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## Adaptation Outcomes in Climate-Vulnerable Locations: Understanding How Short-Term Climate Actions Exacerbated Existing Gender Inequities in Coastal Bangladesh

Saleh Ahmed  
*Boise State University*

Elizabeth Eklund  
*University of Arizona*

Elizabeth Kiester  
*Albright College*

## **Adaptation outcomes in climate vulnerable locations: Understanding how short-term climate actions exacerbated existing gender inequities in coastal Bangladesh**

Saleh Ahmed, Ph.D.<sup>1</sup>

School of Public Service, Boise State University

Boise, ID 83725, USA

E-mail: [salehahmed@boisestate.edu](mailto:salehahmed@boisestate.edu)

Elizabeth Marie Eklund, Ph.D.

School of Anthropology, The University of Arizona

Tucson, AZ 85721, USA

E-mail: [felisbieti@email.arizona.edu](mailto:felisbieti@email.arizona.edu)

Elizabeth Kiester, Ph.D.

Sociology, Albright College

Reading, PA 19604, USA

E-mail: [ekiester@albright.edu](mailto:ekiester@albright.edu)

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<sup>1</sup> Corresponding author

## **Adaptation outcomes in climate vulnerable locations: Understanding how short-term climate actions exacerbated existing gender inequities in coastal Bangladesh**

### **ABSTRACT**

Adverse climate impacts present a significant challenge for the majority of the world's population. It is especially true for smallholder farmers in coastal Bangladesh, where some adaptation initiatives appeared to be short-sighted and reproduced further inequity, poverty, and food insecurity. Based on empirical insights, this paper shows how short-sighted climate responses can adversely affect gender equity illustrated through three adaptation strategies. First, agricultural institutions have traditionally and historically linked with gender roles. Outmigration from the region is gendered as males leave first. This forces increased household and farm responsibilities on female household members and increased vulnerability. This gendered vulnerability becomes compounded by the ways critical weather information flows at the local level. Taking this gendered lens, this paper illustrates how shrimp farming has caused long-term woes for society. These insights help to understand the complexity of climate-society interactions and the importance of long-term planning on any climate adaptation initiatives.

### **KEYWORDS**

Coastal Bangladesh; short-sighted adaptation; Kalapara; migration; weather and climate information; health challenges; gender inequity

## 1. Introduction

People, particularly those in the Global South, are experiencing a 'climate gap' in which the impacts of climate change are disproportionately affecting the most vulnerable and marginalized groups due to historically engrained inequities and the global economy (Benevolenza and DeRigne 2019). This is especially true for thousands of smallholder farmers in coastal Bangladesh (Alston and Akhter 2016; Hossain 2015; Jost et al. 2016). Despite their vulnerability, they are actively engaged in various community-based and household-level adaptation strategies (Ahmed and Kiester 2021). Adaptation to climate change is a long-term process necessary to reduce the increasing vulnerability of those impacted by the climate crisis (IPCC 2014). It is important to understand that adaptation is different from coping strategies, which are short-term, immediate survival mechanisms to any unexpected sudden shocks (Ellis 2000). To address unpredictable yet certain environmental changes due to climate crisis, adaptation efforts need to balance immediate concerns, such as food security, income generation as well as long-term planning priorities, such as crop planting, water salinity, coastal erosion (Cannon and Muller-Mahn 2010; Nalau et al. 2021.; Nobel et al. 2014).

Scholars have found that adaptation processes are shaped by both individual and societal level values along with perceptions of risk, including the impact of societal and institutional policies and mechanisms that may support or create barriers to adaptation efforts (Ahmed and Kiester 2021; Wolf 2011). In particular, policy makers and interventionists must consider sociocultural gendered power relationships and who is included in household and community level decision-making (Rao et al. 2019; Van Aelst and Holvoet 2018). In fact, it is increasingly evident that some climate actions or adaptation interventions are contributing to deepening

inequity, poverty, food insecurity, and other human sufferings (Dhakal and Mahmood 2014; Rahman and Hickey 2019; Schipper 2020). In particular, women are often the most impacted by climate change (Balikoowa et al. 2019; Duffy et al. 2021; Musinguzi et al. 2018), and practice short-term coping mechanisms while men are more likely to pursue long term adaptation strategies (Bastakoti et al. 2020).

Similar examples are available throughout Africa and Asia. In Northern Ghana, a significant agricultural productivity gap exists between male and female household heads due to an unequal distribution of adaptation resources (Adzawla et al. 2020). In Nepal, the forestry industry exacerbated the gap between gender adaptation strategies due to the patriarchy embedded in everyday practices (Bhattarai 2020). Musinguzi et al. (2018) found that women were much less likely to be involved in the small-scale fishing industry in Uganda, both pre-harvest and post-harvest occupations, reflecting less than 10 percent of the industry. This was due to a lack of access to necessary resources. In addition, women were expected to keep up with all the household and farming responsibilities as more men pursued non-household income adaptation strategies which left little time for pursuing fishing-related income.

The global findings on adaptation suggest that climate adaptation strategies must be tailored to be cognizant of the different needs of each gender, the resources available to them, and the sociocultural and religious constraints of their context. (Adzawla et al. 2020; Bryan et al. 2018; Gumucio et al. 2020). Otherwise, these strategies will lead to maladaptation and the furthering of preexisting gendered inequities and vulnerabilities.

In this context, coastal Bangladesh has been no exception, where the government, with support from different development partners, has adopted various policies to address the climate crisis and invested heavily on adaptation measures (World Bank 2009). Women in this region are

disproportionately exposed to, and impacted by, various climate crises (Ahmed and Eklund 2021; BCCSAP 2009; Evertsen et al. 2020; Jordan 2019). Patriarchy restricts women's spheres of influence in Bangladesh (Hafiza and Neelormi 2015; Ray-Bennett 2009). Women are largely facing challenges due to their restricted access to clean and safe water, safe sanitation, health, energy sources in addition to their reproductive and care giving responsibilities (Dewan 2021; Enarson 2000; Ray-Bennett 2009). In addition, morbidity and mortality among children and women are usually high compared to other social groups (Siantz 2013) the maternal mortality rate in rural Bangladesh due to natural disasters has been on the rise (Asadullah et al. 2021). In the region, women experience an extra layer of challenge due to these preexisting vulnerabilities.

Based on empirical research, this paper provides critical insights from three different adaptation strategies – male outmigration, early warning and weather information dissemination the overlooks gendered access barriers, and shrimp farming. These examples highlight how short-sighted climate adaptation actions have increased gender inequity in the region. In this case study, due to increasing climate stresses and decreasing farm production, male members of the household are more likely to migrate to nearby urban centers for various non-farm labor work as sources of alternative income. This adaptation strategy is forcing female family members to have increased household and farm responsibilities due to the absence of the male members of their households. Simultaneously, these women also face the direct consequences of slow and sudden climate crises, since they stay in their villages initially. Second, weather and climate information, including early warning systems are critical in this region, since people are exposed to various extreme and slow-onset weather events. Previously, availability of these critical sources of information substantially helped to reduce mortality and other casualties and losses during extreme weather events (Momtaz and Shameem 2016; Salzenstein and Montu 2021). However,

local farmers rely on agriculture extension agents for most of the farm-related agro-meteorological information. Often these extension agents disseminate relevant information using existing social structures, which are patriarchal and tend to exclude female members of the households. Not only does this impact food security among women, but it also magnifies their social vulnerability due to their preexisting socio-cultural and economic conditions and climate change impacts. Third, in the 1980s and 1990s, shrimp farming initially proved to be an effective livelihood opportunity for millions of poor households in this salinity-prone coastal Bangladesh. However, in recent years local people in the brackish regions that coincides with the shrimping, have started to observe an increasing trend of in local health challenges. While correlation may not be causality, scholars have documented increased malnutrition, skin and eye diseases, and miscarriage among pregnant women in this region (Asadullah et al. 2021; Lee et al. 2021).

This paper expands work by Nilsson et al. (2018) on how United Nation Sustainable Development Goals (SGDs) can positively or negatively interact with other SGDs by illustrating how short-sighted climate adaptations can adversely affect both the intended and other SGDs. Focusing on SDG 13, climate change adaptation alone, without paying critical attention to how adaption strategies interface with gendered institutions can worsen gender inequality, and thus move further away from achieving SDG 5, addressing gender inequity, in the region. Our findings highlight the importance of considering long-term gendered impacts of any climate actions, since women in agrarian communities in the Global South are disproportionately exposed to and impacted by climate change. Any climate actions taken without considering long-term implications will only entrench gender inequity by making women more vulnerable to any localized climate crises. This paper shows climate actions must take a holistic and long-term perspective to avoid any future unintended consequences. While the geographical focus is on

coastal Bangladesh, insights in this paper are relevant for other parts of the world facing similar social, cultural, and environmental challenges.

## **2. Study area and methods**

### ***2.1. Overview of the study area***

Bangladesh ranks among one of the most climate vulnerable countries in the world (Hafiza and Neelormi 2015; Huq and Ayers 2007; Paprocki, 2021; World Bank 2009). Between 2030 and 2100, Bangladesh's surface temperature is predicted to rise from 1.0 to 2.4 degrees Celsius. The peak monsoon rainfall is anticipated to increase significantly: a 4.7 to 11.8 percent increase, over the same timeframe. Simultaneously, there is likely to be a reduction of winter rainfall, which would cause stresses on winter farming and further increase salinity intrusion in the coastal region. The people in coastal Bangladesh are projected to experience a consistent level of mean sea level rise in coming decades (Agrawala et al. 2003; De Lellis et al. 2021).

Due to geographical location, the people in coastal Bangladesh usually experience some of the deadliest tropical cyclones in the world, including the Super Cyclone Sidr in 2007 and Aila in 2009 (Kingsbury 2018; Webster and Webster 2011). Each year, between two to seven cyclones form in the Bay of Bengal (Alam et al. 2003). While some of them reach land or make landfall in neighboring India or Myanmar, at least one cyclone each year reaches land in Bangladesh with an additional severe cyclone every two to four years (Brammer 2016). Coastal Bangladesh is at the frontline of global environmental change (Roy et al. 2016). People in the region are consistently exposed to sea level rise, salinity intrusion, coastal erosion, coastal flooding, and rainfall variability. Cumulatively, these events cause a tremendous amount of annual crop loss, which has a detrimental effect on both income opportunities and food security (Wheeler 2011).





Figure 1: Map of the Kalapara Upazila (sub-district)

Source: Local Government Engineering Department 2021

The geographical focus of this study is Kalapara, which, as illustrated in Figure 1 and Table 1 is the southern-most local government administrative unit of Patuakhali district. An estuarine maze of islands separated by small rivers growing to large inlets along the edge of the Bay of

Bengal, coastal Bangladesh, and subdistricts like Kalapara are highly vulnerable to sea level rise, coastal erosion, and salinity intrusion in land and ground water (Ahmed and Eklund 2021; Dasgupta et al. 2020). The livelihoods of local people are largely dependent on farming and fishing (Lázár et al. 2015; Paprocki 2021). The coastal landscapes in Kalapara are comprised of coastal flood plains, sandy beaches, mangroves, and sand dunes.

<TABLE 1 GOES HERE>

**Table 1:** Study Area (Source: Local Government Engineering Department, 2021)

**Table 1.** Key information on Kalapara

Category	Features
Geographical location	Amtali Upazila in the north and west; Rabnabad channel and Galachipa Upazila in the east; and the Bay of Bengal in the South
Area	492.1 sq. km
Population	237,831
- Male	120,514
- Female	117,317
Households (nos.)	57,525
Administrative Unit	
- Pourashava	2
- Union	12
- Villages	247
Farm Resources	
- Farm lands	40,940 ha
- Main crops	Paddy, pulse, potato, vegetables
Employment	
- Agriculture	57.2%
- Non-agriculture labor	4.8%
- Commerce/small business	13.5%
- Other (e.g., service, construction)	24.5

Source: BBS (2015); GoB (2021)

The average annual rainfall in Kalapara is 2654 mm. In the region, coastal flooding and water logging are common phenomena. During the Super Cyclone Sidr in 2007, which was a Category 5 tropical cyclone, a vast area of croplands was inundated by rain and flooding in the low-lying areas (Paul 2009). Approximately 45% of crops, primarily of the paddy variety, and 80% of trees were severely damaged by strong winds and torrential rainfalls (CDMP2 2014). To date, Kalapara is one of the most disaster-prone areas in the country (GoB 2021). Most importantly, the socioeconomic conditions in this region are closely linked to the region's exposure to a range of hydro-meteorological disasters as noted above. As shown in Table 1, even though agriculture is the main source of employment, the amount of arable land is limited, and density is high. Further, many farmers are small holders (Ahmed and Kiester 2021). And, as will be discussed below, qualitatively people adhere to traditional cultural values of modesty in public places and gendered roles (men as head of the household), setting a backdrop for the restrictions on what assigned females can do and places they can access even as climate change adaptation is forcing the most vulnerable to take on new, non-traditional roles.

## **2.2. Methods**

This paper is based on research led by the primary author between 2015 to 2018. During this period, the author visited the region a number of times, including one extensive research period from September 2017 to January 2018. It was designed as mixed-method research, involving four months of participant observation and imbedded field work included a range of qualitative and quantitative information. In addition to personal familiarity to the region and being a native Bangla speaker, the primary author also collaborated with non-governmental organizations

(NGOs), local development workers, civil society representatives, as well as field assistants from different religious and ethnic backgrounds.

Initially, the primary author used various qualitative techniques, including participant observation, Focused Group Discussions (FGDs), and held key informant interviews (i.e., unstructured interviews of local government officials) to get better insights on the local cultures, challenges, needs, and potential strategies for coping and adapting with increasing weather and climate related stresses in the region.

The primary author asked local community elders for advice on possible location-specific challenges. After months of engagement with communities in the region, the primary author, with the help of the field research team, developed their first set of questionnaires that they used later for interviewing 250 farming households in the region. Questions asked included socio-demographic information, land ownership, social capital, climate vulnerabilities, adaptation and risk reduction, and use of weather and climate information.

Respondents were selected based on three specific criteria: first, only respondents whose primary livelihood was farming were included; second, the research team looked for farmers who had experienced rainfall anomalies, sea level rise, increasing intensity and frequencies of tropical cyclones, salinity intrusions, coastal flooding, and coastal erosions in recent years. The third criterion was based on respondents' farm losses due to the above-mentioned environmental stresses. All the interviews were conducted in the local language. Respondents were distributed across various villages and communities in the Kalapara area. The research team also paid attention to the local diversity of respondent farmers to not overlook mainstream and minority groups in terms of religion (e.g., Hindu, Muslims, Buddhists), gender (e.g., male, female), ethnicity (e.g., Bengali, Rakhine), and income (e.g., smallholder farmers, large farmers).

Qualitative and quantitative data were recorded using semi-structured questionnaire. This information was augmented by detailed field notes.

It is important to highlight that when the research team wanted to explore the long-term impacts of the shrimp farming, particularly the health impacts, the data gathered in the field showed that local people were hesitant to report their struggles and challenges. Contextual and participant-observation (including informal conversations with locals, including women) help illustrate two major reasons why. First, respondent shrimp farmers were afraid of highlighting any negative public health impacts of shrimp farming, since this industry provides them with their primary livelihood. Many of their family members are directly engaged in the shrimp industry in some capacities. Also, the people, who usually control this industry, even at the local level, are members of the local social, economic, and political elites. So, any complaint reported against this industry could jeopardize their opportunity to earn income or engage in this industry. It is also not uncommon that those who have made the largest financial gains in this industry at the local level to have previously used their political power and intimidation tactics to dominate smallholder farmers. Second, even though local women are increasingly facing various health challenges due to their engagement in the shrimp farming industry, reporting health impacts, including skin diseases or child birth-related complications are still a social taboo. In particular, local women expressed concern about the rising number of miscarriages, a highly private and personal topic that is also entangled with social constructions of a women's place, actions, and value. Therefore, some of the findings on the third case study are derived from secondary sources, augmented with discussions with local people and community elders who were willing to go on the record.

### **3. Results**

#### ***3.1. Gendered-dimension of outmigration***

Outmigration is increasingly common in coastal Bangladesh mostly because of the adverse climate impacts on the agricultural industry including both agricultural practices, and agricultural outputs. Most of the local farmers are struggling to produce enough food to feed and support their families let alone generate any income. For many smallholder farmers, a second source of income, or a change in their livelihood may be the only viable options. Working age men are primarily choosing to temporarily or permanently migrate to nearby urban centers or other destinations. Most of them end up in low-skilled labor largely in a city's construction sector or in transportation (e.g., rickshaw pulling) in an attempt to send most of their earning back home to their families.

However, this migration comes with a social (e.g., increased household and farm responsibilities, including family discord, and divorce), economic (e.g., decreased local income), political (e.g., further marginalization), and psychological (e.g., decreased mental wellbeing, including increase mental stresses) costs to female members of the households. As illustrated in Figure 2, as farmland deteriorates, outmigration proceeds in a gendered outmigration feedback cycle. At first, male heads of households and other working age men migrate to nearby or distant urban areas, while the female household members usually stay in their home villages.

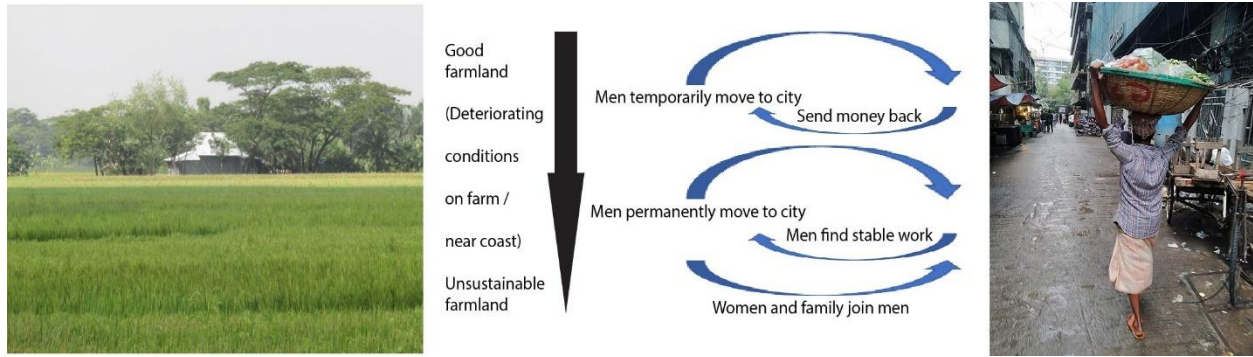


Figure 2: Local migration scenario

While the men are away, the women functionally become the new head of the household. In addition to their typical gendered household responsibilities, the women left behind need to also take over household and farming responsibilities and make key decisions for the family wellbeing. This added farm and managing responsibility leaves women with little time for socialization and other traditionally gendered activities in their communities, which in turn, continues to exclude them from other women, as well as other decision-making processes (Choudhury et al. 2021; Ray-Bennett 2009).

In addition, female members lose access to social spaces like rural markets or farmers' associations, which were already infrequently visited by them. These spaces women traditionally rarely visit. Since women often have limited access to other social services, including opportunities to share their opinions or influence decision-making in local communities while the men of their households are away, they have even fewer opportunities to interact with local government authorities or other government or non-government organizations (NGOs) that may be able to provide services and resources for their families (Tanjeela and Rutherford 2018).

Because of their increased household and farm responsibilities, it is also not uncommon for women to struggle to maintain ties with local NGO workers who offer various rural financial

services. Overall, the absence of the male members of the household increases social and economic vulnerabilities among the female members left behind. Since the women spend most of their time in their villages, their exposure to extreme and slow-onset events are also higher than men. They are often the first victims of any natural hazards. Their compromised disaster response capacity shapes the reality of climate injustices they face.

Ultimately, short-term responses to climate change by migrating to nearby or distant urban centers by the local male farmers tend to create long-term gender inequity and climate injustice. Even though many organizations and scholars acknowledge migration as a means of adaptation, they overlook the long-term impacts including the social, economic, psychological, and environmental consequences facing the female members of the region (Ahmed and Eklund 2021; Erwin et al. 2021; Massey et al. 2010).

### ***3.2. Influence of patriarchy on the critical weather information flow***

Among many other adaptation resources in coastal Bangladesh, early warning and weather and climate information are critical for local people largely because of their dependence on farming as the major livelihood option. Farming in Kalapara is frequently affected by heavy rainfall, sea level rise, tropical cyclones, salinity intrusion, and coastal flooding. For example, people in the area experienced an unprecedented amount of rainfalls in October and in November, 2017, which had a damaging impact on local agriculture. Crops were damaged in the fields before farmers were able to take any precautionary measures. Many of them lost almost half of their crops. For example, in Pakhimara village in Kalapara, a male smallholder farmer mentioned:



“I lost 50% of my crops. I was just not prepared for the rain in November. No one could have predicted that rain was coming.”

This was a common narrative among many other smallholder farmers in the region, whose livelihoods heavily dependent on it. This type of weather and climate anomaly is increasingly common in Bangladesh. Among the interviewed farmers, 51.2% experienced major crop damage during that heavy rainfall in 2017. Empirical findings show that there were no major differences across different types of farmers (defined by religion, gender, or, ethnicity) in the patterns or scale of crop damage. However, due to issues of scale, smallholder farmers reported more significant losses than large farmers. This had a major impact on their household food consumption as well as overall food security and poverty.

To avoid this extent of crop damages, farmers need predictive information, or more access to readily available and usable weather and climate information, including storm tracking and weather forecasts. These will inform local farmers to predict the best time of season to plant so that harvests tend to avoid destructive storms or other natural events, and mitigate damage when unseasonable storms occur. Currently, the Government of Bangladesh is providing this weather and climate information at various time-scales through multiple channels of communication. Despite the urgent nature of this crisis, our findings from interviewing 250 local farmers indicate that almost 70% of the local farmers did not receive any information or early warning, even though the government had previously issued a rainfall warning earlier in the year (see Figure 3).

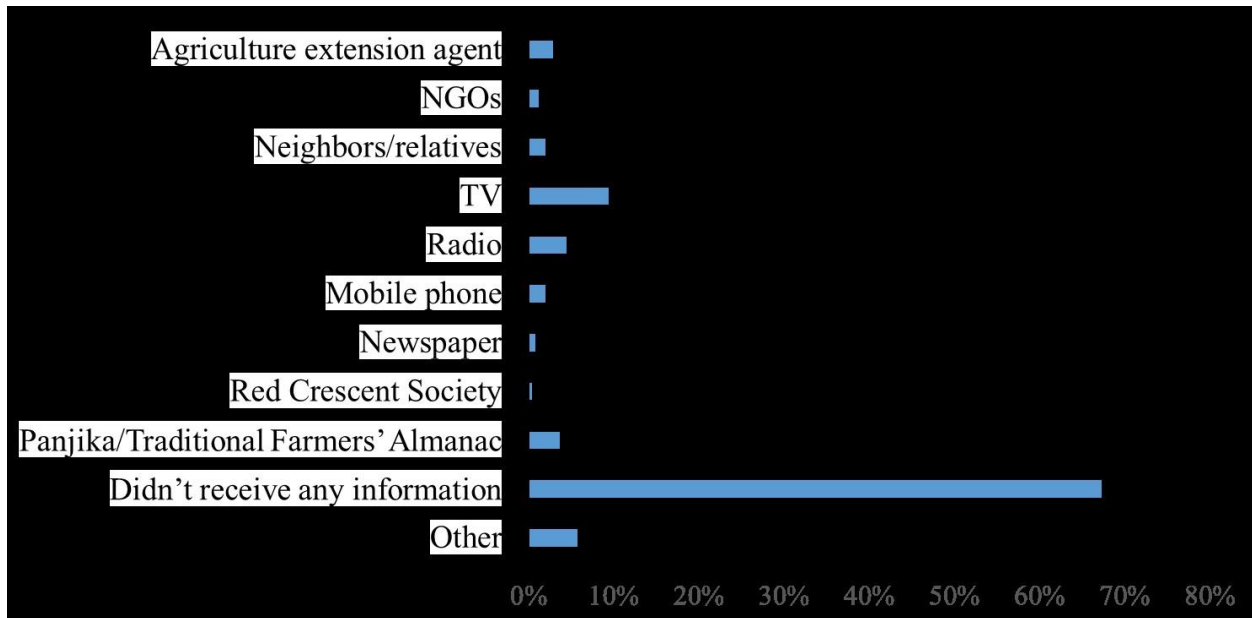


Figure 3: Sources of weather information

The unexpected rainfall late in 2017 shows that not only is the production of weather and climate information important, it is equally critical to pay attention to how that information flows through traditional agrarian societies, in coastal Bangladesh. According to our respondents, those who did have access to information during the rainfall in late 2017 largely received the news from TV (10%), radio (~8%), and from other informal sources (see Figure 3). However, many of them received information from other sources such as from local agriculture extension agents (~5%) and other fellow villagers (~4%). In this context, we paid particular attention to gendered-dimensions of weather information flow in traditional agrarian contexts. Due to these gendered divisions in local society, it is important to identify how local farmers move through social spaces where news is shared. In rural Bangladesh, local markets or rural growth centers play a major role in disseminating multiple forms of information. However, those markets or growth centers are usually male dominated social spaces. Furthermore, the use of those social spaces is shaped by the cultural patterns of the religio-ethnic majority, male Muslim Bengalis.

Usually, every afternoon before or after afternoon prayer (i.e., Maghrib prayer) local farmers visit rural markets. They drink tea, or smoke local cigarettes, and discuss their struggles, needs, or potential opportunities with other fellow farmers. In Bangladesh, rural markets are often treated as the center of social innovations, since people discuss various locally-relevant issues, and try to explore options. Field insights shows that while market activity centers around the Maghrib prayer, Hindu farmers or farmers from ethnic backgrounds also visit the local markets around the same time. The centrality of market activity to rural life is shown by how local agriculture extension agents visit rural markets more frequently than they can visit most of the smaller, rural local villages.

In the markets, agriculture extension agents interact with the local farmers, listening to their concerns and respond to their questions. Often, agriculture extension agents provide critical information and valuable solutions to local farmers regarding their agriculture related issues.

Female farmers are usually excluded from these interactions. It is culturally appropriate for female members of the households to remain at home in the afternoons and evenings. Therefore, women visit rural markets less frequently, and rarely during these peak times when agriculture extension agents are present. This creates two extra challenges for local female farmers. First, going to male dominated rural markets is already a challenge for the local women. Muslim women face an added challenge because their religio-cultural restrictions and norms add a moral barrier to their participation. Hindu women also face similar moral / ethical challenges, but not at the same level Muslim women experience.

Apart from religious norms, ethnic differences can also influence the exclusion of local females from the market activities, or more particularly, interactions with the local agriculture extension agents. In Kalapara, there are thousands of ethnic Rakhine, the majority of whom are

farmers. Rakhine speak Rakhine language, which is a different language than the language of majority Bengali population. Because of this linguistic difference, Rakhine farmers face challenges communicating with local Bengalis, in addition to getting information from TV or radio. One of the Rakhine respondents, a middle age woman, actively engaged in farming and raising poultry, highlighted this linguistic barrier during the interview with lead author by saying:

“I can understand your question, but cannot answer, since I do not have formal Bangla schooling.”

This challenge is equally true for majority of other local Rakhine members. For Rakhine women, the linguistic barrier is layered on top of other gendered expectations and movement restrictions. A large part of women’s vulnerability is caused by gender norms, expectations, and social roles (Ahmed and Kiester 2021; Tanjeela and Rutherford 2018). Women are disadvantaged because of their subordinate position in the family arising out of patriarchy and traditionally embedded values (Hafiza and Neelormi 2015).

One does not have to spend much time as a participant observer to note the overall patriarchal nature of the agrarian society in coastal Bangladesh excludes women from the primary local source of weather and climate information. The market afternoons are welcoming spaces for male Muslim Bengalis, but awkward spaces for women and minorities. Yet, this is where active dissemination of knowledge by agricultural extension agents and other NGO or government actors occurs. There are also the casual conversations in Bangla and broadcasted information from televisions and radios that most of the local people can see in these market places. The gentle burble of dominant language stories emerging from the market space is full of

daily life concerns, and in the agrarian areas, that ranges from tips to warning about inclement weather on the horizon. This information, even in snippets, could be picked up by a man smoking or sipping tea, while the flow of information proceeds at a pace a woman or minority passing through to take care of errand may not hear, or have time to absorb. Or if she does overhear something, it would be unseemly for a her to approach a man she is not related to ask for more information, something one regularly observes men doing on any given market afternoon. This lack of, or unequal access to critical weather and climate information in the region often jeopardize local efforts to cope with natural hazards (Hafiza and Neelormi 2015).

Therefore, it is increasingly evident that due to the lack of consideration and understanding of local culture and norms in the efforts of climate action (SGD 13), gender inequity (SGD 5) has inherently increased.

### ***3.3. Salinity intrusion, shrimp farming and the impact on female health***

Coastal Bangladesh has historically faced high levels of food insecurity. The salinity level in the agricultural lands is expected to increase significantly under future climate change scenarios and exacerbate this problem (Habibullah, Ahmed, and Karim 1998). In the early 1980s, Bangladesh adopted structural adjustment programs, which were prescribed by the International Monetary Fund and the World Bank. During that period, various international development partners began to fund and promote commercial shrimp production in coastal Bangladesh in response to rising global demand. Salinity in the region, availability of shrimp fry, local availability of cheap labor, and land were among the major reasons the shrimp industry rapidly expanded in the region (Dasgupta et al. 2020; Dewan 2021; Paprocki 2021).

Shrimp farming was adopted as a new kind of “cash crop” as a result of these market and broader contextual forces combined with local poverty and food insecurity among the population. It is also common that climate change policies have enabled local social, economic, or political elites to capture land and exploit the policies for their own interests (Sovacool 2018). A large section of local farmers in coastal Bangladesh is functionally landless (i.e., households owning less than 0.05 acres of land) and about 12.66 percent of households are absolutely landless (Morsalin and Islam 2021; BBS Agriculture Census 2008) . In the region, 1.2 million local inhabitants are directly dependent on shrimp production, of which about 185,000 people are involved in fry collection (Ahmed 2012).

However, this change in land use and local livelihood practice brought several social, environmental and ecological challenges (Swapan and Gavin 2011). Initially, shrimp farming appeared to be the solution to the region’s increasing salinity while addressing the pervasive poverty. Initially, Expansion of shrimp farming was celebrated in the area, national and international policy arenas. It provided employments and opportunities for increase income and livelihoods locally. In the national level, the country was able to gain substantial amount of revenue by exporting shrimps to various countries. Despite all the immediate success, female members in the region were always at the bottom of the supply chain of the shrimp industry and were mostly limited to collecting shrimp fry (Islam 2008, see figure 4).



Figure 4: Women collecting shrimp fry in Kalapara. Photo: Saleh Ahmed

While shrimp farming is well suited to the brackish environment, the practice increases salt stress (Das et al. 2017) and further salinizes the groundwater (Islam et al. 2019). Overall, increasing salinity intrusion gradually reduces drinking water supplies (a link to SDG 6, clean water and sanitation). During the dry season, there is less fresh groundwater flow which results in greater salinity resulting in a lack of suitable drinking water, which was also reflected from the statement of a local female smallholder farmer in Kalapara:

“We face severe water shortage during the summer. That time salinity is also high”

Salinity is usually less during the rainy season. Several respondents also mentioned that local salinity particularly increased since the aftermath of Cyclone Sidr in November 15, 2007. This becomes an acute problem for affected communities. Locally, it is quite common that women and adolescent girls need to fetch water from distant sources, walking five to six kilometers each day to fresh water sources in some coastal locations.

Given the sensitive nature of this topic, no data was gathered directly from the shrimp farmers themselves, but rather from community members. They shared with the research team that it is has become increasingly common that women and girls are increasingly facing several health issues. Premature births, miscarriages, and still-births are reported in alarmingly high numbers in these areas (Hafiza and Neelormi 2015; Hayward and Ayeb-Karlsson 2021). These are rates both different from historic conditions. It should also be noted low birthweight, while linked to many other factors, is a well-established marker of poverty and marginalization (Alam et al. 2017; Mahumud et al. 2017), miscarriage is linked to stress (Qu et al. 2017) and there is emerging work on correlation between poor and marginalized women and miscarriage and stillbirth (Hamid et al. 2014). However, several workplace risks factors that should be noted.

The risks of serious pregnancy complications due to dehydration or drinking brackish water are well documented (Mulyani et al. 2018; Zhang et al. 2020) and pregnant women need more fluids than non-pregnant individuals (Zhang et al. 2020).

In Bangladesh, research by Dasgupta et al. (2015) suggests there is a link between the observed rise in miscarriages and the increasing salinity in the drinking water. This places women of 'child-bearing age' working jobs gathering shrimp fry at a greater risk for pregnancy complications due to the decreasing access to suitable drinking water and high sodium exposure at work. The case study of shrimp farming creates an interesting example of what Nilsson et al. (2018) argued, SDGs interact in ways that positively, and negatively impact other goals. Here, a climate action (SDG 13) taking advantage of brackish water for harvest shrimp, it could theoretically reduce hunger (toward SDG 2) and contributed to decent work and economic growth (SDG 8) by providing both jobs, serving as a cash crop. However, shrimp farming also has reduced fresh water availability (SDG 6, see Das et al. 2017 and Islam et al. 2019). Further,



it could be argued that work conditions are less than ideal (not really fulfilling SDG 8 in the long term) given the health hazards listed above. And with women working in the most marginal roles of fry gathering, the benefits have fallen along gendered lines (SDG 5) and appear to be furthering inequity. While more concrete data is needed, the climate adaptation solution of shrimp farming has consequences that need further research before similar policies are expanded.

#### **4. Discussion**

Adaptation to climate change that are short-sighted coping strategies, bringing long-term challenges rather than solutions. The gendered component of climate change vulnerabilities has been well documented (Rao 2019), but the short-term adaptation strategies observed in Kalapara demonstrates how immediate climate response can compound pre-existing vulnerabilities and leading to climate injustices.

In the first example, where we discussed gendered dimension of adaptation, local male farmers people adopted migration as their response to adverse climate impacts. Many scholars and development practitioners also acknowledged migration is one of the key and effective adaptive strategies to a changing climate (Afifi et al. 2016; Bardsley and Hugo 2010; Black et al. 2011; Maharjan et al. 2021; McLeman and Smit 2006; Santos and Morais Mourato 2021; Scheffran et al. 2011). However, in the case of coastal Bangladesh, movement of male members of the households leaves women behind in an increasingly vulnerable situation (Ahmed and Eklund 2021). In a pattern also observed in the upper Indus Basin in Pakistan, men engage in circular migration while women are left behind to take care of the farm even though they do not gain greater decision-making power or autonomy (Gioli et al. 2014). While circumstances for the

women left behind in similar cases in Nepal depended on the amount of money sent home by male family members (Maharjan et al. 2012), in Kalapara the gendered dynamic created an added vulnerability as the already marginalized women face various natural hazards in the region.

The second adaption strategy discussed above, providing farmers with critical weather and climate information, hits a barrier that compromises that adaptation strategy, unless the patriarchal nature of the society is recognized. This finding is consistent with case studies from Malawi (Henriksson et al. 2020), Senegal (Carr et al. 2016), and Uganda (Roncoli et al. 2011). In South Africa, women often had different climate service needs and schedules from men (Archer 2013). The aggregate pattern from research studying women's access to climate services shows how disparities are shaped by social norms, particularly the division of labor (Gumucio 2020). However, the case study presented above demonstrates how gendered divisions go beyond just cultural norms, but also involves moral expectations and religious obligations. Distributed weather and climate information might not get to local farmers unless these gendered religio-cultural norms are taken into consideration by agriculture extension agents and NGO workers. Since available adaptive resources do not consider the way society functions, these channels of communication have little to no value to marginalized female farmers.

The third adaptation strategy, taking advantage of increased salinity and global demands for shrimp, highlights that even though some adaptation initiatives might appear effective at the beginning and have short-term benefits, in the long-term they can cause unexpected woe for society. As noted above, the benefits of shrimp farming should not be readily dismissed. In the 1980's and 1990's areas in coastal Bangladesh were facing extreme hunger and poverty, which benefited greatly later on from the growing shrimp industry. However, emerging data from

Odisha, India (Das et al. 2017), the Mekong Delta (Poelma et al. 2020), and coastal Bangladesh (Islam et al. 2019) indicate that shrimp farming alters the coastal ecology increasing salinity and displacing local livelihoods (Swapan and Gavin 2011; Paprocki 2021). Evidence is only starting to emerge about long term health consequences for the women who work in the shrimp farm. There seems to be a clear link between the shrimp industry, brackish water and loss of suitable drinking water (Islam et al. 2019), and likelihood of miscarriage, including many other health challenges (Dasgupta et al. 2015; Khan et al. 2011; Khan et al. 2014). While the initial benefits of shrimp farming prevented starvation, further shrimp farming in the region needs to consider the emerging health risks, and with a growing incident of climate injustice

However, the impacts of short-sighted climate actions (SDG 13) go beyond just creating gender inequity. Empirical insights suggest that increased gender inequity (SDG 5) in Kalapara can be the direct reason for the following long-term impacts, which are neither locally nor nationally desirable (see table 2).

Table 2. Long-term impacts due to short-term climate action

<b>Cause</b>	<b>Outcomes</b>	<b>Impacts</b>	<b>Impacted SDG</b>	<b>Related Goals</b>
Climate action (SDG 13)	Gender inequity (SDG 5)	Increased poverty	SDG 1: No Poverty	1.1 Eradicate extreme poverty
				1.2 Reduce poverty
				1.4 Equal rights to economic resources as well as access to basic services
		Increased hunger	SDG 2: Zero Hunger	2.1 End hunger and ensure access to sufficient food
				2.2 End all forms of malnutrition
				2.3 Double the agricultural productivity
				2.4 Ensure sustainable food production systems
		Poor health and well-being	SDG 3: Good Health and Well-being	3.1 Reduce maternal mortality
				3.2 End preventable newborn deaths
				3.3 Ensure universal access to health-care services

		Lack of access to water and sanitation	SDG 6: Clean Water and Sanitation	6.1 Achieve universal and equitable access to safe and affordable drinking water
				6.2 Achieve access to adequate and equitable sanitation and hygiene
		Lack of access to decent work and low economic growth	SDG 8: Decent Work and Economic Growth	8.5 Achieve full and productive employment and decent work for all women and men
		Increased inequality	SDG 10: Reduced Inequalities	10.2 Empower and promote the social, economic, and political inclusion of all
		Unsustainable communities	SDG 11: Sustainable Cities and Communities	11.1 Ensure access for all adequate, safe and affordable housing and basic services
		Absence or lack of capacity for responsible consumption and production	SDG 12: Responsible Consumption and Approach	12.2 Achieve the sustainable management and efficient use of natural resources
		Lack of local and regional peace and justice	SDG 16. Peace, Justice, and Strong Institutions	16.1 Significantly reduce all forms of violence and deaths
		16.7 Ensure responsive, inclusive, participatory, and representative decision-making at all levels		

Source: UN (2021)

In Kalapara, some immediate coping mechanisms helped the local people to adjust with the changing climate patterns; however, in the long-term, those can be the reason for major development and livelihood challenges. Potentially, female members of the household would face increased social vulnerability in this climate-vulnerable resource-constrained coastal Bangladesh.

## 5. Conclusion

These examples of short-term coping versus long-term adaption strategies suggest that immediate improvements can sometimes compromise long-term benefits, and sustainability. Therefore, it is important to have a holistic perspective that considers both environmental and socio-economic contexts, including interactions, processes, synergies, and trade-offs between various sub-components at multiple levels in order to avoid negative societal outcomes. Local climate actions should embrace multiple spatial (e.g., micro, meso, macro), social dimensions (e.g., politics, labor markets, the economy, local practices, culture, and religions), and multiple outcomes (e.g., maladaptation and tradeoffs) (Sovacool 2018).

To illustrate this, development strategists should consider each of these examples of adaptation strategies separately. In the case of the adaptation strategy of relocating, the theoretical model just moves entire communities away from vulnerable regions in neat blocks. However, global research has shown that this model is not possible. In many places around the world there are concerns regarding leaving heritage lands, hitting international borders, and conflicts between displaced peoples and receiving communities. The empirical evidence from Kalapara also suggest negative outcomes from the ways in which outmigration occurs. Marginal farmers cannot simply all move, but rather part of the community, specifically men, leave first. This leaves already marginalized women farmers in an even more precarious position, facing gendered barriers on land that is becoming increasingly less productive (and more at risk). Likewise, as coastal regions around the world face increasing pressure from a changing climate, policy interventions need to include not only the directionality but also the process of migration especially when international borders are concerned.

Some strategies, like providing meteorological information may seem overtly straight forward. However, multiple social dimensions, including social ties and religious and cultural values shape the channels that govern the flow and dissemination of knowledge. The concept of a margin by definition makes it harder for the most marginalized, and therefore the most vulnerable, to have access to information. Complex social dynamics make negative synergies between adaptation strategies. For example, men out-migrating leave women behind in social networks they cannot effectively navigate including channels of farm-related information, which then impedes access to either crop saving or, in the case of severe weather, lifesaving information.

Finally, adaptation strategies that do not take into account systemic nuances can create critical maladaptation. The increasing salinity makes coastal Bangladesh a favorable environment for shrimp farming; a livelihood opportunity that benefited many in an area that was struggling in the 1980s. But, as is common in many industries, not all the jobs provide equal benefits. The most hazardous are often taken up by the most marginalized. As outlined above, the most marginalized in this case study are female farmers of child bearing age due to complex social interactions and vulnerabilities. There is a correlation between a high number of still-births, miscarriages, and premature births in this region where women work gathering shrimp fry and drinking brackish water. While correlation is not causality, a socio-ecological systems approach would take these elements into account.

Please note, majority of these adaptation mechanisms were initially effective, since those interventions offered some immediate relief to the people and their livelihoods. As particularly shown in the case of shrimp farming, taking advantage of an increasingly brackish environment helped a region that was struggling, bringing in an almost immediate cash flow and directly

alleviating poverty. However, short sighted climate actions have unintended consequences. As illustrated in this paper, all three adaptations adversely affect women, forcing females into more marginalized and vulnerable situations. The marginalization and vulnerability of women, left behind in increasingly unsustainable coastal farms, unable to access critical climate information, or lacking sufficient access to fresh water while gathering shrimp fry negatively articulates with other SDGs. There is more crop loss, more hunger and poverty, and greater infant, maternal and child mortality.

We need to address these complex dynamics between climate action (SDG 13) and gender equity (SDG 5) to make our societies inclusive and sustainable, which are the key components of the overall agenda of the United Nations Sustainable Development Goals (UNSDGs). Therefore, we need to understand the way in which climate adaptation strategies reproduce inequality and vulnerability, in particular, gendered vulnerability in low-income, climate-vulnerable contexts and the process that magnify inherently unequal outcomes. These insights can help the policy makers, development practitioners, and scholars to design long-term inclusive adaptation strategies, and equitable resilience policies, so that countries across geographies, particularly which are heavily exposed to climate vulnerability, can be on track to achieving the UNSDGs by 2030.

## References:

- Adzawla, W., Baumüller, H., Donkoh, S.A., and Serra, R. 2020. “Effects of climate change and livelihood diversification on the gendered productivity gap in Northern Ghana.” *Climate and Development* 12 (8): 743–55.
- Afifi, T., Milan, A., Etzold, B., Schraven, B., Rademacher-Schulz, C., Sakdapolrak, P., Reiff, A., van der Geestg, K., and Warner, K. 2016. “Human mobility in response to rainfall variability: Opportunities for migration as a successful adaptation strategy in eight case studies.” *Migration and Development* 5 (2): 254–274. <https://doi.org/10.1080/21632324.2015.1022974>
- 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: Organization for Economic Co-operation and Development.
- Ahmed, F.R.S. (2012). Climate Change Issues in Bangladesh & Need for Adaptation to Climate Change. [https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-dhaka/documents/presentation/wcms\\_181127.pdf](https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-dhaka/documents/presentation/wcms_181127.pdf)
- Ahmed, S. and Kiester, E. 2021. “Do gender differences lead to unequal access to climate adaptation strategies in an agrarian context? Perceptions from coastal Bangladesh.” *Local Environment: The International Journal of Justice and Sustainability*. <https://doi.org/10.1080/13549839.2021.1916901>
- Ahmed, S. and Eklund, E. 2021. “Climate Change Impacts in Coastal Bangladesh: Migration, Gender and Environmental Injustice.” *Asian Affairs* 52 (1): 155–174. <https://doi.org/10.1080/03068374.2021.1880213>



- Alam, M.M., M.A. Hossain, and S. Shafee. 2003. "Frequency of Bay of Bengal cyclonic storms and depressions crossing different coastal zones." *International Journal of Climatology* 23(9): 1119–1125.
- Alston, M, and Akhter, B. 2016. "Gender and Food Security in Bangladesh: The Impact of Climate Change." *Gender, Place and Culture: A Journal of Feminist Geography* 23 (10): 1450–64.
- Archer, E. R. M. 2003. "Identifying underserved end-user groups in the provision of climate information." *Bulletin of the American Meteorological Society* 84: 1525–1532.  
doi:10.1175/BAMS-84-11-1525.
- Asadullah, M.N., K.M.M. Islam, and Z. Wahhaj. 2021. "Child marriage, climate vulnerability and natural disasters in coastal Bangladesh." *Journal of Biosocial Science* 53 (6): 948–967
- Balikoowa, K., Nabanoga, G., Tumusiime, D. M., and Mbogga, M. S. 2019. "Gender differentiated vulnerability to climate change in Eastern Uganda." *Climate and Development* 11 (10): 839–49.
- Bardsley, D. K., and Hugo, G. J. 2010. "Migration and climate change: Examining thresholds of change to guide effective adaptation decision-making." *Population and Environment* 32 (2): 238–262. <https://doi.org/10.1007/s11111-010-0126-9>
- Bastakoti, G. B., and P. Doneys. 2020. "Gendered perceptions of climate variability, food insecurity, and adaptation practices in Nepal." *Climate and Development* 12 (6): 547–63.
- BBS Agriculture Census. 2008. *Census of Agriculture 2008*. Dhaka: Bangladesh Bureau of Statistics.

- BBS. 2015. *Population Census – Patuakhali District*. Dhaka: Bangladesh Bureau of Statistics.
- BCCSAP. 2009. *Bangladesh Climate Change Strategy and Action Plan*. Dhaka: Government of Bangladesh.
- Benevolenza, M. A., and DeRigne, L. 2019. “The Impact of Climate Change and Natural Disasters on Vulnerable Populations: A Systematic Review of Literature.” *Journal of Human Behavior in the Social Environment* 29 (2): 266–281.
- Bhattarai, B. 2020. “How do gender relations shape a community’s ability to adapt to climate change? Insights from Nepal’s community forestry.” *Climate and Development* 12 (10): 876–87.
- Black, R., Bennett, S. R. G., Thomas, S. M., and Beddington, J. R. 2011. “Climate change: Migration as adaptation.” *Nature* 478 (7370): 447–449. <https://doi.org/10.1038/478477a>
- Brammer, H. 2016. *Bangladesh: Landscapes, Soil Fertility and Climate Change*. Dhaka: University Press Ltd.
- Bryan, E., Bernier, Q., Espinal, M., and Ringler, C. 2018. “Making climate change adaptation programmes in sub-Saharan Africa more gender responsive: insights from implementing organizations on the barriers and opportunities.” *Climate and Development* 10 (5): 417–31.
- Carr, E. R., Fleming, G., and Kalala, T. 2016. “Understanding Women’s Needs for Weather and Climate Information in Agrarian Settings: The Case of Ngetou Maleck, Senegal.” *Weather, Climate, and Society* 8 (3): 247–264.
- Cannon, T. and Mueller-Mahn, D. 2010. “Vulnerability, resilience, and development discourses in context of climate change.” *Natural Hazards* 55 (3): 621–635.

- CDMP 2. 2014. *Disaster management planning and implementation, Kalapara Upazila, Patuakhali district*. Dhaka: Ministry of Disaster Management and Relief.
- Choudhury, M.U.I., C.M. Haque, A. Nisha, and S. Byrne. 2021. “Social learning for building community resilience to cyclones: role of indigenous and local knowledge, power, and institutions in coastal Bangladesh.” *Ecology and Society* 26(1): 5.  
<https://doi.org/10.5751/ES-12107-260105>
- Das, M., Verma, O.P., Swain, P., Sinhababu, D.P., and Sethi, R. 2017. “Impact of Brackishwater Shrimp Farming at the Interface of Rice Growing Areas and the Prospects for Improvement in Coastal India.” *Journal of Coastal Conservation* 21 (6): 981–92.
- Dasgupta, S., Huq, M., and Wheeler, D. 2015. *Drinking Water Salinity and Infant Mortality in Coastal Bangladesh*. Washington, D.C.: World Bank Group.
- Dasgupta, S., D. Wheeler, M.I. Sobhan, S. Bandyopadhyay, A. Nisha, and T. Paul. 2020. *Coping with Climate Change in the Sundarbans: Lessons from Multidisciplinary Studies*. Washington, D.C.: The World Bank.
- De Lellis, P., M. Ruiz, and M. Porfiri. 2021. “Modeling Human Migration Under Environmental Change: A Case Study of the Effect of Sea Level Rise in Bangladesh.” *Earth’s Future* 9. e2020EF001931 <https://doi.org/10.1029/2020EF001931>
- Dewan, C. 2021. *Misreading the Bengal Delta: Climate Change, Development, and Livelihoods in Coastal Bangladesh*. Seattle: University of Washington Press.
- Dhakal, S. P., and Mahmood, M.N. 2014. “International aid and cyclone shelters in Bangladesh: adaptation or maladaptation?” *Contemporary South Asia* 22 (3): 290–304.

- Duffy, C., Toth, G., Cullinan, J., Murray, U., and Spillane, C. 2021. “Climate smart agriculture extension: gender disparities in agroforestry knowledge acquisition.” *Climate and Development* 13 (1): 21-33.
- Ellis, F. 2000. *Rural livelihoods and diversity in developing countries*. Oxford: Oxford University Press.
- Enarson, E. 2000. *Gender and natural disasters*. Working paper 1. Recovery and Reconstruction Department. Geneva: ILO.
- Erwin, A., Z. Ma, R. Popovici, E.P.S. O’Brien, L. Zanotti, Z. Zeballos, J. Bauchet, N.R. Calderon, and G.R.A. Larrea. 2021. “Intersectionality shapes adaptation to social-ecological change.” *World Development* 138. <https://doi.org/10.1016/j.worlddev.2020.105282>
- Evertsen, K. F., and van der Geest, K. 2020. “Gender, environment and migration in Bangladesh.” *Climate and Development* 12 (1): 12–22.
- Gioli, G., Khan, T., Bisht, S., and Scheffran, J. 2014. “Migration as an adaptation strategy and its gendered implications: A case study from the Upper Indus basin.” *Mountain Research and Development* 34 (3): 255–265. <https://doi.org/10.1659/MRD-JOURNAL-D-13-00089.1>
- GoB. 2021. Kalapara Upazila. <http://kalapara.patuakhali.gov.bd/>
- Gumucio, T., Hansen, J., Huyer, S., and van Huysen, T. 2020. “Gender-responsive rural climate services: a review of the literature.” *Climate and Development* 12 (3): 241–54.
- Habibullah, M., Ahmed, A.U., and Karim, Z. 1998. “Assessment of Foodgrain Production Loss Due to Climate Induced Enhanced Soil Salinity.” In *Vulnerability and Adaptation to*

- Climate Change for Bangladesh*, edited by S. Huq, Z. Karim, M. Asaduzzaman, and Mahtab, F., 55–70. The Netherlands: Kluwer Academic Publishers.
- Hafiza, S., and Neelormi, S. 2015. *Climate Resilient and Empowering Livelihoods for Women*. Dhaka: UN WOMEN.
- Hamid, S., A. U. M., and F. Richard. 2014. *Stillbirth-a neglected priority: understanding its social meaning in Pakistan*.  
<http://dspace.itg.be/bitstream/handle/10390/7894/2014jpma0331.pdf?sequence=1>
- Hayward, G. and S. Ayeb-Karlsson. 2021. “‘Seeing with Empty Eyes’: a systems approach to understand climate change and mental health in Bangladesh.” *Climatic Change* 165: 29.  
<https://doi.org/10.1007/s10584-021-03053-9>.
- Henriksson, R., Vincent, K., Archer, E. and Jewitt, G. 2020. “Understanding gender differences in availability, accessibility and use of climate information among smallholder farmers in Malawi.” *Climate and Development* DOI: 10.1080/17565529.2020.1806777
- Hossain, N. 2015. “Analysis of Human Vulnerability to Cyclones and Storm Surges Based on Influencing Physical and Socioeconomic Factors: Evidences from Coastal Bangladesh.” *International Journal of Disaster Risk Reduction* 13: 66–75.
- Huq, S., and Ayers, J. 2007. *Critical List: The 100 Nations Most Vulnerable to Climate Change. Sustainable Development Opinion*. London: International Institute for Environment and Development. <http://pubs.iied.org/pdfs/17022IIED.pdf>.
- IPCC 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Cambridge: Cambridge University Press.

- Islam, S. M. 2008. "From Sea to Shrimp Processing Factories in Bangladesh: Gender and Employment at the Bottom of a Global Commodity Chain." *Journal of South Asian Development* 3(2): 211 – 236.
- Islam, M. A., Hoque, M. A., Ahmed, K. M., and Butler, A. P. 2019. "Impact of Climate Change and Land Use on Groundwater Salinization in Southern Bangladesh—Implications for Other Asian Deltas." *Environmental Management* 64 (5): 640–49.
- Jalan, J., and Ravallion, M. 1999. "Are the poor less well insured? Evidence on vulnerability to income risk in rural China." *Journal of Development Economics* 58 (1): 61–81.
- Jordan, J. C. 2019. "Deconstructing resilience: why gender and power matter in responding to climate stress in Bangladesh." *Climate and Development* 11 (2): 167–79.
- Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., Tapio-Bistrom, M-L., Nelson, S., and Kristjanson, P. 2016. "Understanding Gender Dimensions of Agriculture and Climate Change in Smallholder Farming Communities." *Climate & Development* 8 (2): 133–144.
- Khan, A. E., Ireson, A., Kovats, S., Mojumder, S. K., Khusru, A., Rahman, A., and Vineis, P. 2011. "Drinking water salinity and maternal health in coastal Bangladesh: implications of climate change." *Environmental Health Perspectives* 119 (9): 1328–1332.  
<https://doi.org/10.1289/ehp.1002804>
- Khan, A.E., Scheelbeek, P. F. D., Shilpi, A.B., Chan, Q., Mojumder, S. K., Rahman, A., Haines, A., & Vineis, P. 2014. "Salinity in drinking water and the risk of (pre)eclampsia and gestational hypertension in coastal Bangladesh: a case-control study." *PLoS ONE* 9 (9): e108715. <https://doi.org/10.1371/journal.pone.0108715>

- Kingsbury, B. 2018. *An Imperial Disaster: The Bengal Cyclone of 1876*. London: C Hurst & Co Publishers Ltd.
- Lázár et al. 2015. “Agricultural livelihoods in coastal Bangladesh under climate and environmental change – a model framework.” *Environmental Science: Processes & Impacts* 17 (6): 1018–1031.
- Lee, D., H. Ahmadul, J. Patz, and P. Block. 2021. “Predicting social and health vulnerability to floods in Bangladesh.” *Natural Hazards and Earth System Sciences* 21: 1807–1823.
- Local Government Engineering Department. (2021). Kalapara Map.  
<https://oldweb.lged.gov.bd/ViewMap2.aspx?DistrictID=1>
- Maharjan, A., Bauer, S., and Knerr, B. 2012. “Do Rural Women Who Stay Behind Benefit from Male Out-migration? A Case Study in the Hills of Nepal.” *Gender, Technology and Development* 16 (1): 95–123.
- Mahumud, R. A., M. Sultana, and A. R. Sarker. 2017. “Distribution and determinants of low birth weight in developing countries.” *Journal of Preventive Medicine and Public Health* 50(1): 18. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5327679/>
- Maharjan, A., Tuladhar, S., Hussain, A., Mishra, A., Bhadwal, S., Ishaq, S., Saeed, B. A., Sachdeva, I., Ahmad, B., Ferdous, J., and Hassan, S. M. T. 2021. “Can labour migration help households adapt to climate change? Evidence from four river basins in South Asia.” *Climate and Development* <https://doi.org/10.1080/17565529.2020.1867044>
- Massey, D.S., W.G. Axinn, and D.J. Ghimire. 2010. Environmental change and out-migration: evidence from Nepal. *Population and Environment* 32: 109–136.
- McLeman, R. A., and Smit, B. 2006. “Migration as an adaptation to climate change.” *Climatic Change* 76 (1): 31–53. <https://doi.org/10.1007/s10584-005-9000-7>

- Momtaz, S. and M. Shameem. 2016. *Experiencing Climate Change in Bangladesh: Vulnerability and Adaptation in Coastal Regions*. London: Academic Press.
- Moriss, S.S., and Wodon, Q. 2003. "The allocation of natural disasters relief funds: Hurricane Mitch in Honduras." *World Development* 31 (7): 1279–89.
- Morsalin, S.S. and M.R. Islam. 2021. "Landlessness as the key challenge to climate change adaptation of the rural poor in Bangladesh: an empirical study." *Asian Geographer*. <https://doi.org/10.1080/10225706.2021.2015694>
- Mulyani, E. Y., Hardinsyah, H., Briawan, D., and Santoso, B. I. 2018. "The impact of dehydration in the third trimesters on pregnancy outcome-infant birth weight and length." *Jurnal Gizi dan Pangan* 13 (3): 157–164.
- Musinguzi, L., Natugonza, V., Efitre, J., and Ogutu-Ohwayo, R. 2018. "The role of gender in improving adaptation to climate change among small-scale fishers." *Climate and Development* 10 (6): 566–76.
- Nalau, J., E. Torabi, N. Edwards, M. Howes, and E. Morgan. 2021. "A critical exploration of adaptation heuristics." *Climate Risk Management* 32: 1011292. <https://doi.org/10.1016/j.crm.2021.100292>
- Noble, I.R., S. Huq, Y.A. Anokhin, J. Carmin, D. Goudou, F.P. Lansigan, B. Osman-Elasha, and A. Villamizar, 2014: Adaptation needs and options. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 833-868



- O'Donnell, M., Mente, A., Alderman, M. H., et al. 2020. "Salt and cardiovascular disease: insufficient evidence to recommend low sodium intake." *European Heart Journal* 41 (35): 3363–3373.
- Paprocki, K. 2021. *Threatening Dystopias: The Global Politics of Climate Change Adaptation in Bangladesh*. Ithaca and London: Cornell University Press.
- Paul, B.K. 2009. "Why relatively fewer people died? The case of Bangladesh's Cyclone Sidr." *Natural Hazards* 50: 289–304.
- Poelma, T., Bayrak, M. M., Nha, D., and Tran, T. A. 2021. "Climate Change and Livelihood Resilience Capacities in the Mekong Delta: A Case Study on the Transition to Rice–shrimp Farming in Vietnam's Kien Giang Province." *Climatic Change* 164 (1-2).  
10.1007/s10584-021-02973-w
- Qu, F., W. Yan, Z. Yu-Hang, B. John, D. Tao, B. Gianluca, M. Ruth, Todd, B. K., W. Fang-Fang, and P.J. Hardiman. 2017. "The association between psychological stress and miscarriage: a systematic review and meta-analysis." *Scientific Reports* 7(1): 1-8.  
<https://www.nature.com/articles/s41598-017-01792-3>
- Rahman, H. M. T., and Hickey, G. M. 2019. "What Does Autonomous Adaptation to Climate Change Have to Teach Public Policy and Planning About Avoiding the Risks of Maladaptation in Bangladesh?" *Frontiers in Environmental Science*  
<https://doi.org/10.3389/fenvs.2019.00002>.
- Rao, N., Lawson, E. T., Raditloang, W. N., Solomon, D., and Angula, M. N. 2019. "Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia." *Climate and Development* 11 (1): 14–26.

- Ray-Bennett, N.S. 2009. “The influence of caste, class, and gender in surviving multiple disaster: a case study from Orissa, India.” *Environmental Hazards* 8(1): 5–22.
- Roncoli, C., Orlove, B. S., Kabugo M. R., and Waiswa M. M. (2011). “Cultural styles of participation in farmers’ discussions of seasonal climate forecasts in Uganda.” *Agriculture and Human Values* 28: 123–138. doi:10.1007/s10460-010-9257-y.
- Roy, M., Hanlon, J., and Hulme, D. 2016. *Bangladesh Confronts Climate Change: Keeping Our Heads above Water*. London and New York: Anthem Press.
- Salzenstein, L. and R. I. Montu. 2021. How Bangladesh is beating the odds on climate disaster deaths. *The New Humanitarian* (2 December 2021).  
<https://www.thenewhumanitarian.org/investigation/2021/12/2/how-Bangladesh-is-beating-the-odds-on-climate-disaster-deaths>
- Santos, C., and Morais, J. M. 2021. “Voices of contention: the value of development narratives in the age of climate (change) migration misconceptions.” *Climate and Development* DOI: 10.1080/17565529.2021.1877103
- Siantz, M.L.de.L. 2013. Feminization of Migration: A Global Health Challenges. *Global Advances in Health and Medicine* 2(5): 12-14.
- Scheelbeek, P. F. D., Chowdhury, M. A. H., Haines, A., Alam, D.S., Hoque, M.A., Butler, A.P., Khan, A.E., Mojumder, S.K., Blangiardo, M. A. G., Elliot, P., and Vineis, P. 2017. “Drinking water salinity and raised blood pressure: evidence from a cohort study in coastal Bangladesh.” *Environmental Health Perspective* 125 (5): 057007. doi: 10.1289/EHP659.

- Scheffran, J., Marmer, E., and Sow, P. 2011. "Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa." *Applied Geography* 33: 119–127. <https://doi.org/10.1016/j.apgeog.2011.10.002>
- Schipper, E., and Lisa, F. 2020. "Maladaptation: When Adaptation to Climate Change Goes Very Wrong." *One Earth* 3 (4): 409–14.
- Sovacool, B.K. 2018. "Bamboo beating bandits: Conflict, Inequality, and Vulnerability in the Political Ecology of Climate Change Adaptation in Bangladesh." *World Development* 102: 183–194.
- Swapan, M. S. Hasan, and Gavin, M. 2011. "A Desert in the Delta: Participatory Assessment of Changing Livelihoods Induced by Commercial Shrimp Farming in Southwest Bangladesh." *Ocean & Coastal Management* 54 (1): 45–54.
- Tanjeela, M., and S. Rutherford. 2018. "The Influence of Gender Relations on Women's Involvement and Experience in Climate Change Adaptation Programs in Bangladesh." *Sage Open* 1–9. <https://doi.org/10.1177/2158244018812620>
- UN. (2021). The 17 Goals. <https://sdgs.un.org/goals>
- Vakis, R., Kruger, D., and Mason, A. 2006. *Shocks and Coffee: Lessons from Nicaragua in Income Stabilization in Agriculture: The Role of Public Policies*. Proceedings of the 86<sup>th</sup> EAAE Seminar. Anacapri, Italy, 21 – 22 October 2004: 171 – 231.
- Van Aelst, K., and Holvoet, N. 2018. "Climate change adaptation in the Morogoro Region of Tanzania: women's decision-making participation in small-scale farm households." *Climate and Development* 10 (6): 495–508.

- Webster, P. and B. Webster. 2011. *Bay of Bengal Tropical Cyclones and Convective Systems: Predictability, Prediction and the Impacts of Climate Change*. Washington, D.C.: World Bank.
- Wheeler, D. 2011. *Quantifying Vulnerability to Climate Change: Implications for Adaptation Assistance*. Washington, D.C.: Center for Global Development.
- World Bank. 2009. *Bangladesh – Policy Note on Climate Change*.  
<http://documents.worldbank.org/curated/en/2009/02/16238737/bangladesh-policy-note-climate-change> .
- Wolf, J. 2011. “Climate change adaptation as a social process.” In *Climate Change Adaptation in Developed Nations*, edited by J. Ford and L. Berrang-Ford, 21–32. Dordrecht: Springer.
- Zhang, N., Zhang, F., Chen, S., Han, F., Lin, G., Zhai, Y., He, H., Zhang, J., and Ma, G. (2020). “Associations between hydration state and pregnancy complications, maternal-infant outcomes: protocol of a prospective observational cohort study.” *BMC pregnancy and childbirth* 20 (1): 82. <https://doi.org/10.1186/s12884-020-2765-x>