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How Far Bangladesh Is Adapted to Climate Change? Evidence from Coastal Areas Applying Climate Change Adaptation Index

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ABSTRACT

Climate change poses a serious threat to the residents of coastal areas in Bangladesh and both domestic and international agencies have implemented measures to adapt to this change. However, it remains uncertain as to how effective these efforts have been in making Bangladesh more resilient to climate change. A study was conducted to investigate the impact of various climate change adaptation measures on Bangladesh's ability to adapt to climate change. The study constructed a climate change adaptation index (CCAI) and applied it to 515 households in coastal districts through direct interviews to evaluate their adaptability status. The results of the study showed that the climate change projects had a moderate impact on education, finance, infrastructure, and disaster preparedness, but poor preparedness in the food and health sectors. Districts closer to the coastal areas were found to be better adapted to climate change than those farther away. The findings of the study have significant practical implications for policymakers and practitioners in identifying and directing resources toward vulnerable sectors.

1. INTRODUCTION

Bangladesh is considered to be one of the most vulnerable developing countries to the effects of climate change [1]. The Intergovernmental Panel on Climate Change (IPCC) estimates that by 2050, 6-8% of Bangladesh's coastal and low-lying lands will be inundated. If the sea and salinity levels continue to rise at the current pace, over 20 million people may become climate change refugees within the next fifty years, according to the United Nations Environment Programme (UNEP) in 2016. Almost 28% of the country's population will be adversely affected by financial, social, and environmental issues. Particularly, sea level rise, drought, flash floods, waterlogging, landslides, cyclones, and salinity issues will have detrimental impacts on the overall ecosystem, including human life. Being a signatory of the UN 2030 Agenda for Sustainable Development Goals (SDC), these climate challenges will have a serious negative impact on achieving SDG 1 (Poverty), SDG 2 (Hunger), SDG 3 (Health), SDG 4 (Education), SDG 6 (Water) and SDG 13 (Climate) directly and indirectly on many other SDGs.

Bangladesh is making significant efforts to adapt to the effects of climate change. These include measures such as controlling saline water, coastal afforestation, cultivating crops that are tolerant to salt, homestead and floating gardening, embankment cropping, and creating alternative livelihoods [2]. The severity of the situation has led the Government of Bangladesh (GOB) to spend over $10 billion US dollars as climate finance on hundreds of projects and activities over the last decade. Most recent data shows that GOB has allocated around 8.99% (US$ 3.37 billion) of total budget for addressing climate change impacts during FY2023-24 [3]. Particularly, GOB has taken several climate adaptation project initiatives such as the Bangladesh Climate Change Trust Fund (BCCTF), Bangladesh Climate Resilience Fund (BCRF), Palli Karma Sahayak Foundation (PKSF), Pilot Project on Climate Resilience (PPCR), and Green Climate Fund (GCF). Additionally, developed countries have pledged to provide $100 billion a year to developing countries since 2020 to combat climate change [4, 5].

Despite the early efforts made by the GOB in mitigating and adapting to climate change, the effectiveness of these initiatives is often questionable. According to experts, it is difficult to determine the impact of climate-change projects funded by both local and foreign sources [5-7]. In many cases, the lack of success in climate finance projects has added to the mistrust of donors and made it harder for Bangladesh to secure further funding. For instance, Bangladesh received only US$139 million from the Global Environment Facility (GEF), a significantly lower amount compared to neighboring countries such as India (US$743 million), Nepal (US$217 million), and Sri Lanka (US$259 million) [6]. Additionally, there is a general lack of awareness and initiatives to claim carbon credits from green projects in Bangladesh.

Several authors have identified institutional and capacity-related issues as the main reasons for the limited success and

accessibility of climate finance. For instance, it is reported that the lack of integration of climate finance in the Sustainable Development Goals (SDGs), insufficient transparency in disbursement, as well as the complexity in implementing and assessing the impact of climate finance are some of the issues that persist in Bangladesh now [5]. Additionally, a study found that a lack of understanding of human resources in applying, managing, implementing, and evaluating the impact of climate finance projects poses a significant challenge [6].

Climate finance projects are often declined due to the lack of impact assessment on climate change adaptation. Bangladesh is one of the most vulnerable countries in the world when it comes to climate change. Therefore, it is urgent to investigate the impact of climate-financed projects on adapting to climate change.

In spite of the growing body of literature on climate change adaptation, there is a lack of empirical evidence on the development and application of a comprehensive climate change adaptation index in the context of a vulnerable country. Existing studies have focused on the partial dimension of adaptations: agriculture [8], agriculture and migration [9], homestead forests [10], income [11], livelihood, health and agriculture [12], food security [13], finance and information [14]. This study aims to merge all these dimensions and develop a comprehensive climate change adaptation index that includes food, health, education, finance, infrastructure, and disaster response.

This study makes several contributions. First, it develops a scoring-based climate change adaptation index, which fills an important gap in the current literature. Second, it extends the existing studies [13], which suggested that credit should be included, and Cabana et al. [15] recommended focusing on economic and financial conditions. Third, this study will guide practitioners and policy makers with empirical evidence about which dimension of adaptability is lacking and needed to be emphasized.

2. REVIEW OF LITERATURE

Scientific findings led to critical policy formulations and the development of various response mechanisms to address climate risks. Among various approaches to response mechanisms, adaptation has emerged as an integral tool as to how to manage the impacts of negative effects of climate change [16]. Over time, several researchers and academicians have tried to come up with a definition for adaptation that encapsulates all aspects of the climate change debate. Numerous areas and concepts that have been highlighted and linked to or covered while developing a definition for adaptation can be summed up in some prominent literature and research work. Particularly, the idea of adaptation is referred to as the reduction of vulnerability [17, 18] mitigation of negative impacts of weather extremes [13]; proactive, responsive or pre-emptive measure to reduce adverse effects [19]; alterations of behavior/structures of the human or economic system to lessen vulnerability [20]; and coping-ability (spontaneous or deliberate) of a system to changing conditions [21] of climate change. There are many commonalities in all of these aspects that can be synthesized with the contemporary developments of the climate change discourse. Hence, adaptation can be referred to as a process through which the actual and expected adverse impacts of climate change can be accommodated/adjusted or a process that may assist in capitalizing and enhancing the opportunities created by climate change within ecological-social-economic systems [22-24]. Central to the debate of the adaptation to climate change can also be understood well while exploring the factors, conditions, and process of adoption. The degree to which adaptation can be successful often depends on adaptive capacity that relates to various factors such as vulnerability, resilience, sensitivity or susceptibility, level of exposure, and their underlying factors (e.g., socio-economic-cultural and institutional issues) [25]. For example, a region that is located in a coastal area is highly exposed to climate extremes that make such a region more sensitive or susceptible to the outcome of natural calamities such as land inundation or water contamination, which ultimately put the respective community in a vulnerable position. The degree of vulnerability is also subject to the level of coping ability of the marginalized group. Thus, while developing or evaluating any adaptation strategy, the underlying factors of the adaptive process should be considered as well.

Response to climate change through adaptation is often argued to be planned or autonomous [24]. Autonomous adaptation refers to a process that occurs naturally in response to any impact of climate change. There are arguments against this concept as well. It is claimed that economic agents are rational beings and, with available market information and their knowledge, make decisions deliberately to maximize their quality of life or to tackle obstacles or hindrances (e.g., climate extremes) [26]. This argument defies the assumed rationale of the concept 'autonomous adaptation'. On the other hand, there is considerable consensus for planned adaptation to be effective in dealing with climate issues. By its name, planned adaptation refers to strategies that are consciously taken by individual rational agents, institutions, or third parties to let sufferers adjust to or overcome the negative impacts of climate change. Some adaptation strategies in the agricultural sector include diversification of current initiatives (e.g., farmers involved in non-firm activities) [27]; weather insurance [28]; usage of varieties of crops along with soil and water preservation tactics [29]; shifting different crop cultivation based on changing climate states [30]; renting-in or renting-out land [27]; temperature controlled methods (e.g., greenhouse); and man-made irrigation canals and reservoirs [31]. Apart from the agricultural sector, there are some common adaptation strategies that apply to any community facing climate change. Migration or relocation is also an adaptation strategy that applies to anyone facing severe climate risk at one's current location (e.g., moving away from coastlines) [32]. Some argue that migration is a last resort option that mostly occurs at the local level and often it happens for a short-term period [33]. In contrast, many claims that relocation known as a transformational adaptation strategy which is a long-term effective solution [31].

Arguments related to awareness of climate change and its link to adaptive capacity need special attention. It is often argued that lack of awareness acts as a barrier to adaptation strategies. Evidence shows that having a better understanding or awareness about climate change can assist people in making an informed decision regarding appropriate adaptation strategies, lead to enhanced capacity to handle climate change issues, reduce vulnerability, and improve the standard of human life [34, 35]. In support of this view, a recent study conducted in Niger [36] shows that *"...effective adaptation to climate change impacts is highly dependent on the extent of community awareness"*. In light of this discussion, evidence

also shows that the level of awareness is apparently much lower in developing countries compared to developed nations [37]. Moreover, awareness and perceptions regarding climate change vary among rural people of developing nations. It is reported that rural people of developing nations often fail to understand the real reason for climate change as they perceive it as a regular natural phenomenon, and surprisingly, many are still in the denial stage [35]. Hence, it is of utmost importance that the dynamics of awareness should be taken into consideration while assessing the effectiveness of adaptation strategies to climate change.

Bangladesh is in a natural calamity-prone region of South Asia. It is widely cited as the most vulnerable country to climate risk in the world [1, 38]. Also, it is subject to serious threats to negative impacts of climate change to its environment and livelihood [3]. Low-lying floodplains, which are created by vast delta of major Asian rivers (Brahmaputra, Ganges, Meghna) and their branches; conic-form Bay-of-Bengal of southern region; and presence of the Himalayas in the northern part exposed the country to severe natural calamities like major storms and cyclones, monsoon rainfalls and flooding [39, 40]. It is cited that around 90% of Bangladesh is *"...less than 10m above sea level, with almost 10% of the country below 1m"* [16]. With such vulnerable characteristics, Bangladesh often tops the disaster list as frequent climate extremes such as tropical storms and cyclones that severely hit its southern coastal regions. Whereas, the northern part embraces regular flooding. The historical data shows that Bangladesh has experienced more than 300 climate extremes between 1900 and 2015 [27]. Out of the long list, in 2007, one of the major recent disasters documented, named Sidr, took 3295 lives, demolished around 1.5 million houses and 2.2 million hectares of arable land, totaling US$1.67 billion worth of damages [39, 41]. It is to be noted that, in addition to geographical and structural characteristics, Bangladesh usually faces higher casualties because of the nature of population distribution. A large portion of the population (26%) of the country is exposed to climate risks as they are situated in cyclone-prone southern coastal regions, and 70% of the population lives in floodplains [42]. The historical temperature data also support evidence for climate change in Bangladesh [43]. For the last 100 years, the average temperature has increased between 0.4℃ to 0.8℃ in Bangladesh [44]. It is predicted that the temperature will keep on rising at an increasing rate of 1℃, 1.4℃, and 2.4℃ by 2030, 2050 and 2100 respectively [41]. Because of rising global warming, Bangladesh is also expected to experience the highest sensitivity to sea level rise by the year 2050 [41]. Bangladesh predominantly being an agricultural-based country, the agricultural sector suffers the most from any natural disaster [16]. Due to the rise in seawater levels and rising temperature, it is reported that Bangladesh is gradually losing arable land and experiencing decreasing crop yields [45]. In urban areas, poor people are disproportionately exposed to climate risk. Marginalized people who live in slums in urban areas are more prone to suffer from waterlogging, waterborne diseases, malnutrition, and frequent homelessness, mainly due to the fragility of their physical infrastructure [16]. Gender is another dimension that puts women in a more vulnerable state in Bangladesh. In a typical patriarchal society, women usually do not have access or ownership to land, do not have any capacity to access to credit or institutional support, work in poor conditions, and are subject to exploitation.

Moreover, it is identified that the women in Bangladesh are more adversely affected by climate hazards than the males as they are disproportionately marginalized by income, nutrition, and flood-prone living conditions [38, 46]. Other socio-economic issues such as income, education, access to finance, and local government resources often hinder adaptation strategies in Bangladesh [23, 47]. In general, it is common that not everyone is equally exposed to climate risk in Bangladesh. Instead, the disproportionate exposure to climate risk is a result of inherent socio-economic issues of the country. Thus, for any adaptation strategy to be effective, development issues of the society must be considered.

Bangladesh is popularly known as an early mover in planning adaptation strategies to tackle climate risks [23]. In order to tackle the impacts of climate risks, several adaptation strategies have been implemented in Bangladesh. Particularly, as mentioned earlier, two-thirds of the population is involved in agriculture and therefore most of the adaptation strategies are implemented in the agricultural sector. It is observed that, in response to variable rainfall and temperature, farmers use more climate-resilient crops [48]. Depending on the situation, short and long-term migration is also used to manage climate risks by farmers [49]. Data shows that around a quarter of the households that are subject to tidal surge floods and around 16% of the households that are affected by riverbank corrosion usually relocate to urban areas [50]. However, the migratory movement was also affected by government interventions. For example, after the tornado that took place in 2004, government aid resulted in very limited outmigration [51]. Government and non-government initiatives are also prominent in coastal regions, as one-fourth of the population lives there. Prominent adaptation initiatives taken in the coastal regions include *"...construction of multistoried cyclone shelters, improvement of forecasting and warning capacity, establishing a coastal volunteer network, and coastal reforestation of mangroves"* [23]. An increase in literacy rate also acts as a catalyst for adaptation strategies to be effective in Bangladesh. However, in many cases adaptation strategies fail to attain its goals due to inadequate knowledge about climate change, lack of inclusivity of local community issues, and lack of an integrated approach [52].

As mentioned earlier, the frequency and intensity of climate extremes will increase in the future in Bangladesh [53]. According to Data, populations that would be exposed to risk from sea level rise will be 27 million by 2050, up from 13.2 million in 2008 [53]. It is reported that Bangladesh is ranked 7th as per most disaster-prone vulnerable country due to climate change and, hence, it will require substantial amount of funding to handle the impacts of the climate change [1]. With respect to this potential hazards, World Bank has estimated that Bangladesh would require an astounding 5 billion US$ per year by 2050 as adaptation fund [54]. However, current government can only afford to fund 1 billion US$ annually to tackle the adaptation initiatives [44]. This huge gap could partly be filled up by the donor agencies who are also critical in funding climate change adaptation and mitigation programs. Hence, it is of utmost important to measure the effectiveness of the ongoing adaptation strategies in Bangladesh in order to make informed judgments about the future directions of climate change management programs in Bangladesh.

Finally, assessment of various adaptation strategies is crucial in optimizing policy initiatives [55, 56]. In response to address the dynamics of climate change, a range of indices

have been established such as the Notre Dame-Global Adaptation Index (ND-GAIN), Global Climate Risk Index, Climate Vulnerability Index (CVI), Environmental Sustainability Index (ESI), Environmental Performance Index (EPI). However, arguments remain regarding their role in assessing adaptation initiatives. Particularly, ND-GAIN focuses on funding directions for adaptation initiatives in relation to ranking of vulnerable countries and their readiness to climate change [57]. Global Climate Risk Index assess the extent of loss due to weather extreme [58]. CVI measures how countries are exposed to climate extremes and their impacts towards World Heritage properties [59]. ESI intends to rank countries as per their environmental policy compliances [60]. EPI rank countries in terms of *"environmental health and the vitality of their ecosystems"* [61]. It is to be noted that none of these indices intend to measure the adaptation strategies.

From slightly different angle, efforts are there to develop indices to measure adaptability or capability for adaptation. A study conducted in India proposed an index, Adaptation Capability Index (ACI), to assess potential adaptation to climate change in mountain region [62]. Another study in India developed a Composite Adaptability Index (CAI) through Analytical Hierarchy Process (AHP) where the idea is to assess how the urban system could adapt to urban flooding [63]. However, the objectives of such indices are not targeted toward adaptation evaluation rather to measure adaptive capabilities. There are very few studies that actually put effort to develop adaptation assessment indices. Notably, Index for Climate Change Adaptation in China (ICCAC) has been developed to measure adaptation initiatives but there are few limitations of the index [64]. Particularly, there is an omitted indicator, climate change impacts on infrastructure, in ICCAC and also there is relevant year-wise weighing issue which may influence results. Then, climate change adaptation index (CCAI) is developed in Colombia to evaluate national adaptation initiatives where factors were chosen related to the energy sector only [65]. Therefore, the application of the CCAI of Colombo is limited to a particular case. Another study conducted in Nepal tried to bridge a methodological gap in evaluating adoption of climate change adaptation initiatives [66]. This index focuses on aggregate level data on adaptation practices while ignoring farm level data which may be equally important. There were a range of studies that tried to evaluate adaptation strategies but their objective is not to develop indices though. Similarly, there are studies on Bangladeshi context where the initiatives were to address various aspects of adaptation such as households' perceptual assessment to climate change and adaptation [10]; exploration of various adaptation strategies and barriers [9, 12]; examination of adaptation techniques in the agricultural sector, their inherent factors and [13]; adaptation readiness of the Dhaka city [67]. But none of the studies tried to develop a comprehensive index to evaluate adaptation strategies/policies/initiatives.

From the above discussion it can be noted that wider initiatives are there to address various aspects of climate change and adaptation issue but those are different in terms of context, goal and not free from limitations. As discussed earlier, the geography, socio-economic dynamics along with propensity to climate extreme events put Bangladesh in a unique case and, hence, the challenge remains to evaluate adaptation initiatives. Thus, this work took the initiative to establish a comprehensive index suitable for the Bangladeshi context.

3. METHODOLOGY

3.1 Construction of climate change adaptation index (CCAI)

Measuring the economic impacts of climate change is a critical area. The Intergovernmental Panel on Climate Change (IPCC) stressed the impact measurement complexities of climate change in its Fifth Assessment Report [23]. According to the IPCC's 5th Assessment Report, the economic assessment of climate change is contestable as various estimations are based on assumptions that are often disputable. Moreover, many important factors, such as *"…loss of human lives, cultural heritage, and ecosystem services"* [23] are challenging to measure in monetary values while assessing the economic impact of climate change. In line with this argument, the impact assessment of climate change initiatives is also challenging. In a recent study [68] highlighted that *"…traditional climate economics and financial risk models are not properly equipped to consider the characteristics of climate risks".* Hence, problems remain to identify and articulate the connections and extent of effectiveness of various climate change adaptation initiatives on climate change. Thus, in this study, a modest attempt has been made to develop a climate change adaptation index (CCAI) and explore its linkages with various adaptation initiatives.

Adaptation measures taken by the Government of Bangladesh (GoB) include coastal afforestation, homestead forests, controlling saline water, saline-resistant crops, floating gardening, embankment cropping, and creating alternative livelihoods. Existing literature on the climate change adaptation index [8-14, 64] focused on agriculture, health, food, livelihood, and credit as elements of adaptation. By considering all the aspects of adaptability, six dimensions- food, health, education, finance, infrastructure, and disaster response- were included in the development of the CCAI.

In assigning weight among the dimensions, equal weights (0.15) were assigned in each dimension, except food and disaster response (0.20). Within food and disaster, one additional sub-dimension weight was assigned as both of these aspects are regarded as severity factors having a profound impact [13].

3.2 Sampling

Households residing in coastal villages are the population of this survey. Villages are the smallest administrative unit in Bangladesh and were the primary unit of data collection. Villages are superseded by upazila (sub-district), zila (district), and bibhag (division). A stratified random sampling technique was followed based on the strata of administrative hierarchy in choosing the sample households. Out of 19 coastal districts, 12 districts are situated in the southern belt of the coastal region, which has higher exposure to natural calamities. According to the Bangladesh Integrated Water Resources Assessment, these 12 districts are subject to severe flooding due to climate change and are assessed as the most vulnerable districts of Bangladesh. Within these 12 districts, as per the vulnerability index, Bagerhat scores 6.2 (Very High), Patuakhali scores 5.2 (High), Barguna scores 5.0 (High) and Lakhipur scores 6.5 (Very High) [69]. These four highly vulnerable districts (Barguna, Bagerhat, Patuakhali, and Laxmipur) (see Figure 1) have 3,035 villages with 1,274,768 households [70]. By considering cost and time, 515

households were surveyed randomly from four upazilas out of the above-mentioned districts, residing in 16 villages (four from each district) (see Table 1) with a structured questionnaire through direct interviews.

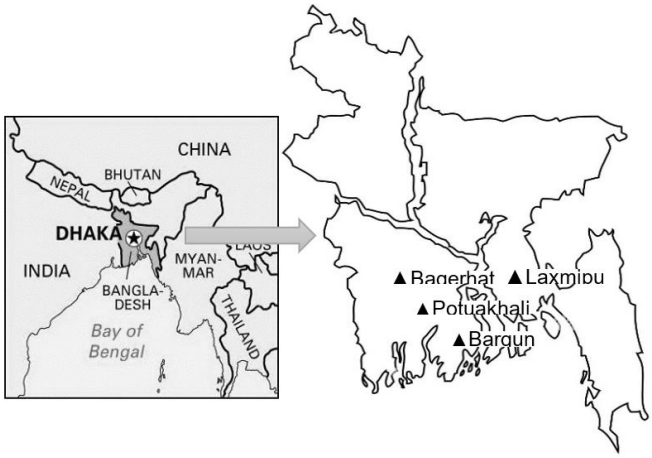

Figure 1. Study area
Figures are not drawn to scale

Table 1. Name of the villages surveyed

District	Upazila	Village
Laxmipur	Ramgoti	Sobujgram, Balurchor, Chor doctor
Patuakhali	Kalapara	Faridgonj, Nobabgonj, Khalilpur
Barguna	Pathorghata	Dokhin Charduari, Soherabad, Hoglapasha
Bagerhat	Soronkhula	Bogibondor, Khuriakhali, Chalitabunia

3.3 Survey instrument

Table 2. An example of scoring by using the staple scale

Dimensions	Category	Degree of Adaptation	Scores	Explanation
Food	Water	1. Safe drinking water is more than 30-minute walk from home	-5	Access to water is very difficult
		2. Safe drinking water is within 15-minute walk from home	-3	Access to water is difficult
		3. Can get safe drinking water in the household	0	Got easy access to water
		4. Provide safe drinking water to neighbours	+3	Have surplus water supply
		5. Future access to safe drinking water is also ensured	+5	Future supply is also ensured

A structured survey instrument has been used to measure the extent of adaptation through a climate change adaptation index (CCAI). Table 2 shows the content of the survey instrument. CCAI was calculated by using a staple scale used to distinguish between areas having negative, low, and high degrees of adaptation. Like the Likert scale, Semantic Differentials (SD), and Numerical Scales, the Staple scale also produces interval data [71]. Table 3 presents an example of negative, neutral, and positive adaptation measurement scales used in the survey. The scale interval was set according to the vulnerability indicators, deprivation threshold, and weights suggested [72, 73] and adjusted in the context of coastal areas of Bangladesh [74].

Table 3. Content of the survey instrument

Household Basic Information	
Number of family members, gender, age, education, income; asset holding	
Awareness on Climate Change	
Familiarity with climate change terms, perils and benefits of climate change	[74, 75]
Climate Change Intervention	
Acceptance of cash, kind or information support to adapt to climate change in the form of loan or grant in BCCSAP	[76, 77]
Climate Change Adaptation Index	
Climate change adaptation status in terms of six categories: food, health, education, finance, infrastructure, disasters	[75, 76]

4. FINDINGS

4.1 Summary

Figure 2 shows the summary findings of the CCAI for the four surveyed coastal districts: Laxmipur, Patuakhali, Barguna, and Bagerhat. From Figure 2, we can see that the average CCAI in all the districts is below 50 (out of 100), which indicates that the households of these districts are poorly adapted to climate change. The only exception is Barguna district, where the score of the CCAI is above 50.

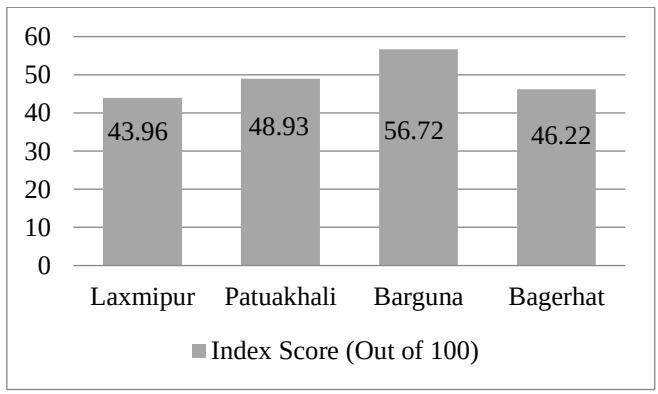

Figure 2. Climate change adaptation index (CCAI): District-wise status

If we narrow it down to the village-wise index (Figure 3 next page), the highest index (64) is observed in Hoglapara village of Barguna district, while the lowest (43) is found to be in Bogibondor village of Bagerhat district. However, considering all the villages, Barguna district shows the best score, whereas Laxmipur district shows the weakest adaptation to climate change. Figure 4 (next page) shows that there might be a connection between proximity to the sea and

the level of adaptation. Villages of Barguna and Potuakhali districts showed higher CCAI, which are located comparatively closer to the sea (Figure 4 square tiles). Whereas villages of Laxmipur and Bagerhat districts, which showed the lowest CCAI, are the farthest from the sea. This phenomenon is further examined in the following sections.

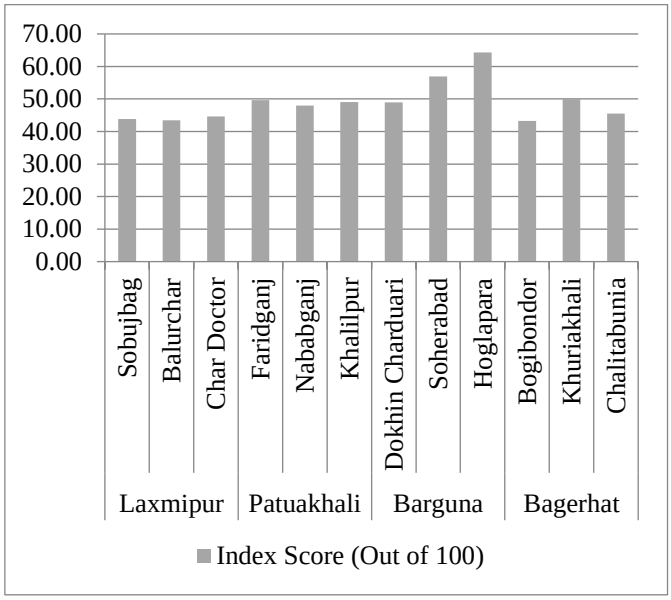

Figure 3. Adaptation to climate change: Villages

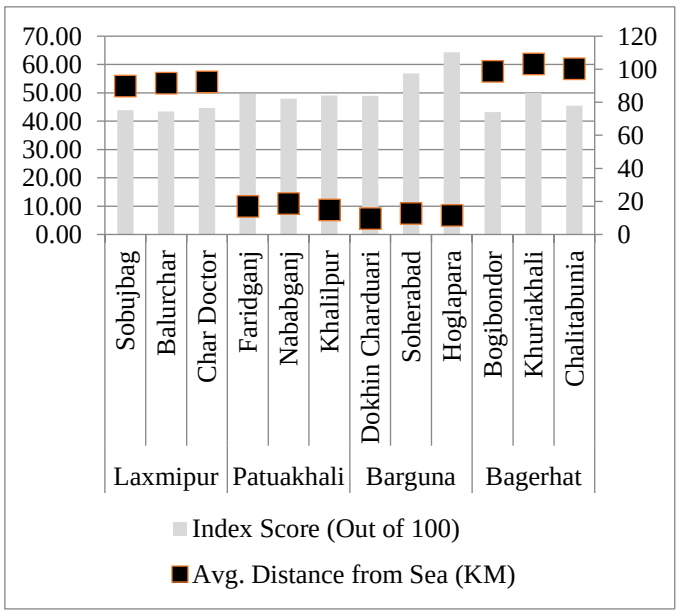

Figure 4. Adaptation & distance from the sea

4.2 Village-wise findings

4.2.1 Laxmipur

From Figure 5, we can see that the households of Laxmipur district were comparatively well adapted in education and disaster management categories (above 50 points), while their score in health and finance elements are low (below 40 points). With regard to distance, on average, the villages of Laxmipur district surveyed are located 90 kilometres away from the coastline (Figure 6). Interestingly, this district has shown a comparatively low average CCAI than other closely located coastal districts.

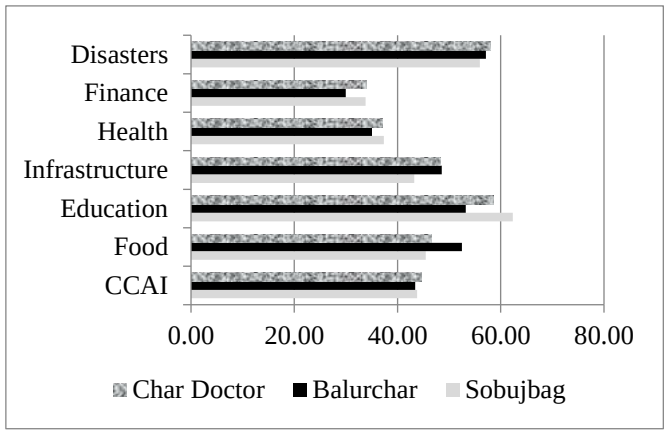

Figure 5. Laxmipur: Adaptation to various indicators

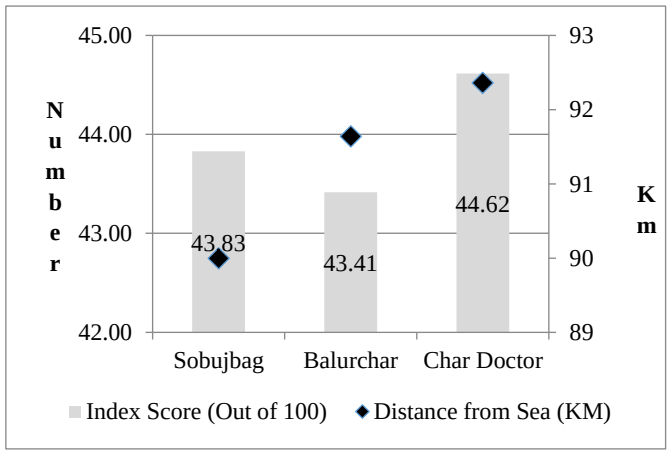

Figure 6. Laxmipur adaptation & distance from sea

4.2.2 Patuakhali

From Figure 7, we can see that the households of Patuakhali district were comparatively well adapted in health and education categories (above 60 points) while they did poorly in finance and food elements (below 40 points). With regard to distance, the villages of Patuakhali district surveyed are located within 15 to 20 kilometres of the coastline (Figure 8). In contrast to Laxmipur and Bagethat districts (distance-wise), Patuakhali district showed better CCAI scores which is an intriguing finding.

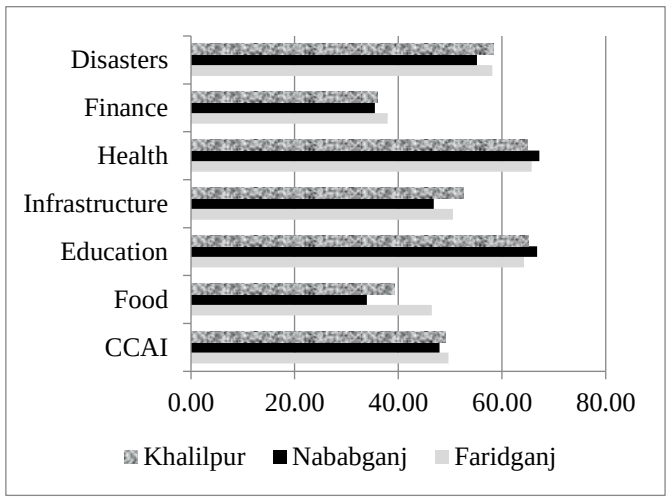

Figure 7. Patuakhali: Adaptation to various indicators

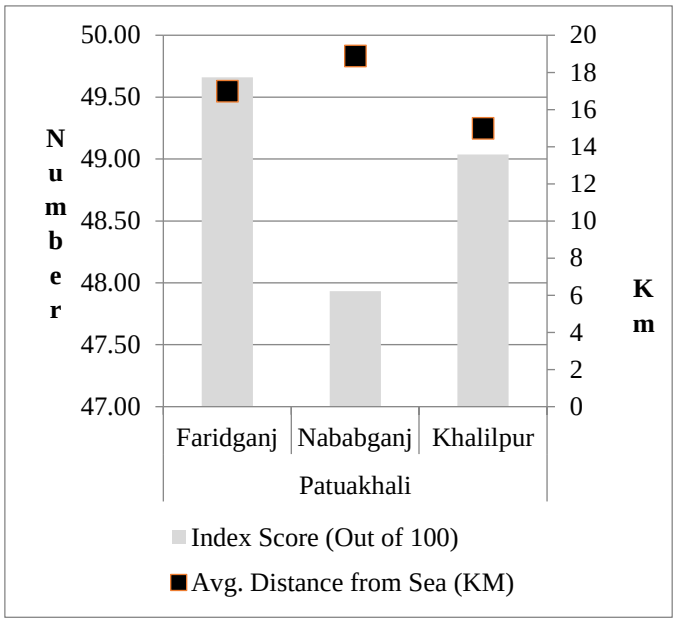

Figure 8. Patuakhali: Adaptation & distance from sea

4.2.3 Barguna

From Figure 9, we can see that the households of Barguna district scored the highest CCAI among all the coastal districts surveyed (56 points). Particularly, Hoglapara village showed the highest index (64 points) among all the surveyed villages. Overall, all the villages of Barguna were comparatively well adapted in health and education categories (above 60 points), while their score in finance and food elements were lower (below 40 points). With regard to distance, the villages of Barguna district surveyed are located within 9 to 12 kilometers of the coastline (Figure 10). In a similar vein to the findings of Patuakhali, it can be observed that the CCAI score of Barguna is praiseworthy compared to the CCAI score of the Laxmipur and Bagethat districts that are distantly located.

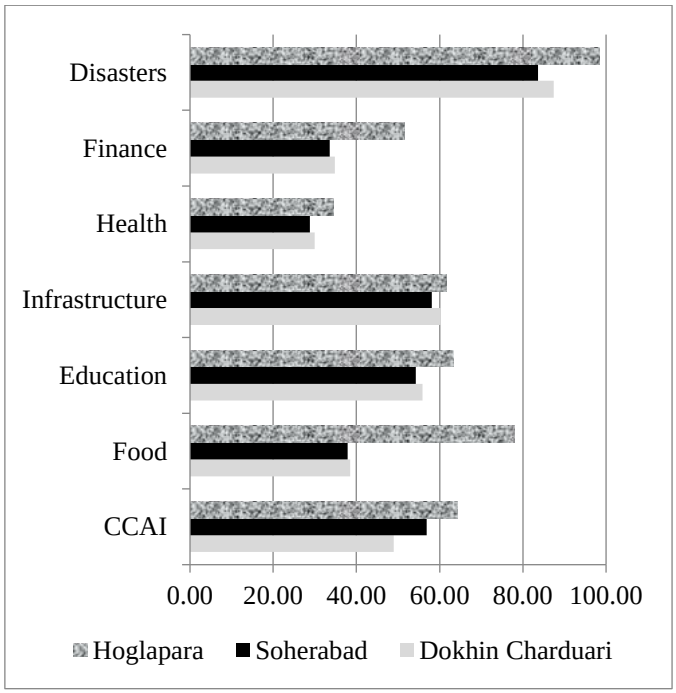

Figure 9. Barguna: Adaptation to various indicators

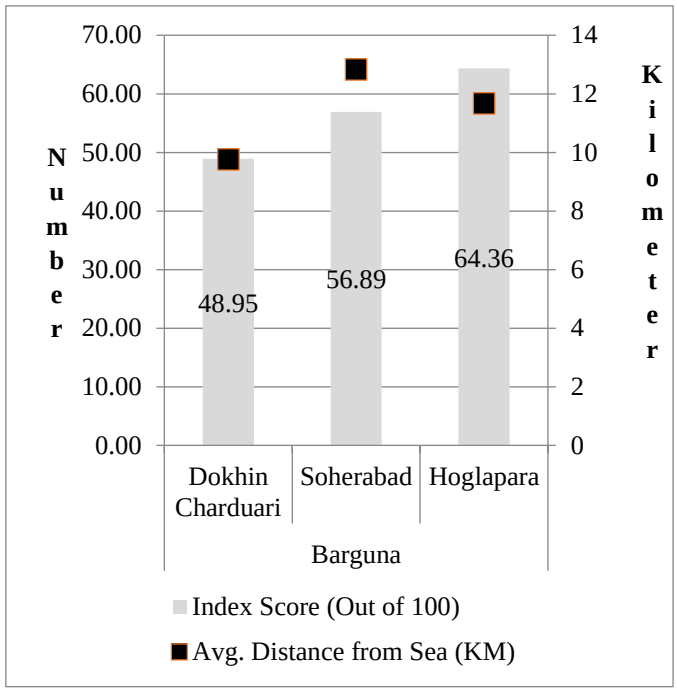

Figure 10. Barguna: Adaptation & distance from sea

4.2.4 Bagerhat

From Figure 11, we can see that the households of Bagerhat district were comparatively well adapted in health, infrastructure, and disaster management categories (above 50 or more points). Particularly, Khuriakhali village was doing exemplary by scoring more than 60 points in disaster and health categories, whereas they did poorly in finance and food elements (below 40 points). In terms of distance, the villages of the Bagerhat district surveyed are located within approximately 100 kilometres of the coastline (Figure 12). Compared to closely located districts, this district showed relatively poor CCAI.

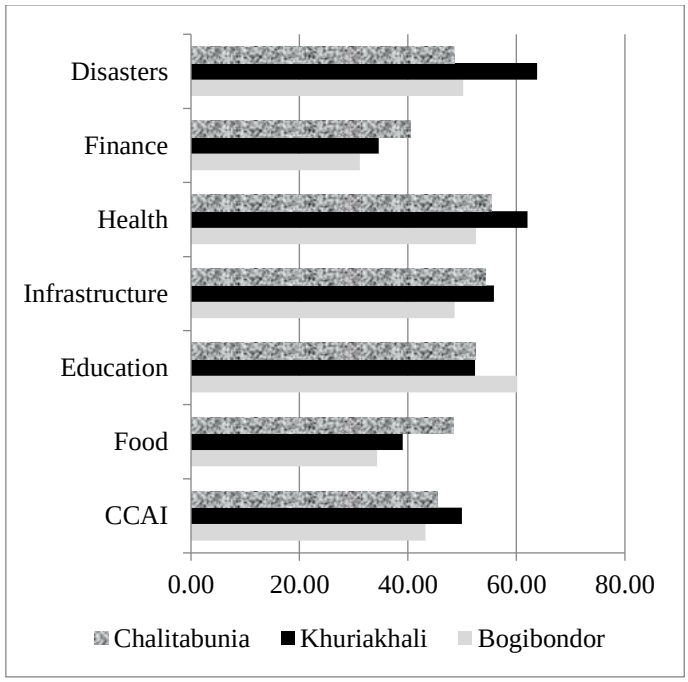

Figure 11. Bagerhat: Adaptation to various indicators

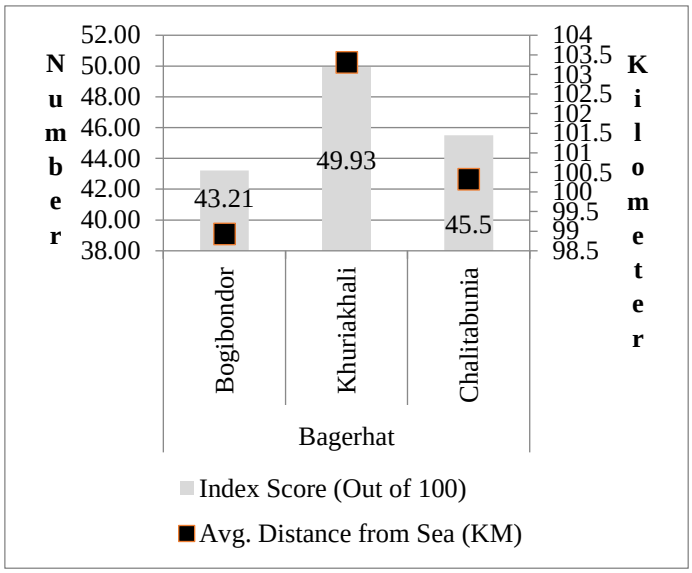

Figure 12. Bagerhat: Adaptation & distance from sea

4.2.5 Adaptation indicator-wise findings

Figures 13 to 18 summarizes results according to adaptation indicators, where adaptation to disasters shows highest index (65), whereas finance indicators show lowest (36). Infrastructure and education are shown above 50 average adaptation index, while health and food are showing below 50 average. Definitely finance is one of the key adaptation indicators requiring particular focus.

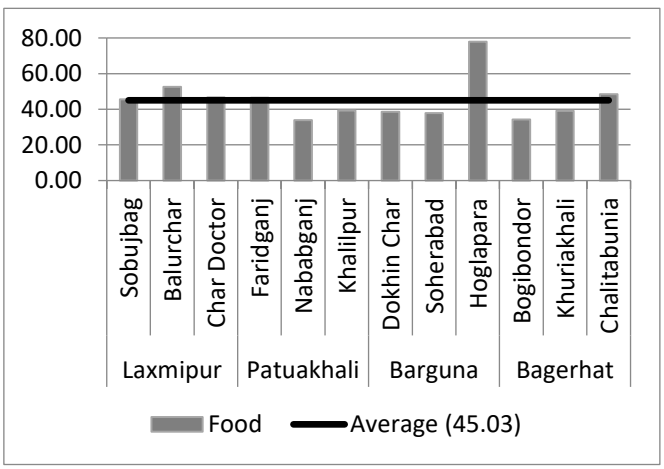

Figure 13. Food indicator

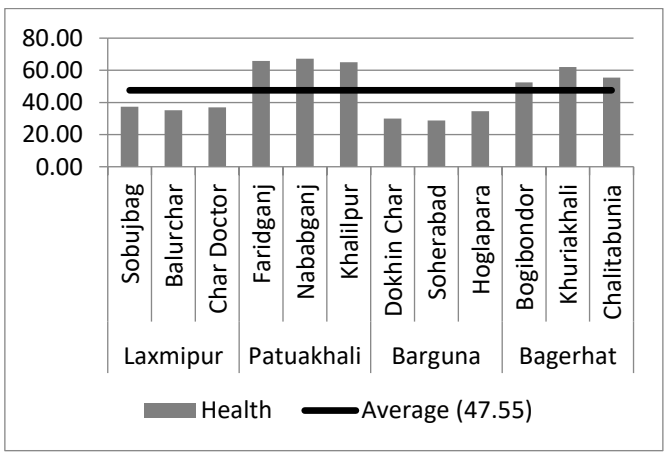

Figure 14. Health indicator

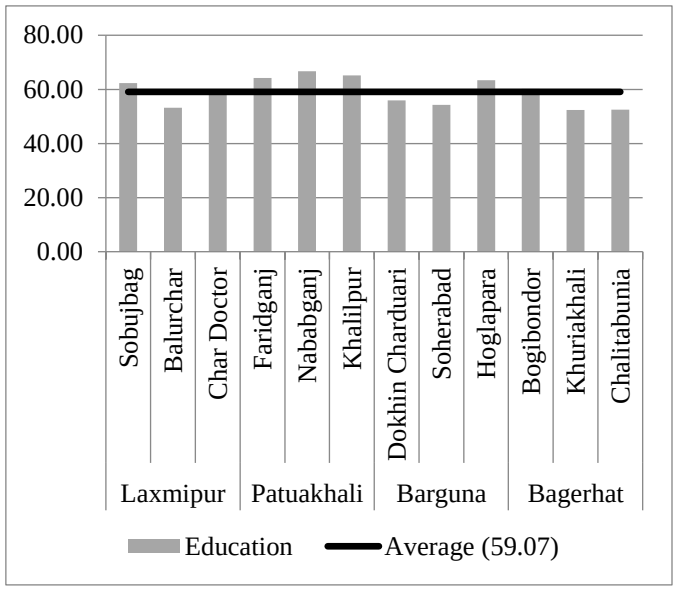

Figure 15. Education indicator

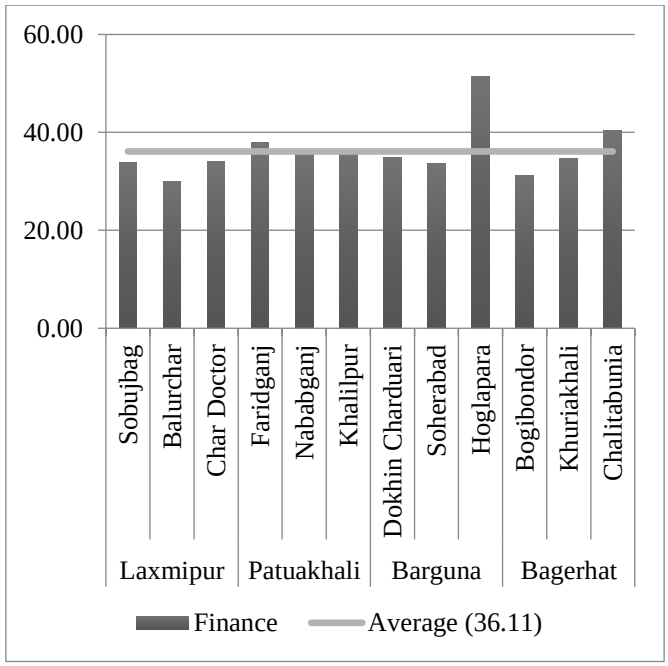

Figure 16. Finance indicator

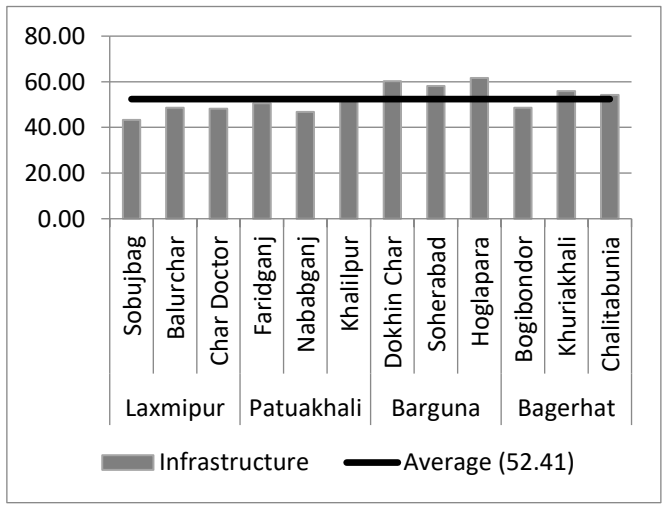

Figure 17. Infrastructure indicator

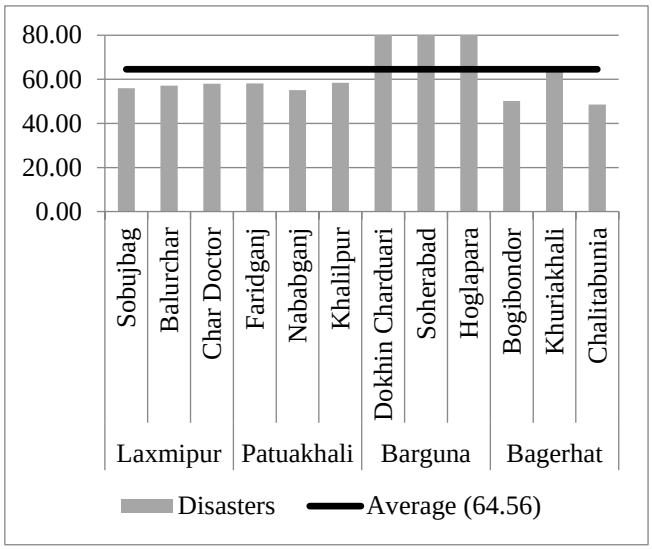

Figure 18. Disaster indicator

5. DISCUSSION

The climate change adaptation index (CCAI) was applied to four vulnerable coastal districts of Bangladesh - Laxmipur, Patuakhali, Barguna, and Bagerhat - and revealed poor adaptability, with an average index of around 50. This fall in climate finance in recent years is justified, and is consistent with previous studies that have shown similar findings regarding climate change indicators and their adaptability status [2, 78, 79]. The barriers to adaptation include lack of awareness, institutional obstacles, spiritual norms, and traditional systems, as cited in a study by Chowdhury et al. [52].

When we look at the results based on adaptation indicators, the village of Hoglapara in the Barguna district has performed relatively better regarding food adaptation. In contrast, the village of Nababgonj in Patuakhali district has fared poorly. Barguna district has been a pioneer in adopting a range of strategies to adapt to climate change. The most important factor contributing to higher adaption in Barguna was the community's experience with climate change, which significantly shaped farmers' perceptions and awareness [79]. Farmers realized the danger of climate change very closely. They used indigenous knowledge and planned adaptation strategies that impacted adaptation dimensions, namely, food (introducing new crops, homestead gardening, mixed cropping, livestock animals), education (Indigenous knowledge), finance (off-farm employment), infrastructure (constructed or repaired embankment), and disaster response (re-digging of the canal). Socio-economic variables such as literacy rate, education, farming status, farm and non-farm income, total family expenditure, and owned and cultivatable land contributed towards their adaptive capacity.

The villages in the Potuakhali district have a high comparative index in terms of education. This could be attributed to the district's proximity to the Bay of Bengal, which is frequently affected by tropical cyclones such as Sidr, Aila, and Mohaseen. Additionally, government and non-government organizations have conducted various preparedness activities, such as raising awareness about signaling, evacuation, relocation, search and rescue, and medical first aid. These activities may have helped educate the community and prepare them to adapt to climate change [78].

The disaster preparedness indicator has the highest average index score out of all the indicators. The villages in Barguna district have the highest score in this indicator because the residents have developed innovative ideas to prepare for and adapt to disasters caused by climate change. They have a long tradition of utilizing their indigenous knowledge and technology to be well-prepared. Some of these ideas include elevated house basements, livestock farms, land for cultivation, road and pond banks, separate storage for food and grains, monitoring weather changes, and changing their lifestyle. These ideas are worth mentioning [2] and could serve as an example for other communities in disaster-prone areas.

Our research has revealed that living closer to the seashore can enhance a person's ability to adapt to climate change. The result of the study is also consistent with the findings of Maiella et al. [80]. Specifically, residents of Patuakhali and Barguna districts, which are within 20 km of the coast, demonstrated a higher Climate Change Adaptability Index (CCAI) compared to those living farther away in Laxmipur and Bagerhat districts, which are more than 90 km from the coast. Other studies have also found that people living in proximity to the coast tend to have more practical experience in dealing with climate change consequences, making them more resilient and adaptable to climate change [60, 81, 82].

The findings of the study provide insightful implications for the sustainable development of the country through adaptation. Tracking and monitoring of adaptation by CCAI will ensure that the country is on track of sustainable development by coping with climate change in achieving SDG 1 (Poverty), SDG 2 (Hunger), SDG 3 (Health), SDG 4 (Education), SDG 6 (Water) and SDG 13 (Climate).

National and global practitioners and policymakers can use Barguna's community-based adaptive experience, which showed the highest CCAI, as a model for developing their region's adaptive capacity. It is imperative that investing in basic socio-economic indicators such as education, income, land ownership, and knowledge helps to promote planned adaptation through positive perceptions. Using CCAI dimension-wise results, practitioners and policymakers may design projects to inject support in lagging areas and enhance the adaptive capacity of the communities.

6. CONCLUSIONS

This study aimed to develop and apply a climate change adaptation index to assess the level of climate change adaptability in Bangladesh, specifically in coastal regions. The results showed that the overall adaptation status in these coastal districts could be improved, notably concerning food and health indicators. Interestingly, two coastal districts near the sea demonstrated comparatively better overall and indicator-specific adaptability index. This geographical proximity to the seashore encourages proactive behavior among residents regarding adaptability, which is fascinating. This finding warrants further investigation and requires policymakers' attention to understand better the factors contributing to successful adaptation strategies in these areas.

In the domain of climate change adaptation theory, this particular study has a significant number of implications for scholars, practitioners, and policymakers. From the theoretical perspective of climate change, this study has broadened the horizon of climate change adaptation measurement from the perspective of vulnerable developing countries by presenting

an index. It will enrich the current literature on adaption theory by stressing the importance of quantifying adaptation status to identify the gap in adaptive capacity, influencing factors, and re-allocation of incentives. The study's findings will help scholars enrich theories of planned adaptation by balancing the importance of various incentives to achieve a higher degree of adaptability to climate change [27]. Practitioners and policymakers can emphasize adaptation sectors such as food and health to improve adaptability.

However, this study is not free from limitations. The first and foremost limitation of this research is the limited coverage in terms of sample size. Due to COVID-19 restrictions and other logistic issues, we could cover only four coastal districts. The results cannot be generalized for all the coastal districts of Bangladesh. Second, the CCAI needs to be reevaluated, and the possibility of including other dynamics of indicators and dimensions of adaptability be tested with a broader data set. Lastly, a follow-up study is required for a time-series cross-regional comparison to draw more generalized conclusions. These areas leave the scope for future research.

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REFERENCES

[1] LoGIC. (2023). Climate vulnerability index (CVI). Local Government Initiative on Climate Change (LoGIC), Local Government Division. https://www.flipsnack.com/77777E5569B/climate-vulnerability-index-draft/full-view.html.

[2] Islam, M., Shitangsu, P., Hassan, M. (2015). Agricultural vulnerability in Bangladesh to climate change-induced sea level rise and options for adaptation: A study of a coastal Upazila. Journal of Agriculture and Environment for International Development, 109(1): 19-39. https://doi.org/10.12895/jaeid.20151.218

[3] Ministry of Finance. (2023). Climate financing for sustainable development: Budget report 2023-24. Finance Division, Ministry of Finance, Government of the People's Republic of Bangladesh.

[4] United Nations Framework Convention on Climate Change (UNFCCC). (2024). Introduction to climate finance. https://unfccc.int/topics/climate-finance/the-big-picture/climate-finance-in-the-negotiations#:~:text=Climate%20Finance%20in%20the%20Paris,existing%20obligations%20under%20the%20Convention.

[5] Huq, S. (2016). Politics of Climate Change: Climate finance in Bangladesh. The Daily Star.

[6] Chattaopadhyay, S. (2017). How can Bangladesh access a larger slice of the climate finance pie? Dhaka Tribune.

[7] Haque, M. (2017). Climate finance for the poor: A framework for understanding, engaging local communities. Dhaka Tribune.

[8] Sarkar, U.K., Dubey, V.K., Jena, J.K. (2013). Freshwater fish biodiversity of India: Pattern, utilization, importance, threats, and challenges. Reviews in Fish Biology and Fisheries, 23: 555. https://doi.org/10.1007/s11160-013-9306-x

[9] Filho, W.L., Alam, G.M.M., Nagy, G.J., Rahman, M.M., Roy, S., Wolf, F., Kovaleva, M., Saroar, M., Li, C. (2022). Climate change adaptation responses among riparian settlements: A case study from Bangladesh. PLoS One, 17(12): e0278605. https://doi.org/10.1371/journal.pone.0278605

[10] Baul, T.K., Peuly, T.A., Nandi, R., Kar, S., Karmakar, S. (2022). Role of homestead forests in adaptation to climate change: A study on households' perceptions and relevant factors in Bandarban Hill District, Bangladesh. Environmental Management, 69(5): 906-918. https://doi.org/10.1007/s00267-022-01598-8

[11] Uddin, M.N., Bokelmann, W., Entsminger, J.S. (2014). Factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: A farm level study in Bangladesh. Climate, 2(4): 223-241. https://doi.org/10.3390/cli2040223

[12] Chowdhury, M.A., Hasan, M.K., Islam, S.L.U. (2022). Climate change adaptation in Bangladesh: Current practices, challenges and the way forward. The Journal of Climate Change and Health, 6(2022): 100-108. https://doi.org/10.1016/j.joclim.2021.100108

[13] Kandel, G.P., Bavorova, M., Ullah, A., Pradhan, P. (2024). Food security and sustainability through adaptation to climate change: Lessons learned from Nepal. International Journal of Disaster Risk Reduction, 101: 104279. https://doi.org/10.1016/j.ijdrr.2024.104279

[14] Khanal, S., Lutz, A.F., Immerzeel, W.W., De Vries, H., Wanders, N., Van Der Hurk, B. (2019). The impact of meteorological and hydrological memory on compound peak flows in the Rhine river basin. Atmosphere, 10(4): 171. https://doi.org/10.3390/atmos10040171

[15] Cabana, D., Rölfer, L., Evadzi, P., Celliers, L. (2023). Enabling climate change adaptation in coastal systems: A systematic literature review. Earth's Future, 11(8): e2023EF003713. https://doi.org/10.1029/2023EF003713

[16] Ayers, J., Huq, S., Wright, H., Faisal, A.M., Yanveer, S. (2014). Mainstreaming climate change adaptation into development in Bangladesh. Climate and Development, 6(4): 293-305.

[17] Aguiar, F.C., Bentz, J., Silva, J.M.N., Fonseca, A.L., Swart, R., Santos, F.D., Penha-Lopes, G. (2018). Adaptation to climate change at the local level in Europe: An overview. Environmental Science and Policy, 86(2018): 38-63. https://doi.org/10.1016/j.envsci.2018.04.010

[18] Smit, B. (1993). Adaptation to climate variability and change. Environment Canada.

[19] Stakhiv, E. (1993). Evaluation of IPCC adaptation strategies. Institute of Water Resources, U.S. Army Corps of Engineers.

[20] Smith, J.B., Ragland, S.E., Pitts, G.J. (1996). A process for evaluating anticipatory adaptation measures for climate change. Water, Air, and Soil Pollution, 92(1-2): 229-238. https://doi.org/10.1007/BF00175568

[21] Watson, R.T., Zinyowera, M.C., Moss, R.H. (1996). Climate Change 1995: Impacts, Adaptation and Mitigation of Climate Change: Scientific-Technical Analysis. Cambridge University Press.

[22] Fankhauser, S. (2017). Adaptation to climate change.

Annual Review of Resource Economics, 9: 209-230. https://doi.org/10.1146/annurev-resource-100516-033554
[23] Intergovernmental Panel on Climate Change (IPCC). (2014). Climate change 2014: Impacts, adaptation, and vulnerability. In Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Cambridge University Press.
[24] Smit, B., Burton, I., Klein, R.J.T., Wandel, J. (2000). An anatomy of adaptation to climate change and variability. Climate Change, 45(1): 223-251. https://doi.org/10.1007/978-94-017-3010-5_12
[25] Klein, R.J.T., Tol, R.S.J. (1997). Adaptation to climate change: Options and technologies. In Climate: Global Change and Local Adaptation, pp. 157-168. Dordrecht: Springer Netherlands.
[26] Kahn, M. (2016). The climate change adaptation literature. Review of Environmental Economics and Policy, 10(1): 166-178. http://doi.org/10.1093/reep/rev023
[27] Eskander, S.M.S.U., Barbier, E.B. (2018). Agricultural adaptation to natural disasters through the land rental market: Evidence from Bangladesh. Working Paper No. 236, Grantham Research Institute on Climate Change and the Environment, London School of Economics.
[28] Barnett, B.J., Mahul, O. (2007). Weather index insurance for agriculture and rural areas in lower-income countries. American Journal of Agricultural Economics, 89(5): 1241-1247.
[29] Di Falco, S., Veronesi, M. (2013). How can African agriculture adapt to climate change? A counterfactual analysis from Ethiopia. Land Economics, 89(4): 743-766. https://doi.org/10.3368/le.89.4.743
[30] Wang, J., Mendelsohn, R., Dinar, A., Huang, J. (2010). How chinese farmers change crop choice to adapt to climate change. Climate Change Economics, 1(3): 167-186. https://doi.org/10.1142/S2010007810000145
[31] Castells-Quintana, D., Lopez-Uribe, M.D.P., McDermott, T.K.J. (2018). Adaptation to climate change: A review through a development economics lens. World Development, 104: 183-196. https://doi.org/10.1016/j.worlddev.2017.11.016
[32] Henderson, V.H., Storeygard, A., Deichmann, U. (2014). 50 years of urbanization in Africa: Examining the role of climate change. World Bank Development Research Group Policy Research, Working Paper, 6925.
[33] Beine, M., Parsons, C. (2015). Climatic factors as determinants of international migration. The Scandinavian Journal of Economics, 117(2): 723-767. https://doi.org/10.1111/sjoe.12098
[34] Ajuang, C.O., Abuom, P.O., Bosire, E.K., Dida, G.O., Anyona, D.N. (2016). Determinants of climate change awareness level in Upper Nyakach Division, Kisumu County, Kenya. SpringerPlus, 5(1): 1-20. https://doi.org/10.1186/s40064-016-2699-y
[35] Mustafa, G., Latif, I.A., Bashir, M.K., Shamsudin, M.N., Anwar, S. (2017). Adaptation strategies to climate change: A comparative analysis of field extension services and farmer training in the Punjab, Pakistan. Journal of Environmental Management, 199(2017): 215-228.
[36] Ado, A.M., Leshan, J., Savadogo, P., Bo, L.M., Shah, A.A. (2019). Farmers' awareness and perception of climate change impacts: Case study of Aguie district in Niger. Environment, Development and Sustainability, 21: 2963-2977. https://doi.org/10.1007/s10668-018-0173-4
[37] Lee, T.M., Markowitz, E.M., Howe, P.D., Ko, C.Y., Leiserowitz, A.A. (2015). Predictors of public climate change awareness and risk perception around the world. Nature Climate Change, 5(11): 1014-1020. https://doi.org/10.1038/nclimate2728
[38] Hossain, M.S., Qian, L., Arshad, M., Shahid, S., Fahad, S., Akhter, J. (2019). Climate change and crop farming economic impacts. International Journal of Climate Change Strategies and Management, 11(3): 424-440.
[39] World Bank. (2010). Climate change risks and food security in Bangladesh. World Bank.
[40] Intergovernmental Panel on Climate Change (IPCC). (2007). Climate change: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
[41] Cash, R.A., Halder, S.R., Husain, M., Islam, M.S., Mallick, F.H., May, M.A., Rahman, M., Rahman, M.A. (2014). Reducing the health effect of natural hazards in Bangladesh. The Lancet, 382(9910): 2094-2103. https://doi.org/10.1016/S0140-6736(13)61948-0
[42] Shahid, S. (2011). Impact of climate change on irrigation water demand of dry season Boro rice in northwest Bangladesh. Climatic Change, 105: 433-453. https://doi.org/10.1007/s10584-010-9895-5
[43] Adger, W.N., Huq, S., Brown, K., Conway, D., Hulme, M. (2003). Adapting to climate change in the developing world. Progress in Development Studies, 3(3): 179-195. https://doi.org/10.1191/1464993403ps060oa
[44] Mustafa, G., Latif, I.A., Bashir, M.K., Shamsudin, M.N., Daud, W.N. (2019). Determinants of farmers' awareness of climate change. Applied Environmental Education & Communication, 18: 219-233. https://doi.org/10.1080/1533015X.2018.1454358
[45] Banerjee, O., Mahzab, M., Raihan, S., Islam, N. (2015). An economy-wide analysis of climate change impacts on agriculture and food security in Bangladesh. Climate Change Economics, 6(1): 1550003. https://doi.org/10.1142/S2010007815500037
[46] Neelormi, S., Adri, N., Ahmed, A. (2009). Gender dimensions of differential health effects of climate change induced water-logging: A case study from coastal Bangladesh. In Proceedings of IOP Conference Series: Earth and Environmental Science, 6: 142026. https://doi.org/10.1088/1755-1307/6/14/142026
[47] Christensen, K., Raihan, S., Ahsan, R., Uddin, A.M.N., Ahmed, C.S., Wright, H. (2012). Ensuring access for the climate vulnerable in Bangladesh: Financing local adaptation. ActionAid Bangladesh (AAB), Action Research for Community Adaptation in Bangladesh (ARCAB), Bangladesh Centre for Advanced Studies (BCAS), and International Centre for Climate Change and Development (ICCCAD).
[48] Moniruzzaman, S. (2015). Crop choice as climate change adaptation: Evidence from Bangladesh. Ecological Economics, 118: 90-98. https://doi.org/10.1016/j.ecolecon.2015.07.012
[49] Penning-Rowsell, E.C., Sultana, P., Thompson, P.M. (2013). The 'last resort'? Population movement in response to climate-related hazards in Bangladesh. Environmental Science & Policy, 27: S44-S59. https://doi.org/10.1016/j.envsci.2012.03.009

[50] Foresight. (2011). Migration and global environmental change: Future challenges and opportunities. Final Project Report, UK Government Office for Science.
[51] Paul, B.K. (2005). Evidence against disaster-induced migration: The 2004 tornado in north-central Bangladesh. Disasters, 29(4): 370-385. https://doi.org/10.1111/j.0361-3666.2005.00298.x
[52] Chowdhury, M.A., Hasan, M.K., Islam, S.L.U. (2022). Climate change adaptation in Bangladesh: Current practices, challenges and the way forward. The Journal of Climate Change and Health, 6: 100-108. https://doi.org/10.1016/j.joclim.2021.100108
[53] Wheeler, D. (2011). Quantifying vulnerability to climate change: Implications for adaptation assistance. CGD Working Paper 240, Center for Global Development (CGD), Washington, DC, USA. https://doi.org/10.2139/ssrn.1824611
[54] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2023). Improved coordination of international climate finance (ICICF). GIZ.
[55] Brooks, N., Anderson, S., Ayers, J., Burton, I., Tellam, I. (2011). Tracking adaptation and measuring development. Climate Change Working Paper, No. 1.
[56] Lesnikowski, A.C., Ford, J.D., Berrang-Ford, L., Barrera, M., Berry, P. (2013). National-level factors affecting planned, public adaptation to health impacts of climate change. Global Environmental Change, *23*(5): 1153-1163. https://doi.org/10.1016/j.gloenvcha.2013.04.008
[57] Lesnikowski, A.C., Ford, J.D., Berrang-Ford, L., Barrera, M., Heymann, J. (2015). How are we adapting to climate change? A global assessment. Mitigation and Adaptation Strategies for Global Change, 20: 277-293. https://doi.org/10.1007/s11027-013-9491-x
[58] Germanwatch. (2024). Who suffers most from extreme weather events? Weather-related loss events in 2019 and 2000 to 2019. https://www.germanwatch.org/en/19777, accessed on Aug. 2, 2024.
[59] Climate Vulnerability Index (CVI). (2024). https://cvi-heritage.org/#:~:text=The%20Climate%20Vulnerability%20Index%20(CVI)%20is%20a%20rapid%20assessment%20tool,Community%20Vulnerability, accessed on Aug. 2, 2024.
[60] Milfont, T.L., Evans, L., Sibley, C.G., Ries, J., Cunningham, A. (2014). Proximity to coast is linked to climate change belief. PloS ONE, 9(7): e103180. https://doi.org/10.1371/journal.pone.0103180
[61] World Economic Forum. (2020). Nature and biodiversity: This is the state of sustainability around the world. Ahttps://www.weforum.org/agenda/2020/06/chart-of-the-day-this-is-the-state-of-sustainability-around-the-world/, accessed on Aug. 2, 2024.
[62] Pandey, R., Maithani, N., Aretano, R., Zurlini, G., Archie, K.M., Gupta, A.K., Pandey, V.P. (2016). Empirical assessment of adaptation to climate change impacts of mountain households: Development and application of an Adaptation Capability Index. Journal of Mountain Science, 13: 1503-1514. https://doi.org/10.1007/s11629-015-3499-5
[63] Vajjarapu, H., Verma, A. (2021). Composite adaptability index to evaluate climate change adaptation policies for urban transport. International Journal of Disaster Risk Reduction, 58: 102205. https://doi.org/10.1016/j.ijdrr.2021.102205
[64] Lin, F., Ying, C., Kuang, S.Y., Hao, G. (2021). Index for climate change adaptation in China and its application. Advances in Climate Change Research, 12(2021): 723-733. https://doi.org/10.1016/j.accre.2021.06.006
[65] Pineda, A.A.L., Rojas, O.A.V., Jonathan, M.P., Sujitha, S.B. (2019). Evaluation of climate change adaptation in the energy generation sector in Colombia via a composite index — A monitoring tool for government policies and actions. Journal of Environmental Management, 250: 109453. https://doi.org/10.1016/j.jenvman.2019.109453
[66] Khanal, U., Wilson, C. (2019). Derivation of a climate change adaptation index and assessing determinants and barriers to adaptation among farming households in Nepal. Environmental Science & Policy, 101: 156-165. https://doi.org/10.1016/j.envsci.2019.08.006
[67] Araos, M., Ford, J., Berrang-Ford, L., Biesbroek, R., Moser, S. (2016). Climate change adaptation planning for Global South megacities: The case of Dhaka. Journal of Environmental Policy & Planning, 19(6): 682-696. https://doi.org/10.1080/1523908X.2016.1264873
[68] Monasterolo, I., Roventini, A., Foxon, T.J. (2019). Uncertainty of climate policies and implications for economics and finance: An evolutionary economics approach. Ecological Economics, 163: 177-182. https://doi.org/10.1016/j.ecolecon.2019.05.012
[69] Haque, S.M., Ashwaq, O., Sarief, A., Azad John Mohamed, A.K. (2020). A comprehensive review about SARS-CoV-2. Future Virology, 15(9): 625-648. https://doi.org/10.2217/fvl-2020-0124
[70] Bangladesh Bureau of Statistics. (2022). https://bbs.gov.bd/, accessed on Aug. 2, 2024.
[71] Cooper, D., Schindler, P. (2008). Business Research Methods (10th ed.). McGraw-Hill/Irwin.
[72] ND-GAIN Index. (2015). University of Notre Dame Global Adaptation Index. https://www.preventionweb.net/publication/nd-gain-index, accessed on Aug. 2, 2024.
[73] Human Development Reports. (2023). Global Multidimensional Poverty Index (MPI). United Nations Development Programme. https://hdr.undp.org/content/2023-global-multidimensional-poverty-index-mpi#/indicies/MPI, accessed on Aug. 2, 2024.
[74] Zamudio, A.N., Parry, J. (2016). Review of current and planned adaptation action in Bangladesh. https://idl-bnc-idrc.dspacedirect.org/server/api/core/bitstreams/465e06bf-3efe-45d3-91fa-010296bf717d/content.
[75] Ministry of Finance. (2022). Climate financing for sustainable development: Budget report 2021-22. Finance Division, Government of the People's Republic of Bangladesh. https://doi.org/10.1371/journal.pone.0103180
[76] Chen, C., Noble, I., Hellmann, J., Coffee, J., Murillo, M., Chawla, N. (2015). University of notre dame global adaptation index. University of Notre Dame.
[77] Ministry of Environment and Forests. (2009). Bangladesh climate change strategy and action plan 2009. Government of the People's Republic of Bangladesh.
[78] Alam, M.Z., Halsey, J., Haque, M.M., Talukdar, M., Moniruzzaman, M., Crump, A.R. (2018). Effect of natural disasters and their coping strategies in the Kuakata coastal belt of Patuakhali, Bangladesh. Computational Water, Energy, and Environmental

Engineering, 7: 161-182. http://doi.org/10.4236/cweee.2018.74011
[79] Kabir, A., Hasan, M.M., Ahmed, B., Islam, S. (2020). Climate change perception and adaptation strategies of southwest coastal Bangladesh. American Scientific Research Journal for Engineering, Technology, and Sciences, 66(1): 47-68.
[80] Maiella, R., La Malva, P., Marchetti, D., Pomarico, E., Di Crosta, A., Palumbo, R., Cetara, L. (2020). The psychological distance and climate change: A systematic review on the mitigation and adaptation behaviors. Frontiers in Psychology, 11: 1-14. https://doi.org/10.3389/fpsyg.2020.568899
[81] Jones, C., Hine, D.W., Marks, A.D.G. (2017). The future is now: Reducing psychological distance to increase public engagement with climate change. Risk Analysis, 37: 331-341. https://doi.org/10.1111/risa.12601
[82] Kim, K., Ahn, S.J. (2019). The moderating role of cultural background in temporal framing: Focusing on climate change awareness advertising. Asian Journal of Communication, 29(4): 363-385. https://doi.org/10.1080/01292986.2019.1624793