Chapter 2
Strategies and Barriers to Adaptation of Hazard-Prone Rural Households in Bangladesh

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Introduction

The issues of climate change and hazards are an ongoing part of human civilization. However, poor people in developing countries whose subsistence livelihood depend upon the utilisation of natural resources are the first and most affected by the climate change which increases their vulnerability (Alam 2016; IPCC 2014; Bardsley and Wiseman 2012; McDowell et al. 2013; Salick et al. 2009; Thomas and Twyman 2005). Climate change can manifest in four main ways: (i) slow change in mean climate conditions, (ii) increased inter annual and seasonal variability, (iii) increased frequency of extreme events, and (iv) rapid climate changes causing catastrophic shifts in ecosystems (Tompkins and Adger 2004).

Bangladesh is most vulnerable to climate-driven hazards, which pose a major risk to the lives, livelihoods and food security of the 64% of the rural population who depend on agriculture (GoB 2011; IPCC 2007). Scholar argued that farmers' capacity to adapt to the compounding influences of climate change, which can affect households' resources and resilience, is uncertain due to their poor socio-economic conditions (Wood et al. 2014; Lobell et al. 2008; IPCC 2007; Adger and Vincent

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W. Leal Filho and J. Nalau (eds.), *Limits to Climate Change Adaptation*, Climate Change Management, https://doi.org/10.1007/978-3-319-64599-5_2

2005). Therefore, adaptation measures are important to help the poor communities to cope with extreme weather conditions and associated climatic variations (Niles et al. 2015; Gandure et al. 2013; Rosenzweig et al. 2013; Adger et al. 2003).

In Bangladesh, the coastal and riverine households are the most susceptible to the impacts of climate-driven hazards, including riverbank erosion (Alam et al. 2017a, b; Alam 2016, 2017; GoB 2010) and recent models of hydrological impacts of climate change in different climatic zones have shown this to be true across Asia (Eregno et al. 2013). In particular, the hazard of riverbank erosion is a common problem in Bangladesh, which contributes to the loss of both physical and material endowments through loss of land, natural resources and employment opportunities of the riverine rural households and thus threatening their food security and livelihoods (Alam et al. 2017a, b). Due to climate change, they are also expected to face a projected increase in mean annual temperature, uncertainty in rainfall, and surges in disease, pest and weed pressure on crops and livestock which might have disastrous impact on their livelihood (Alam 2016).

In Bangladesh, twenty districts out of 64 in the country are prone to the riverbank erosion (CEGIS 2012; GoB 2010); while another study asserted that some parts of 50 districts in the country are subject to riverbank erosion (Elahi et al. 1991) (see the map in Fig. 2.1). Moreover, resource-poor households in the riverine areas are more prone to the impacts of frequent floods and waterlogging due to their proximity to the river, which also increases their vulnerability (Alam et al. 2016). About 8700 ha of homestead and farming land are lost to riverbank erosion, which displaces approximately 200,000 people annually (GoB 2010).

Despite increasing recognition of the need of adaptation to reduce such households' vulnerability, limited research, however, has so far been carried out in the domain of adaptation (discussed in section "Review of Literature"). Moreover, not all communities within the country are uniformly affected by climate change and hazards due to differential livelihood options and resources for adaptation (Alam 2016). Therefore, hazards-prone resource-poor household's strategies and barriers to adaptation which is not so far explored, is crucial to formulate and implement effective and sustainable adaptation policies in Bangladesh and elsewhere.

Moreover, in terms of barriers to adaptation in Bangladesh, the following ones are commonly seen: (i) cultural values which mean that people tend to remain in areas where extreme events occur (e.g., coastal and riverbank areas), (ii) lack of access to funds to implement adaptation measures, especially those related to infrastructure (iii) lack of access to technologies to adapt, and (iv) lack of a policy framework to implement adaptation measures in a sustainable way. Apart from the above, a major barrier is related to the fact that social systems make it difficult for people to reduce the adverse effects of climate on their livelihood and well-being, increasing their vulnerability. This study, using survey data from the most severe riverbank erosion-prone areas in Bangladesh, aims to provide information on adaptation strategies of the household and barriers to adaptation. The research questions to understand this are: (a) what adaptation strategies can the resource-poor households adopt to enhance their resilience?; and (b) what are the barriers to adaptation?

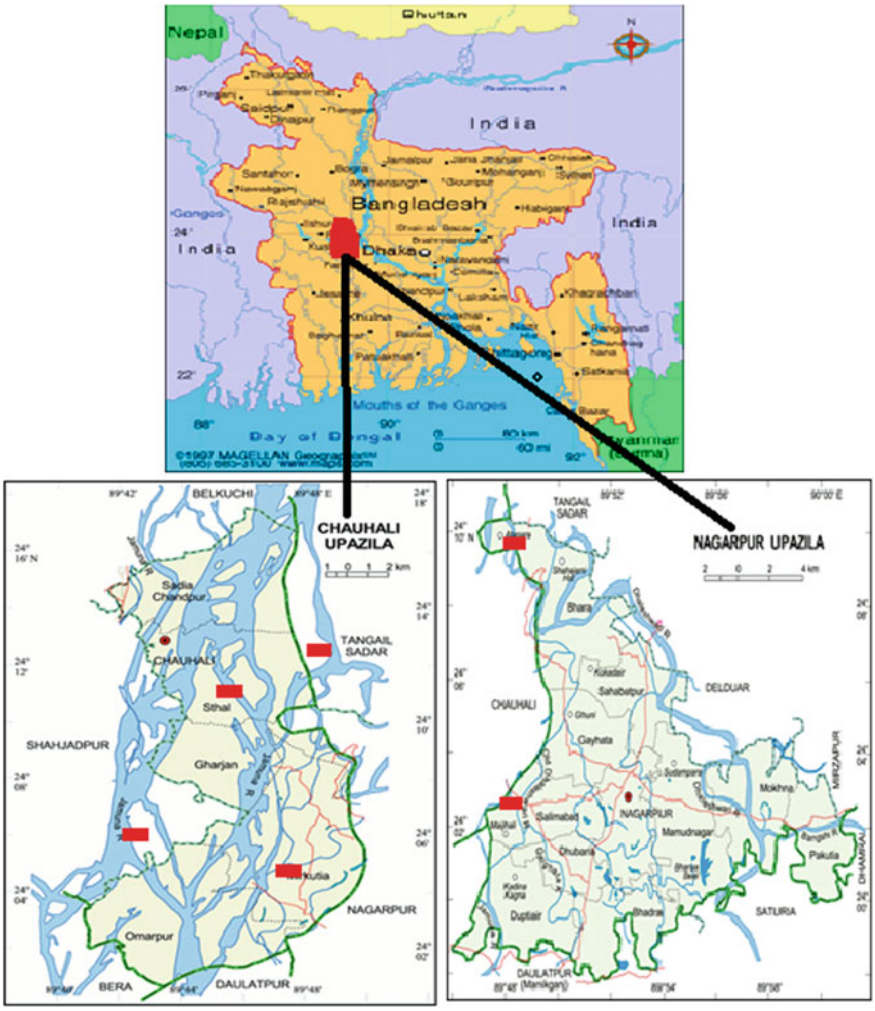

Fig. 2.1 The study areas The Nagarpur and ChauhaliUpazilas

The paper is organized as follows: a review of the literature is presented in section "Review of Literature"; "Methodology" section presents descriptions of the study areas, the data collection procedure and the analysis of the data; the results are presented and discussed in section "Results and Discussion"; and "Conclusions" section provides a summary and some policy guidelines.

Review of Literature

Globally, mitigation and adaptation are the two major policy responses to climate change. Adaptation has the potential to reduce the adverse impacts of climate change (IPCC 2001). IPCC defines adaptation as the adjustment in human or natural systems in response to climatic or environmental stimuli, which buffer harm or exploit beneficial opportunities (IPCC 2001). However, adaptation strategies vary from sector to sector, community to community and place to place (Malone and Brenkert 2008; Smit and Wandel 2006). Scholars argue that all adaptation is not good (Eriksen et al. 2011; Nyong et al. 2007). For example, the adaptation measures that deliver short-term gains and economic benefits can lead to increased vulnerability in the medium or long run (Jones and Boyd 2011). According to Smith et al. (2000), to fully understand adaptation, it is important to know three fundamentals of adaptation namely, adaptation to what, who adapt and how adaptation occurs?

There are few adaptation studies in Bangladesh that mainly focus on drought prone areas in Bangladesh (see, for example, Alam 2015; Alauddin and Sarker 2014; Sarker et al. 2013; Habiba et al. 2012). Few studies also focus on low lying and saline-prone areas (Rashid et al. 2014; Anik and Khan 2012). Though these studies provide important policy inputs, however, these might not be effective and applicable to other hazard-prone communities due to the heterogeneity of the impact of the various hazards and the socio-economic conditions of the households and therefore their responses vary (Alam 2016). This is particularly important for the most vulnerable riparian communities who are poorly resourced. There are studies on displacement and the socio-economic impacts of riverbank erosion in Bangladesh (see, for example, Alam 2016, 2017; Alam et al. 2017a, b; Ahmed 2015; Lein 2010; Hutton and Haque 2004; Makenro 2000; Elahi 1989; Zaman 1989; Rogge and Haque 1987; Greenberg 1986; Hossain 1984). However, there is a lack of in-depth empirical research on how the resource-poor hazard-prone households' response to climate change and hazards and what the factors are limiting their local adaptive responses. Scholars have argued that local level adaptation knowledge is a key to promoting the resilience of vulnerable communities (Alam et al. 2017a, b; Hiwasaki et al. 2014; Alexander et al. 2011; Green and Raygorodetsky 2010; Ellen 2007; Nyong et al. 2007). In terms of policymaking, farmers' local knowledge of adaptation strategies will have immense significance if they are supported by relevant government organizations, NGOs and research for the overall sustainability of the adaptation process in the country.

Methodology

Study Area

This study is based on the data collected from riverbank erosion-prone areas in Bangladesh as a case study. A multistage sampling technique was employed to

collect the data. The sever riverbank erosion-affected district, upazila[1] and riverine villages were selected through consultation with the local experts. For each village, respondents were selected randomly. For the field survey, the Chauhaliupazila of the Sirajgonj district and the NagarpurUpazila of the Tangail district were selected (Fig. 2.1). The area is about 200 km north of Dhaka, the capital of Bangladesh. The Jamuna[2] River crosses the study area. The erosion rate of the river was around 5000 ha/year in the 1980s but only 2000 ha/year in recent years (CEGIS 2012). Data were collected from six riverine villages—Kashpukuria, Moradpur, Kairat, Datpur, Kashkawalia and Atapara.

Sampling, Questionnaire and Data Collection

Selection of the units of analysis is considered as the entry point in social science research. The unit of analysis influences greatly to the decision of research design, data collection and data analysis. In this study, the unit of analysis was households and for data collection, the household head (either male or female) was the survey participant. In Bangladesh, household heads have the power to exercise decision-making over household's resources and setting strategies (Alam 2016). First, a complete list of riverine households in the selected villages was collected from the Department of Agricultural Extension. In each village, 15% of the household heads were interviewed, which gives a sample size of 380 households for the study. For the cross-sectional household survey, 5% of the population is considered to be adequate (Bartlett et al. 2001). To ensure randomness in the sampling, a computer-generated random number table was applied to the list to select the 380 households.

Before data collection commenced, a structured survey questionnaire was tested with 20 respondents to ensure the adequacy of the information obtained and to avoid any ambiguity in the questions. Data were collected using face-to-face interviews between January and May 2014. The questionnaire sought information on the impact of climatic hazards, including riverbank erosion, on livelihoods and their response strategies. In the case of adaptation strategies, the respondents were asked about their range of practices. The respondents were also asked to mention the factors that limiting their successful adaptation.

Data Analysis

Descriptive analysis and Chi-square test were conducted to see whether there were differences between the farming groups in the adoption of adaptation strategies.

[1]Lower administrative unit of government; below district level but above village level.

[2]Bangladesh is composed of the floodplains and the deltas of three main rivers—the Padma (Ganges in India), the Jamuna and the Meghna (Brahmaputra in India).

Due to the small size of the land holdings, the households were categorized as large farm (12%) (>2.5 acres), medium farm (28%) (1.5–2.49 acres), small farm (33%) (1.49–0.5 acres) and landless (27%) (<0.5 acres) for a meaningful presentation of the results.

Results and Discussion

The results of the study are discussed in different phases. In the first phase, the socio-economic characteristics of the respondents are presented. The adaptation strategies of the households and barriers to adaptation are described later.

Socio-economic Characteristics

The information of households' socio-demographic and economic characteristics is very useful to get an insight into the profile of the study households and to formulate effective policy interventions. This information can be served as the delimitation of the study so that whatever findings or outcomes derived from this study can be described within the domain of this profile (Alam 2016). Socio-economic characteristics of the study households are presented below.

Half of the household heads belong to the age group of 46–60 years (Table 2.1). Average age of the household heads is around 45 years. Currently, the life expectancy at birth in Bangladesh is 70.3 years (UNESCO 2015). The majority of household heads is male (88%) as against women of 12%. The average family size of 5.21 is relatively large compared to the national average of 5.0 (BBS 2012). More than 46% of households had six members or more. The mean education level of the household was below primary level (3.17 years). More than 29% of respondents did not attend school. In Bangladesh, the estimated literacy rate was 61.5% in 2015 (UNESCO 2015). Majority of the household heads had education level between primary and secondary level. Only 9% had more than secondary education level.

Households' farm size is relatively low since all households had experienced loss of some of their land. More than 27% household belongs to the landless group. Household occupation groups are classified according to the main source of income (i.e., >50%) (Table 2.1). As expected, most of the households in the study areas depend on agriculture (71%) which is relatively higher than national statistics (BBS 2012). Service holders or affluent households usually live in nearby town or other places that are free from erosion problems.

Since most of the farmers depend on agriculture, therefore their income level is also low. More than 50% of households belong to the income level of Tk 61,000 to Tk 150,000 per year (US$ 1 = Tk 77). Road and transport communication is also inadequate in the areas. Farmers mainly use vans, bicycles, rickshaws, scooters, and tempo driven by small machines to market their products.

Table 2.1 Some selected socio-economic characteristic of the study households

Characteristics/variables	Number	Percentage
Age of HH head (mean: 45; range: 25–65)		
≤ 30 years	36	10
31–45 years	134	35
46–60 years	191	50
61–65 years	19	5
Gender of HH head		
Male	335	88
Female	45	12
HHs family members (mean: 5.21; range: 3–11)		
3	31	8
3–5	174	45
≤ 6 members	175	46
Education (mean: 3.17 years; range: 0–16)		
Illiterate	109	29
Primary (level 1–5)	137	36
Secondary (level 6–10)	104	27
Higher secondary (level 11–12)	21	6
<Higher secondary (level 12–16)	9	2
Employment status		
Agriculture	271	71
Business + Agriculture	75	20
Services + Agriculture	34	9
HHs yearly income (Tk) (mean: 35,000 Tk; Std. 38456)		
≥ 35,000	39	10
36,000–60,000	137	36
61,000–150,000	151	40
≤ 151,000	53	14
Farm category (average farm size: 0.56 acres)		
Large farm (>2.5 acres)	45	12
Medium farm household (1.5–2.49 acres)	107	28
Small farm household (1.49–0.5 acres)	127	33
Landless (<0.5 acres)	101	27

HH household

Households' Adaptive Strategies

The study revealed that all the households were responding to climate change and hazards through adopting a range of agricultural and non-agricultural adaptation strategies. An agricultural adjustment includes various techniques to boost up crop production such as adoption of new crop varieties, changing plantation time and irrigation techniques. By adopting agricultural adjustments, households can lessen

the effects of riverbank hazard and other climate change issues on production and income. Non-agricultural adjustments, on the other hand, represent the practices that dampen the production and income ability such as sell of rest of land, livestock and poultry.

The study identified 15 farming and non-farming adaptation strategies, which were practiced by the respondents based on their long-term knowledge and perceptions of climate change (Table 2.2). Hazard-affected households response varies depending on their socio-economic conditions as well as the political and social settings. Most of the households adopted more than one strategy. Based on the respondents' main choice, the most common adaptation practices were changing plantation time, cultivation of pulses, cultivation of spices and oil seeds, homestead gardening, tree plantation and migration (Table 2.2).

Adaptation strategies were, however, shaped by farming category. A significant difference was found (χ^2-test, $p < 0.003$) in the adoption of adaptation strategies. We conducted a post-hoc analysis to see the location of the difference. The result indicates that non-agricultural adaptation was practiced mostly by small and landless farm households while agricultural adjustments were practiced mainly by large and medium farms. This indicates that wealthier farmers are in a better position to respond to the challenges posed by climate change and variability through adopting different strategies in agriculture whereas small and landless farmers have few choices.

Farmers were found to change their cultivation practices in response to the changing climate. For example, crop cultivation was found to be diversified in the study area. In the past, farmers rarely cultivated horticultural and cereal crops, and large parts of their farmland remained fallow in the dry season. Large and medium farmers (farmers with cultivatable land) were found to be adopting the HYV rice and wheat varieties as part of their response to the changing climatic conditions. Important changes is that they were cultivating spices and oil seeds in the newly formed char lands which had remained fallow due to the unavailability of crop varieties suitable for such land previously. In responding to the adverse effects of climate change, households were changing the planting times of their crops. Most of the land in the char areas and/or near to the river is subject to water logging and flooding during the rainy seasons. But the crops are now cultivated in a way that enables harvesting to be done before a hazard can arise. This adjustment evolved from long-term local knowledge and perceptions about the climate. Vegetable cultivation appeared to be the most common adaptation strategy in the study area. During field visit it was observed that small and landless farmers cultivated different types of short duration winter and summer vegetables.

The continuous loss of land through riverbank erosion is the main problem for the households. In order to ensure the sustainable use of the available land, households were practicing homestead gardening and tree plantation, particularly the small and landless farmers (Table 2.2). Homestead gardening provides a continuous supply of nutrients in the food chain and can be an important source of income. However, the small and the landless farmers have limited access to financial institutions and extension services. They were undertaking small

Table 2.2 Adaptation strategies of the households in the study area

Adaptive measure	Responses	Farm category			
		Large	Medium	Small	Landless
Agricultural adjustment					
Change planting time	8	x	x	x	
Cultivation of pulses	11	x	x	x	
Cultivation of wheat and other crops	4	x	x	x	
Tree plantation	6	x	x		
Cultivation of spices and oil seed	10	x	x	x	x
Cultivation of local Aman rice	5	x	x		
Cultivation of vegetables	6	x	x	x	x
Cultivation of HYV rice varieties (e.g., BRRI-28, 29)	8	x	x	x	x
Livestock rearing	7	x	x	x	x
Poultry rearing	5		x	x	x
Duck rearing	3			x	x
Homestead gardening	5			x	x
Non-agricultural adjustment					
Migration	12			x	x
Off-farm work (van, rickshaw, tampo driving)	7			x	x
Petty business	3			x	x

[a]According to main adaptation strategies although there were multiple options

businesses such as grocery shops, a tea stall and vendoring that require less capital. Many of them had taken up driving as their occupation in the face of diminishing employment in farming. Government organizations and NGOs can play an enabling role in improving their livelihoods by providing training and financial support.

Migration, both seasonal and permanent, was also found to be an important adaptation strategy, especially for the small and the landless farmers. Households with limited agricultural land used to migrate in search of alternative livelihoods for a few months. This temporary migration is very common in the study area, especially during the rainy seasons when there is limited scope for farming and non-farming employment. This local level knowledge of adaptation is crucial for policy makers to support and promote adaptation strategies, and to turn them into effective and sustainable action.

Limiting Factors to Adaptation

While the study households were found adopting a range of adaptation strategies, however, they reported some barriers that preventing them from successful adaptation. The respondents were asked to mention the limiting factors to adaptation and

categorise these into 'main barriers' and 'barriers' only. They mentioned nine limiting factors for successful adaptation. The main barriers include lack of information about riverbank erosion and related climatic issues, knowledge of appropriate adaptation, appropriate crop varieties and credit facility (Table 2.3). They also mentioned other post-production related problems such as lack of storage facilities, marketing and transportation facilities, which is crucial for policy intervention towards improving their livelihood.

Understandably the barriers were felt heterogeneously among the farming groups. For example, the households who had relatively less land ownership were mentioned the lack of credit, own land and knowledge about appropriate adaptation as the main barriers to adaptation. There was highly significant ($p < 0.007$) lower average land size among the households who mentioned these as a main barrier compared to the rest of the respondents who did not mention these as a main barrier (independent sample t test). In case of credit, the large and medium farmers have had relatively better access to both government and NGOs credit facilities. The small and landless farmers in particular have hardly any access to government credit facilities, which appeared to be the main barriers for them (Table 2.3). The lack of institutional access and credit facilities can limit their ability to get the necessary resources and technologies they might want to adapt to the changing condition. Since the small and landless farmers have resource limitations therefore access to financial institution is crucial for them to promote adaptation.

Moreover, the large and medium farmers stated the lack of storage and marketing facilities as their main barriers that might prevent them from getting the right price of their products. The fact is that traders were not able to come in the area due to the poor road transportation system. Even the small and landless labours who are in need of seasonal job were not able to go to the cities easily due to the poor transportation system.

Table 2.3 Perceived barriers to adaptation measures

Barriers to adaptation	Response by farm category			
	Large	Medium	Small	Landless
Lack of information about riverbank erosion and related climatic issues	√√	√√	√√	√√
Lack of appropriate variety	√√	√√	√√	–
Lack of knowledge concerning appropriate adaptation	√	√	√√	√√
Lack of credit/money/saving	–	√	√√	√√
Lack of suitable land for cultivation	–	–	√√	√√
Lack of own land	–	–	√√	√√
Lack of storage facilities	√√	√√	–	–
Lack of marketing facilities	√√	√√	√√	–
Lack of transportation facilities	√	√	√	√

Where, √√ = main barriers, √ = barriers

Conclusions

Most of the farmers of Bangladesh depend on agriculture for their livelihood, which is most vulnerable to climate change. This chapter provides information of vulnerable households' adaptation strategies based on their farming status and barriers to adaptation in Bangladesh. The study reveals that farmers have adopted a range of adaptation strategies, which vary significantly among farming groups. The large and medium farmers have adopted mainly agricultural adjustments such as diversifying crops and tree plantation whereas the small and landless farmers mostly adopted non-agricultural adjustment such as driving and migration. They have also adopted the strategies of homestead gardening, and poultry and duck rearing towards improving their food security and livelihood.

Study also reveals some barriers to adaptation, which limit their successful adoption of adaptation strategies. The important barriers include lack of information about riverbank erosion and related climatic issues, knowledge of appropriate adaptation, appropriate crop varieties and credit facility. The lack of institutional access and credit facilities particularly for small and landless farmers can limit their ability to get the necessary resources and technologies they might want to adapt to the changing condition.

Scientists need to continue to develop crop varieties, high-value and flood-prone crops and technologies suitable to local conditions, especially in the emerging char lands, to accelerate the adaptation process. The NGOs should come forward to disseminate various information including successful adaptation among farmers and stimulate them to adopt with appropriate support such as credit and technical support. Development of improved communication, transportation and access to markets and services also vitally important to accelerate the effective and logical adoption of adaptation processes in these vulnerable areas. This will enhance the resilience of vulnerable households in riparian areas across Bangladesh.

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