. A whole spectrum of people reported that they are still landless in the Char region. Additionally, they said that because of their close ties to property registration officials, wealthy and powerful individuals from Kutubdia Island own the majority of the land in the Char area. In exchange for money, they either lease their prone lands to landless Char residents or they keep a cut of the agricultural products produced on these areas.



In response to studies on cyclonic hazards beyond the regions under observation, long-term period variation techniques are implemented. In addition to cyclonic sea surge and wind that demolish portions of the coastal embankments every year, excessive rain during the monsoon season might partially account for the destruction of residential structures. Every year, on average, cyclone-related sea surges or high tides from the Bay of Bengal swamp between two and three kilometers of the Maheshkhalī coastal site and between five and six kilometers of Sandwip Island's and Kutubdia's outer restriction. Through the usage of dust, the island residents there have increased the height of their homes' plinths, known locally as bithi. Property owners are more likely to protect their own family members and belongings against extreme tidal surges if the plinth is large enough. In Maheshkhalī, the plinth is five feet high; on Sandwip and Kutubdia Island, it is around six feet above cropland. A large enough plinth increases the likelihood that homeowners will be able to protect their own family members and belongings from severe tidal surges. The average height of the plinths in Taberlar Char has been increased by the local inhabitants to around eight toes above the cornfield. Since there is no barrier protecting the Taberlar Char area, the island gets completely submerged every year during the monsoon season by the Bay of Bengal's tidal surge.

In order to safeguard their valuable property and seeds from extreme tidewater in the path of tidal surges, the coastal communities of Kutubdia and Sandwip have improved their protection by raising the plinth of their houses by roughly ten feet. Respondents of the interview also mentioned that during a powerful cyclonic surge, their shed-roof dwellings could serve as life-saving shelters. One extremely important way to protect lives, homes and dwellings from wind and sea surges is to plant shrubs across the dwelling house. The island and coastal people said that large, branching trees are usually planted throughout the house since they are more productive.

Approximately 75% of the coastal population seeks cover in hurricane shelters at some point during the storm, while one-third of those who remain use traditional knowledge, such as techniques for building homes. Discipline examination It has been noted that some houses are constructed adjacent to embankments in such a way that the top of the house is raised to the same level as the embankment in order to protect the roof or structure from the catastrophic collapse. A typical residential structure has a peak height of 10 or 12 feet above the ground, but a lower height could be as low as two or three feet. A residence's roof is three (3) five feet above the ground. The 1991 devastation completely roused the local populace and destroyed the katcha residential buildings. Some houses have suffered partial breaks, and



people have lost their lives. In light of the severe damage and massive loss, some buildings include Chochala (four-sided roofs), which shield homes from cyclonic winds with particular guidelines and have a lower top than houses with sided roofs. As a result, their roofs shield the house from strong winds. Usually, Kutubdia and Sandwip determine these housing styles.

In flood-prone areas of Bangladesh, people tend to build their homes on clay platforms on faster terrain so that water does not rise to the plinth level during tidal surges (Parveen et al., 2009; Paul, 2010). When calamities strike, people seek refuge on embankments to preserve their lives; occasionally, they establish permanent residences on the higher ground. About 25% of the dwellings in Kutubdia, Sandwip and Maheshkhalia are built up at the top land, with the remaining homes being built very close to the coast to defend against hurricane surge damage.

Several important findings were drawn from the analysis. One main finding is that local communities' indigenous knowledge has a significant role in catastrophic risk mitigation efforts. The study also found that indigenous knowledge is a valuable resource that communities have, enabling them to deal with a variety of threats and calamities. The study came to the identical conclusion that disaster risk reduction practitioners might very well combine traditional knowledge with state-of-the-art medical knowledge to increase the efficacy of catastrophe threat reduction strategies. Disaster hazard discount practitioners lack indigenous experience, even as communities lack access to modern scientific knowledge and technology. As a result, their examination also revealed that, if applied to the management of disaster operations, indigenous knowledge can be extremely beneficial to both community members and practitioners of disaster risk reduction. Consequently, at every stage of the disaster hazard discount process, local communities' indigenous knowledge is a crucial empowerment tool.

The study's results underscore the urgent need for targeted interventions and policy measures to enhance climate resilience in vulnerable regions. The geographical context plays a significant role in shaping the challenges faced by rural communities and this needs to be considered when designing adaptation strategies. To address the limited access to resources and climate-resilient infrastructure, the government and relevant stakeholders must prioritize the development of essential infrastructure such as roads, bridges and communication networks. Improving access to information and resources is crucial for building resilience and preparedness against climate hazards. Community-based adaptation strategies emerge as a key solution in empowering local communities to actively participate in decision-making



processes. By involving the affected residents in planning and implementing adaptation measures, these strategies are more likely to be effective and sustainable. Such approaches can also foster a sense of ownership and responsibility, leading to better outcomes in adapting to changing climatic conditions. Furthermore, the study highlights the importance of disaster awareness and preparedness in rural areas. Educating communities about climate hazards, early warning systems and evacuation plans can significantly improve their ability to respond to emergencies and reduce potential damages. Overall the study's qualitative insights provide valuable information for policymakers and governmental bodies to formulate evidence-based policies and strategies. By understanding the specific challenges faced by rural communities in these vulnerable regions, decision-makers can better address the unique needs and obstacles hindering climate change adaptation efforts. This study highlights the importance of considering geographical context while designing climate adaptation strategies in rural coastal and riverine parts of Bangladesh. Proactive adaptation efforts, community engagement and climate resilient infrastructure are essential components for successful climate change adaptation in these vulnerable regions. The research highlights the significance of considering the geographical context when planning and implementing adaptation measures. The study emphasizes the need for proactive adaptation tactics, climate-resilient rural infrastructure and community-based strategies. The findings of this study contribute to the existing knowledge on climate change adaptation in the region and provide valuable insights for policymakers and stakeholders in their pursuit of effective and localized adaptation strategies. Policymakers should prioritize the development of essential infrastructure, enhance access to information and resources and involve local communities in decision-making processes to build climate resilience effectively.

Conclusion and Recommendations

By addressing these challenges and promoting targeted interventions, Bangladesh can improve its climate change adaptation efforts and enhance the well-being of rural communities in the face of climate uncertainties. The qualitative insights obtained from this study have significant implications for climate change adaptation efforts in rural coastal and riverine areas of Bangladesh. To effectively address the identified challenges, policymakers and relevant stakeholders should prioritize the following recommendations:



Climate-Resilient Infrastructure: The government must invest in the development of climate-resilient rural infrastructure, including roads, bridges and communication networks. This will enhance access to information and resources, enabling communities to respond better to climate hazards.

Community-Based Adaptations: Involving local communities in decision-making processes is crucial for the success and sustainability of adaptation strategies. Empowering communities to actively participate in planning and implementing measures will foster a sense of ownership and responsibility, leading to better outcomes in adapting to changing climatic conditions.

Disaster Awareness and Preparedness: Education and awareness programs should be implemented in rural areas to inform communities about climate hazards, early warning systems, and evacuation plans. This will significantly improve their ability to respond to emergencies and reduce potential damages.

Targeted Interventions: Policies and strategies should be tailored to the unique geographical context of each region, taking into account the specific challenges and vulnerabilities faced by local communities. A one-size-fits-all approach may not be effective in addressing the diverse needs of different areas.

By addressing these recommendations, Bangladesh can enhance its climate change adaptation efforts and improve the resilience of vulnerable communities in the face of climate uncertainties. The findings of this study contribute valuable insights for policymakers and stakeholders, facilitating the development of evidence-based and localized adaptation strategies to mitigate the impact of climatic hazards in these regions.

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Competing Interests

The authors have no competing interests associated with this study.

Data Availability

The study utilized data from Focus Group Discussions, Key Informant Interviews and secondary sources, resulting in predominantly narrative exploration. The data collected and analyzed during the study can be made available upon request to the corresponding author.



Author Contributions

Ashim Kumar Saha and Dr. Prabal Barua made equal contributions to this study. Ashim Kumar Saha conducted the research and developed the research manuscript, while Dr. Prabal Barua designed the research and formatted the manuscript according to journal guidelines. Both authors collaborated on interpreting the results and writing the manuscript precisely.

References

- Al-Maruf, A., Mira, S. A., Rida, T. N., Rahman, M. S., Sarker, P. K., & Jenkins, J. C. (2021). Piloting a weather-index-based crop insurance system in Bangladesh: Understanding the challenges of financial instruments for tackling climate risks. *Sustainability*, *13*(15), 1–18.
<https://doi.org/10.3390/su13158616>
- Bandyopadhyay, N., Bhuiyan, C., & Saha, A. K. (2020). Drought mitigation: Critical analysis and proposal for a new drought policy with special reference to Gujarat (India). *Progress in Disaster Science*, *5*, 100049. <https://doi.org/10.1016/j.pdisas.2019.100049>
- Barua, P., Rahman, S. H., & Morshed, M. H. (2017). Sustainable adaptation for resolving climate displacement issues of south eastern islands in Bangladesh. *International Journal of Climate Change Strategies and Management*, *15*(2), 440-465.
- Barua, P., & Rahman, S. H. (2018). Community-based rehabilitation attempt for the solution of climate displacement crisis in the coastal area of Bangladesh. *International Journal of Migration and Residential Mobility*, *1*(4), 358-378.
- Barua, P., & Rahman, S. H. (2019). Impact of river erosion on livelihood and coping strategies of displaced people in South-Eastern Bangladesh. *International Journal of Migration and Residential Mobility*, *2*(1), 34-55.
- Barua, P., Rahman, S. H., Barua, S., & Ismail, M. M. R. (2020). Climate change vulnerability and responses of fisherfolk communities in the South-Eastern coast of Bangladesh. *Water Conservation and Management*, *4*(1), 20-31.
- Barua, P., Rahman, S. H., & Eslamian, S. (2021). Global climate change and inequalities, reduced inequalities. In W. Leal Filho, A. M. Azul, L. Brandli, A. Lange Salvia, P. G. Özuyar, & T. Wall (Eds.), *Encyclopedia of the UN Sustainable Development Goals*. Springer, Cham.



- Barua, P., Rahman, S. H., & Barua, M. (2021). Sustainable management of agriculture products value chain in responses to climate change for South-Eastern coast of Bangladesh. *Modern Supply Chain Research and Applications*, 3(2), 98-126.
- Barua, P., & Rahman, S. (2019). Indigenous knowledge for community resilience against seasonal flooding: The case of South-Eastern coast of Bangladesh. *IUP Journal of Knowledge Management*, 17(4), 47-64.
- Barua, P., & Rahman, S. (2019). Indigenous knowledge and sustainable value chain approach to climate change adaptation in the fisheries sector of coastal Bangladesh. *IUP Journal of Knowledge Management*, 17(2), 21-42.
- Barua, P., & Rahman, S. (2018). The role of traditional ecological knowledge for South-Eastern island community of Bangladesh perspective for disaster management. *IUP Journal of Knowledge Management*, 18(1), 35-50.
- Barua, P., & Rahman, S. (2017). Indigenous knowledge practices for climate change adaptation in the southern coast of Bangladesh. *IUP Journal of Knowledge Management*, 15(4), 88-100.
- Barker, R., van Koppen, B., & Shah, T. (2000). A global perspective on water scarcity and poverty: Achievements and challenges for water resource management. *A Global Perspective on Water Scarcity and Poverty: Achievements and Challenges for Water Resource Management*.
<https://doi.org/10.5337/2011.0049>
- CDP. (2020). *The role of companies in building a water-secure world*.
- Chowdhury, M. A., Hasan, M. K., Hasan, M. R., & Younos, T. B. (2020). Climate change impacts and adaptations on health of internally displaced people (IDP): An exploratory study on coastal areas of Bangladesh. *Heliyon*, 6(9), e05018. <https://doi.org/10.1016/j.heliyon.2020.e05018>



- Ebi, K. L., Boyer, C., Bowen, K. J., Frumkin, H., & Hess, J. (2018). Monitoring and evaluation indicators for climate change-related health impacts, risks, adaptation, and resilience. *International Journal of Environmental Research and Public Health*, 15(9), 1-11. <https://doi.org/10.3390/ijerph15091943>
- Garcia, A., Tschakert, P., & Karikari, N. A. (2020). 'Less able': How gendered subjectivities warp climate change adaptation in Ghana's Central Region. *Gender, Place and Culture*, 27(11), 1602-1627. <https://doi.org/10.1080/0966369X.2020.1786017>
- Govoni, N. A. (2012). Complimentary copy. In *Dictionary of Marketing Communications*. <https://doi.org/10.4135/9781452229669.n742>
- Hunter, D. (2005). New challenges in an era of global water scarcity. *Sustainable Development Law & Policy*, 5(Winter), 2-4.
- Iqbal, M. K., Wahid, C., & Kutubuddin, H. (2021). Bangladesh Delta Plan 2100: Charting a course for sustainable ocean governance and maritime development. *BMJ Special Issue*, 59-76. <https://doi.org/10.2519-5972>
- Karim, M. R., & Rahman, M. A. (2015). Drought risk management for increased cereal production in Asian least developed countries. *Weather and Climate Extremes*, 7, 24-35. <https://doi.org/10.1016/j.wace.2014.10.004>
- Karki, S., Burton, P., & Mackey, B. (2020). Climate change adaptation by subsistence and smallholder farmers: Insights from three agro-ecological regions of Nepal. *Cogent Social Sciences*, 6(1). <https://doi.org/10.1080/23311886.2020.1720555>
- Mbow, C., Smith, P., Skole, D., Duguma, L., & Bustamante, M. (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Current Opinion in Environmental Sustainability*, 6(1), 8-14. <https://doi.org/10.1016/j.cosust.2013.09.002>

- Md, A., Gomes, C., Dias, J. M., & Cerdà, A. (2022). Exploring gender and climate change nexus, and empowering women in the South Western coastal region of Bangladesh for adaptation and mitigation. *Climate*, 10(11). <https://doi.org/10.3390/cli10110172>
- Morsalin, S. S., & Islam, M. R. (2023). Landlessness as the key challenge to climate change adaptation of the rural poor in Bangladesh: An empirical study. *Asian Geographer*, 40(2), 121-143. <https://doi.org/10.1080/10225706.2021.2015694>
- Nurzaman, A., Shaw, R., & Roychansyah, M. S. (2020). Measuring community resilience against coastal hazards: Case study in Baron Beach, Gunungkidul Regency. *Progress in Disaster Science*, 5, 100067. <https://doi.org/10.1016/j.pdisas.2020.100067>
- Nzeh, E. C. (n.d.). Technological challenges of climate change adaptation in Nigeria: Insights from Enugu State. *Working Paper Series*, 52.
- Piguet, É. (2008). Migration and climate change. *Futuribles: Analyse et Prospective*, 341. <https://doi.org/10.1051/futur:200834131>
- Rahaman, M. M. (2005). Bangladesh – From a country of flood to a country of water scarcity – Sustainable perspectives for solution. *Seminar on Environment and Development*. <https://doi.org/10.13140/RG.2.1.2866.9600>
- Rahman, M. S., & Gain, A. (2020). Adaptation to river bank erosion induced displacement in Koyra Upazila of Bangladesh. *Progress in Disaster Science*, 5, 100055. <https://doi.org/10.1016/j.pdisas.2019.100055>
- Schwerdtle, P. N., Baernighausen, K., Karim, S., Raihan, T. S., Selim, S., Baernighausen, T., & Danquah, I. (2021). A risk exchange: Health and mobility in the context of climate and environmental change in Bangladesh—a qualitative study. *International Journal of Environmental Research and Public Health*, 18(5), 1-17. <https://doi.org/10.3390/ijerph18052629>



Smith, A., Schellnhuber, H. J., & Mirza,

Smith, A., Schellnhuber, H. J., & Mirza, M. M. Q. (2001). Vulnerability to climate change and reasons for concern: A synthesis. In *Climate change 2001: Impacts, adaptation and vulnerability* (pp. 913–970).

Strategic, U., Interdisciplinare, S. S., & Nr, S. (2021). *CEEOL și EBSCO*, 3(3), 1–331.

Sufri, S., Dwirahmadi, F., Phung, D., & Rutherford, S. (2020). A systematic review of community engagement (CE) in disaster early warning systems (EWSs). *Progress in Disaster Science*, 5, 100058. <https://doi.org/10.1016/j.pdisas.2019.100058>

USAID. (2009). *Addressing water challenges in the developing world: A framework for action* (Report, 1–32).



Short Autobiography of the Led Author

Mr. Ashim Kumar Saha is working as a Programme Manager (Planning, Monitoring & Evaluation-PM&E) in NETZ Bangladesh Partnership for Development and Justice at Lalmatia, Dhaka 1207. With a graduation and post-graduation degree from Department of Sociology at University of Dhaka in 2005 & 2006, he has been consistently demonstrated exceptional research skills since his student days, actively participating in review studies under the guidance of a professor-supervisor. Throughout a 14-years professional career, he has made significant contributions to various fields, including education, food and nutrition, injury and drowning prevention, WASH, climate change adaptation-mitigation, DRR, public health, NTDs, leprosy and disability, legal aid and human rights sectors. He has an impressive publication record, having submitted and successfully published abstract papers for international conferences, online journals and prestigious universities and organizations. He has also authored 12 international peer reviewed journal publications and developed comprehensive training modules and session materials to enhance the early career researchers effectively. His proficiency in English extends to various professional tasks, including writing and editing research papers and abstracts. His expertise in this area has earned them recognition as an editorial board member of the abstract review committee for the 14th World Conference on Injury Prevention and Safety Promotion in Adelaide, Australia. Having worked as a co-principal investigator on several research projects, he has gained valuable experience in advanced research methods, such as baseline studies, cross-sectional analyses, randomized controlled trials (RCTs), mid-term and end-line evaluations and mixed-method qualitative & quantitative research. He has also demonstrated his ability to work with marginalized communities and engage in participatory action research and international collaborations. His expertise extends beyond research, as he has also excelled in critical data analysis, scientific writing, and the development of monitoring and evaluation frameworks. He is well-versed in project cycle management, logical framework analysis and theory of change. His proficiency in data management and literature review systems, such as SPSS, MS-Access, REDCap, Kobo Collect and Mendeley Desktop further enhances his research capabilities. As a testament to his commitment to professional growth, he has received training on Research Methods and Scientific Paper Writing from renowned institutions like the Johns Hopkins International Injury Research Unit and Bloomberg Philanthropies. He has voluntarily facilitated multidimensional research projects and provided guidance under the Youth Researchers Program (YRP), collaborating with esteemed faculty members and sectoral experts. He has actively participated in World Safety Conference, Bangkok, Thailand; World Conference on Drowning



Prevention, Durban, South Africa; Unequal World Online Conference, New York, USA; pre-conference Global Injury Prevention at Adelaide, Australia; ILC-2022 at Hyderabad, India; International Renewable Energy and Sustainability & Geo Science conference-2023 at Dubai, UAE GAPP/AUC-Urban climate symposium on cities and climate change in developing countries-2023 at Cairo, Egypt. Recently he has participated on International Conference on Economics, Law and Government (ELG 2023) at University of Economics Ho Chi Minh City, Vietnam about Accelerating Inclusive Green Transition in Developing Countries dated on 28-29 September 2023 as an abstract presenter whereas title is “Empowering Sustainability: Bangladesh's Journey towards a Green Energy Future”. He is also editorial board member of Asian Council of Science Editors (ACSE).

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