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# **Current Practices, Challenges, and Future Directions of Climate Change Adaptation in Bangladesh**

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## **ABSTRACT**

The people of Bangladesh have become more vulnerable to the effects of climate change due to their geographic location and socioeconomic characteristics. Effective adaptation strategies will mitigate negative impacts on livelihood, health, agriculture, and the environment, especially in coastal areas. Diverse scientific and indigenous knowledge are being used to deal with the effects of climate change. Nonetheless, a number of obstacles are impeding long-term adaptation. The goal of this study is to identify present and likely adaptation options as well as impediments to coping with climate change consequences in Bangladesh. As disasters become more frequent and intense, many people are being forced to urban areas, where natural and man-made difficulties make long-term adaptation difficult. Climate change adaptation is also hampered by a lack of in-depth knowledge of vulnerabilities, ignoring the demands of local populations, and insufficient integration of policies and programs. Lack of in-depth knowledge of vulnerabilities, neglecting the desires of local residents, and insufficient integration of policies and programs all impede climate change adaptation.

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Keywords: Bangladesh, Climate change, Adaptation, Migration, Health

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## **1. Introduction**

Climate change is making developing and underdeveloped countries more vulnerable, and Bangladesh is experiencing severe climate change effects due to a lack of economic, social, technological, and institutional resources [1]. Many driving causes of migration will be influenced by climate change, affecting the most vulnerable communities [2]. Climate change has already had an impact on many resource-poor households' livelihoods and resources [3]. Climate change-induced vulnerability, as well as other social, economic, and environmental issues, put coastal areas at risk [4]–[5]. Overemphasis on technological breakthroughs, important cultural aspects, marginalization of informal communities, and a breakdown in connection and cooperation with institutional communities, on the other hand, remain obstacles to adaptation techniques [6]. Adaptation to climate change in Bangladesh's coastal areas is complicated by a mix of climate variables, spatial dynamics, and the engagement of several stakeholders [7]–[9]. Understanding the implications of climate change, practical adaptation strategies, and implementation issues faced in the real world are all important aspects of developing national adaptation plans [10]. Although migration is a complex problem from a variety of angles, the massive influx from Bangladesh into Northern India over the last several decades has resulted in increased ethnic tensions and violence [11]. It is critical to identify the barriers to ensure long-term adaptation. The purpose of this study is to summarize the effects of climate change in Bangladesh on several aspects such as agriculture, groundwater, livelihood, and health, as well as possible adaptation techniques and obstacles. This research will assist government and non-government stakeholders, including researchers and policymakers, in understanding climate change in Bangladesh from an adaptation perspective.

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## **2. An Overview of Climate Change in Bangladesh**

In Bangladesh, the frequency and intensity of extreme climatic occurrences have increased noticeably in recent decades [12]. The average temperature has increased by 0.20°C every decade [13]. For 2011–2020, a 153 mm rise in annual rainfall was expected [13], and recent studies have found an increasing tendency for three seasons, with the exception of winter, which is becoming cooler and drier while the rest of the year is becoming warmer and wetter [14]–[16]. Because of their low adaptation capacity and direct exposure to natural disasters, coastal and riverine communities in Bangladesh are extremely

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susceptible [17]. Riverbank erosion and other climate hazards have harmed the lives and livelihoods of these communities [18]. Many people have relocated their families as a result of these concerns, with the majority of climate-related internally displaced persons being relocated to char lands, which are islands separated from the mainlands and surrounded by rivers [19]. According to some studies, the people who live in the char areas are the most vulnerable to climate change [20]. Multiple natural calamities and socioeconomic vulnerabilities force people living in the char lands to relocate from one char to the next [21]–[23].

### 2.1. Farming and groundwater

Climate change has a significant impact on evapotranspiration, runoff, and groundwater levels in Bangladesh. One policy to reverse this reduction has been increased usage of surface water [24]. Surface water, on the other hand, is both expensive and scarce. As a result, many small farmers have attempted to transition to aquaculture, thereby altering the typical agricultural landscape [25]. Bangladesh is highly vulnerable to climate change due to its reliance on agriculture. Agriculture provides a living for around 60% of the coastal population [26]. Following Cyclone Aila in 2009, 82% of shrimp producers converted to rice and other crop production [27]. Crop yields, however, are declining due to saline intrusion, which may reduce crop outputs by 15.6 percent [28–29]. This results in additional diversification into aquaculture [27], [30–31], and a feedback cycle that causes soil salinity [32]. A large loss in agricultural output is also projected as a result of sea-level rise-induced land inundation [33].

### 2.2. Migration to cities

By the end of the century, global mean sea-level rise is expected to be between 0.29 and 1.1 metres [34]. Increased frequency of floods, inundation of wetlands, and increased shoreline and riverbank erosion are all coastal implications of sea-level rise [35–38]. This has an impact on economic and livelihood options, resulting in internal and international migration from coastal locations. Men that migrate in pursuit of work leave behind women who lack socioeconomic security for their families [39]. Approximately 90% of rural migrants stay permanently in urban areas, like as Dhaka, Chattogram, Khulna, and Rajshahi [40]. People living in megacities, particularly poor migrants, are particularly vulnerable to climate variability and natural disasters [41–42]. Dhaka's Land Surface Temperature (LST) has risen by about 2 degrees Celsius due to urbanization [43]. Despite limited resources, many community-level initiatives omit the urban severe poor [44]. In addition, rising migration is expected to have an impact on the public health and infrastructure sectors in Bangladesh's urban areas [45].

### 2.3. Public health

Climate change endangers human health, and rare diseases have become increasingly common in Bangladesh [1]. Climate change and pollution are having a negative impact on the health sector [46–49]. Malnutrition and a lack of safe drinking water are on the rise [50, 51]. Furthermore, the scarcity of freshwater has both direct and indirect implications on human health [52–53]. Water-borne, water-washed, and water-related diseases are found to be 8%, 14%, and 11% higher in Bangladesh's coastal regions [49], [54]. Groundwater contamination has been linked to hypertension, preterm birth, and acute respiratory infectious illnesses [55–56]. In addition to physical health effects, considerable mental health effects have been recorded [57]. Migrant women, in particular, are extremely sensitive to negative health consequences [58]. Furthermore, floods and cyclones immediately harm important health infrastructures, food supplies, and essential fundamental services, restricting their capacity to respond with growing crises [59]. Lack of effective healthcare assistance, especially the absence of gynecologic and obstetric care, adds to the pain and may emerge as a source of societal conflict [60–62]. Table 1 shows the effects of climate change on health in Bangladesh. Table 2 shows the most prevalent coping mechanisms for health-related difficulties used in Bangladesh. People stockpile and store goods and pharmaceuticals in preparation for extreme weather occurrences such as cyclones and floods. Netting around beds, especially at dawn and dusk, provides some protection from vector-borne diseases by keeping mosquitoes and fleas out [72]. Personal hygiene is maintained in order to prevent food-borne and water-borne infections, and community awareness and readiness programs are implemented in order to prepare for significant temperature swings.

**Table 1 - Climate change's effects on health in Bangladesh**

Climatic variables or aspects	Impacts on health
Rising temperature and heatwaves	Headache, skin burn, hypothermia, heatstroke, dementia, psychological disorder, mood disorders, anxiety
Changing pattern of rainfall	Skin diseases, cough, risk of snake bit, fever, cholera, diarrhea
Salinity intrusion	Hypertension, skin diseases, miscarriage of pregnant women, acute respiratory infection, diarrheal diseases
Natural disasters	Physical injuries, diarrhea, cholera, mental illness, malnutrition, infectious diseases, losses of lives
Floods and waterlogging	Cholera, diarrhea, malnutrition, skin diseases
Variable precipitation	Waterborne diarrheal diseases, non-cholera diarrhea, cardiovascular diseases, respiratory diseases
Increasing breeding of vectors	Visceral leishmaniasis
Groundwater overexploitation	Melanesia, leukomelanosis, keratosis, hyperkeratosis, dorsum, nonpettingedema, gangrene, skin cancer
Stagnant weather conditions	Cardiovascular, respiratory, and allergy diseases
Groundwater pollution	nervousness, damage of reproductive and endocrine systems
Decreased food production	Micronutrients deficiency, malnutrition

Adapted from [10], [22], [69]–[71], [47], [52], [63]–[68]

**Table 2: Bangladesh's adaptation to climate change-related health problems.**

Issues	Health coping strategies
Access to healthcare	Deciding between qualified and unqualified providers,
Mental health	Discuss with relatives, friends, and neighbors, avoid self-medication and traditional practices
Extreme weather events	Preparation in advance for food and medications, availability of safe water, assurance of accessible public health service during a post-disaster situation
Vector-borne disease	Netting around beds, avoid being outdoors at dawn and dusk
Food-borne disease	Maintenance of hygiene during preparation and consumption of food
Waterborne disease	Precautions regarding health impacts of algal blooms
Disruption of air quality	Regular monitoring and warning during high pollution days
Heatwaves/ Cold waves	Health warning approach in community level, preparedness initiatives during emergency periods

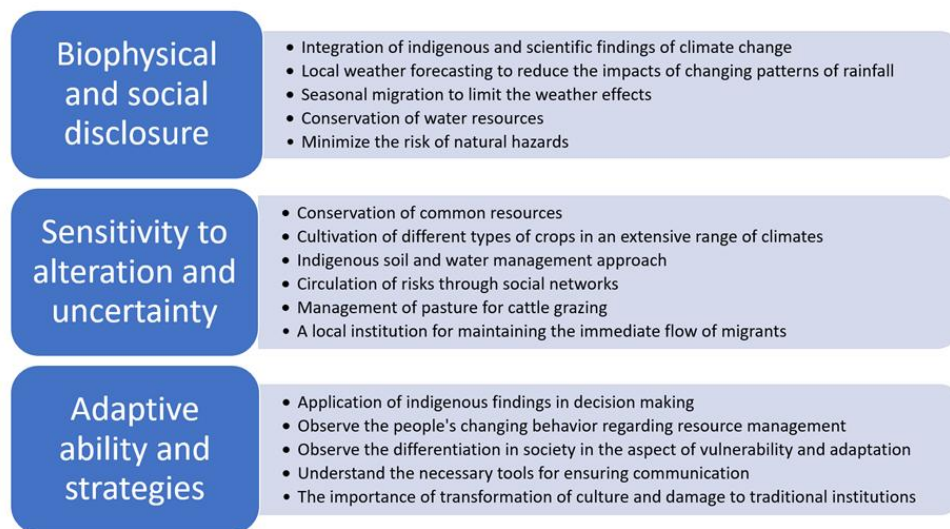
Adapted from [72]–[74]

#### 2.4. Gender

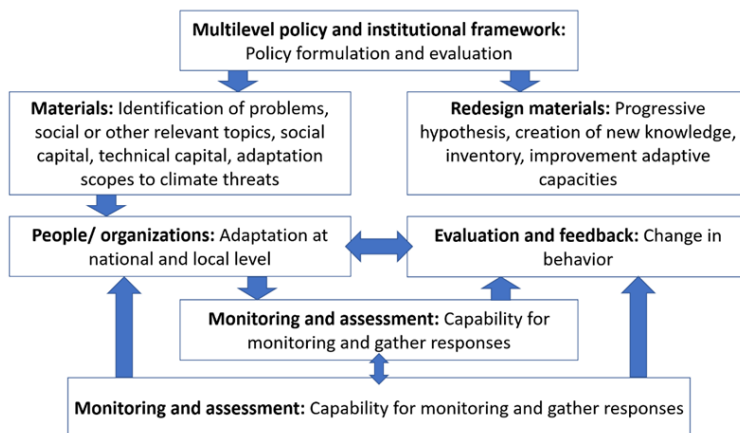
Gender is one of the most important markers of vulnerability, covering a wide variety of concerns such as natural resource depletion, access to knowledge and decision-making, and livelihood prospects [75–78]. Uneven power dynamics in numerous formal and informal institutions, as well as sociocultural norms, are the primary drivers of women's vulnerability [79–80]. Climate change reduces food and water availability, putting additional strain on women, who are traditionally expected to handle such household responsibilities [81–83]. Natural calamities and a scarcity of safe water sources frequently force women to trek long distances to fetch water for their family [84]. According to Alston and Akhter [82], women will continue to face food insecurity and unsafe water-related concerns until gender equality is achieved at the national and local levels. Inadequate and degraded sanitation infrastructure results in unsanitary behaviors and diseases, with women and teenage girls bearing the brunt of the burden [84]. Pregnancy complications such as eclampsia, hypertension, and pre-eclampsia are common in coastal areas [85]. Disasters, sicknesses, and a lack of opportunity all hinder women's ability to generate additional income [86]. Increased access to education can aid in the development of gender-inclusive resilience and adaptive ability [87].

### 3. Climate change adaptation in Bangladesh: planning, program, and practices

The South Asian region has the world's most diversified ecosystems and climate regimes [88]. To meet global mitigation and adaptation targets, a concerted multinational effort involving money, technological transfer, and capacity building is required. Farmers are cultivating saline-tolerant rice, moving to other types, experimenting with planting dates, converting paddy to fish production, and practicing crop rotation to adapt to the increased salinity level [89]. A project called "Reducing Vulnerability to Climate Change (RVCC)" [90] has also adopted certain measures in Bangladesh's southwestern areas. People in Bangladesh's flood-prone areas have a strong religious faith, which allows them to accept natural disasters as divine tests [91]. The value of local knowledge in climate change adaptation has been underlined in several research. Using local information to combine with adaptation-related decisions can lead to more flexibility [92]. Figure 1 summarizes examples of indigenous knowledge in adaptation.

**Figure 1:** Potential adaption options that include indigenous knowledge. Adapted from [93]–[95]

Institutional framework and capacity-building issues, including adequate local and national governance, should be addressed to ensure long-term adaptation [5]. Different types of factors connect multilevel policy and institutional frameworks, and some of these aspects require reformation. Furthermore, ensuring the development of adaptive ability requires a cumulative interaction among multiple components (Figure 2).



**Figure 2:** The importance of institutions in instilling adaptive capacities in households and communities. Adapted from [96]–[103]

Despite producing legal documents in policy, plans, and programs on adaptation, Bangladesh's institutional structure and competence for climate change adaptation and catastrophe management are still insufficient [104]. To ensure national adaptation to climate change, organizational systems must be devised [96]. To encourage adaptation with proper implementation techniques, several measures should be implemented within institutional actions.

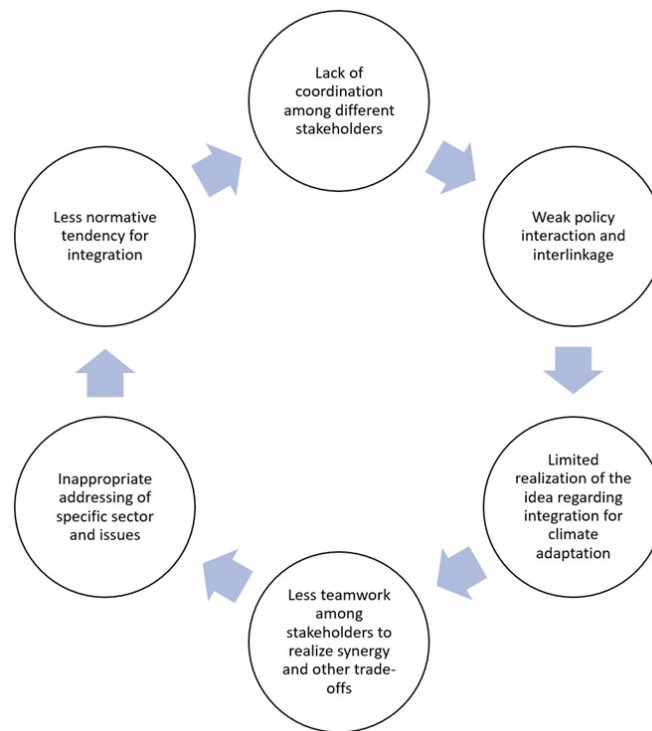
### 3.1. Climate change adaptation challenges

Climate change consequences cannot be measured within a border because they are felt on a global scale [80]. Institutional barriers, in combination with natural causes, raise vulnerabilities and limit adaptive capacity [105]. Figure 3 summarizes the impediments to problem identification and improvement of adaptation plans. One of the most fundamental issues for ensuring proper adaptation is policy integration (Figure 4) [104].



**Figure 3:** Barriers to climate change adaptation in Bangladesh. Adapted from [106]–[109]

The implementation of numerous adaptation-related projects and programs is hampered by a lack of institutional mechanisms and organizational capacities [110]. There are additional difficulties in building fair and reliable resilience evaluation frameworks [111]. Climate change adaptation is hampered by a lack of understanding, which is sometimes combined with spiritual norms and traditional systems [91]. Furthermore, gendered regional regulations and attitudes have an impact on adaptation strategies and can obstruct livelihoods [112].



**Figure 4:** Major barriers to policy integration for climate change adaptation. Adapted from [113]-[116]

#### 4. Conclusion

Bangladesh has a number of issues as a result of climate change impacts and adaptation, and the following concerns must be addressed:

- The specific goal of adapting to climate change through an inclusive process should be verified and represented in national policy. Furthermore, adequate governance and budgeting should be ensured [91], [117].
- Creating alternative options for disadvantaged people and small-scale businesses requires livelihood diversification, especially given the realities of agriculture and aquaculture [118].
- Displaced persons' rights must be protected in order to preserve their survival and physical security, particularly in slum regions. To establish global accountability, climate-induced migrants should be granted legal legitimacy and protection.
- A climate-change-resistant health-care system, as well as increased accessibility for vulnerable populations, must be built [119].
- To prevent health hazards, everyone should have access to safe drinking water [50], [120].
- From a social, financial, political, and cultural perspective, women's adaptive capacity should be stressed [87], [121].
- The application of local knowledge can help communities adapt [95]. Furthermore, knowledge sharing across many stakeholders can aid in long-term climate change adaptation and enhance public awareness [122]-[123].

Various aspects of climate change adaptation in Bangladesh have been discussed in this review. Migration and gender issues, as well as policy and governance consequences, can help to boost future research on climate change adaptation for Bangladesh and other developing nations.

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