



# Gender, Climate Change Adaptation, and Cultural Sustainability: Insights From Bangladesh

## OPEN ACCESS

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The focus of this paper is mainly to investigate climate change adaptation practices and the applicability of a cultural sustainability approach in understanding gender dimension of the residents of the southwest coast of Bangladesh. It is one of the most vulnerable regions in South Asia due to the significant impacts of climate change. The long-term effects of climate change in this region are the increasing salinity in farmlands, heatwaves, and sea-level rise. The southwest coast of Bangladesh is a classic example of “good practice” as well as the center for learning, implementing, and communicating climate change adaptation actions in practice. The reason for this the collective action carried out to initiate and improve adaptation activities by the Ministry of Environment, Forest and Climate Change of the Government of Bangladesh, as well as several national and international development and non-government organizations (NGOs). Using a systematic review of literature, and field-based case studies, we examined how gender and cultural issues (such as the adaptive capacity of men and women, and the transformation of gendered power relations) have been addressed to successfully implement climate change adaptation initiatives in the context of the nominated study area. Our study results revealed that both male and female participants were strategic and capable of dealing with climate change impacts, although the adaptive capacity of the former group was comparatively sturdier than the later. The extent of cultural sustainability was found to be weaker in the study region compared to many other coastal communities in the country. The efforts made by NGOs in collaboration with the governmental bodies of Bangladesh were found contributory in providing knowledge of climate change along with the techniques to adapt to its consequences for the people of the study region. Similarly, the activities of NGOs were found influential in helping the government to support people in adapting to climate change in terms of the gendered and cultural sustainability perspectives. Our findings contribute to the field of climate change impacts in understanding the complexities of rural development.

**Keywords:** climate change, adaptive capacity, gender, sustainability, Bangladesh

## INTRODUCTION

Bangladesh is one of the world's most vulnerable countries to climate change due to its extremely low and flat topography (Chowdhury et al., 2018; Islam and van Amstel, 2018; Roy, 2020). Two-thirds of the country is very low lying, less than five meters above sea level. The coastal districts are even more low-lying and vulnerable to natural disasters (Kabir et al., 2016; Abedin et al., 2020; World Bank, 2020). People practice various climate change adaptation strategies to survive in coastal Bangladesh. In this area, both men and women play important roles in climate change adaptation practices (Ahmed, 2017; Tanjeela and Rutherford, 2018). Loss of life would be equal if men and women were given equal economic and social rights; however, more women would die if these rights are unequally provided (Neumayer and Plümer, 2007; Ayeb-Karlsson, 2020; Roy, 2020). This indicates that climate-induced vulnerability depends on the extent of social as well as economic rights enjoyed by men and women. Gender discrimination has negative impacts on adaptive capacity. In line with this, cultural sustainability can be measured through economic, social, and environmental indicators (Soini and Dessein, 2016). A society becomes culturally sustainable when its economic and environmental aspects as well as access to physical resources are stronger.

Culture is an important resource for both climate change mitigation and adaptation (UNESCO, 2020). Culture influences society's response to all aspects of global climate change. Climate change threatens cultural dimensions of lives and livelihoods, including the material and lived aspects of culture, identity, community cohesion, and sense of place. Also, how societies respond and adapt to climate-related risks has important cultural dimensions (Adger et al., 2012). Hence, climate change adaptation requires a broader cultural shift (Wamsler and Brink, 2018). For instance, cultural sustainability determines a society's adaptive capacity related to climate induced disasters. Humanitarian interventions of governmental agencies help to increase the adaptive capacity of the people to respond to impacts of climate change. The Ministry of Environment, Forest and Climate Change (MOEFCC) of Bangladesh has formulated plans and policies for promoting the adaptive capacity of households within the coastal regions of the country. The main goal is to work for environmental preservation in order to maintain people's economic growth and cultural values, as well as protecting the geography of the area (Everett et al., 2010; World Bank, 2019, 2021). Primarily, the impact of climate change for adaptation can be planned for short, medium and long-term, where cultural sustainability is linked to medium adaptation measures with the cropping practices. A study conducted in the southwestern coastal Bangladesh shows that the male-headed households are more likely to transform the farming practices as compared with female headed households that conversely tended to receive assistance from NGOs as an adaptation strategy (Aryal et al., 2020). The livelihood assets which include natural, financial, physical, social capital, highly determine their capacity to adopt the adaptation strategies to cope and manage climate risk by a household (Jakobsen, 2013; Berman et al., 2015). The multiple roles in building resilience played by non-governmental

organizations have been enhancing the adaptive capacity of the people and hence influencing the perception and culture to adaptation on climate change in the coastal areas (Islam and Walkerden, 2015; Aryal et al., 2020).

Bangladesh is unique in its rich history of NGO engagement (Vinck et al., 2020). NGOs have taken a number of steps to promote discussion and debate about climate change issues (Hasan et al., 2018). NGOs help communities cope with challenges in agriculture, health, water, settlements, finance, and community identity in many disaster-prone countries. Due to the fragility of the settlements, physical isolation from the mainstream economy, and exposure to disaster risks, rural livelihoods in developing countries are more likely to be affected by shocks (Harvey et al., 2014). NGOs provide financial assistance to the poor for enabling them to generate income, build assets, and protect themselves from risks (Seddiky and Giggins et al., 2021). NGOs provide microloans to the people residing in the region already vulnerable to climate-induced disasters. Such loans help poor people in choosing resilient livelihood options. Services offered by NGOs mainly include provision of relief, sanitation equipment, and safe drinking water facilities (Islam and Walkerden, 2015). Overall, they provide avenues for the coastal communities in strengthening their social as well as natural capital. The role of the local NGOs in Bangladesh is thus inevitable (Hasan et al., 2018) because of their contributions to strengthening the cultural sustainability of the country's households. Evidence gathered through recent studies in Bangladesh demonstrates that there are clear differences between men and women with regard to climate change adaptation. This also applies to the assistances received from government and NGOs for climate change adaptation for building resilience (Aryal et al., 2020).

The Sixth Assessment Report of Intergovernmental Panel on Climate Change (IPCC, 2021a) identified that the role of human influence in climate change is unequivocal. In terms of decision-making, the level of user engagement and co-production between scientists, practitioners and intended users are key determinants of the type of climate strategies and their usefulness in supporting adaptation, mitigation and risk management decisions (IPCC, 2021b). It is important therefore to adopt strategies that can help reduce the anthropogenic threats and ensure sustainability in the long-term. Previously, IPCC also identified climate impacts as the key cause of environmental vulnerability, while adaptation strategies were key measures to reduce vulnerability within the prevailing systems (Jerneck, 2018). In the context of climate change, sustainable, equitable, and effective adaptation action plans are important. This is because the climate change hotspots are often identified by climatic shifts which results the change in social structures, culture and livelihood sensitivity which exacerbate vulnerability (de Sherbinin, 2014; De Souza et al., 2015; Rao et al., 2019). However, very few studies have explored the underlying social drivers of vulnerability. Therefore, there is a need to understand climate change adaptation as transformative climate action.

Gender equality and adaptation should learn how development in theory and practice has addressed gender,

women, and the environment (Change, 2011; Pelling and Manuel-Navarrete, 2011; Rao et al., 2019). Gender is a deeply ingrained contextual condition that shapes vulnerability by intersecting with other conditions and socioeconomic drivers. Gender-based climate change vulnerability is the result of a complex web of interconnected factors (such as social and gender, political, economic, and geographic location). Manifestations of vulnerability to climate change vary in different groups of people, based on their positions in a social and gender structure in a particular location and at a particular time. However, while there is a growing body of research into the impacts of climate change on society that particularly recognizes the differential and unequal impacts of climate change on women and men, “the picture is far from complete” (Goodrich et al., 2019). Several studies on climate change adaptation explore the natural systems perspective, but the ways in which gender and cultural issues are impacted by climate change remain un-investigated (Abdulkadir, 2017; Jerneck, 2018). For example, a study on the gendered patterns of rural livelihoods in Vietnam found that unequal opportunities for females reduced their capacity to adapt to climate change (Ylipaa et al., 2019). However, their national strategies for climate change only address technical solutions to adaptation, with little concern for existing gender inequalities. Consequently, these mechanisms fail to provide long-term solutions to these problems (Ylipaa et al., 2019). Therefore, this paper examines how gender and cultural issues have been addressed in the process of climate change adaptation in the southwest coastal region of Bangladesh. Addressing this issue is essential because it will assist the MOEFCC and NGOs to plan and implement effective initiatives to enhance the climate adaptive capacity of the coastal people from the perspectives of gendered roles and cultural sustainability.

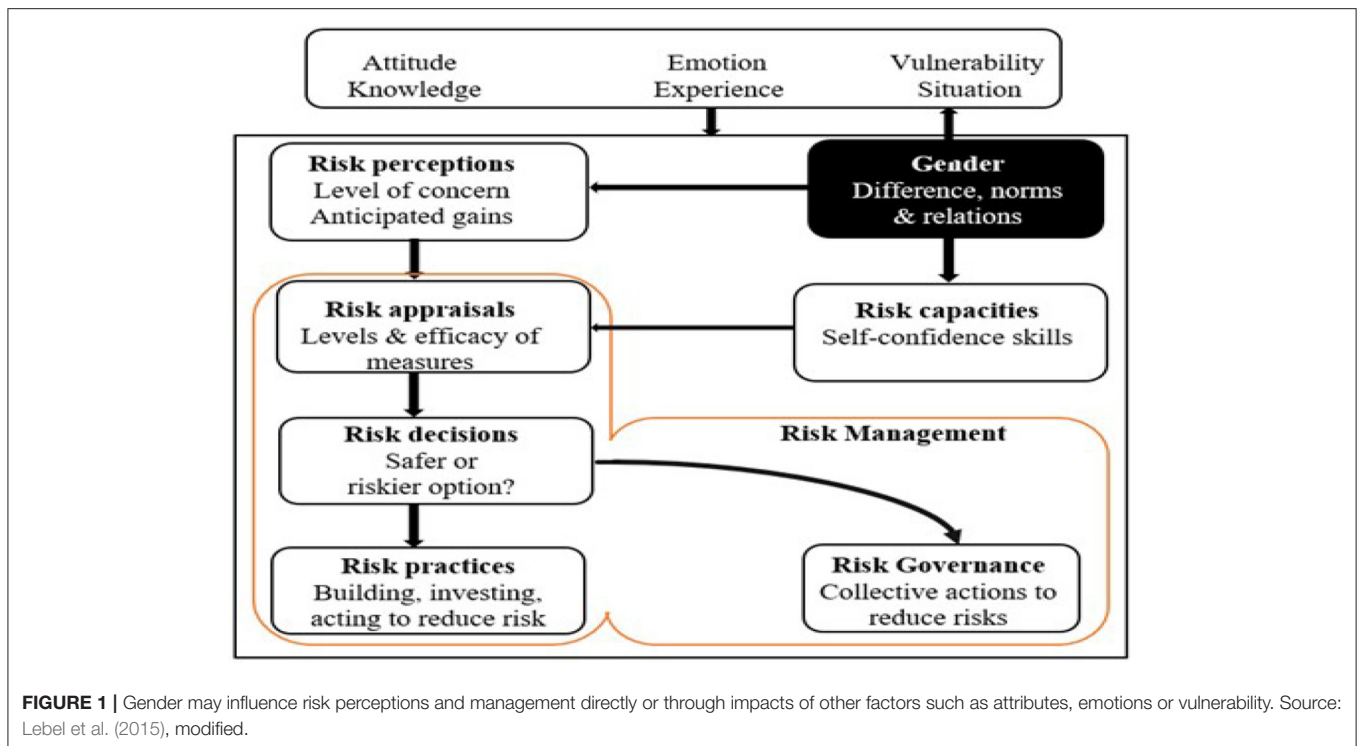
This paper outlines the core concepts in adaptation and explains the rationale for gender-sensitive research on climate change and cultural sustainability. More specifically, this discussion comprises three main phenomena. Firstly, it explains how vulnerability occurs due to different climatic events and local adaptation strategies of the coastal people. Secondly, it assesses the gender role and cultural sustainability in the climate change adaptation process. It also summarizes the role of government and NGOs in climate change adaptation. The adaptation knowledge of coastal people passed down through the generations but are unaware of the magnitude of associated impacts (Makondo and Thomas, 2018). In this regard, the paper finally concludes with insights gained from the research on adaptive strategies of coastal people on climate change, gendered relations and their efforts to create a sustainable environment.

## METHODS OF REVIEW AND CASE STUDIES

The methods used in this paper are review and case study, particularly associated to the works initiated by two NGOs of the country-LEDARS (Local Environment Development and Agricultural Research Society) and Care Bangladesh in Shyamnagar sub-district. The initiatives of these organizations

have helped coastal communities of Bangladesh in creating and improving their climate change adaptation actions and strategies for achieving improved livelihood outcomes. These organizations help people to learn as well as enhance their understandings about effective measures to deal with climate change effects. They are one of the key stakeholders and play important role in alleviating poverty of the coastal communities. As of now, the key activities of these organizations are disaster preparedness, food processing, fishing, forestry and so on (Roy et al., 2017). Mainly, LEDARS has focused on enhancing the capacity of communities to adapt to agriculture related undertakings. This organization has helped farmers by teaching them the ways to use improved techniques and high yield seeds and crops for increasing the amount of harvest even in the waterlogged areas of coastal regions (Ahsan, 2013; Kuddus et al., 2021). Likewise, CARE Bangladesh has provided farm and off-farm based skills to marginal people of the country's coastal areas. For example, the learning of technical skills such as electric and tile works and tailoring by this organization are considered expedient (Ahamed, 2013). The relevance of drawing the implications of these two NGOs in this study is because they focus on the issue of gender sensitivity while offering skill-based training to the people of coastal communities. Scholars including Ahamed (2013), Alam and Rahman (2014) and Rakib et al. (2017) argue that the empowerment of women and enhancement of their capacities in skill-based training has reduced a gender gap in terms of adaptation capacity of the people of coastal communities in southwest coast of Bangladesh.

The study of gender roles and their differences from a historical perspective has shown that history can explain part of the persistence of variations in gender norms despite economic development and increase in women's education. The historical traits studied are useful sources of exogenous variant. The fact that gender norms show remarkable persistence does not mean that they never change (Giuliano, 2020). Applying the models of social learning, the literature has started to study cultural change at the intergenerational scale (Fogli and Veldkamp, 2011; Fernandez, 2013; Giuliano and Nunn, 2021). Giuliano and Nunn (2021) in their study predicted that the stability of the external environment is a key determinant of cultural persistence. The understanding is that in the stable environment, all cultural values and beliefs (including beliefs about the role of women) tend to prevail as they comprise information helpful to the current generation. Conversely, if the environment changes drastically from one generation to another, it makes the previous generation's cultural beliefs less likely to be useful to the current generation. Simple and low-cost interventions can increase the percentage of women majoring in a male-dominated fields, which seems to indicate that women's preferences might not be contrary to those of men (Porter and Serra, 2020). Galor et al. (2020) have shown that languages that emphasize gender differences correlate with gender biases; the current emphasis on introducing neutral forms could help fight such biases. Most research illustrate that differences in cultural norms regarding gender roles tend to persist but evolve very slowly. As the culture has little room for policy intervention, the authors argue that if differences in male and female labor market participation originate inside the family,



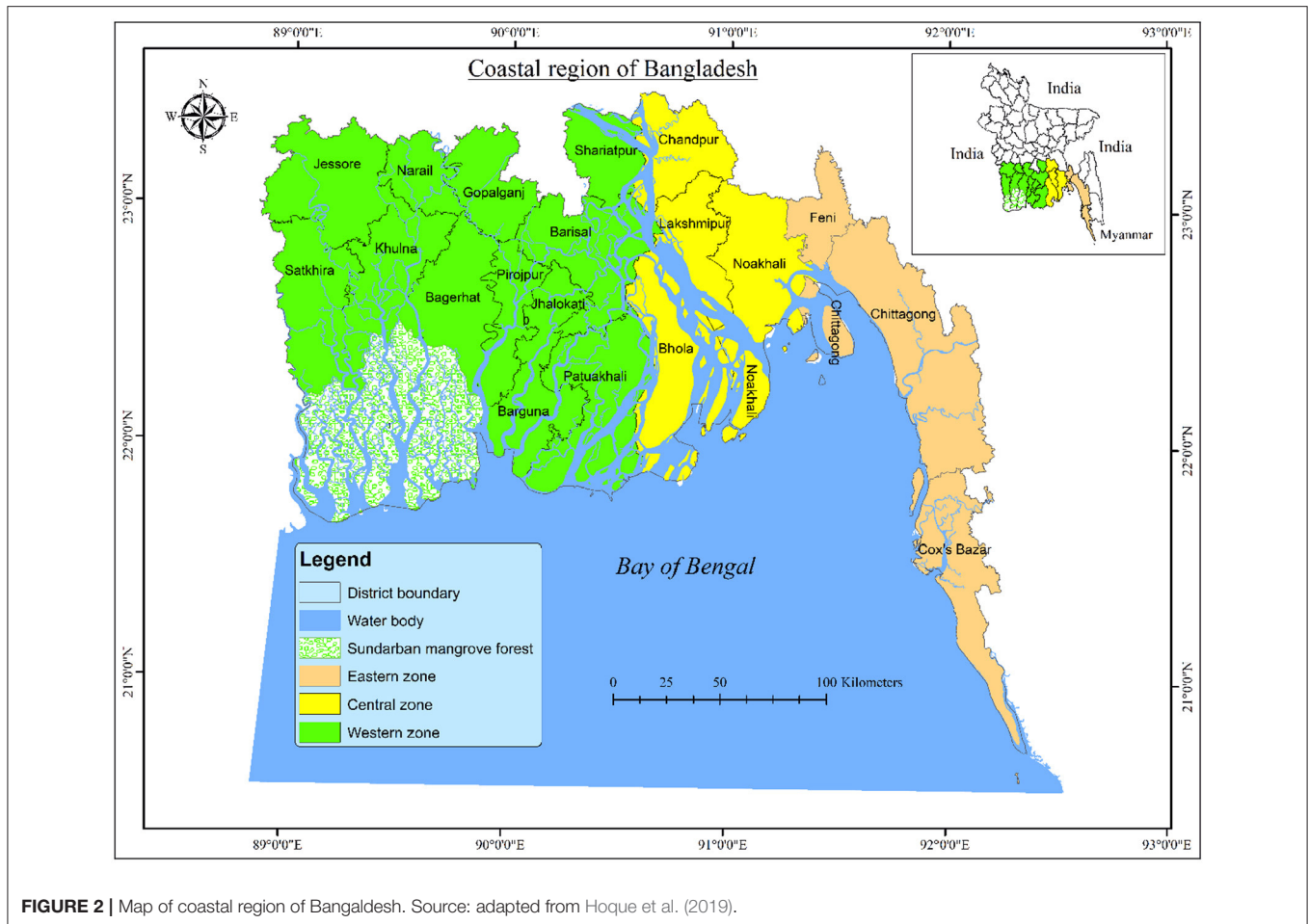
providing women a better outside option would increase their implicit bargaining power.

Traditional positive adaptation strategies with respect to issues, such as values, ethics, risk, knowledge and culture, construct societal limits to adaptation to seasonal climate variability (Makondo and Thomas, 2018). It is anticipated that adaptation and mitigation efforts in addressing climate change are crucial. Such efforts and actions may be self-perpetuating and therefore be addressed. Recognizing this concern, this paper attempts to highlight some of the coping strategies used by the populations in coastal areas of Bangladesh that impact gender and culture, amidst the adversity of environmental stresses due to climate change. There are few studies that explore lived values and fairness together in the context of climate adaptation, while social researchers argue that local values need to be incorporated into climate adaptation to achieve fairer processes and outcomes. Lived values which include the social values, tradition, culture, heritage and social status are helpful in understanding vulnerability to climate change and providing a social metric for evaluating the relative fairness of local adaptation options (Graham et al., 2018).

While this paper draws on the framework of Lebel et al. (2015), it also draws insights from Kuruppu (2009), Mortreux and Barnett (2009), Karlsson and Hovelsrud (2015), Graham et al. (2018), and Neef et al. (2018). **Figure 1** presented above showcases how gender differentiated roles can influence the risk perception and management of climatic risks directly, or can be addressed through multiple factors including attributes, emotions or vulnerability. It outlines how understanding gender differences and norms can help gauge the level of risk concerned

and analyse vulnerability, emotional experience and traditional knowledge of communities. It also helps us estimate the capacities of individuals or communities to withstand climatic risks. Adopting a comprehensive and inclusive approach, it will help make safer risk decisions through collective actions and strategic governance mechanisms. Ultimately, it will help build good practices, investigate actions, and update interventions to reduce the risk over time.

One of the reasons to alter cultural identity of a certain community is change in livelihoods of the people of that community (Schmidt and Pearson, 2016). A supportive community can be effectively engaged in community-based adaptation efforts (Mikulewicz, 2017). Engaging with community organizations may be an effective means of accommodating the views of socially networked circumstantial sea changers, regional retirees, and the community minded business owners (Graham et al., 2018). The review commences with the sociodemographic, geographic, and weather-related features of the study region followed by discussions of how the adaptive capacities of people of both genders (male and female) to climate change have been enhanced through cultural sustainability. The content of this review paper has been divided into three segments. Firstly, it provides the background of the study region by exploring and identifying the of climate change through different variables of weather. Secondly, it discusses the strategies adopted by people at local levels to cope with or adapt to climate change perturbations. Thirdly, an account of the gendered role in adapting to climate change is emphasized in reference to the implications of cultural sustainability that also necessitates economic, environmental and social sustainability. Regarding the contributions of various



**FIGURE 2** | Map of coastal region of Bangladesh. Source: adapted from Hoque et al. (2019).

sectors in enhancing the adaptive capacity of the people of the coastal region of southwest Bangladesh, the role of NGOs and government are discussed.

## BANGLADESH AS A CASE STUDY: REFLECTION FROM LITERATURE

Bangladesh is known as largest deltaic regions in the world. As a low-lying delta, it is widely recognized as highly vulnerable to the impacts of climate change, particularly sea-level rise and changes in runoff (World Bank, 2015). This section will illustrate some of the incidences of climatic impacts on the coastal regions of Bangladesh, including salinity intrusion, cyclones, sea level rise, water logging and their related impacts on the socio-economic aspects of the coastal communities. About 609 islands have been identified within the coastal zone of Bangladesh (Islam, 2004), with approximately, 36 million people live in the coastal region (Ahsan, 2013; Ahmad, 2019). This coastal area is made up of 19 districts and 147 sub-districts (*Upazilas*). (Hoque et al., 2019 see **Figure 2**) Along with the growth of population in the country, the extent of the extraction of limited natural resources is also increasing in the region (Islam et al., 2020). Global climate change has caused adverse impacts on the coastal zone, resulting in

salinity intrusion and sea level rise, and making the coastal areas of Bangladesh more vulnerable (Minar et al., 2013; Uddin et al., 2019).

## Vulnerability Posed by Climate Change

Extreme climatic events have negative impacts on lives and livelihoods, creating the food insecurity. The key consequences of climate change in the coastal region of Bangladesh are water logging, salinity intrusion, sea level rise, cyclones, and tidal bore. In terms of the number of people affected by sea level rise, Bangladesh is the seventh most vulnerable country in the world. Referring to an assessment of the World Bank (2021), Minar et al. (2013) estimate that the sea level rise in Bangladesh would reach one meter by 2070, resulting in 18% submersion of its terrestrial lands as well as permanent relocation of 13 million people.

## Salinity Intrusion

Climate change-induced problems of salinity are prevalent both on land and water throughout the coastal region of Bangladesh. This in turn threatens agricultural productivity, conservation of coastal biodiversity and human health. It is apparent from the study of the Government of Bangladesh and UNDP (2009) that agriculture is the main livelihood option for the people of coastal

Bangladesh (Sarker et al., 2012; Faisal et al., 2021). Poor and marginalized people depend heavily on natural resources (for example, agriculture, fisheries) for their livelihoods (Helgeson et al., 2013). Salinity intrusion reduces agricultural productivity and makes livelihoods vulnerable (Alam et al., 2017; Rahim et al., 2018). In the coastal region of Bangladesh, about 0.4 million people depend for their livelihoods on agriculture, including rice production and shrimp collection (Paul and Vogl, 2011; Uddin and Nasrin, 2013). These two main sources of livelihoods are significantly threatened by the problem of salinity intrusion (Alam et al., 2017).

The report of the Soil Resource Development Institute (SRDI, 2010) shows that more than one million hectares of arable lands in Bangladesh have been affected by saltiness intrusion, caused by moderate and rapidly increasing extreme events. It also notes that up to 71% of the developed zones in Shyamnagar *upazila* are affected by high level salinity (above 12 ds/m). The total size of salinity-affected land in Bangladesh was 83.3 million hectares in 1973, increasing to 102 million hectares in 2000, rising to 105.6 million hectares in 2009, and continuing to increase. In the last 35 years, salinity has increased around 26 percent in Bangladesh, spreading into non-coastal areas as well (Haider, 2019). As indicated by the Bangladesh Bureau of Statistics (BBS) survey, the net cultivated area of Satkhira district was reduced by about 7% from 1996 to 2008 (Khanom, 2016). It was discovered that after cyclone Aila, total rice production in Satkhira had dropped from 0.53 million tons in 2008 to 0.46 million tons in 2009 (BBS, 2011). Again, the report indicates that production of the main rice crop (Aman) in Satkhira dropped to an even greater extent, from about 0.4 million tons in 2008 to 0.2 million tons in the year 2010. These statistics demonstrate the adverse impacts of salinity intrusion on Bangladesh's agriculture. Moreover, the problem of salinity has reduced the economic capability of the coastal people because agriculture is the main source of their livelihoods (Alam et al., 2017).

The sources of drinking water for the coastal communities of Bangladesh are highly precarious due to frequent salination. A recent study in Satkhira district revealed that 34.3% of the people drinking water with salinity concentrations of <1,000 mg/l salinity had high blood pressure, compared to 42.6% of people drinking water with salinity concentrations of 2,000 mg/l (Nahian et al., 2018). Extra sodium remaining in the saline water is also harmful for pregnant women (Khan et al., 2011). Saline water is harmful for humans and biodiversity. Therefore, it is important to reduce environmental pollution to decelerate the impacts of climate change.

## Cyclones

This section analyses several consequences of cyclones caused in Bangladesh since 1970. Its coastal regions have experienced cyclones of varied magnitude, with long-lasting impacts on communities' livelihoods, shelter and sanitation. Cyclone Sidr and Cyclone Aila are two key examples of coastal cyclone. Category-4 Cyclone Sidr hit Bangladesh on 15th November 2007. This caused the death of 3,406 people and a huge loss of public and private property, totalling nearly 1.7 billion US dollars, as indicated by the Government of Bangladesh (Rahman,

2019). Although the Sundarbans is considered the world's largest continuous mangrove forest and the protector from various coastal disasters in Bangladesh (Islam et al., 2013), it was significantly damaged by the tidal surge of Sidr. The Sundarbans cover about 6,000 square kilometers of the country, deemed a World Heritage Site (WHS) in 1997 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), and greatly enriches the biodiversity of Bangladesh. The eastern part of Bangladesh was severely affected by the tidal surge of Cyclone Sidr, threatening the biodiversity of this region. Cyclone Aila followed, hitting Bangladesh on 26 May 2009, causing 339 human casualties and financial losses of 295.6 million US dollars. Along with deaths and injuries, serious health problems such as diarrhea, skin diseases and eye infections occurred during this period, including a deadly national outbreak of diarrhea (Mallick et al., 2011).

Cyclones are devastating for Bangladesh, and they significantly increase the economical vulnerability of the coastal people. People lost their households, crops, cattle and wage labor jobs on which they depended for their everyday activities. On 3 May 2021, another severe tropical cyclone named Foni hit the Odisha coast in Puri, India, causing large scale damage (Chauhan et al., 2021). After crossing West Bengal as a severe cyclone, it made landfall in Bangladesh as an ordinary category cyclone. Fani was one of the most powerful cyclones formed in the Bay of Bengal since 1999, close to cyclone Sidr in strength. Under the influence of this severe cyclonic storm, the low-lying areas of the coastal districts—Chittagong, Noakhali, Laxmipur, Feni, Chandpur, Borguna, Bhola, Patuakhali, Barisal, Pirozpur, Jhalokathi, Bagherhat, Khulna, and Satkhira—along with their offshore islands and chars—were inundated by a storm surge 4–5 feet high (Bilkis, 2019). Around 50 people were reported dead in both countries. Despite the preparation and evacuation efforts, severe damages to houses, farmland and critical infrastructure were reported (MetMatters, 2021).

Cyclone Bulbul, a reincarnation of Cyclone Mamto, made landfall over India on November 9, 2019, before entering Bangladesh on November 10, 2019. The cyclone hit thirteen southern districts of the country, bringing winds of up to 120 kilometers per hour (75 miles per hour) and gusts of up to 130 kilometers per hour (80 mph). The cyclone remained over Bangladesh for about 36 h, making it one of Bangladesh's longest-lasting cyclones in the last 52 years. Due to the heavy rains and tidal surges, the impacted coastal sea line was inundated by more than 3 m (19–20 feet) on average. Around 722,674 people were affected by the cyclone in the districts of Satkhira, Khulna, Bhola, Bagerhat, Patuakhali, Barguna, and Pirozpur. Cyclone Bulbul wreaked havoc on over 108,000 homes and 117,000 hectares of crops, as well as causing significant damage to several embankments (IFRC, 2020).

According to CARE (2020) on the 20th and 21st of May 2021, the "super cyclone" Amphan that passed through Bangladesh had worst effects. In total, 76 *upazilas* in 19 districts were impacted, with eight districts having a severe to moderate impact. A total of 26 people were killed, and 2.6 million people were affected. More than 200,000 homes were completely or partially destroyed, and more than 176,000 hectares of productive land were washed

away, including standing crops and fish/shrimp farms. Many people lost their only source of income, which will have far-reaching consequences for food security, sanitation, security, health, and education (CARE, 2020). The speed of climate change has put the coastal community of Bangladesh at a high risk of cyclones. Embankments and proper preparations for cyclones can reduce this vulnerability. In addition, initiatives such as public awareness are important for making the people of coastal regions mindful of the impacts of climate change, as well as possible measures for their mitigation.

## Sea Level Rise

Global sea-level rise is the most obvious manifestation of climate change in the ocean and will ultimately affect every coastal state and nation on the planet (Griggs, 2021). Climate change is not only altering weather patterns but also accelerating sea-level rise, leading to increased inundation and saline contamination (Chen and Mueller, 2018). Sea level rise along the coasts of Bangladesh is another basic variable that menaces worldwide climate change vulnerability. The meteorological department of the South Asian Association for Regional Cooperation (SAARC) undertook a project to observe this change. It completed an examination on relative sea level rise in the Bay of Bengal for a period of 22 years from 1977 to 1998. The SAARC's meteorological department measured sea level information and identified that the sea level was rising by 4.0, 6.0, and 7.8 mm/per year, respectively, at Hiron Point, Char Ganga and Cox's Bazar (Kay et al., 2015). The outcome of that project revealed that the extent of sea level rise along the coastline of Bangladesh was significantly higher than the rate of 1.0–2.0 mm/year worldwide in the 20th century. As laid out by Alam (1996), the Ganges-Brahmaputra delta is dying down at a rate of 2–4 mm/year. However, the relative sea level rise in the Bay of Bengal is impacted by some local factors, such as structural settings, dreg loads and deltaic subsistence.

Although there is no particular study about sea level ascent in the Bay of Bengal, these instances prove that the scenario is being changed and coastal people are now facing increasing challenges from adverse climatic conditions (Rahman and Rahman, 2015a; Esteban et al., 2017). As noted by the Bangladesh Department of Environment (DOE), sea level rise in the country may reach 30–100 cm by 2100, while the IPCC anticipates a worldwide sea level rise of 26–59 cm. A previous study by the DOE in 1993, anticipated a rise of 30–150 cm in sea level for Bangladesh by 2050 (Karim and Mimura, 2008). The report by IPCC (The Intergovernmental Panel on Climate Change) and the NAPA (National Adaptation Plan of Action) for Bangladesh on sea level rise studies estimated rises of 14, 32, and 88 cm for the years 2030, 2050, and 2100, respectively. It has been estimated that by 2050, one in every seven people in Bangladesh will be displaced by climate change (Khan, 2019). Up to 18 million people may have to move because of sea level rises alone (Islam et al., 2021). Karim and Mimura (2008) argued that if sea levels continue to rise, Bangladesh could lose its southern low-lying area, creating huge social, economic and cultural chaos and causing great sorrow and suffering to the coastal people economically, socially and environmentally. Therefore, it is necessary to control

unsystematic climate change to prevent the destruction that would follow rising sea levels.

## Water Logging

Water logging has influenced the coastal regions of Bangladesh with settlement immersion, salinity intrusion and loss of biodiversity. Moreover, the southwest coast is particularly vulnerable as it has already faced huge economic loss due to water logging and consequent lag in agriculture and fisheries sectors. This is because the extra saline in the soil and water is harmful for agricultural production as well as fisheries. Sarwar's study (Sarwar, 2005) reveals that education and health services providing institutions have also broken down due to water logging.

The government of Bangladesh has recommended the national and global analysts to focus on the research related to sea level rise and water logging in the country. The significance of estimating and observing the current as well as future effects of environmental change in Bangladesh are important not only to the government of Bangladesh but also to the non-governmental organizations and policy makers. Salinity intrusion and sea level rise have negative impacts on the economy and are also harmful for marine ecosystems. Shrimp farming and pond culture can be jeopardized by salinity intrusion, sea level rise and water logging (Hoque et al., 2013). This is because the saline water of the sea washes over agricultural lands and freshwater reservoirs during coastal cyclones. This has led to the heaviest loss in the economy of the coastal areas. There was a loss of 1.7 billion dollars from Cyclone Sidr (Islam et al., 2013). Climate change has severe wide-ranging impacts on the ecosystem of the coastal area. A 45 cm sea level rise will inundate 75% of the Sundarbans (Payo-Payo et al., 2016), destroying much flora and fauna (Agrawala et al., 2003). Sea level rise can also cause salinity intrusion in coastal regions. Agriculture, the salt industry and coastal ecosystems are all under threat due to climate change. Likewise, the IPCC estimates that 29,846 square kilometers of land will be lost, and 14.8 million people will become landless in Bangladesh if the level of sea rises to one meter (IPCC, 2001). Educational infrastructure will be damaged due to cyclones and sea level rise (Ripon and Al-Mamun, 2020). Floods, especially high intensity floods, often devastate physical infrastructure such as road networks, market places, homes and administrative buildings. Many students may be unable to go to school or college and as a result unable to support their families. Floods and the consequences of sea level rise lead to poverty augmentation. Even though climate change is global, its negative impacts are more severely felt by poor people and poor countries. They are more vulnerable because of their high dependence on natural resources and a limited capacity to cope with climate variability and extremes (Ripon and Al-Mamun, 2020). People will be deprived of clothing and other fundamental needs (Sarwar, 2005). Landless people may be compelled to migrate to other parts of the country (Davis et al., 2018). This will also create shortages of jobs leading people to become involved in illegal activities and immoral behaviors. Also, migration will lead to loss of housing, and food security (Davis et al., 2018). Overall, the community may be faced with chaos. Therefore, climate change may have severe

impact on the economy, environment, and society. For example, due to climate change, coastal regions of Bangladesh are losing their cultural sustainability. However, these problems can be minimized by controlling pollution, planting trees and protecting natural resources through combining traditional and scientific knowledge and practices of coastal ecosystems (Rahman and Rahman, 2015b).

From the literature surveyed, the multifarious challenges of climate change facing Bangladesh are clear. Temperature rises, erratic rainfall, sea level rises, water logging, cyclones and storm surges all have devastating impacts on their resilience building capability. One of the major components of climate change adaptation is the integration of all segments of people in the society, which often omit women's participation in the whole process. Therefore, the viability or sustainability of adaptation practices remains questionable. The following section will illustrate the role of gender dimensions on the risk perception, vulnerability analysis, safe decision making and effective governance of the adaptation practices.

## DISCUSSION OF THE FINDINGS

Although Bangladesh's South-west is rich in natural resources, global climate change has had a negative impact on the coastal zone, making it difficult for the community to adapt to the threat. According to Minar et al. (2013), by 2070, Bangladesh's sea level will have risen by one meter, submerging 18% of its terrestrial lands and forcing 13 million people to relocate permanently. Salinity intrusion, on the other hand, puts agricultural productivity, coastal biodiversity conservation, and human health at risk. Cyclones of varying magnitude have hit the country's coastal regions, wreaking havoc on people's livelihoods, shelter, and sanitation. Furthermore, as discussed in the earlier section, Bangladesh's coastal regions have been extremely affected by water logging resulting in settlement immersion, salinity intrusion, and the loss of biodiversity. The existing literature shows numerous effects and challenges of climate change in Bangladesh. Temperature rises including the events of erratic rainfall, sea level rise, water logging, cyclones, and storm surges all wreak havoc on people's ability to build resilience. One of the most important aspects of climate change adaptation is the inclusion of all segments of society, which frequently overlooks women's participation. As a result, the goal of achieving the long-term viability of adaptation strategies cannot be successful.

This paper identifies several strategies that the coastal communities in southwest coast of Bangladesh have been adopting to deal with climatic threats. As low-income level is one of the main causes of increased vulnerability among individuals and households of coastal people, they devise multiple adaptation strategies, including, vegetable production using Mud Towers, adopting saline-tolerant crops, producing vegetables on dams, cultivating saline-tolerant vegetable around the shrimp ponds, using domestic water for irrigation and vegetable production, installing Pond Sand Filters to have purity water, rainwater harvesting, forestation in the islands, have improved cookstoves usage (increasing women's participation). These all practices

represent viable opportunities to withstand the climatic impacts on the coastal region of Bangladesh. We analyse the role and traditional skills of women in the coastal region toward climate adaptation. Such as: their contribution in producing vegetables and earning extra income for the family, planting trees to reduce disaster impacts, cooking and fetching water for families during and after disaster, taking care of the family members, storing food for disasters and saving money and borrowing loans from NGOs etc. However, despite multiple roles of women, several challenges are being faced by them, including non-recognition of women's work in the man-dominated society, less control over family assets, limited access to labor market, male-ownership of the lands and livestock. Moreover, women have mobility restrictions, less scope for education, training or skills, which tend to limit their adaptive capacity to the climatic hazards.

This section discusses the sustainability conditions of the coastal people from the perspectives of cultural sustainability, economic sustainability, environmental sustainability and social sustainability. Various short-term plans addressed to climate risks lead to negative effects in the long-term. So, sustainability is one of the important aspects for this study. It illustrated that the cultural aspects of the coastal communities are central in identifying the risk perceptions, community resilience and feature toward enhancing their climate adaptability. The economic sustainability of the coastal community is fragile due to extreme poverty, higher dependence of natural resources for their livelihood, such as: agriculture vegetable production, fishing which are highly susceptible to natural disasters. Their environmental sustainability is also hampered due to several causes such as forest degradation, marine pollutions, and species extinction and biodiversity loss. The state of social sustainability is also critical as a wider community of in the coastal areas do not have access to education. There is a lack of proper sanitation and hygiene infrastructure, inadequate health and poor communication systems with remote areas that reduce livelihood opportunities. Even though the issues associated to women's social empowerment are drawing attentions day by day, deeply rooted cultural norms, believes, and social stigmas have prevented from making the full utilization of such potentials. All these are the bottlenecks of adaptive capacity of the coastal people.

It also discusses several actions of the Bangladesh Government in the policy and institutional level to adapt to climatic threats. Few programmes have been undertaken by the government to reduce climatic risks but there are limitations in terms of the implementation of policies at local level as well as reflection of local needs and a lack of integration of gender-based concerns in actions in these policies. Finally, it also highlights the role of NGOs to enhance people's resilience and adaptability to climate change in the coastal regions. It discusses about NGOs' role in teaching modern skill sets related to agriculture practices, crop varieties, skills training, providing financial assistance as well as contributing to protect environment and their cultural integrity. Hence, it is highly beneficial to engage local practices, cultures in designing effective adaptation strategies that should integrate local people,



and their social patterns to bring successful outcomes in the ground.

## Different Local Adaptation Strategies of the Coastal People

Our research shows that low income is a major contributor to increased vulnerability in the coastal areas of Bangladesh. Farmers and wage workers are the most at risk. They cannot manage their lives and household expenses with these uncertain income and low earning opportunities. Deb and Haque (2016) claim that wealthy people are less vulnerable to disasters. Their purchasing power allows them to save for emergencies and decent housing. Moreover, the use of saline-tolerant crops and fruits shallow deep tube wells, rainwater harvesting, and pond sand filters are other important local adaptation strategies (Kulshreshtha, 2019; Manusher Jonno Foundation, 2021).

### Vegetable Production Using Mud Towers

Many families in Bangladesh's coastal areas have small plots of land, where they grow vegetables (Hoque et al., 2013). Then, seeds are sown into a mud tower with organic fertilizer mixture. This method works well for Bangladesh's southwest coastal region. However, mud gets swept away during heavy rainfall. Hence, mud towers should be macadamized. This method protects vegetables from salinity and water logging. While this method is considered cost effective for small scale vegetable production, it is not so for large scale production due to the requirement of extra salinity free soil.

Water has become a scarce resource during the dry (Rabi) season for agricultural irrigation, domestic and other uses, threatening the overall agricultural development in Bangladesh. According to Hossain et al. (2021), increased water uses based cropping patterns, irrigation inefficiency, river course changes, excessive groundwater extraction, seasonal variability, shift in critical rainfall period, rainfall intensity scarcity have caused water scarcity. In the dry season, farmers in Bangladesh use shallow/deep tube wells to extract water for irrigation. But Bangladesh's coastal ground water is salty. In the dry season, rainwater is scarce in Bangladesh's coastal region. During the dry seasons, shallow and deep tube wells are used to irrigate rice and vegetables. They are popular and sustainable methods of crop cultivation in dry seasons, and should be installed according to Department of Public Health Engineering (DPHE) instructions. It will help to collect large amounts of water quickly and can be used for a long time after installation.

### Saline Tolerant Paddy

Rice is a staple food for the people especially in the coastal region of Bangladesh. In this region, where salinity intrusion is constantly increasing (Ripon and Al-Mamun, 2020), saline tolerant paddy such as BINA-8, BRRI Dhan 50, and BRRI Dhan 38 are the best options. It has helped to safeguard food security and financial stability of the people of coastal Bangladesh. These types of saline tolerant paddy are produced at a rate of 17, 24 pounds per bigha (a unit of land area ranging from 1/3 to 1 acre). It is highly valued, though less than field-grown homestead vegetables. Paddy production requires a lot of work

and data. Unlike the former (field-based vegetable agriculture), this practice requires money (Sarwar, 2005). Moreover, fertilizer and pesticides need to be applied on time, as informed by the technicians of Upazila agriculture office. Hence, saline-tolerant paddy seems to be a key element of food sufficiency or the long-lasting practice to reduce food insecurity in coastal Bangladesh.

### Vegetable Cultivation on Roadside Dams and the Banks of Shrimp Gher

Large dams protect Bangladesh's southwest coast from disasters (IPCC, 2001). Vegetables can be grown in the dam because it does not require irrigation. The dams are less salinized during the rainy seasons. Large-scale production of pumpkin, okra, cucumber, tomatoes can be grown in greater quantities. Vegetable cultivation can make use of non-arable lands. People without access to agricultural land can use these dams. Poor people can get their vitamins by collecting vegetables from these dams. Consequently, it come to be a very effective strategy for the poor and vulnerable people.

Salinity makes irrigation difficult in coastal areas (Hoque et al., 2013). Therefore, people try to grow crops by using the rainwater harvested during the rainy season. There are many shrimp-ghers (saline water fishing ponds) along the southwest coast of Bangladesh. This approach is financially advantageous as it lowers the production costs. Various types of vegetables can be grown around these gher, but saline-tolerant vegetables are more lucrative. However, this method can be adopted only during the rainy season. Although this approach is feasible for short-term and seasonal it allows farmers to produce more yields in their less lands, supporting them to maintain their food security in the long run.

### Reuse of Domestic Water

Lack of freshwater prevents coastal residents from growing vegetables indoors. They use freshwater to wash vegetables, bathe, and clean kitchenware (CARE, 2020). This water can be reused to irrigate vegetable gardens. The vegetables grown by households in their gardens can support them to fulfill at least their own consumptions. The process of reusing water is easy and cheap. Especially, reused water becomes important for households when they face scarcity of fresh water for irrigation. Additionally, it helps to reduce pollution, making it one of the best approaches to adapt to climate change at household level.

### Pond Sand Filters

Coastal dwellers face water shortages for irrigation and drinking (Chen and Mueller, 2018). Floods and other natural disasters have resulted in drinking water crisis. Pond Sand Filters (PSF) are a popular coastal water purification option. It purifies water with sand and is usually found near a pond. PSF works well because it is a low-cost innovation that effectively removes bacteria and turbidity. In heavily polluted surface waters, PSF may not be able to remove all microbes. The DPHE helps people to install PSF, which uses sand and pebbles to filter pond water. Water tanks must be cleaned periodically. A Pond Sand Filter Committee (PSFC) is also formed PSF requires BDT 100,000 for the set-up. Although it is considered a standard water supply method, some

users complain about the obligation of long lines as well as the wastage of time. Also, some criticize about the quality of water in the pond (Harun and Kabir, 2013).

### Rainwater Preservation

Rainwater harvesting is a viable solution to inadequate drinking water sources in coastal areas. Coastal groundwater is salty, and surface water is contaminated with bacteria, dust, and other pollutants. Hence, drinking water becomes scarce. As stated above, coastal dwellers in Bangladesh can collect rainwater during the rainy season and store it for drinking later. For this, households can use either plastic, concrete, or mud pot. A pipe can also be used to collect rainwater. This method is affordable and simple for all, regardless of financial situation.

### Fish Cultivation in Cages

Bangladesh's coastal belt is surrounded by numerous rivers and canals. Fish farming in cages can be a lucrative business for the poor and marginalized. This method does not necessitate the use of land. The materials used to construct the cage are bamboo and net. This strategy is quite effective because it simultaneously satisfies the need for protein and allows poor people who do not have access to a pond for fish cultivation.

### Making High Concrete Foundations for House

Many coastal homes in Bangladesh are at risk of natural disasters. Coastal homes should be built on high concrete foundations to avoid flooding and tidal surges. This strategy works because houses without foundations are more vulnerable to natural disasters. Concrete foundations are safer during floods and tidal surges. It reduces damage during cyclones (CARE, 2020). Houses built with concrete materials are more durable, safer, and comfortable.

### Forestation in the *Char*

Forestation can reduce tidal bore and cyclone risks in the islands (*chars*) and riverbank of coastal Bangladesh (Karim and Mimura, 2008). Coastal residents of Bangladesh can contact the Forest Department to plant mangroves along the riverbank. Permission from the Department of Forestry is required to plant trees along the riverbanks that will yield a fixed profit. Moreover, these forests provide income and firewood while reducing the risks of natural disaster events. Forestation is the only option for a clean and healthy environment (Sarker et al., 2003).

### Making Improved Stoves

The main driver of climate change is greenhouse gas emissions. Large amounts of black smoke cause the greenhouse effect. Industries, brickfields, vehicles, and the traditional Bangladeshi stove all emit black smoke that pollutes the air. Improved stoves can help cut CO<sub>2</sub> emissions (MetMatters, 2021). It can also save up to 40% on firewood. The improved stove emits less CO<sub>2</sub> than traditional forms of oven. It saves time, money, and the environment. In terms of cooking energy, the use of improved stoves can help to maintain the long-term climate change adaptation strategy particularly from the perspective of gender integration. Rural women, who are resource-dependent, play an important role in these adaptation activities. These

strategies help to close the gender gap to a large extent as more women participate.

Although effective, these strategies may not be equally useful or feasible for long-term in the context of all communities as the members or households of different communities may find diverse ways of adapting to climate change depending on their geographic, social, economic and cultural backgrounds.

## Gender Roles in Climate Change Adaptation

This section analyzes differential gendered roles performed by men and women in relation to climate change adaptation in the Southwest Bangladesh. Climate induced disasters are undeniable in Bangladesh's southwest coastal region. Climate change affects both men and women. But how they are affected by climate change varies. In Bangladesh, family decisions are usually made by the male members of the family and mostly work outside home. However, the role of women in the family cannot be underestimated. They fight for their family's survival and work with men to meet basic needs of the family. They use their traditional and long-practiced nature friendly knowledges from generation to generation to adapt to climate change. Such as: homestead vegetables are grown by women for their households and sell them for extra income. Men benefit from this extra income to meet family expenses, where women play a vital part. Men also sometimes help them in selling these vegetables in the market and make money. They plant papaya, lemon, and guava trees. Poor people cannot afford vitamin-rich fruits. Hence, women grow and harvest betel nuts and betel leaves. During and after disasters, livestock suffers from a lack of fodder. Women collect water hyacinth and cultivate Napier grass for livestock. Water hyacinth and Napier grass are collected by women. Water hyacinth is also an energy source. Women plant date palms and fan palms to reduce disaster risk. This tree's sap is a popular and expensive beverage. As, the coastal region of Bangladesh is surrounded by rivers and canals, many people collect fish. Men catch fish, and women process and dry them. Women plant trees, including fruit trees, to help reduce disaster risk. Their male members use or sell fishing nets. Women cook for the family during and after a disaster. They use filter or tube wells to fetch water (Alam and Rahman, 2014). Livestock and poultry raising, and selling are important sources of income for rural coastal women-run households. Women use indigenous knowledge, innovation, and adaptation to raise livestock. They know the types of fodder suitable for livestock (Islam and Shamsuddoha, 2017).

NGOs also provide skills training and provide them directions in food preparation and livestock and poultry disease prevention. Moreover, they also borrow money from NGOs, which is an additional economic income for the family and buy animal feed (Ahmed, 2017). While we focused on agriculture-based strategies, coastal women are increasingly interested in skill-based strategies. Women are found undertaking this type of work. Women's tailoring is a well-known industry. Women can wear a variety of designs, such as karchupi, block, and batik. Some women are also interested in working as tile

operators, even though it is a physically demanding job. Society has also aided and encouraged them to participate in such endeavors. After finishing their household chores, women also work outside (Ahmed, 2017). In conclusion, women in Bangladesh's coastal areas work harder than men to support their families.

Similarly, women gendered roles can have a direct effect on risk perception and management of climate change, or they can be addressed indirectly through multiple factors such as attributes, emotions, or vulnerability (Rakib et al., 2017). Such as: women prepare for disasters ahead of time, lowering the family's risk. They make mud stoves and store dry firewood for emergencies. Dry foods can help people survive when food is scarce. Women stockpile chira, muri, khoi, biscuits, molasses, and other foods for emergencies. Women save money for their families' needs. They make chhika, a jute bag hung from a high point to keep food fresh. Women wrap the tube in plastic to keep from saline contamination. They bury valuables like jewelry and documents in the soil by digging a hole (Alam and Rahman, 2014). Women look after their children, parents, and disabled family members. For disabled or sick family members living in flood-prone areas, women create an elevated bed from chouki (wood and rope) (Rakib et al., 2017).

Despite these efforts by women in the face of disaster, their adaptive capacity is lower than men for a variety of reasons. Women have less control over their family's assets. Land, livestock, and poultry are mostly owned by men in most families. Women have limited access to the labor market. Men control physical assets such as equipment and machinery, limiting women's mobility, education, and training (Ahmad, 2012). These are some of the factors affecting women's adaptive capacity. Because both men and women are members of a society, women's lower adaptive capacity leads to societal imbalance and cultural sustainability.

## Sustainability of the Coastal People of Bangladesh

### Interpretation of Social and Cultural Sustainability in the Region

Cultural sustainability relates to the notion of sustainable development. Cultural sustainability was first introduced by the World Commission on Culture and Development (WCCD) in 1995. Cultural sustainability refers to inter- and intra-generational access to cultural resources (WCCD, 1996). The growing influence of cultural sustainability is outlined as a fourth pillar, equal to social, economic, and environmental concerns within sustainable development agendas (Hawkes, 2001; Loach et al., 2017; Pop et al., 2019; Sabatini, 2019). Soini and Birkeland (2014) argue that the concepts of culture, development, and sustainability are interconnected. According to United Cities and Local Governments (UCLG), culture is linked to all 17 SDGs. Habitat of people, their values such as the location, religions, traditions, along with the historical remains determine their social and cultural structure (Fairclough and Rippon, 2002; Antrop, 2003; Palang and Fry, 2003; Claval, 2004; Axelsson et al., 2013; UNESCO, 2021). Cultural components

of sustainability include creativity, literacy, critical knowledge, trust, empathy respect, recognition, sense of place, risk (Axelsson et al., 2013). However, these social and cultural dimensions are not easy to define or measure, and their inclusion in planning is not well developed (Colantonio, 2007; Magis and Shinn, 2009). Cultural sustainability is an important attribute to the community's adaptation strategies as it builds the fundamental supportive ground for the people to work together, belief toward same goal and enhance social asset to build their adaptability. Hence, cultural sustainability is a key aspect of the coastal community of Bangladesh to develop effective climate change adaptation strategies (Kopfmüller, 2019).

Social sustainability was introduced in the Brundtland report originally, as a Social Development concept (WCED, 1987). It prioritized on issues like health and decrease the income gap between rich and poor in order to reduce global poverty. The concept of social sustainability continues to develop with recent new concepts like human wellbeing, safety and a healthy environment, access to education, participation, social justice, solidarity and security, happiness and quality of life (Thin, 2002; Colantonio, 2007). Cultural values can be described as social capital. The social networks and norms enable the collective action, emphasizing the importance of social capital for the creation of a vibrant democratic system (Putnam, 2000). The dimension of social capital can be illustrated by mapping the cultural policy environment with respect to the presence of cultural institutions, level of participation in cultural life. Hence, social capital is a cultural property of a human community.

Accordingly, coastal communities' economic, ecological, and social sustainability, along with the mal-adaptation practices hampering the community are described here. The study has identified cultural and social sustainability is dependent on various variables, discussed below:

**Education:** Education is a valuable human resource (Ahsan, 2013). According to Bangladesh Bureau of Statistics (BBS), adult literacy is above average, and primary school enrolment is below average (BBS, 2011). According to a DPE survey, Shaymgar upazila in Khulna had 6,999 preschool aged children, 6,778 of whom were enrolled in pre-primary school, and 252 were not. Thirty-seven thousand seven hundred fifty-one children aged 6–10 attended primary schools, 37,404 of whom were enrolled. Three hundred forty-seven kids were out of school (Upazila Profile of Shyamgar Upazila, 2014). In some communities, illiteracy is rampant. Most of the children in Chautaldandi Union of Cox's Bazar sadar Upazila collect fish. They sell fish to support their families (Miyaji et al., 2020). Their families are unwilling to educate them, but an educated society can inspire people to create a more sustainable society. To improve coastal literacy rates and social sustainability, coastal communities must be made aware of the importance of education. Otherwise, the primary school dropout rate will hinder social sustainability which may lead to mal adaptation in the long run.

**Sanitation:** Coastal households should use water sealed latrines or septic tanks. However, only 11% of households have

a water-sealed latrine. Only a small percentage of water sealed latrines are found in Bhola, Barguna and Jhalkathi (Ahsan, 2013). During a disaster, the water-sealed latrines are damaged (Khoda Bux, 1995). In such situations, people use raw “Kacha” latrines with bamboo walls (Mallick et al., 2011). These cause various health issues.

**Communication:** The coastal zone has a higher density of roads. It is 0.71 km/km<sup>2</sup> compared to 0.67 km/km<sup>2</sup> elsewhere in the country. There are many difficult routes to Bangladesh's coastal areas. Padda Pukur, Gabura, and Kaikhali Unions of Shymnagar Upazila are difficult to reach. Motorcycles and vans are the main modes of transport. During the rainy season, muddy and slippery roads force people to walk long distances. Also, the “char” communication system is terrible. People struggle to get to schools and hospitals due to poor communication systems. Lack of communication and transportation is one of the main obstacles to social sustainability.

**Livelihood Security:** Coastal Bangladeshi people rely on natural resources like fish, crab, wood, honey, and wax from the Sundarbans for their livelihood. Many people survive solely on these resources (Sarker et al., 2003). People mostly engage in farming and fishing (Ahsan, 2013). Small farming employs 26.1 percent of the population. 7.8% of major livelihood groups are fishermen (BBS, 2011). Resources are vital in agriculture and fishing, for example. Aside from poor health and education, the coastal region has the lowest livestock in the country (Ahsan, 2013). Natural disasters are common in this area (Khan et al., 2014). As a result of this maladaptation practice, the issue of livelihood security for Bangladesh's coastal population is more urgent than elsewhere. Given the foregoing, it is reasonable to conclude that coastal areas have lower social sustainability. Proper planning, adherence to an adaptation strategy, and long-term infrastructure, among other things, can help increase the area's cultural sustainability, the government's assistance as well as climate change preparedness are required.

### Economic Sustainability

The coastal region of Bangladesh has 7 million population (Ahsan, 2013). It is a home to many different livelihood groups. Most of these people engage in agriculture. Agriculture supports livelihood of two-thirds of the coastal households. The coastal region of Bangladesh is economically more fragile compared to other parts of Bangladesh (Abedin et al., 2020). The GDP per capita of this region is lower than the national average. Per capita GDP in a coastal area of Bangladesh was BDT 55,760 in 2012 (BBS, 2012). However, GDP in other parts of the country in the same year was BDT 58,530. However, compared to other coastal districts like Noakhali, Lakshmipur and Gopalganj, Khulna and Chittagong have higher levels. Coastal Bangladesh has a high degree of caloric poverty. The Southwest coastal zone of Bangladesh has a 52% absolute poverty rate, with 25% being extremely poor (Ahsan, 2013). Chandpur, Laxmipur, and Bagerhat are the poorest coastal areas. More than 30% live in poverty (Ahsan, 2013). Coastal Bangladeshis earn less than other Bangladeshis. They live in poverty as a result. Agricultural production is also difficult due to the region's

geological location. Natural disasters exacerbate the situation, as farmers lose crops, homes, jobs, livestock, and other assets. Although they try to overcome the first disaster, they are again hit by following disasters. Hence, the coastal people of Bangladesh have a poorer economic situation than the rest of the nation.

### Environmental Sustainability

The majority of South Asian coasts have a fragile ecosystem (Rasul et al., 2006; Subramanian, 2012). Despite the lack of treatment plants, Bangladesh's industries pollute many rivers and coastal waters. Domestic waste treatment facilities are lacking in Bangladesh's coastal towns (Rahman and Rahman, 2015). Moreover, Chittagong's port is a major international hub, connected to major shipping lanes. It can accommodate 1,000 ships and 40–50 oil tankers, while Mongla can accommodate 500. Many fishing trawlers also fish (Shamsuzzaman et al., 2017). These ships and trawlers pollute the environment by discharging oil and waste into the water. Shipbreaking operations in southern Bangladesh pollute the environment with heavy metals and waste (Hossain, 2001; Hossain et al., 2021). Furthermore, climate change and pollution have put the Sundarbans Forest in jeopardy (Islam and Bhuiyan, 2018). It burns 13,000 tons of coal per day and emits around 8 million tons of CO<sub>2</sub>. The Rampal power plant, which is located near this forest, uses 13,000 metric tons of coal per day and emits about 8 million tons of CO<sub>2</sub>. This power plant emits 0.75 million tons of fly ash and 0.2 million tons of bottom ash annually (Islam and Al-Amin, 2019). As a result, many animal and plant species are endangered. These pollutants harm not only the environment but also human health and coastal biodiversity (Islam and Bhuiyan, 2018). It is highly necessary to consider that Bangladesh will run out of oxygen if the Sundarbans Forest is damaged. Pollution deteriorates the environment and will ultimately reduce the coastal sustainability.

### Role of Government in Climate Change Adaptation

Bangladesh has been preparing for climate change adaptation since 2000, with policies and rules in place. Each ministry has a climate change cell to combat conventional climate change. The National Adaptation Program of Action (NAPA) was established in 2005 to address the immediate and urgent climate change adaptation activities (MOEF, 2005). The Government of Bangladesh (GOB) took several initiatives in 2009–2010. Some of them are as follow.

- (a) GOB allocated BDT 700 crores for climate change activities.
- (b) It revised Bangladesh Climate Change Strategy and Action Plan in 2008 (BCCSAP). It pledged to adapt to climate change.
- (c) It established Bangladesh Climate Change Trust Fund (BCCTF) in 2009. Around US\$ 100 million has been channelized through this fund since its establishment.

Other multilateral funds include Bangladesh Climate Change Trust Fund, Green Climate Fund (GCF), Adaptation Fund (AF), Least Developed Countries Fund (LDCF), Climate Investment

Fund (CIF), and Climate Change Fund (CCF). Besides, the multilateral funds, it has been receiving other funds and loans from various International Financial Institutions and bilateral development partners. A robust system of monitoring the accountability has been adopted by the government to ensure the transparency and appropriate utilization of such funds. Ahmed et al. (2015) report that about 300 climate change adaptation and mitigation projects were funded by the Bangladeshi government. Some of the climate change adaptation strategies adopted by the Bangladeshi government for the population along the country's coastal regions are listed below:

**Providing clean water and sanitation:** In 2006, the government launched a project to provide safe drinking water and 100% sanitation to coastal residents.

**Mitigation of extreme risk:** Cyclones are becoming more frequent due to climate change. Vulnerable people living along the coastlines are highly susceptible to them. To reduce vulnerability, the government has built or organized more cyclone centers.

**Char land afforestation:** From 2006 to 2009, the government reforested char land as planting trees reduces disaster risks.

**Improvement of livestock:** GOB launched the "Smallholder Livestock Development Project" (SLDP) to improve livestock rearing in the coastal area.

**Capacity-building training:** Training for human resource development was organized to reduce coastal poverty (Coastal Development Strategy, 2006). Vulnerability Group Development (VGD), Vulnerability Group Feeding (VGF), relief, and the Guchagram program for extreme poverty climate change adaptation have been adopted (Barua and Rahman, 2018).

Despite constant efforts to adapt to climate change, Bangladesh has some limitations. Central government offices are developing climate change adaptation plans, but not local government institutions like Upazilas and unions. Local leaders are aware of community needs, but their limited involvement in central decision-making has made effective resolution difficult. The central level of decision-making undervalues gender-based climate adaptation (Ahmad and Rahman, 2011). Local institutions can help community members. For Bangladesh's coastal areas, gender-based planning is required. Cultural sustainability can only be achieved through effective planning and implementation.

Local Government Engineering Department (LGED) Office of Shyamnagar Upazila is working toward mobilization of local human and physical resources of the region. In collaboration with Bangladesh University of Engineering and Technology, LGED is also working on salinity problem with its new idea "Vetiver grass". The root of the grass can spread up to 3–5 m which when planted on the side of the roads may strengthen the road structure. Another project, ECRRP (Emergency Cyclone Reconstruction and Rehabilitation Program) running since 2007 has built twenty-one cyclone shelters. Through "Kakra-Kuchia" Project, Fisheries department of the Upazila is working on enhancing the financial and physical capacity of the community. Agricultural office tried to increase physical resources by providing seeds and training. In 2017, the office of Public Health Engineering provided tube wells (450), PSF (600), rainwater harvesting system (around 200–300), MAR (nearly 10) to

enhance livelihood standards of the coastal communities of Bangladesh (Rahman, 2017).

## Role of NGOs in Climate Change Adaptation

Numerous NGOs operate in the coastal area of Bangladesh. NGOs generally work to alleviate coastal poverty by teaching locals how to cope with the effects of climate change, such as: disaster preparedness, food processing, fishing and forestry (Roy et al., 2017). NGOs in Bangladesh have introduced several adaptation strategies for coastal people, such as to water scarcity. Some of them are discussed below.

Sushilon, a local NGO, introduced Pond Sand Filters (PSF). Pond Sand Filters are installed by Caritas Bangladesh to help reduce water scarcity (Ahmed et al., 2015). Every year, waterlogging destroys many crops. A solution devised by local non-profits involves cultivating Baira (Ahmed et al., 2015). The Local Environment and Agriculture Research Society (LEDARS) works on agricultural adaptation in Bangladesh's southwest coast. Coastal salinity intrusion and water logging are common problems. Every year, these natural disasters destroy many crops. LEDARS developed several adaptation strategies to help farmers grow crops. These have helped reduce crop damage from climate change.

Crop yields are high in the coastal areas. PSFs help improve the health and livelihood of coastal residents. CARE Bangladesh. It trains marginalized coastal communities in farm and non-farm skills. They teach technical skills like electric, tile, and tailoring. It also addresses gender issues while providing skill-based training to coastal residents. CARE Bangladesh is now training many women in skill development (Ahmed, 2017). The gender gap is expected to abridge because of such training. Several NGOs, including the UNDP and Women in Development, are working to close the gender gap in coastal communities in southwest Bangladesh (Ahamed, 2013).

NGOs have been providing microfinance loans to Bangladeshis. Previously, people would take out high-interest loans. However, in the last three decades, people have tried to privatize family finances. By making debtors poorer, microfinance is seen as a major and modern way of private financing. Microfinance is a vital tool for development (Fenton et al., 2017). It can improve economic conditions and women's participation in family finances. Women can play a significant role in the economy and society when gender gaps are reduced in climate change adaptation. International and national NGOs work for environmental protection in Bangladesh (Hossain and Siddique, 2015). NGO's working for a greener Bangladesh includes Greenpeace, the International Institute for Environment and Development, Bangladesh Paribesh Andolon, Action Aid, and Ongikar Bangladesh Foundation. Despite Bangladesh's deteriorating environment, some NGOs are working to improve it.

NGOs are vital in Bangladesh's coastal region's economic, social, and environmental sectors (Ahsan et al., 2009). They also help Bangladesh's coastal culture survive. Hence, from this section, several adaptation strategies in the coastal regions and women's contribution in climate adaptation measures have been highlighted. Furthermore, the fragile condition of

environmental, economic, social and cultural sustainability has been highlighted, which need more attention in future to enhance climate resilience. Several government and NGO interventions have also been discussed. Nonetheless, there are several challenges that hinder the adaptive capacity of the coastal population to climate change. These need to be addressed properly for effective and sustainable climatic measures for the future.

## Summary and Conclusion

Bangladesh's coastal region is more vulnerable to climate change and frequent natural disasters due to its geological location. Natural disasters and climate change have made life more difficult for people and households in Bangladesh's coastal areas compared to people and households in other parts of the country. As depicted in the model presented by Lebel et al. (2015), the coastal communities also have their own inter-generational knowledge and skills, attitude and experience with vulnerable situations. They use those skills to perceive risks and understand the level of concerns to take effective measures. As the study identifies, these coastal residents have implemented some adaptation strategies to cope with the effects of climate change and natural disasters. Agriculture-based adaptation strategies are well-known in this area because most of the population is dependent on agriculture. Furthermore, the people have devised plans to deal with the effects of natural disasters, such as climate change, as well as the management of drinking water and additional income in times of need.

However, the vulnerability situation does have gender-differentiated implications due to different in gender norms, relations and cultures. It highly impacts the risk capacities of vulnerable and marginal communities to enhance their self confidence and adaptive power. It has been seen that even though women have a lower adaptive capacity than men, both men and women played an equal role in implementing adaptation strategies. Women use their indigenous knowledge and endurance to do their best effective risk decision and employ different practices to ensure the wellbeing of their families. Women's contributions to disaster preparedness are admirable. The coastal region of Bangladesh has a lower social and economic sustainability than the rest of the country because

it is more disaster prone and has some impassable areas. Environmental pollution is a major issue throughout the country. Many industries and sea ports have grown in the southwestern part of Bangladesh due to the presence of many rivers and the Bay of Bengal. The environment in this region has become more vulnerable due to these industries, ports, and over-harvesting of natural resources. As a result, reducing pollution in the environment can assist in resolving most of the climate change related issues.

As a result of these factors, cultural sustainability in coastal areas is lower than in other parts of the country. Bangladesh's government has taken several steps to mitigate the effects of climate change in the country, particularly in its coastal region. NGOs are also very active in Bangladesh's coastal region, which is prone to natural disasters due to climate change. These organizations have assisted people in developing their adaptive capacity by providing skill enhancement and capacity building training as well as offering microfinance loans. However, in order to develop effective climate change adaptation plans and risk management strategies, the GOB must work with local and non-governmental organizations in a collaborative manner. These strategies should also give priority to the local knowledge, believes, cultural attributes to gain a successful outcome in the ground.

This paper is a systemic review of the literature pulled out from relevant journal articles, books, government and non-government documents and other relevant sources. The strength lies in the context of covering social and environmental aspects of climate change adaptation initiatives. However, due to COVID-19 restrictions, the study was unable to collect primary information from the field, which would have provided further in-depth insights to the paper. Nonetheless, it widens the scope of further research and studies to understand the interlinkages among the spheres of gender, climate change adaptation and cultural sustainability.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

## REFERENCES

- Abdulkadir, A. (2017). "Climate change adaptation, mitigation, and the attainment of food security in the Sudano-Sahelian Belt of Nigeria," in *Handbook of Climate Change Mitigation and Adaptation* (New York, NY: Springer), 849–61.
- Abedin, M., Ray, B., Kibria, M. G., and Shaw, R. (2020). "Smart water solutions to address salinity, drinking water and health issues in coastal Bangladesh," in *Public Health and Disasters*, eds E. Chan and R. Shaw (Singapore: Springer), 129–43.
- Adger, W. N., Barnett, J., Brown, K., Marshall, N., and O'Brien, K. (2012). Cultural dimensions of climate change impacts and adaptation. *Nat. Clim. Chang.* 3, 112–117. doi: 10.1038/nclimate1666
- Agrawala, S., Ota, T., Ahmed, A. U., Smith, J., and Van Aalst, M. (2003). *Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans*. Paris: OECD, 1–49.
- Ahamed, M. (2013). Community based approach for reducing vulnerability to natural hazards (cyclone, storm surges) in coastal belt of Bangladesh. *Proc. Environ. Sci.* 17, 361–371. doi: 10.1016/j.proenv.2013.02.049
- Ahmad, H. (2019). Bangladesh coastal zone management status and future trends. *J. Coast. Zone Manage.* 22, 1–7. doi: 10.4172/2473-3350.1000466
- Ahmad, M., and Rahman, A. (2011). "The stimulating role of NGOs in Bangladesh," in *Climate of Coastal Cooperation*, ed R. Misdorp (The Netherlands: Coastal & Marine Union), 62–63.
- Ahmad, N. (2012). *Gender and Climate Change in Bangladesh: The Role of Institutions in Reducing Gender Gaps in Adaptation Program*. Washington, DC: World Bank.
- Ahmed, A. (2017). *An Assessment of Community-Based Adaptation Practices in the South-Western Region of Bangladesh, Final Report*. Available online at: [https://www.carebangladesh.org/upload/files/publication\\_1507809496\\_3.pdf](https://www.carebangladesh.org/upload/files/publication_1507809496_3.pdf) (accessed March 2, 2022).

- Ahmed, A. U., Haq, S., Nasreen, M., and Hassan, A. W. R. (2015). *Sectoral Inputs Towards the Formulation of Seventh Five Year Plan (2016-2021)-Climate Change and Disaster Management*. Dhaka: General Economics Division (GED), Planning Commission, Ministry of Planning.
- Ahsan, D., DelValls, T., and Blasco, J. (2009). The relationship of national and international environmental NGOs in Bangladesh and their role in wetland conservation. *Int. J. Environ. Res.* 3, 23–34. doi: 10.22059/IJER.2009.12
- Ahsan, R. (2013). *Climate migration and urban changes: a study of adaptation in Bangladesh (Ph.D. Thesis)*. University of South Australia, Adelaide, SA.
- Alam, K., and Rahman, M. H. (2014). Women in natural disasters: a case study from southern coastal region of Bangladesh. *Int. J. Dis. Risk Reduct.* 8, 68–82. doi: 10.1016/j.ijdr.2014.01.003
- Alam, M. (1996). "Subsidence of the Ganges-Brahmaputra Delta of Bangladesh and associated drainage, sedimentation and salinity problems," in *Sea-Level Rise and Coastal Subsidence*, eds J. D. Milliman and B. U. Haq (Springer, Dordrecht), 169–192.
- Alam, M. Z., Carpenter-Boggs, L., Mitra, S., Haque, M. M., Halsey, J., Rokonuzzaman, M., et al. (2017). Effect of salinity intrusion on food crops, livestock, and fish species at kalapara coastal belt in Bangladesh. *J. Food Qual.* 2017, 1–23. doi: 10.1155/2017/2045157
- Antrop, M. (2003). "The role of cultural values in modern landscapes," in *Landscape Interfaces*, eds H. Palang and G. Fry (Dordrecht: Springer), 91–108.
- Aryal, J. P., Sapkota, T. B., Rahut, D. B., Krupnik, T. J., Shahrin, S., Jat, M. L., et al. (2020). Major climate risks and adaptation strategies of smallholder farmers in coastal Bangladesh. *Environ. Manage.* 66, 105–120. doi: 10.1007/s00267-020-01291-8
- Axelsson, R., Angelstam, P., Degerman, E., Teitelbaum, S., Andersson, K., Elbakidze, M., et al. (2013). Social and cultural sustainability: criteria, indicators, verifier variables for measurement and maps for visualization to support planning. *Ambio* 42, 215–228. doi: 10.1007/s13280-012-0376-0
- Ayeb-Karlsson, S. (2020). When the disaster strikes: gendered (im)mobility in Bangladesh. *Clim. Risk Manage.* 29, 100237. doi: 10.1016/j.crm.2020.100237
- Barua, P., and Rahman, S. H. (2018). Community-based rehabilitation attempt for solution of climate displacement crisis in the coastal area of Bangladesh. *Int. J. Migr. Resid. Mobil.* 1, 358–378. doi: 10.1504/IJMRRM.2018.094811
- BBS (2011). *Statistical Yearbook of Bangladesh*. Dhaka: Bangladesh Bureau of Statistics Division, Ministry of Planning (MoP), Government of Bangladesh (GoB).
- BBS (2012). *Statistical Yearbook of Bangladesh*. Dhaka: Bangladesh Bureau of Statistics Division, Ministry of Planning (MoP), Government of Bangladesh (GoB).
- Berman, R. J., Quinn, C. H., and Paavola, J. (2015). Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: implications for adapting to future climate change. *Clim. Dev.* 7, 71–84. doi: 10.1080/17565529.2014.902355
- Bilkis, I. (2019). *Cyclone Fani weakens, to hit Bangladesh at Midnight*. Available online at: <https://www.dhakatribune.com/bangladesh/nation/2019/05/03/fani-to-hit-bangladesh-at-midnight-with-winds-of-up-to-100km-h> (accessed July 14, 2021).
- CARE (2020). *Bangladesh Cyclone Amphan Joint Needs Assessment - Bangladesh*. Available online at: <https://reliefweb.int/report/bangladesh/bangladesh-cyclone-amphan-joint-needs-assessment-31-may-2020> (accessed October 18, 2021).
- Change, G. E. (2011). Vulnerability before adaptation: toward transformative climate action. *Global Environ. Change* 21, 1160–1162. doi: 10.1016/j.gloenvcha.2011.07.008
- Chauhan, A., Singh, R. P., Dash, P., and Kumar, R. (2021). Impact of tropical cyclone "Fani" on land, ocean, atmospheric and meteorological parameters. *Mar. Pollut. Bull.* 162, 111844. doi: 10.1016/j.marpolbul.2020.111844
- Chen, J., and Mueller, V. (2018). Coastal climate change, soil salinity and human migration in Bangladesh. *Nat. Clim. Chang.* 8, 981–985. doi: 10.1038/s41558-018-0313-8
- Chowdhury, F. R., Ibrahim, Q. S. U., Bari, M. S., Alam, M. J., Dunachie, S. J., Rodriguez-Morales, A. J., et al. (2018). The association between temperature, rainfall and humidity with common climate-sensitive infectious diseases in Bangladesh. *PLoS ONE* 13, e0199579. doi: 10.1371/journal.pone.0199579
- Claval, P. (2004). "The languages of rural landscapes," in *European Rural Landscapes: Persistence and Change in a Globalising Environment* (Dordrecht: Springer), 11–39.
- Coastal Development Strategy (2006). *Water Resources Planning Organization*. Statistics Division, Ministry of Planning, the Government of Bangladesh. Available online at: <http://extwprlegs1.fao.org/docs/pdf/bgd175355.pdf> (accessed December 12, 2021).
- Colantonio, A. (2007). "Social sustainability: An exploratory analysis of its definition, assessment methods metrics and tools," in *EIBURS Working Paper Series*, Oxford.
- Davis, K. F., Bhattachan, A., D'Odorico, P., and Suweis, S. (2018). A universal model for predicting human migration under climate change: examining future sea level rise in Bangladesh. *Environ. Res. Lett.* 13, 064030. doi: 10.1088/1748-9326/aac4d4
- de Sherbinin, A. (2014). Climate change hotspots mapping: what have we learned? *Clim. Change* 123, 23–37. doi: 10.1007/s10584-013-0900-7
- De Souza, K., Kituyi, E., Harvey, B., Leone, M., Murali, K., and Ford, J. (2015). Vulnerability to climate change in three hot spots in Africa and Asia: key issues for policy-relevant adaptation and resilience-building research. *Regional Environ. Change* 15, 747–753. doi: 10.1007/s10113-015-0755-8
- Deb, A. K., and Haque, C. E. (2016). "Livelihood diversification as a climate change coping strategy adopted by small-scale fishers of Bangladesh," in *Climate Change Adaptation. Resilience and Hazards* (Cham: Springer), 345–368.
- Esteban, M., Takagi, H., Mikami, T., Aprilia, A., Fujii, D., Kurobe, S., et al. (2017). Awareness of coastal floods in impoverished subsiding coastal communities in Jakarta: Tsunamis, typhoon storm surges and dyke-induced tsunamis. *Int. J. Disaster Risk Reduct.* 23, 70–79.
- Everett, T., Ishwaran, M., Ansaloni, G. P., and Rubin, A. (2010). *Economic Growth and the Environment. Defra Evidence and Analysis Series. MPRA Paper No. 23585*. Available online at: <https://mpra.ub.uni-muenchen.de/23585/1/economic-growth-environment.pdf> (accessed August 09, 2021).
- Fairclough, G., and Rippon, S. (2002). "Europe's Cultural Landscape: archaeologists and the management of change," in *Europae Archaeologiae Consilium Paper 2*. Exeter: Short Run Press Ltd.
- Faisal, M., Saha, M. K., Sattar, M. A., Biswas, A. M. A. A., and Hossain, M. A. (2021). Evaluation of climate induced hazards risk for coastal Bangladesh: a participatory approach-based assessment. *Geom. Nat. Hazards Risk* 12, 2477–2499. doi: 10.1080/19475705.2021.1967203
- Fenton, A., Paavola, J., and Tallontire, A. (2017). The role of microfinance in household livelihood adaptation in Satkhira District. Southwest Bangladesh. *World Dev.* 92, 192–202. doi: 10.1016/j.worlddev.2016.12.004
- Fernandez, R. (2013). Cultural change as learning: the evolution of female labor force participation over a century. *Am. Econ. Rev.* 103, 472–500. doi: 10.1257/aer.103.1.472
- Fogli, A., and Veldkamp, L. (2011). Nature or nurture? Learning and the geography of female labor force participation. *Econometrica* 79, 1103–1138. doi: 10.3982/ECTA7767
- Galor, O., Özak, Ö., and Sarid, A. (2020). Linguistic traits and human capital formation. *AEA Papers Proc.* 110, 309–313. doi: 10.1257/pandp.20201069
- GED (2015). MDGs to Sustainable Development Transforming Our World: SDG Agenda for Global Action (2015– 2030). A Brief for Bangladesh Delegation, Unga 70th Session. General Economics Division. Available online at: <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication> (accessed November 17, 2021).
- Giuliano, P. (2020). Gender and culture. *Oxford Rev. Econ. Policy* 36, 944–961. doi: 10.1093/oxrep/graa044
- Giuliano, P., and Nunn, N. (2021). Understanding cultural persistence and change. *Rev. Econ. Stud.* 88, 1541–1581. doi: 10.1093/restud/rdaa074
- Goodrich, C. G., Udas, P. B., and Larrington-Spencer, H. (2019). Conceptualizing gendered vulnerability to climate change in the Hindu Kush Himalaya: contextual conditions and drivers of change. *Environ. Dev.* 31, 9–18. doi: 10.1016/j.envdev.2018.11.003
- Graham, S., Barnett, J., Mortreux, C., Hurlimann, A., and Fincher, R. (2018). Local values and fairness in climate change adaptation: insights from marginal rural Australian communities. *World Dev.* 108, 332–343. doi: 10.1016/j.worlddev.2017.12.008
- Griggs, G. (2021). "Rising seas in California - an update on sea-level rise science," in *World Scientific Encyclopedia of Climate Change: Case Studies of Climate*

- Risk, Action, And Opportunity, ed W. Dash (Singapore: World Scientific), 105–111.
- Haider, R. (2019). *Climate Change-Induced Salinity Affecting Soil Across Coastal Bangladesh – Bangladesh. A Report Produced by UNB United News of Bangladesh and IPS Inter Press Service*. Available online at: <https://reliefweb.int/report/bangladesh/climate-change-induced-salinity-affecting-soil-across-coastal-bangladesh> (accessed July 24, 2021).
- Harun, M. A., and Kabir, G. M. M. (2013). Evaluating pond sand filter as sustainable drinking water supplier in the Southwest coastal region of Bangladesh. *Appl. Water Sci.* 3, 161–166. doi: 10.1007/s13201-012-0069-7
- Harvey, C. A., Rakotobe, Z. L., Rao, N. S., Dave, R., Razafimahatratra, H., Rabarijohn, R. H., et al. (2014). Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Philos. Trans. R. Soc. B Biol. Sci.* 369, 20130089. doi: 10.1098/rstb.2013.0089
- Hasan, M. M., Sarker, M. A., Uddin, M. N., Rahman, M. Z., and Lei, B. (2018). Role of a coastal NGO in attaining climate resilience in Bangladesh. *Am. J. Clim. Change* 7, 187–203. doi: 10.4236/ajcc.2018.72013
- Hawkes, J. (2001). *The Fourth Pillar of Sustainability: Culture's Essential Role in Public Planning*. Melbourne: Common Ground.
- Helgeson, J. F., Dietz, S., and Hochrainer-Stigler, S. (2013). Vulnerability to weather disasters: the choice of coping strategies in rural Uganda. *Ecol. Soc.* 18, 2. doi: 10.5751/ES-05390-180202
- Hoque, M. A. A., Saika, U., Sarder, B. C., and Biswas, K. K. (2013). Environmental and socio-economic impacts of salinity intrusion in the coastal area: a case study on Munshigong Union, Shymnagar, Satkhira. *Jahangirnagar Univ. Environ. Bull.* 2, 41–49. doi: 10.3329/jueb.v2i0.16329
- Hoque, M. Z., Cui, S., Xu, L., Islam, I., Tang, J., and Ding, S. (2019). Assessing agricultural livelihood vulnerability to climate change in coastal Bangladesh. *Int. J. Environ. Res. Public Health* 16, 4552. doi: 10.3390/ijerph16224552
- Hossain, M. A., and Siddique, M. N. A. (2015). Water-A limiting resource for sustainable agriculture in Bangladesh. *EC Agric.* 1, 124–137.
- Hossain, M. N., Rahaman, A., Hasan, M., Uddin, M., Khatun, N., and Shamsuddin, S. M. (2021). Comparative seasonal assessment of pollution and health risks associated with heavy metals in water, sediment and Fish of Buriganga and Turag River in Dhaka City, Bangladesh. *SN Appl. Sci.* 3, 1–16.
- Hossain, M. S. (2001). Biological aspects of the coastal and marine environment of Bangladesh. *Ocean Coast. Manag.* 44, 261–282. doi: 10.1016/S0964-5691(01)00049-7
- IFRC (2020). *Final Report Bangladesh: Cyclone Bulbul*. Available at Bangladesh: Cyclone Bulbul Final Report - Operation DREF n° MDRBD023 - Bangladesh | ReliefWeb
- IPCC (2001). *Climate Change 2001: Mitigation, Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge University Press, UK.
- IPCC (2021a). “Climate change 2021: the physical science basis,” in *Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, eds V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, et al. Cambridge University Press, UK.
- IPCC (2021b). “Summary for policymakers,” in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, eds V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, et al. Cambridge University Press, UK.
- Islam, A., Shaw, R., and Mallick, F. (2013). “National adaptation programme of action,” in *Climate Change Adaptation Actions in Bangladesh* (Tokyo: Springer), 93–106.
- Islam, M., Tamanna, S., Amstel, A. V., Noman, M., Ali, M., Saadat, S., et al. (2021). “Climate change impact and comprehensive disaster management approach in Bangladesh: a review,” in *Bangladesh II: Climate Change Impacts, Mitigation and Adaptation in Developing Countries*, eds Md. N. Islam and A. van Amstel (Cham: Springer), 1–39.
- Islam, M. M., Pal, S., Hossain, M. M., Mozumder, M. M. H., and Schneider, P. (2020). Coastal ecosystem services, social equity, and blue growth: a case study from South-Eastern Bangladesh. *J. Mar. Sci. Eng.* 8, 815. doi: 10.3390/jmse8100815
- Islam, M. N., and Al-Amin, M. (2019). The rampal power plant, ecological disasters and environmental resistance in Bangladesh. *Int. J. Environ. Stud.* 76, 922–939. doi: 10.1080/00207233.2019.1662183
- Islam, M. N., and van Amstel, A. (2018). *Bangladesh I: Climate Change Impacts, Mitigation and Adaptation in Developing Countries*. Cham: Springer.
- Islam, M. R. (2004). *Where Land Meets the Sea: A Profile of the Coastal Zone of Bangladesh*. Bangladesh: University Press.
- Islam, M. R., and Shamsuddoha, M. (2017). Socioeconomic consequences of climate induced human displacement and migration in Bangladesh. *Int. Sociol.* 32, 277–298. doi: 10.1177/0268580917693173
- Islam, R., and Walkerden, G. (2015). How do links between households and NGOs promote disaster resilience and recovery: a case study of linking social networks on the Bangladeshi coast. *Nat. Hazards* 78, 1707–1727. doi: 10.1007/s11069-015-1797-4
- Islam, S. M., and Bhuiyan, M. A. H. (2018). Sundarbans mangrove forest of Bangladesh: causes of degradation and sustainable management options. *Environ. Sustain.* 1, 113–131. doi: 10.1007/s42398-018-0018-y
- Jakobsen, K. (2013). Livelihood asset maps: a multidimensional approach to measuring risk-management capacity and adaptation policy targeting—a case study in Bhutan. *Regional Environ. Change* 13, 219–233. doi: 10.1007/s10113-012-0320-7
- Jerneck, A. (2018). Taking gender seriously in climate change adaptation and sustainability science research: views from feminist debates and sub-Saharan small-scale agriculture. *Sustain. Sci.* 13, 403–416. doi: 10.1007/s11625-017-0464-y
- Kabir, R., Khan, H. T. A., Ball, E., and Caldwell, K. (2016). Climate change impact: the experience of the coastal areas of Bangladesh affected by Cyclones Sidr and Aila. *J. Environ. Public Health* 2016, 1–9. doi: 10.1155/2016/9654753
- Karim, M. F., and Mimura, N. (2008). Impacts of climate change and sea-level rise on cyclonic storm surge floods in Bangladesh. *Global Environ. Change* 18, 490–500. doi: 10.1016/j.gloenvcha.2008.05.002
- Karlsson, M., and Hovelsrud, G. K. (2015). Local collective action: adaptation to coastal erosion in Monkey River Village, Belize. *Global Environ. Change* 32, 96–107. doi: 10.1016/j.gloenvcha.2015.03.002
- Kay, S., Caesar, J., Wolf, J., Bricheno, L., Nicholls, R. J., Islam, A. S., et al. (2015). Modelling the increased frequency of extreme sea levels in the Ganges–Brahmaputra–Meghna delta due to sea level rise and other effects of climate change. *Environ. Sci. Processes Impacts* 17, 1311–1322. doi: 10.1039/C4EM00683F
- Khan, A. A. (2019). Social and legal barriers to improving human rights of climate change displaced people in Bangladesh. *J. Interrupted Stud.* 2, 103–117.
- Khan, A. E., Ireson, A., Kovats, S., Mojumder, S. K., Khusru, A., Rahman, A., et al. (2011). Drinking water salinity and maternal health in coastal Bangladesh: implications of climate change. *Environ. Health Perspect.* 119, 1328–1332. doi: 10.1289/ehp.1002804
- Khan, M. M. H., Bryceson, I., Kolivras, K. N., Faruque, F., Rahman, M. M., and Haque, U. (2014). Natural disasters and land-use/land-cover change in the southwest coastal areas of Bangladesh. *Regional Environ. Change* 15, 241–250. doi: 10.1007/s10113-014-0642-8
- Khanom, T. (2016). Effect of salinity on food security in the context of the interior coast of Bangladesh. *Ocean Coast. Manag.* 130, 205–212. doi: 10.1016/j.ocecoaman.2016.06.013
- Khoda Bux, M. (1995). *Drinking water supply and sanitation to suit post cyclone situation in the coastal region of Bangladesh* (Master's Thesis). Bangladesh University of Engineering and Technology, Dhaka.
- Kopfmüller, J. (2019). From the cultural dimension of sustainable development to the culture of sustainable development. *Sustain. Dev. Relat. Cult. Knowledge Ethics* 2011, 93–106. Available online at: <<http://books.openedition.org/ksp/4326>>
- Kuddus, M. A., Alam, M. J., Datta, G. C., Miah, M. A., Sarker, A. K., and Sunny, M. A. R. (2021). Climate resilience technology for year round vegetable production in northeastern Bangladesh. *Int. J. Agric. Res. Innov. Technol.* 11, 29–36.
- Kulshreshtha, S. N. (2019). *Agricultural Economics - Current Issues. IntechOpen*. London.
- Kuruppu, N. (2009). Adapting water resources to climate change in Kiribati: the importance of cultural values and meanings. *Environ. Sci. Policy* 12, 799–809. doi: 10.1016/j.envsci.2009.07.005
- Lebel, P., Whangchai, N., Chitmanat, C., and Lebel, L. (2015). Risk of impacts from extreme weather and climate in river-based Tilapia cage culture in Northern Thailand. *Int. J. Global Warm.* 8, 534–554. doi: 10.1504/IJGW.2015.073054



- Loach, K., Rowley, J., and Griffiths, J. (2017). Cultural sustainability as a strategy for the survival of museums and libraries. *Int. J. Cult. Policy* 23, 186–198. doi: 10.1080/10286632.2016.1184657
- Magis, K., and Shinn, C. (2009). “Emergent principles of social sustainability.” in *Understanding the Social Dimension of Sustainability*, eds J. Dillard, V. Dujon, and M. King (New York, NY; London: Routledge), 15–44.
- Makondo, C. C., and Thomas, D. S. G. (2018). Climate change adaptation: linking indigenous knowledge with western science for effective adaptation. *Environ. Sci. Policy* 88, 83–91. doi: 10.1016/j.envsci.2018.06.014
- Mallick, B., Rahaman, K. R., and Vogt, J. (2011). Social vulnerability analysis for sustainable disaster mitigation planning in coastal Bangladesh. *Disaster Prevent. Manage. Int. J.* 20, 220–237. doi: 10.1108/09653561111141682
- MetMatters (2021). *Cyclone Fani impacts India and Bangladesh | Royal Meteorological Society*. Available online at: <https://www.rmets.org/metmatters/cyclone-fani-impacts-india-and-bangladesh> (accessed September 14, 2021).
- Mikulewicz, M. (2017). Politicizing vulnerability and adaptation: on the need to democratize local responses to climate impacts in developing countries. *Clim. Dev.* 10, 18–34. doi: 10.1080/17565529.2017.1304887
- Minar, M. H., Hossain, M. B., and Shamsuddin, M. D. (2013). Climate change and coastal zone of Bangladesh: vulnerability, resilience and adaptability. *Middle East J. Sci. Res.* 13, 114–120. doi: 10.5829/idosi.mejsr.2013.13.1.64121
- Miyaji, M., Okazaki, K., and Ochiai, C. (2020). A study on the use of cyclone shelters in Bangladesh. *Jpn. Architect. Rev.* 3, 590–600. doi: 10.1002/2475-8876.12177
- MOEF (2005). *Annual Report*. The Ministry of Environment, Forest and Climate Change, Government of Bangladesh Ministry of Environment and Forest. Available online at: [moef.gov.bd](http://moef.gov.bd) (accessed October 2, 2021).
- Mortreux, C., and Barnett, J. (2009). Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environ. Change* 19, 105–112. doi: 10.1016/j.gloenvcha.2008.09.006
- Nahian, M. A., Ahmed, A., Lázár, A. N., Hutton, C. W., Salehin, M., Streatfield, P. K., et al. (2018). Drinking water salinity associated health crisis in coastal Bangladesh. *Elementa Sci. Anthropocene* 6, 2. doi: 10.1525/elementa.143
- Neef, A., Bengel, L., Boruff, B., Pauli, N., Weber, E., and Varea, R. (2018). Climate adaptation strategies in Fiji: the role of social norms and cultural values. *World Dev.* 107, 125–137. doi: 10.1016/j.worlddev.2018.02.029
- Neumayer, E., and Plümper, T. (2007). The gendered nature of natural disasters: the impact of catastrophic events on the gender gap in life expectancy, 1981–2002. *Ann. Assoc. Am. Geogr.* 97, 551–566. doi: 10.1111/j.1467-8306.2007.00563.x
- Palang, H., and Fry, G. (2003). *Landscape Interfaces: Cultural Heritage in Changing Landscapes*. Dordrecht: Kluwer Academic Publishers.
- Paul, B. G., and Vogl, C. R. (2011). Impacts of shrimp farming in Bangladesh: challenges and alternatives. *Ocean Coast. Manag.* 54, 201–211. doi: 10.1016/j.ocecoaman.2010.12.001
- Payo-Payo, A., Genovart, M., Bertolero, A., Pradel, R., and Oro, D. (2016). Consecutive cohort effects driven by density-dependence and climate influence early-life survival in a long-lived bird. *Proc. R. Soc. B Biol. Sci.* 283, 20153042. doi: 10.1098/rspb.2015.3042
- Pelling, M., and Manuel-Navarrete, D. (2011). From resilience to transformation: the adaptive cycle in two Mexican urban centers. *Ecol. Soc.* 16, 11. doi: 10.5751/ES-04038-160211
- Pop, I. L., Borza, A., Buiga, A., Ighian, D., and Toader, R. (2019). Achieving cultural sustainability in museums: a step toward sustainable development. *Sustainability* 11, 970. doi: 10.3390/su11040970
- Porter, C., and Serra, D. (2020). Gender differences in the choice of major: the importance of female role models. *Am. Econ. J. Appl. Econ.* 12, 226–254. doi: 10.1257/app.20180426
- Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York, NY: Simon and Schuster.
- Rahim, M. A., Siddiqua, A., Binte Nur, M. N., and Zaman, A. K. M. M. (2018). Community perception on adverse effects of natural hazards on livelihood and enhancing livelihood resiliency: a case study at Patharghata Upazila, Barguna. *Proc. Eng.* 212, 149–156. doi: 10.1016/j.proeng.2018.01.020
- Rahman, M. A., and Rahman, S. (2015a). Natural and traditional defense mechanisms to reduce climate risks in coastal zones of Bangladesh. *Weather Clim. Extremes* 7, 84–95. doi: 10.1016/j.wace.2014.12.004
- Rahman, S., and Rahman, M. A. (2015b). Climate extremes and challenges to infrastructure development in coastal cities in Bangladesh. *Weather Clim. Extremes* 7, 96–108. doi: 10.1016/j.wace.2014.07.004
- Rahman, S. H. (2017). *Assessing the Gaps in Policies and Practices to Protecting Climate Vulnerable at Three Districts in Bangladesh*. Available online at: [https://www.researchgate.net/publication/323867897\\_Assessing\\_the\\_Gaps\\_in\\_Policies\\_and\\_Practices\\_for\\_Protecting\\_Climate\\_Vulnerable\\_at\\_Three\\_Districts\\_in\\_Bangladesh](https://www.researchgate.net/publication/323867897_Assessing_the_Gaps_in_Policies_and_Practices_for_Protecting_Climate_Vulnerable_at_Three_Districts_in_Bangladesh) (accessed December 8, 2021).
- Rahman, T. (2019). *Addressing Climate Change and Grassroots Level Adaptation Measures to Food Security in Northwestern Bangladesh*. (Masters Thesis submitted to the Faculty of Environmental Studies), York University, ON.
- Rakib, M. A., Islam, S., Nikolaos, I., Bodrud-Doza, M., and Bhuiyan, M. A. (2017). Flood vulnerability, local perception and gender role judgment using multivariate analysis: a problem-based “participatory action to Future Skill Management” to cope with flood impacts. *Weather Clim. Extremes* 18, 29–43. doi: 10.1016/j.wace.2017.10.002
- Rao, N., Mishra, A., Prakash, A., Singh, C., Qaisrani, A., Poonacha, P., et al. (2019). A qualitative comparative analysis of women’s agency and adaptive capacity in climate change hotspots in Asia and Africa. *Nat. Clim. Chang.* 9, 964–971. doi: 10.1038/s41558-019-0638-y
- Rasul, M. G., Faisal, I., and Khan, M. M. K. (2006). Environmental pollution generated from process industries in Bangladesh. *Int. J. Environ. Pollut.* 28, 144–161. doi: 10.1504/IJEP.2006.010881
- Ripon, H., and Al-Mamun, S. (2020). Climate change and its diverse impact on the rural infrastructures in Bangladesh. *Disaster Adv.* 13, 67–75.
- Roy, I., Raquib, T., and Sarker, A. K. (2017). Contribution of NGOs for socio-economic development in Bangladesh. *Sci. J. Bus. Manage.* 5, 1–8. doi: 10.11648/j.sjbm.20170501.11
- Roy, S. (2020). “Post-cyclone Aila and mobility rights of the Shora Muslim women of the Bangladesh Sundarbans forest,” in *Climate Change, Hazards and Adaptation Options*. Climate Change Management, eds W. Leal Filho, G. Nagy, M. Borgia, P. Chávez Muñoz, and A. Magnuszewski (Cham: Springer). doi: 10.1007/978-3-030-37425-9\_32
- Sabatini, F. (2019). Culture as fourth pillar of sustainable development: perspectives for integration, paradigms of action. *Eur. J. Sustain. Dev.* 8, 31–31. doi: 10.14207/ejsd.2019.v8n3p31
- Sarker, M. A. R., Alam, K., and Gow, J. (2012). Exploring the relationship between climate change and rice yield in Bangladesh: an analysis of time series data. *Agric. Syst.* 112, 11–16. doi: 10.1016/j.agry.2012.06.004
- Sarker, M. H., Huque, I., Alam, M., and Koudstaal, R. (2003). Rivers, chars and char dwellers of Bangladesh. *Int. J. River Basin Manage.* 1, 61–80. doi: 10.1080/15715124.2003.9635193
- Sarwar, M. G. M. (2005). *Impacts of Sea Level Rise on the Coastal Zone of Bangladesh*. (Masters Thesis submitted to Programme in Environmental Science), Lund University, Sweden.
- Schmidt, M., and Pearson, O. (2016). Pastoral livelihoods under pressure: ecological, political and socioeconomic transitions in Afar (Ethiopia). *J. Arid Environ.* 124, 22–30. doi: 10.1016/j.jaridenv.2015.07.003
- Seddiky, M., Giggins, H., and Gajendran, T. (2021). Non-DRR NGOs strategies for livelihood development in the coastal communities of Bangladesh: A case study. *Nat. Hazards* 1–21.
- Shamsuzzaman, M. M., Islam, M. M., Tania, N. J., Al-Mamun, M. A., Barman, P. P., and Xu, X. (2017). Fisheries resources of Bangladesh: present status and future direction. *Aquacult. Fish.* 2, 145–156. doi: 10.1016/j.aaf.2017.03.006
- Soini, K., and Birkeland, I. (2014). Exploring the scientific discourse on cultural sustainability. *Geoforum* 51, 213–223. doi: 10.1016/j.geoforum.2013.12.001
- Soini, K., and Dessein, J. (2016). Culture-sustainability relation: towards a conceptual framework. *Sustainability* 8, 167. doi: 10.3390/su8020167
- SRDI (2010). *Saline Soils of Bangladesh*. Dhaka: Soil Resource Development Institute, SRMAF Project, Ministry of Agriculture, GoB.
- Subramanian, V. (2012). *Coastal Environments: Focus on Asian Coastal Regions*. Dordrecht: Springer.
- Tanjeela, M., and Rutherford, S. (2018). The influence of gender relations on women’s involvement and experience in climate change adaptation programs in Bangladesh. *Sage Open* 8, 2158244018812620. doi: 10.1177/2158244018812620

- Thin, N. (2002). *Social Progress and Sustainable Development*. Bloomfield: Kumarian Press.
- Uddin, M. N., Islam, A. S., Bala, S. K., Islam, G. T., Adhikary, S., Saha, D., et al. (2019). Mapping of climate vulnerability of the coastal region of Bangladesh using principal component analysis. *Appl. Geograp.* 102, 47–57. doi: 10.1016/j.apgeog.2018.12.011
- Uddin, M. T., and Nasrin, M. (2013). Farming practices and livelihood of the coastal people of Bangladesh. *Prog. Agric.* 24, 251–262. doi: 10.3329/pa.v24i1-2.19177
- UNESCO (2020). *Experts Highlight the Role of Culture for Climate Change Mitigation and Adaptation*. Available online at: <https://en.unesco.org/news/experts-highlight-role-culture-climate-change-mitigation-and-adaptation> (accessed January 22, 2022).
- UNESCO (2021). *Culture for Sustainable Development*. Available online at: <https://en.unesco.org/themes/culture-sustainable-development> (accessed February 10, 2022).
- Upazila Profile of Shyamnagar Upazila (2014). *Profile of Munshigonj Union - Local Capacity Building and Community Empowerment (LCBCE) Programme*. Available online at: [Union profile\\_Munshigonj-shy\\_2014.pdf](http://Union%20profile_Munshigonj-shy_2014.pdf) (satkhira.gov.bd) (accessed February 10, 2022).
- Vinck, P., Ferguson, S., and Bollettino, V. (2020). *Academic/NGO Collaboration to Understand Climate Change and Disaster Resilience Implementation in Bagerhat District, Bangladesh*. Harvard Humanitarian Initiative, MA.
- Wamsler, C., and Brink, E. (2018). Mindsets for sustainability: exploring the link between mindfulness and sustainable climate adaptation. *Ecol. Econ.* 151, 55–61. doi: 10.1016/j.ecolecon.2018.04.029
- WCCD (1996). *Our Creative Diversity - Report of the World Commission on Culture and Development*. Paris: UNESCO.
- WCED (1987). *Our Common Future. The Report of the World Commission on Environment and Development*. Oxford: Oxford University Press.
- World Bank (2015). *Bangladesh: The Challenges of Living in a Delta Country*. Available online at: <https://blogs.worldbank.org/endpovertyinsouthasia/bangladesh-challenges-living-delta-country> (accessed October 2, 2021).
- World Bank (2019). *Coastal Resilience in Bangladesh: Protecting Coastal Communities From Tidal Flooding and Storm Surges*. Available online at: <https://www.worldbank.org/en/results/2019/09/10/coastal-resilience-in-bangladesh-protecting-coastal-communities-from-tidal-flooding-and-storm-surges> (accessed July 20, 2021).
- World Bank (2020). *Bangladesh: Building Resilience to Climate Change*. Available online at: <https://www.worldbank.org/en/results/2016/10/07/bangladesh-building-resilience-to-climate-change> (accessed December 11, 2021).
- World Bank (2021). *Building Coastal Resilience to Protect Lives and Livelihoods in Bangladesh*. Available online at: <https://www.worldbank.org/en/results/2021/04/26/building-coastal-resilience-to-protect-lives-and-livelihoods-in-bangladesh> (accessed January 5, 2022).
- Ylipaa, J., Gabrielsson, S., and Jerneck, A. (2019). Climate change adaptation and gender inequality: insights from rural Vietnam. *Sustainability* 11, 2805. doi: 10.3390/su11102805
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