DISASTER PREPAREDNESS AT HOUSEHOLD AND COMMUNITY LEVELS: THE CASE OF CYCLONE PRONE COASTAL BANGLADESH

A Dissertation

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by

Md. Nasif Ahsan

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Abstract

Within the current framework of disaster risk management, the main focus has been shifted from post-disaster rehabilitation to a holistic pre-disaster preparedness approach in Bangladesh. As a result, the mortality rate due to tropical cyclones has significantly decreased over the last four decades. However, the socioeconomic asset loss has not decreased as much as the mortality rate. This dissertation explores the status of disaster preparedness for tropical cyclones in the southwestern coastal area of Bangladesh. Considering cyclone evacuation decisions and disaster training participation as two key parameters of disaster preparedness, this dissertation navigates with three objectives: (i) to identify factors affecting evacuation decisions and actions at the household level, (ii) to identify the impact of preparedness training on making at-risk people socioeconomically resilient to hazard shocks, and (iii) to overview community level preparedness actions in in reducing disaster risks. Utilizing primary data collected through structured questionnaires from (1) households and (2) disaster managers and their associates at the community level, this dissertation focuses on the hazard event of tropical cyclone Aila, which made landfall in May 2009 in coastal Bangladesh. Different test statistics such as a z-test, chi-squared test, and correlation are applied as analytical tools to perform quantitative analyses. In addition, Principal Component Analysis (PCA) and Regression models are used for the first two objectives, respectively. For the third objective, only descriptive statistics is applied.

In order to realize the first objective, a systematic literature review and an empirical case study are performed. Major findings from the literature review reveal that the evacuation decision during cyclones is driven by different factors of early warning, risk perception, and evacuation decision-making processes. Findings from the empirical case study suggest that the factors related to warning messages, the attributes of cyclone shelters, risk perception, and socioeconomic issues of the households affected evacuation decision making. Major findings for the second objective suggest that despite the detrimental impacts in terms of consumption shock, financial damage, and limited access to basic utilities due to Cyclone Aila, participation in cyclone

preparedness training seems to improve the resilience capacity of people at risk, as reflected through their better adaptive (both anticipatory and reactive) capacities, response, and recovery. Key findings for the third objective reveal the pros and cons of the existing practices of disaster preparedness actions carried out by the disaster managers, including their associates at the community level. These existing preparedness actions at the community level are found to help the at-risk people not only to become aware about the hazard risks but also to respond (e.g., seeking information, performing necessary actions before evacuation) properly before, during, and after hazards.

This dissertation concludes by proposing a number of hard and soft policy recommendations based on empirical findings from the household and community levels. The hard policy measures include the construction of additional cyclone shelters and killas to accommodate both people and animals during hazard times. The soft policy measures suggest upgrading the existing cyclone warning system, innovating the warning message content, disseminating warnings through voice messages in local dialects through community radio and mobile phones, arranging more preparedness training with specific modules on practical to-dos during emergencies, and ensuring efficient preparedness actions by demolishing gaps between activities of GOs and NGOs by properly executing the Disaster Management Act in Bangladesh. Proper implementation of the suggested measures is likely to synergize preparedness actions between the household and community levels, which will safeguard not only at-risk peoples' lives but also the socioeconomic assets for their livelihoods.

Keywords: Tropical cyclone, Bangladesh, evacuation, preparedness training, households, community

The author works at the International Centre for Water Hazard and Risk Management (ICHARM), Japan

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Md. Nasif Ahsan
Tsukuba, Ibaraki

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List of Abbreviations

AAL	Average Annual Loss
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Center
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
CCA	Climate Change and Adaptation
CNN	Cable News Network
CPP	Cyclone Preparedness Programme
CS	Cyclone shelter
DM	Disaster Management
DMB	Disaster Management Bureau
DMC	Disaster Management Committee
DRR	Disaster Risk Reduction
EW	Early Warning
EWS	Early Warning System
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GO	Government Organization
IFRC	International Federation of Red Cross and Red Crescent Societies
IGA	Income Generating Activities
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
JAXA	Japan Aerospace Exploration Agency
Km.	Kilometer
LG	Local Government
LGED	Local Government Engineering Department
MoDMR	Ministry of Disaster Management and Relief
NGO	Non-Government Organization
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
OLS	Ordinary Least Squared
PADM	Protective Action Decision Model

PAR	Pressure and Release
PCA	Principal Component Analysis
PSW	Pond Sand Filter
RRF	Risk Reduction Fair
RWH	Rain Water Harvest
SCT	Social Cognitive Theory
SE	Standard Error
SOD	Standing Orders on Disaster
SREX	Special Report on Extreme Events
SWC	Storm Warning Centre
SWOT	Strength, Weakness, Opportunity, Threat
UDMC	Union Disaster Management Committee
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UP	Upazilla Parishad
WCDR	World Conference on Disaster Reduction
WHO	World Health Organization

1. Introduction

1.1. Background of the Dissertation

Statistical data suggests that an increase in natural hazards over the last two decades has been triggered by the impact of global climate change in most parts of the world (Birkmann & Teichman, 2010). These hazards account for an estimated global average annual loss (AAL) equivalent to US$314 billion, which would be nearly US$70 per working-aged individual if the said global amount is shared equally among the world's total population (United Nations International Strategy for Disaster Reduction [UNISDR], 2015a, p. 55). Among natural hazards, tropical cyclones globally affect 660 million people and contribute to AAL by just over 25% (Centre for Research on Epidemiology of Disasters [CRED], 2015, p. 18; UNISDR, 2015). The latest assessment report (AR5) by the Intergovernmental Panel on Climate Change (IPCC) suggests that among different natural hazards, the frequency of tropical cyclones is likely to either decrease or remain unchanged in the future, globally; however, the intensity of these extreme events is likely to increase, with heavier precipitation and maximum wind speed causing a higher degree of imminent disaster risk from tropical cyclones (IPCC, 2014).

Bangladesh, a South Asian developing nation, is well recognized in the both scientific and negotiating communities as a hotspot of diverse natural hazards, including tropical cyclones, floods, droughts, river erosion, temperature anomalies, tornados, and landslides (Emergency Data Base [EM-DAT], 2016). Of these natural hazards, tropical cyclones have become a regular phenomenon in the last two decades, causing miserable suffering to millions of coastal inhabitants who are vulnerable to the hazard shocks (Government of Bangladesh [GoB], 2005). In addition, these coastal people at risk live in an extremely dynamic estuarine flat plain where both the intensity and frequency of tropical cyclones are very high (Parvin & Shaw, 2013). Over time, Bangladesh has become a cyclone-prone country due to its geographical location. Every year nearly 10% of the world's cyclones originate in the Indian Ocean and the adjacent Bay of Bengal, contributing to at least 85% of the cyclone-led damages worldwide (Choudhury, 2002). People at risk in coastal Bangladesh are the worst victims of these cyclones and storm surges, which are the most lethal cascading effects[1] from cyclones due to the low elevation of the land (Chowdhury, Bhuyia, Choudhury, & Sen, 1993). Furthermore, the funnel-pattern coastline

[1] In the disaster risk domain, "cascading effects" refers to the drivers turning relatively minor hazards into significant socioeconomic impacts on the living standard of the affected people (Xie et al., 2014).

decreases the width of cyclone-triggered surges but at the same time increases their height at the northern part of the Bay of Bengal (Flierl & Robinson, 1972). Every year, on average, at least 17 tropical cyclones form in the Bay of Bengal, peaking from April to May (i.e., summer time) and then from October to December (i.e., winter time) (Alexander, 1993; GoB, 2013; Haque, 1997).

Table 1.1. Major tropical cyclone-caused mortality in Bangladesh.

Time	Name of the cyclone	Category (wind speed)	Mortality
Year 1970	Cyclone Bhola	Super Cyclonic Storm (Wind speed: 222 km/h)	300,000
Year 1985	Tropical Cyclone	Very Severe Cyclonic Storm (Wind speed: 154 km/h)	11,069
Year 1988	Tropical Cyclone	Very Severe Cyclonic Storm (Wind speed: 160 km/h)	5,708
Year 1991	Cyclone Gorky	Super Cyclonic Storm (Wind speed: 235 km/h)	138,000
Year 2007	Cyclone Sidr	Super Cyclonic Storm (Wind speed: 260 km/h)	3,500
Year 2009	Cyclone Aila	Very Severe Cyclonic Storm (Wind speed: 120 km/h)	150
Year 2016	Cyclone Roanu	Severe Cyclonic Storm (Wind speed: 100 km/h)	26

Source: Asian Disaster Preparedness Center [ADPC], 2002; Cyclone Preparedness Programme [CPP], 2016; United Nations Development Programme [UNDP], 2010.

Over time, cyclone-induced mortality has been decreased significantly in Bangladesh, as shown by Table 1.1. Such a scenario implies that people at risk seem to become conscious about their roles during an imminent hazard threat. Again, such a level of consciousness is likely to be driven by different disaster preparedness actions adopted and implemented by the stakeholder agencies in the last several decades. In recent time Bangladesh has been well recognized for its disaster management ability. Within South Asia, Bangladesh was the first country to establish a separate Disaster Management Bureau to deal with crises from natural hazards. An example of the ability of the stakeholder agencies (GOs and NGOs) to manage emergency situations in Bangladesh is the case of the very recent tropical cyclone Roanu (International Institute for Environment and Development [IIED], 2016) that made landfall on 22 May 2016 along the southwest, south, and southeast coastal parts of Bangladesh. Within a span of less than three days, half a million people were shifted to safer locations with the help of the GOs and NGOs (Cable News Network [CNN], 2016). Twenty-six deaths were reported during this cyclone across the coastal areas, with a massive destruction of physical assets (*Daily*

Star, 2016). Nonetheless, it is also reported that a good number of people at risk did not comply with the evacuation advisory disseminated by the concerned agencies (e.g., CPP volunteers, radio news) (*Daily Purbanchal*, 2016). This scenario is consistent with those of cyclone Gorky (in 1991), cyclone Sidr (in 2007), and cyclone Aila (in 2009), when on average 25% of the victims were not interested in evacuating even after receiving the evacuation orders (Bern et al., 1993; Haque, 1995; Mallick, Rahaman, & Vogt, 2011; Paul & Dutt, 2010; UNDP, 2010, p. 9). Even though preparedness for cyclone hazards has been significantly improved in Bangladesh in recent decades, still the disaster preparedness activities carried out by stakeholder agencies do not appear to be operated as efficiently as they should have been, which is reflected by the case of non-compliance of at-risk people during different cyclones. In addition, how the preparedness actions in terms of training are making the households resilient to hazard shocks has not been investigated well. In this backdrop, it is necessary to investigate why the households are motivated or dissuaded to evacuate at the time of imminent cyclone threat, how the preparedness actions (e.g., training) are making the households more resilient against hazard shocks, and which community level actions play key roles in making those people better prepared for disasters.

1.2. Objectives and Rationale for the Spatial Focus of the Dissertation

Considering the aforementioned issues of evacuation compliance and training in the issue of disaster preparedness in Bangladesh, this dissertation navigates with the following three broad objectives:

1) to identify factors affecting evacuation decisions and action at the household level,
2) to identify impact of preparedness training in making at-risk people socioeconomically resilient to hazard shocks, and
3) to overview community level preparedness actions in reducing disaster risks.

The aforementioned objectives are recognized in this dissertation by performance of a local level study. In this backdrop we put spatial focus on a southwestern coastal area in Bangladesh known as Koyra, which is a sub-district. Koyra belongs to the exposed coastal region of Bangladesh that has the following geophysical pattern: an interplay of tidal regime (i.e., high tide and low tide), salinity intrusion, and cyclone-triggered storm surge. This identical geophysical pattern has caused a different lifestyle for its inhabitants, with a higher incidence of poverty, a lower living standard, and very limited livelihood opportunities. Furthermore, this area often suffers from multifarious natural hazard threats and vulnerability, especially cyclone

threats. In the recent past, two consecutive cyclones—Sidr in 2007 and Aila in 2009—battered this area, resulting in significant damage to economic and noneconomic assets. Such damages cause detrimental impacts on the economic prospects of this area, where such prospects consist of proximity to the seashore and ecosystem benefits from the world's largest mangrove forest, *Sundarbans*. For example, people highly depend on fishery, fry-collection, timber, *golpata* (nipa-palm), and honey collection for their earnings, and for these activities they depend on the shoreline and the *Sundarbans.* In addition, Koyra has become a popular gateway of tourism with the *Sundarbans,* which creates an income prospect for the local people. In the recent past a number of studies have pointed to Koyra as one of the hot-spots of global climate change-triggered extreme events, with a domination of tropical cyclones (Ahsan & Warner, 2014; UNDP, 2010). Henceforth, this dissertation focuses on the disaster preparedness status of people at risk in Koyra, both at the household and community levels. The major findings from this dissertation are expected to provide empirical local scenarios that may be useful for formulating policy recommendations for required preparedness schemes in homogeneous coastal areas in Bangladesh and other parts of the world. Using the practical experiences, concerned stakeholder agencies are likely to prepare efficient and well-coordinated disaster preparedness actions whose implementation is likely to save not only lives but also many precious assets, as every $1 invested in disaster preparedness saves $7 after a disaster (UNDP, 2015).

1.3. Methodology of the Dissertation

As this dissertation deals with both household and community level issues, we utilize primary data for this study. For the household level we collect data from 420 households through face-to-face interviews by using a structured questionnaire, while for community level analysis, 40 disaster managers and their associates are chosen for a face-to-face interview where we also use a structured questionnaire. We apply different theoretical and analytical approaches for different Chapters in this dissertation. Chapters 2 and 3 address objective 1. We apply a systematic literature review in Chapter 2 to explore the critical factors affecting cyclone evacuation decisions in Bangladesh, and in Chapter 3 we apply the Principal Component Analysis (PCA) to identify the major determinants that actually explain evacuation decision-making at the household level. Chapter 4 deals with objective 2, where we apply Ordinary Least Squared Regression (OLS) and Ordered Logistic Regression models to perform the quantitative analysis. In both Chapters 3 and 4 we apply different parametric (e.g., z-test, correlation) and non-parametric (e.g., chi-squared) tests along with the Chapters' analytical tools. In Chapter 5,

while dealing with Objective 3, we apply simple descriptive statistical tools (e.g., table and charts) to explore the empirical findings.

1.4. Scope of the Dissertation

In general, disaster preparedness refers to the actions adopted with a view to preparing for, and lessening, the harmful consequences of disasters. In other words, such preparedness refers to the apprehension and prevention of extreme events, mitigating their effects and impacts on the people at risk, and responding to and effectively coping with their medium- and long-term adverse consequences (International Federation of Red Cross and Red Crescent Societies [IFRC], 2001). Henceforth, disaster preparedness can be considered as a consistent and synergistic process of actions from a wide spectrum of activities, rather than a specific sectoral activity. As disaster preparedness consists of multifarious actions, this dissertation particularly focuses on (i) cyclone evacuation decisions and preparedness training at the household level and (ii) different risk-reduction-oriented awareness building, response, and recovery actions at the community level. In this context, cyclone evacuation decisions and preparedness training are considered the most important disaster preparedness actions from a household perspective, while commonly applied preparedness actions are considered at the community level.

1.5. Outline of the Dissertation

This dissertation consists of seven Chapters. The current Chapter (i.e., Chapter 1) provides the background of the problem, objective, rationale, methodology, and scope of the dissertation; Chapter 2 presents a systematic literature review on factors affecting evacuation decisions in Bangladesh by considering both individual household and community phenomena. Chapter 3 shows empirical evidence on factors affecting evacuation decisions at the household level by utilizing primary data. Chapter 4 also presents primary data-based empirical findings on the contribution of disaster preparedness training on the socioeconomic resilience of households toward hazard shocks. Chapter 5 depicts the findings of different methods of preparedness and awareness-building actions at the community level, which are also obtained from primary data. Chapter 6 integrates the major findings from Chapters 2-5 into local policy suggestions and recommendations, and Chapter 7 concludes this dissertation by providing a brief idea on the contribution of this dissertation and prospects of future research.

1.6. Common Terms Used in the Dissertation

The following common terms are obtained from the glossary of terminology of the UNISDR on Disaster Risk Reduction (UNISDR, 2009) and IPCC's Special Report on Extreme Events (SREX) (IPCC, 2012a).

Adaptive capacity: The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.

Coping capacity: The ability of people, organizations, and systems, using available skills and resources, to face and manage adverse conditions, emergencies, or disasters

Disaster: A serious disruption of the functioning of a community or a society caused by the combination of hazards and conditions of vulnerability while causing widespread human, material, economic, or environmental losses that exceed the ability of the affected community or society to cope using its own resources.

Disaster risk: The potential disaster losses, in lives, health status, livelihoods, assets, and services, which could occur to a particular community or a society over some specified future time period.

Disaster risk reduction (DRR): The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Early warning system: The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Evacuation: The immediate and urgent movement of people away from the threat or actual occurrence of a hazard. This type of evacuation is commonly known as an emergency evacuation.

Exposure: People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Natural hazard: A natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Preparedness: The knowledge and capacities developed by governments, professional response and recovery organizations, communities, and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent, or current hazard events or conditions.

Recovery: The restoration, and improvement where appropriate, of facilities, livelihoods, and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

Resilience: The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Response: The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety, and meet the basic subsistence needs of the people affected.

Risk: The combination of the probability of an event and its negative consequences.

Tropical cyclone: The general term for a strong, cyclonic-scale disturbance that originates over tropical oceans. Distinguished from weaker systems (often named tropical disturbances or depressions) by exceeding a threshold wind speed. A tropical storm is a tropical cyclone with one-minute average surface winds between 18 and 32 m/s. Beyond 32 m/s, a tropical cyclone is called a hurricane, typhoon, or cyclone, depending on geographic location.

Vulnerability: The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard.

2. Literature Review[2]

2.1. Background Motivation

In recent decades, many studies have addressed a wide spectrum of issues on cyclone evacuation. In this domain, authors generally focus on how individuals interpret warning signals and messages, how they perceive hazard risks, and what type of protective response they choose as countermeasure (Dash & Gladwin, 2007; Lindell & Perry, 2012; Mileti & O'Brien, 1992). The body of literature in this domain, however, is not considerable for Bangladesh. The handful of empirical studies that address evacuation during cyclones describe the evacuation decision-making process and different factors affecting this process in coastal Bangladesh (Ahsan, Takeuchi, Vink, & Warner, 2016; Paul & Dutt, 2010; Paul, Rashid, Islam, & Hunt, 2010; Paul & Routray, 2011, 2013). In this Chapter, we briefly examine the existing literature on early warning and evacuation during rapid onset hazards (i.e., tropical cyclones) with a view to identifying and assessing important dimensions of the evacuation decision-making process in Bangladesh. In particular, we focus on the following three issues: (i) the features and roles of early warning within social communication processes, (ii) different social dimensions of risk perception, and (iii) evacuation decision-making with a focus on protective responses in Bangladesh. Therefore, within the themes of early warning, risk perception, and evacuation decision making (Sections 2.3, 2.4, and 2.5, respectively) we first discuss the issues in general and then link these discussions to the context(s) of Bangladesh. Given the ever-increasing threats from tropical cyclones in Bangladesh, this Chapter provides an overall scenario of the elements associated with cyclone evacuation decision at the household level.

2.2. Method

This review follows a systematic combination of a quantitative statistical approach and a qualitative content analysis. To identify most suitable documents and most representative indicators in line with the scope of this Chapter (i.e., evacuation), we conducted a quantitative

[2] A similar version of this chapter is published in an article form in Journal of Disaster Research, Vol. 11 (4), page 742-753, 2016, doi: 10.20965/jdr.2016.p0742

analysis in two steps, while for analyzing the thematic issues, we performed a qualitative content analysis.

2.2.1. Quantitative approach

2.2.1.1. Selection of relevant documents

Documents were selected by a relatively broad and multifaceted search strategy. Academic databases, namely Scopus and Web of Science, were used to select the relevant documents. These documents were articles, books, and book chapters published in English. The timeline considered for these documents was 1975-2015. For a comprehensive search of documents within the natural hazard domain, a combination of the following words was used: "evacuation," "cyclone," or "hurricane," as shown in Table 2.1. These searches provided nearly 900 results in the first round, which were further refined in the second round of searching by using specific words, namely: "social science" and "Bangladesh." After excluding the duplicates in the second round, we obtained 209 and 16 articles for social science and Bangladesh, respectively. We further refined the results to 209 documents by applying key words: "evacuation decision," "evacuation process," "evacuation behavior," and "evacuation strategies," which resulted in 91 documents. Out of these 91 documents, a careful screening by reading abstracts with respect to relevancy finally resulted in 25 documents (22 articles, 2 book chapters, and 1 book). This led to a final total of 41 documents, of which 25 different documents are from social science themes (excluding Bangladesh) and 16 documents (15 articles and 1 book chapter) concern Bangladesh in connection with evacuation during rapid onset hazards (i.e., cyclone).

Table 2.1. Selection process of relevant documents.

Source	**Search criteria**	**Results**	**Refined by**	**Results**	**Refined by key-words**	**Selected**
Scopus, Web of Knowledge	evacuation ; AND cyclone OR hurricane	870	social science	209*	91	25
			Bangladesh	16	16	16
Total document selected						**41**

* after duplicates are excluded

2.2.1.2. Selection of relevant indicators

In order to determine the important indicators that are most likely to influence evacuation

decisions, 225 (= 209+16 (see the fifth column of Table 2.1.)) selected documents were analyzed. A freely available software program, "VOSviewer" (www.vosviewer.com), was applied to determine the evacuation-related indicators that occurred and co-occurred in the titles and abstracts of those 225 selected documents, ignoring how many times a specific indicator was cited within a document. We set the threshold frequency (i.e., number of times a specific indicator appears in selected documents) at 20 to be considered in the VOSviewer program, which in the end provided 29 indicators from 225 documents.

Setting a threshold frequency at more or less than 20 provides either too many or too few indicators. In this case, out of 29 indicators we considered the occurrence and co-occurrence scores of each indicator and chose the top 15 indicators (≈ 52%), as shown in Table 2.2. The

Table 2.2. Indicators with themes and (co-)occurrence scores (N=225).

Serial	Indicators	Occurrence*	Co-occurrence*	Themes		
				Early warning	Risk perception	Evacuation decision-making
1	Evacuation	135	729			
2	Risk	89	519			
3	Hurricane	79	455			
4	Evacuee	72	451			
5	Warning	71	392			
6	Response	71	444			
7	Information	69	448			
8	Individual	63	391			
9	Households	57	359			
10	Resident	56	329			
11	Analysis	56	342			
12	Model	53	336			
13	Decision	47	284			
14	False alarm	43	283			
15	Preparedness	42	229			

* For a detailed explanation, please see http://www.vosviewer.com/getting-started#VOSviewer manual
Source: Analysis from VOSviewer.

scores of occurrence and co-occurrence actually reflect the bibliographic networking map for

the documents considered within the system of the VOSviewer. Appendix B presents the map of the bibliographic network of the indicators of Table 2.2. We finally categorized these 15 indicators under three broad themes: early warning, risk perception, and evacuation decision-making. In Table 2.2 the colored cells indicate the specific theme(s) related to each indicator.

2.2.2. Qualitative content analysis

Content analysis was performed by comparing the similarities and differences of the general findings with regard to early warning, risk perception, and evacuation decision-making of the 25 documents with a non-Bangladesh context with those from the 16 documents with a Bangladesh context. All of these 41 (= 25+16) documents were analyzed by using software known as QSR NVivo (version 10), which is a program that uses descriptive coding methods for qualitative analyses. The software was used to code each document for references to early warning, risk perception, and evacuation decision-making. The issues resulting from the analysis by NVivo consisted of: (a) early warning: features (language, terms, threat information, etc.), components (source, channel, receiver, etc.), and recipient characteristics (literacy level, asset possession, connection with peers, etc.); (b) risk perception: vision and hearing, language/family/peer-network, credibility of warning source, specificity of risk information, perceived hazard characteristics, and stakeholders' perception; and (c) evacuation decision: facilitators and impediments, gender issues and social norms, dependency ratio in the household, and distance to safe havens.

Out of the 41 selected documents, four documents (≈ 10%) address early warning, risk perception, and evacuation decision-making; five documents (≈ 12%) address only early warning; nine documents (≈ 22%) address only risk perception; 11 documents (≈ 27%) address only the evacuation decision-making process; and 12 documents (≈ 29%) address a combination of two of the above themes. All 41 selected documents are presented in accordance with their associated themes, dimensions, factors, and context (general/ Bangladesh) in Appendix C.

Within the scope of this Chapter, the published documents were selected by using particular search engines, namely: Scopus and Web of Science. This means we did not consider other relevant library databases such as the Academic search premier, Google scholar, University of Colorado at Boulder's natural hazards center library, the University of Delaware's disaster research center library, PubMed, or FEMA's (Federal Emergency Management Agency) resource and document library within our scope. Therefore, these library databases can be

considered within the scope of future studies on cyclone evacuation research.

As mentioned in the introduction, we first focus on the themes (i.e., early warning, risk perception, and evacuation decision-making in Sections 2.3, 2.4, and 2.5, respectively) in general and then connect these issues to the context of Bangladesh in each section. The general discussion in the listed sections is mostly based on the content analysis from 25 documents (see the first row of Table 2.1.), and the Bangladesh-related discussion is based on the content analysis of 16 documents (see the second row of Table 2.1.).

2.3. Early Warning

Slightly over 31% of the selected documents emphasize an understanding of the underlying factors that affect evacuation decisions in pre-states of disasters (Baker, 1991; Dash & Morrow, 2000; Huang, Lindell, Prater, Wu, & Siebeneck, 2012; Mileti & O'Brien, 1992; Sorensen, 2000). Warning characteristics such as the content and style of a message, channel(s) through which it is conveyed, frequency, and traits associated with its source have been the focal points of relevant previous studies, as mentioned by 12% of the selected documents (Garcia & Fearnley, 2012; Mileti & O'Brien, 1992; Mileti & Sorensen, 1990). These studies about understanding evacuation in terms of protective response suggest trust as the critical factor of a warning message that eventually leads to the decision to evacuate. Therefore, the more specific and less ambiguous (in terms of information and credibility) the warning is, the more likely it is that a protective response (i.e., evacuation) takes place. In other words, if warnings are heard, understood and believed, they are very likely to instigate evacuation.

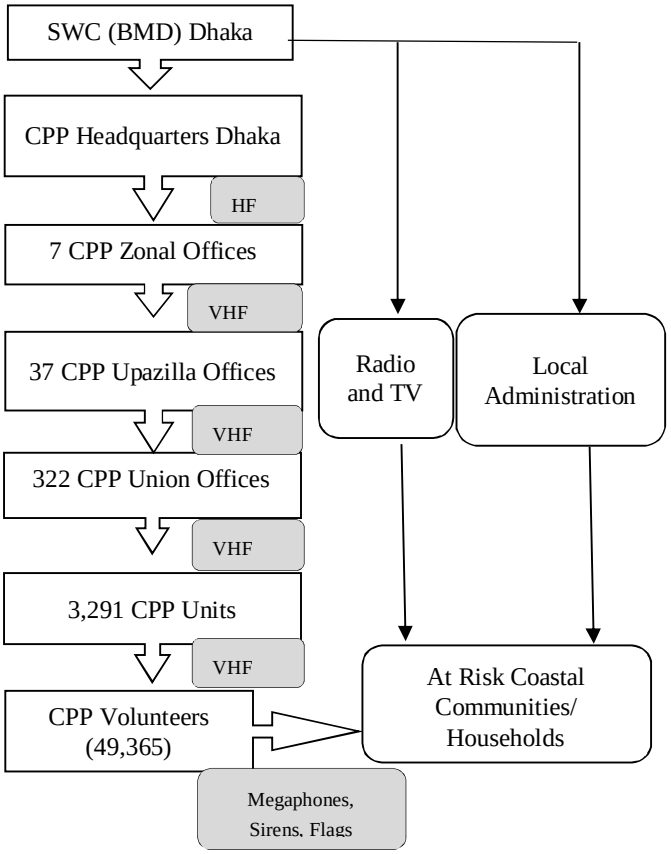

Figure 2.1. Cyclone warning dissemination process in Bangladesh.

Source: Paul et al., 2010.

A warning, as suggested by 14% of the selected documents, functions like a social process involving a range of activities as well as carrying a message, which is transmitted from a source via a channel to a recipient, resulting in a protective response that depends on the recipient's characteristics (Hanson, Vitek, & Hanson, 1979; Haque, 1995; Mesa-Arango, Hasan, Ukkusuri, & Murray-Tuite, 2013; Paul, 2012; Sorensen & Sorensen, 2007). Different individuals may receive the same warning, but some may fail to comprehend the core message in the same way. The response to such warning messages depends on, among other factors, how people interpret the content of the warning message (Wilson & Tiefenbacher, 2012). Individuals are stimulated by different environmental and social cues such as sights, smells, sounds, and the behaviors of their neighbors and peers (Lindell & Perry, 2012). For instance, even a shout of "FIRE" in a shopping mall is very likely to be heard, apprehended, interpreted, and responded to differently by different individuals. Conventionally, the words "alert" and "warning" are sometimes used interchangeably, although some distinctions exist. The National Academic Press [NAP] defines "alert" as a notification to the recipients that something significant may happen, while "warning" provides more detailed information revealing the event and suggests what protective action should be adopted by the recipient (NAP, 2013).

One way to investigate why evacuation compliance to respond to warnings varies is to understand how individuals receive, apprehend, interpret, and trust, as suggested by just over 7% of the selected documents addressing general issues (Huang et al., 2012; Mileti & O'Brien, 1992; Mileti & Sorensen, 1990). In addition, around 13% of the documents, addressing both the general and Bangladesh context, indicate that individuals are also affected by their physical, psychomotor, cognitive, and economic abilities, along with their social networks (Dow & Cutter, 2002; Haque, 1997; Lindell & Perry, 2012; Nigg, 1995; Paul et al., 2010). Reviews of hazard early warning systems by Mileti and O'Brien (1992) and Sorensen and Sorensen (2007) determined several environmental, social, and psychological attributes that are likely to influence the early warning process, although these reviews suggest that only a few of those attributes can be influenced to make the warning process more efficient and effective. Thus, response to a warning message is likely to vary depending on the message's source, content and style, channel attributes, and frequency; the source's credibility; and the recipient's characteristics (Bean et al., 2016; Mileti & O'Brien, 1992). If people at risk do not trust the warning and/or have doubts about the level of threat, then the protective response is likely to be low.

The process of early warning dissemination for cyclones in Bangladesh has improved over the last three decades, although some key challenges remain in the use of collected information in dynamic contexts where information has to be disseminated at multiple levels through a number of channels. The current early warning dissemination process is presented in Figure 2.1, where the process starts with the Storm Warning Center (SWC) of the Bangladesh Meteorological Department (BMD) and ends with the coastal communities/households at risk through a number of channels, such as Coastal Preparedness Programme (CPP) unit/volunteers, local administration, and state-operated radio and television.[3] About 31% of the Bangladesh-related studies assessing evacuation compliance during cyclones Gorky (a category 4 tropical cyclone in 1991), Sidr (a category 4 tropical cyclone in 2007), and Aila (a category 1 tropical cyclone in 2009) have suggested that the evacuation decisions of households were influenced more by social, individual, and household attributes than by the actual warning messages (Ahsan et al., 2016; Haque, 1995; Paul, 2012; Paul et al., 2010). This is because the warning messages during the above-mentioned cyclones lacked credibility due to the absence of specific and relatively accurate information such as the time of the cyclone's possible landfall, exact trajectories, wind speed, surge-heights, etc. in the messages' content (Haque, 1997; Paul et al., 2010). Furthermore, several cases of false alarms, such as the tsunami warning in September 2007 and warnings for cyclones Rashmi in October 2008 and Bijli in April 2009, also brought into question the accuracy and credibility of the existing warning system in Bangladesh, as indicated by 19% of the documents (Ahsan et al., 2016; Paul & Dutt, 2010; Paul & Routray, 2013). This fact urges reexamination of the link between early warnings and responses of people at risk, as addressed in contemporary evacuation studies.

In the recent past, tropical cyclones making landfall in coastal Bangladesh have caused significantly more economic and non-economic damage as compared to fatalities among the exposed people (GoB, 2014). In this context, as suggested by around 31% of the Bangladesh-related studies, the relevant agencies' weakness in understanding the evacuation process at the local level often leaves hundreds of people in an open space trying to reach safe havens, and thousands in their destroyed homes located in low-lying exposed zones—as happened during Cyclone Gorky (in 1991) and Cyclone Sidr (in 2007) in Bangladesh (Bern et al., 1993; Haque,

[3] At present, while issuing a first warning for any cyclone, a Standing Order for Disaster (SOD) is also initiated by the BMD. This SOD contains the subsequent guidelines for all stakeholders regarding how to respond to an imminent cyclone threat.

1995; Paul & Dutt, 2010; Paul et al., 2010). In the absence of accurate estimates, the Centre for Research on the Epidemiology of Disasters (CRED), the World Bank, and the Government of Bangladesh (GoB) reported approximately 140,000 fatalities along the southeastern coast during Cyclone Gorky and 3,400 fatalities along the southwestern coast during Cyclone Sidr in Bangladesh (EM-DAT, 2016; GoB, 2008; World Bank, 2011). While there were only 190 fatalities and just over 7,000 severe physical injuries during Cyclone Aila, nearly 75% of the at-risk households did not evacuate due to their skeptical attitude toward the warning message (UNDP, 2010). Therefore, understanding how to better motivate evacuation in Bangladesh is still a critical question. In this connection, apart from the early warning dissemination process being an important factor of evacuation decision making, another equally important factor during such decision making is how individuals perceive risk.

2.4. Risk Perception

Risk perception in the disaster domain integrates the broader associations of threat perceptions, options of protective response, and actors within the outline (Lindell & Perry, 2012). Thus, focusing only on early warning may lead to a partial scenario of the complicated process of evacuation decision-making. Risk perception, in general, becomes complicated due to the high degree of uncertainty within the situational context, such as determining the probability of different levels of impact. Hence, emergency managers have a mammoth task of estimating and understanding both the probability of the hazard and possible countermeasures, as indicated by around 8% of the selected documents (Burton, Kates, & White, 1978; Meissen & Voisard, 2010). Emergency agencies expect that people at risk will behave rationally (i.e., receive a warning, understand the danger level from the message, and evacuate to safe havens), however, very often, many of the people at risk do not comply with advisories by taking protective measures (Dash & Gladwin, 2007; UNDP, 2010). In understanding the process of evacuation decision-making, nearly 20% of the selected documents suggest risk perception as a focal point consisting of risk identification and risk assessment (Baker, 1991; Dash & Gladwin, 2007; Sjöberg, 2000; Sorensen, 2000; Tierney, 1994). In this case, knowledge of hazards alone does not expedite the evacuation decision-making process. Rather, the available information needs to be translated into a meaningful message about the pending havoc (Dash & Gladwin, 2007). The magnitude of risk can be considered either from a technical perspective on the basis of the likelihood of an adverse event to occur, along with the degree of impact from it (Dow & Cutter, 2002), and/or from a nontechnical (i.e., social) perspective based on psychomotor (e.g.,

vision and hearing), cognitive (e.g., languages including dialects), and social (e.g., family and peer-network) resources (Dhar & Ansary, 2008; Lindell, Kang, & Prater, 2011; Lindell & Perry, 2012).

The concept of risk perception from a hazard perspective was assessed by Sjöberg (2000) using a psychometric approach and a cultural approach. He investigated the nexus among heuristics, biases, and risk perception and suggested that the heuristics phenomenon resembles a presumption of belief distortion, which is cognition driven, while bias relates to beliefs of construal tendencies, which are value driven. Interestingly, Sjöberg and Biel (1983) found that there exists a strong correlation between beliefs and values. Lindell and Perry (2012) argued that risk perception is a cross-product of the affected individual's capacity (i.e., attention, comprehension, and interpretation capacities) and social and environmental cues. Considering risk perception on a common platform, they attempted to identify mutual links among threat perceptions, protective response perceptions, and stakeholder perceptions, which constitute the response pattern toward an imminent hazard threat. Thus, individual, sociocultural, and environmental determinants are treated as inevitable aspects while analyzing and understanding hazard risks. This implies that, in case of any impending hazard threat, information processed in sociocultural contexts is likely to influence an individual's capacity to identify and assess the degree of danger. Otherwise, such a degree of danger is very likely to be increased if the potential threats become perceived threats and vague perceptions of potential damages eventually become real (Dash & Gladwin, 2007; Tierney, 1994).

A distinct finding from 12% of the selected documents suggests that, during cyclone evacuation, risk perception is more important than negative threat appeal[4] or fear-arousing communications (Mulilis & Duval, 1997; Weinstein, 1988, 1989). For the people at risk in coastal areas, such a perception is seemingly affected by the notions of "misses," "near misses," and "hits" of the impending cyclone. Therefore, a common notion indicates that a previous unnecessary evacuation provokes a lower likelihood of evacuation for future cyclones. Moreover, a false alarm, also known as the "crying wolf syndrome" (Breznitz, 1984), challenges the credibility of future warning messages, which eventually reduces compliance with evacuation advisories (Dow & Cutter, 1998). Slightly over 31% of the documents addressing the Bangladesh context suggest that over a period of 17 years (i.e., from Cyclone Gorky in 1991

[4] Negative threat appeal or fear-arousing communication refers to a persuasive message that is likely to arouse fear and divert people's behavior through the threat of impending danger.

to Cyclone Sidr in 2007), the average evacuation rate increased from slightly below 27% to around 33%, indicating only a 6% increase in evacuation rate, which is not satisfactory at all, considering the goals for motivating people for evacuation compliance that were adopted in the cyclone preparedness scheme by the concerned agencies (Haque, 1995, 1997; Paul, 2012; Paul & Dutt, 2010; Paul et al., 2010). Among the factors inhibiting the people at risk from evacuating in Bangladesh, nearly 38% of the relevant documents specifically indicated false alarms as a very common factor (Paul, 2012; Paul & Dutt, 2010; Paul et al., 2010; Paul & Routray, 2011, 2013). For instance, during the category-4 Cyclone Sidr, around 19% of the sample respondents specifically reported that they did not trust the cyclone warning, and one of the reasons behind this disbelief was a false tsunami warning in coastal Bangladesh two months prior to Sidr's landfall (Paul, 2012). This percentage might be relatively small; nonetheless, it urges looking into the mutual link between at-risk peoples' risk perception and the trustworthiness of the warning message.

During tropical Cyclone Aila (in 2009), a category-1 cyclone that caused significant damage in southwestern coastal Bangladesh, the fatality rate was very low (190 people were killed) due to the timely evacuation by people at risk (UNDP, 2010). Although only around 25% of the households were found to be willing to evacuate during the cyclone, the spillover effects of a paradigm shift from postdisaster rehabilitation to predisaster preparedness under the disaster management program by the Bangladesh government were found to be effective over time through the behavior of people at risk (GoB, 2011c, 2014; UNDP, 2010). The local CPP volunteers, NGOs, disaster management committees steered by the local government, and available media informed the people about the tentative trajectory of Aila 26 hours before its landfall. This was further validated by the findings from the indigenous knowledge of people at risk, which eventually helped them decide to evacuate to the nearest safe haven within a reasonable time frame (GoB, 2011c; Nirapad, 2009). The most notable phenomenon in this case was the way households at risk started preparing for evacuation by utilizing information from their peer networks and from indigenous knowledge—such as the roar of the wind together with movements of ants and aquatic species indicating an imminent hazard—given their limited access to both required information and resources. Similar to the experiences of evacuees from developed countries reported by Dow and Cutter (2002), the evacuees during Aila did not encounter any traffic delays but experienced space insufficiency in cyclone shelters and the absence of well-directed evacuation routes (UNDP, 2010). In light of the above-mentioned

scenario, just over 31% of Bangladesh-related documents investigated the factors affecting evacuation behavior/decisions during cyclones in Bangladesh (Ahsan et al., 2016; Paul, 2012; Paul & Dutt, 2010; Paul et al., 2010; Paul & Routray, 2013). These studies found that the households who delayed evacuation were less likely to find the space they required inside the cyclone shelters, and this delay was mainly governed by their personal "optimistic bias" (Weinstein, 1989). Furthermore, the ex-post cyclone households who received rehabilitation aid more quickly, especially for reconstructing their damaged houses, were less likely to experience adverse impacts during a longer period (Akter & Mallick, 2013; Nadiruzzaman & Paul, 2013). Hence, risk perception appears to have greater effect on the rapidity of the decision-making process of people at risk for prior, during, and post cyclone states.

A poor understanding of "risk perception for a community" is likely to turn even well-planned policies into inept ones (Slovic, 1987). Risk perception is, therefore, a critical factor in understanding how individuals decide whether or not to evacuate. In the context of coastal Bangladesh—whether individuals in high-risk[5] zones or risk[6] zones or low-risk[7] zones intend to evacuate as a devastating cyclone approaches—an understanding of the way individuals make decisions about an imminent hazard is of great significance in addressing the issue of cyclone evacuation decision processes. This may also pave the way to redesigning evacuation messages that incorporate essential information from the forecasting. Otherwise, deviations in forecasting messages may lead to confusion and distrust, which will eventually inhibit the people at risk from evacuating, as reported by Roy, Sarkar, Åberg, and Kovordanyi (2015) during Cyclone Sidr in Bangladesh. It is, therefore, very important to understand how people proceed from receiving evacuation messages to deciding to evacuate, which is a process addressing both warning compliance and risk perception.

2.5. Evacuation Decision Making

Contemporary research on evacuation decision-making mainly has considered intrinsic characteristics of evacuees and non-evacuees, as suggested by 25% of the total amount of selected documents (Ahsan et al., 2016; Alam & Collins, 2010; Dash & Gladwin, 2007; Garcia & Fearnley, 2012; Haque, 1997; Huang et al., 2012; Lindell et al., 2011; Mesa-Arango et al., 2013; Paul & Dutt, 2010; Paul et al., 2010). Apart from several general issues (e.g., safe haven

[5] Within 50 km. from the seashore.
[6] Within 51-75 km. from the seashore.
[7] Within 76-100 km. from the seashore.

features, transport, routes, etc.); specific issues such as impediments associated with evacuation (e.g., the certainty of getting space for household members inside the safe haven) during cyclones are addressed by 12% (Dow & Cutter, 1998; Lindell et al., 2011; Mileti & O'Brien, 1992; Paul & Dutt, 2010; Paul et al., 2010), evacuation compliance is addressed by 10% (Dow & Cutter, 1998; Lindell et al., 2011; Paul, 2012; Paul & Dutt, 2010), and household and community aspects are addressed by 12% (Dhar & Ansary, 2012; Lindell et al., 2011; Mesa-Arango et al., 2013; Paul, 2012; Paul & Dutt, 2010) of all the selected documents (i.e., 41 documents). Again, nearly 12% of the selected documents (general context) that applied different models addressing evacuation decisions considered risk perception, sheltering behavior, fear-arousing communication, hazard characteristics, and certain versus probabilistic outcomes from hazards (Lindell & Perry, 2012; Mesa-Arango et al., 2013; Mileti & O'Brien, 1992; Mulilis & Duval, 1997; Paul & Dutt, 2010).

Lindell and Perry (2012) have developed a multistage model (the Protective Action Decision Model (PADM)) describing overlapping processes that are likely to trigger evacuation compliance during natural hazards. This model integrates the processing of information obtained from multifarious social and environmental cues with specific messages that social sources disseminate through different media and channels to those at risk. The PADM focuses on three processes: (i) reception and comprehension of warning messages or exposure, (ii) attention to social/environmental cues, and (iii) interpretation of social/environmental cues, considered as critical predecisional functions that precede all remaining functions. All subsequent functions are based on three core perceptions: threat perceptions, protective response perceptions, and stakeholder perceptions, as already mentioned in the previous section on risk perception. Together these form a platform for decision makers on how to respond toward an impending hazard. The authors show a mutual relationship in their model among perceived threat, personal risk, and protective response (i.e., evacuation). This work has been comprehensive in introducing both social and environmental contexts to the forefront in modeling evacuation decision making. However, this model, as pointed out by Lindell and Perry (2012), encountered a shortcoming in the form of hypothesizing that each successive variable intercedes the link between the variable that precedes it and the variable that succeeds it.

Huang et al. (2012), in contrast, focused on contextual factors of a household's evacuation decision-making process. Their study presents the importance of formal warning messages, perceived storm characteristics, and previous hazard experiences, all of which are mostly social

factors and likely to affect the expected personal impacts of evacuation decision. This study suggests that emergency agencies need to carefully understand their target groups, so that concrete messages can be transmitted through the right channels to increase impractical low expectations on personal impacts or to lessen the overestimation of evacuation hindrances.

In line with the core findings from the studies by Lindell and Perry (2012) and Huang et al. (2012), 50% of the primary data-based selected documents on Bangladesh also denote a distinct influence of social factors (e.g., social custom of maintaining "purdah" by women) on a household's evacuation decision-making processes during cyclones (Ahsan et al., 2016; Bern et al., 1993; Haque, 1997; Ikeda, 1995; Paul, 2012; Paul & Dutt, 2010; Paul et al., 2010). Findings from these documents show that households at risk in coastal Bangladesh are not only expected to manage situational contexts but also to deal with sociocultural hurdles in the event of an imminent cyclone threat. Regardless of whether a household belongs to a southwestern (comprising mostly rural areas) or southeastern (comprising both rural and urban areas) coastal community in Bangladesh, it is very likely to work in its own distinct way regarding the common objective of evacuation, and thus, a cohesive evacuation compliance is hardly to be found even within one area type (urban/rural or solely rural). Again, among the selected documents for Bangladesh, nearly 19% point out that gender and the number of dependent members in the household (Ahsan et al., 2016; Ikeda, 1995; Paul, 2012), a distrust of warning messages (Haque, 1997; Paul, 2012; Paul & Dutt, 2010), the characteristics of public shelters (Haque, 1997; Haque & Blair, 1992; Paul & Dutt, 2010), and the income level of the household (Alam & Collins, 2010; Paul, 2012; Paul & Routray, 2013) significantly influence evacuation decision-making. The same trend is exhibited by nearly 13% of the documents addressing the literacy level of decision makers (Ahsan et al., 2016; Paul, 2012), the number of disabled members in households (Paul & Dutt, 2010; Paul et al., 2010), and the fear of burglary (Ahsan et al., 2016; Haque & Blair, 1992) in coastal Bangladesh. These factors, subject to situational contexts, are likely to either motivate people to, or dissuade people from, the evacuation process. A major influence in Bangladesh is a social custom known as "purdahh," which is in vogue for adult women. This concept implies a curtain, used figuratively to indicate the separation of women from men, which must be maintained when adult women go outside (Ikeda, 1995). Some 19% of the selected documents have found this "purdah" as a pivotal factor that either dissuaded or delayed the household members' evacuation decision-making process (Ikeda, 1995; Paul, 2012; Paul et al., 2010). In addition, about 13% of the relevant documents indicate

that lessons learned from previously experienced hazards at the household level affect evacuation decision-making (Paul, 2009; Paul et al., 2010). Summarizing the above-mentioned findings shows that decision makers at household levels in Bangladesh are influenced specifically by the process of receiving an early warning message, identifying and assessing potential damages of structural and non-structural assets from the impending hazard(s) while interpreting the message, and finally choosing the best possible protective response.

In connection with the above-mentioned diverse factors, results from the primary data-based studies performed after Cyclones Gorky, Sidr, and Aila hit Bangladesh suggest that a number of specific factors, categorized under four broad types, stand out as significant determinants for successful evacuation compliance: (i) characteristics of the public cyclone shelter (e.g., location of the shelters and availability of killas[8] adjacent to the shelter), (ii) characteristics of early warning messages and the status of disaster preparedness training, (iii) risk perceptions of households at risk, and (iv) socioeconomic conditions of households at risk (Ahsan et al., 2016; Haque, 1997; Paul & Dutt, 2010; Paul et al., 2010). Subject to the availability of early warning systems, CPP units, and emergency teams of the local government, the above-mentioned determinants may affect evacuation processes differently within and between areas (Haque & Blair, 1992). This implies that even though some similarities exist among the factors affecting evacuation decision-making in general, several differences also emerge. For example, as pointed out by nearly 31% of the selected documents, during the category-4 Cyclone Gorky that made landfall in southeastern coastal Bangladesh, the fear of burglary, inefficient and less-credible cyclone warning messages, and insufficient disaster preparedness training were found as the major factors influencing households' evacuation decision-making (Bern et al., 1993; Dove & Khan, 1995; Haque, 1997; Haque & Blair, 1992; Ikeda, 1995). During another category-4 Cyclone, Sidr, that made landfall in southwestern coastal Bangladesh, as indicated by nearly 19% of the selected documents, the most important factors influencing/determining the onset of an evacuation process were reported to be difficulty in understanding cyclone warning messages, false alarms, distance to the nearest public cyclone shelter, poor maintenance of existing cyclone shelters, and availability of killas in the neighborhood of a cyclone shelter (Paul, 2012; Paul & Dutt, 2010; Paul et al., 2010). However, during both events the common factors were: insufficient cyclone shelters, overcrowded cyclone shelters, warning signal related

[8] A killa is a heightened earthen platform for safekeeping livestock during natural hazards such as cyclones and floods.

problems, and absence of dissemination of previous cyclone experiences to the people at risk. It is interesting to note that the impact zone of Cyclone Gorky comprised both urban and rural areas, whereas the impact zone for Cyclone Sidr comprised mostly rural areas, some peri-urban areas, and some less urban areas. These facts suggest that diverse spatial attributes (e.g., road network, proximity to exposed area, etc.) in rural, urban, and peri-urban areas were likely to affect the evacuation decision-making process of the people residing in different zones in coastal Bangladesh.

2.6. Discussion

In Sections 2.3, 2.4, and 2.5 the relevant issues were first discussed in general and then connected to the context of Bangladesh. From this section onward, we focus only on the context of Bangladesh. In this light, major findings from the content analysis of early warning, risk perception, and the evacuation decision-making process in Bangladesh can be summarized into the following aspects. First, the credibility of warning messages appears to be a very important determinant in evacuation compliance in Bangladesh. The findings of the content analysis show that in Bangladesh only one agency, the Bangladesh Meteorological Department (BMD), prepares forecasting and warning messages without the support of any other specialized units (e.g., Regional Specialized Meteorological Center, analysis and forecasting unit, and liaison teams at regional and local levels), as well as without utilizing advanced forecasting systems (e.g., high-resolution satellite image, CLIPER5[9]). This tends to lead to a lack of accuracy in the forecasts (e.g., intensity level, landfall time, and trajectory of the storm). Hence, during cyclone events, such a less advanced forecasting system not only fails to provide sufficiently accurate forecasts but also has produced false alarms on several occasions. Second, no study applying exclusively either psychometric, or cultural, or cognitive, or affective approaches has been conducted so far in Bangladesh in order to assess the different dimensions of risk perception in evacuation research. Hence, there exists a knowledge gap on the applicable drivers, together with sources of objective and subjective risk perceptions (i.e., electronic media versus the roar of the wind) of people at risk in coastal Bangladesh. Third, the critical factors affecting the evacuation decision-making process in Bangladesh during cyclones seem to be governed by socio-cultural determinants (e.g., purdah), although these determinants are not addressed in depth by the studies conducted in Bangladesh up till now. In addition, issues specific to

[9] This is a statistical storm-track prediction model based on climatology and persistence (NOAA, 2006).

developed countries, such as “shadow evacuations” (i.e., a situation when people from areas outside a declared evacuation area voluntarily evacuate, resulting in road congestion that eventually inhibits the egress of those evacuating from an area at risk) have never been studied in Bangladesh, as these are the least likely scenario to occur during cyclone evacuations in Bangladesh.

The findings from the content analysis suggest that the determinants of early warning, risk perception, and evacuation decision-making are not mutually distinctive, but overlap on some occasions. Therefore, the mutual relationship among these three themes is not unidirectional; rather it is bi- and/or multidirectional. For example, risk perception is likely to be affected by the content specificity of the warning message, on the one hand, while evacuation compliance on the other hand largely depends on the degree of risk perceived by the at-risk people. This above-stated seemingly simple relationship may not be simple, because there can be other determinants that are likely to affect the evacuation process both at the individual and household levels. In this context, we may consider the given knowledge level of an individual or the main decision-maker at a household level. Depending on the knowledge level, an individual is likely to look for critical information about the impending hazard(s) from reliable sources and, consequently, crosscheck among sources if the information is incomplete or confusing (e.g., unknown scientific terms in a warning message and different messages from different sources). Again, utilizing this knowledge level the concerned individual, subject to his/her physical and mental capabilities, is able to perceive the degree of risk from the hazard and decide to evacuate for a safe haven within a reasonable time frame. Interestingly, this knowledge level depends on a number of factors such as literacy level, access to different media (e.g., TV and radio), indigenous knowledge, previous hazard experiences, connection to local emergency agencies, and disaster preparedness training. These results clearly imply that it is very difficult to conclude that a single determinant exclusively affects early warning, or risk perception, or evacuation decision-making. This is also true for the people at risk in coastal Bangladesh, with a lesser degree of access to resources for making evacuation decisions during tropical cyclones.

Until now the studies carried out in Bangladesh on cyclone early warning and evacuation decision-making processes have been mostly qualitative and did not apply any exclusive models using psychometric, cultural, cognitive, or affective approaches (see Alam & Collins, 2010; Bern et al., 1993; Dove & Khan, 1995; Haque, 1995, 1997; Haque & Blair, 1992; Ikeda, 1995). So far, the most comprehensive quantitative study applying multivariate analysis has been

performed by Paul (2012), in which the themes of social cognitive theory (SCT) (Bandura, 1991; Gladwin, Lazo, Morrow, Peacock, & Willoughby, 2007; Paul, 2012) have been applied. Conventionally, SCT considers factors, such as the ethnic and immigration status of the warning recipient and the cost and availability of public transport, that are not widely applicable in the context of Bangladesh and are thus not incorporated in the multivariate analyses by Paul (2012). At this point, we believe that apart from the result of Paul's (2012) study, the other studies by Paul et al. (2010), Paul and Dutt (2010), Haque (1995, 1997), and Paul and Routray (2011) have also contributed substantially to the understanding of the evacuation decision-making process in coastal Bangladesh.

2.7. Concluding Remarks

The main aim of this Chapter was to review the relevant literature and identify and assess the critical determinants affecting the evacuation decision-making process during tropical cyclones in Bangladesh. In this light, the major findings of this systematic review suggest that cyclone evacuation compliance is governed by a number of overlapping factors that can be considered under the themes of early warning, risk perception, and evacuation decision-making. In addition, the current forecasting system for disseminating early warning messages, and the knowledge gap on evacuation research for policy-making in Bangladesh, are identified as critical issues in addressing cyclone evacuation compliance.

As a final remark, we would like to mention a recurring challenge for evacuation research, especially in the social science domain: the problem of recall, which is also noted by Dash and Gladwin (2007). Once a tropical cyclone makes landfall or misses, and time passes, the affected people or people at risk are likely to have difficulty remembering precisely what happened frame by frame during the storm and how their insights of the situation changed during the decision-making process. Generally, studies have been carried out during the aftermath of a disaster and, unfortunately, some respondents justify that they chose the best possible decisions, diverging from their memory at the time. Thus, more careful and systematically designed simultaneous pre- and post- cyclone studies should be carried out to deal with "recall bias" problems addressing evacuation decision-making processes in coastal Bangladesh, as well as globally. Such endeavors are likely to become a breakthrough in developing efficient ways to enhance evacuation compliance, along with framing constructive guidelines for all stakeholder agencies.

3. Disaster Preparedness Actions at the Household Level: Empirical Evidence on Factors Affecting Cyclone Evacuation Decisions[10]

3.1. Problem Statement

A recurring challenge for emergency agencies is to ensure the compliance of people at risk in coastal areas with directives on cyclone warnings (Stein, Buzcu-Guven, Dueñas-Osorio, Subramanian, & Kahle, 2013). In response to such warnings, evacuation is advised to minimize losses from a catastrophe by temporarily moving people from exposed areas to safe havens (Sharma, Patwardhan, & Parthasarathy, 2009). The success of such response-led evacuations depends on how individuals receive, understand, trust, and comply with warning messages (Dash & Gladwin, 2007). An individual's response to a hazard warning is substantially correlated with various societal aspects, because their interactions with social groups play a key role in deciding whether to evacuate or not (Burnside, Miller, & Rivera, 2007; Mileti, 1999; Mileti & O'Brien, 1992). Hence, as people receive a hazard warning, they proceed through a social cognitive process that governs their individual risk assessment capacity, and thereafter they opt for evacuation by utilizing their given knowledge and information that is available to them.

Over time, the evacuation decision-making process—especially for people at risk in coastal areas—has not only changed but also become more complicated, as a growing number of factors are likely to influence this process. The assessment and prediction of potential cyclone damage conducted by emergency agencies with regard to the vulnerability of people at risk have been more frequently updated and have become more diverse than ever before, though the process still encounters multifarious uncertainties (Dow & Cutter, 2000). In Bangladesh, a number of information sources such as television, state radio, and online newspapers provide regular forecasts several times a day. However, people at risk in coastal areas have a lesser degree of access to televisions and online newspapers, while counting more on state radio messages. This is the same for local disaster managers, who substantially rely on emergency warnings to make evacuation decisions during cyclone hazards (Haque, 1997; Paul & Dutt, 2010).

Considering the North American context, studies by Kim and Oh (2014), Mesa-Arango et al. (2013), and Baker (1991) on evacuations during Hurricane Katrina in 2005 and Ivan in 2004, as well as storms that made landfall between 1961 and 1989, suggest that when public officials

[10] A similar version of this chapter is published in an article form in Environmental Hazards, Vol 15(1), page 16-42, 2016, doi: 10.1080/17477891.2015.1114912

assertively issued hazard warnings and evacuation advisories, on average, slightly over 80% of coastal residents at risk heeded the warnings and responded accordingly in areas from Massachusetts to Texas across the United States and in the Caribbean. Consistent with this North American scenario, and in contrast with previous cyclones in Bangladesh since 1970, a relatively lower incidence of fatalities occurred in coastal Bangladesh during Cyclone Aila, a category I tropical cyclone in 2009, partly because emergency agencies delivered on-time cyclone warnings along with assertive actions and partly because they ensured the timely evacuation of people at risk in the coastal zone out of the cyclone's predicted trajectory (Mallick et al., 2011; Mallick & Vogt, 2013; UNDP, 2010). Cyclone fatality statistics in Bangladesh suggest a death toll of 784,050 over a period of 234 years (1775–2009) (Akhand, 2003; EM-DAT, 2016); however, over the last four decades (1970–2009), if the trend of cyclone fatalities is presented on an annual basis, we find a decrease of 2.5% per year (GoB, 2014; Haque et al., 2012). This downward trend in fatalities appears to be attributable to the efforts of the Bangladesh government agencies and associated domestic/international agencies. Yet despite the best possible efforts by emergency agencies, on average, at least 25% of the victims of Cyclones Gorky in 1991, Sidr in 2007, and Aila in 2009 were not interested in evacuating, even after receiving warnings and evacuation orders (Bern et al., 1993; Haque, 1995; Mallick et al., 2011; Paul & Dutt, 2010; UNDP, 2010, p-9). In the case of Cyclone Aila, even with a lower fatality rate compared with the other two, around 7,100 people were reported to be severely injured and some 100,000 livestock animals were killed (UNDP, 2010), numbers that might have been lower if the people at risk had evacuated with their livestock in a timely fashion to safe havens. Thus, it is important to identify which factors governed the evacuation decision-making processes of these people.

The previous Chapter revealed the factors affecting cyclone evacuation behavior in Bangladesh on the basis of a systematic review of documents. This Chapter explores the responses of people at risk in southwestern coastal Bangladesh to cyclone warnings and evacuation orders during Tropical Cyclone Aila by investigating factors that influenced their evacuation decisions through an empirical case study approach.

3.2. Cyclone Preparedness in Bangladesh: Institutional Arrangements

Historically, as stated in Chapter 1, Bangladesh is a cyclone-prone country due to its geographical location. Around 10% of the world's cyclones originate in the Indian Ocean and the adjacent Bay of Bengal each year, which accounts for at least 85% of the cyclone damage

worldwide (Choudhury, 2002). People in coastal Bangladesh suffer the most from such cyclones, in particular from storm surges, the most lethal hazard triggered by cyclones, due to the low elevation of the land relative to sea level (Chowdhury et al., 1993). The funnel-pattern coastline decreases the width of cyclone-triggered surges (i.e., waves) but increases their height in the northern part of the Bay of Bengal (Flierl & Robinson, 1972). On average, at least 17 tropical cyclones form in the Bay of Bengal each year, peaking from April to May and then from October to December (Alexander, 1993; GoB, 2013; Haque, 1997).

Having suffered from the deadliest cyclone in the history of Bengal (Cyclone Bhola) in 1970, the government of newly independent Bangladesh[11] initiated three specific countermeasures to minimize cyclone impacts: (1) the cyclone preparedness program (CPP); (2) the construction of public cyclone shelters; and (3) the construction of high earthen platforms known as killas to protect livestock during hazard emergencies. Upon a suggestion by the United Nations, the CPP was established in 1972 through an agreement between the government of Bangladesh and the Bangladesh Red Crescent Society (the then counterpart of the Red Cross Society) (GoB, 2011b; Paul, 2012), which has not only acted as an independent unit but also has functioned to support the Storm Warning Center (SWC) of the Bangladesh Meteorological Department (BMD) and local governments during emergencies. The SWC is in charge of preparing all weather forecasts and hazard warnings. Together with designated channels, hazard warnings are also disseminated (before, during, and after a hazard period) by CPP volunteers to at-risk communities at the local level, as shown in Figure 2.1 in Chapter 2. Each unit of the CPP at the local level (i.e., the union[12] level), covering one to two villages with a population of 2,000 to 3,000 within a 2 km^2 radius, consists of 15 volunteers from five specific wings: signal, shelter, rescue, first-aid, and relief (GoB, 2011a; Karim & Mimura, 2008). CPP volunteers use different basic warning gear (e.g., handheld sirens, megaphones, signal lights, and transistor radios) and assist at-risk communities during emergencies (GoB, 2011d).

Under a scheme to protect coastal at-risk communities from cyclones and storm surges, a program initiated in 1972 successfully completed the construction of 542 public cyclone shelters by 1992 (GoB, 2014, Annex 5). In 1993, the Multi-Purpose Cyclone Shelter Project (MCSP) was kicked off, under which such shelters, designed to withstand the intensity and

[11] Bangladesh received its independence from Pakistan on 16 December 1971 after a nine-month liberation war. At the time of Cyclone Bhola in 1970, Bangladesh was known as East Pakistan.

[12] The lowest tier of local government in Bangladesh, which is a part of an upazilla (sub-district).

impact of tropical cyclones, were constructed in cyclone risk areas (Khan, 2007). These multi-purpose cyclone shelters are used as schools, community centers, and temporary government offices in nonemergency times. At present, 3,751 cyclone shelters are available in 15 coastal districts of Bangladesh (GoB, 2013, p-21), of which 56% are located in high-risk areas[13], 24% in risk areas[14], 9% in low-risk areas[15], and 11% in nonrisk areas[16] (GoB, 2009, p-A10). Among the existing shelters, about 7% have become unusable and dilapidated due to lack of proper maintenance and river erosion (Debnath, 2007; GoB, 2009). As a result, the shelters that are still in a usable condition can accommodate only around 15% of the total coastal population (Shamsuddoha & Chowdhury, 2007). These shelters are also poorly equipped, with insufficient lighting and space and unhealthy sanitation facilities, and are not supplied with clean water and/or separate toilets for males and females (Paul et al., 2010).

Out of 872 raised earthen platforms (killas) required to protect livestock from strong cyclone winds and storm surges, only 196 have been constructed so far in cyclone-prone areas (GoB, 2008, 2011c; Karim, 2006). A killa provides shelter to roughly 300 to 400 livestock animals, especially cattle and poultry (Talukder, Roy, & Ahmad, 1992). Like some of the cyclone shelters, many killa sites have become dilapidated and eventually inaccessible due to poor maintenance, and in some cases have turned into habitats for harmful species. The existing usable killas in cyclone-prone locations are still insufficient to accommodate an optimal number of livestock animals during emergencies (Paul, 2012). Table 3.1 presents a trend in the development of three supporting measures to mitigate cyclone devastation, as the country has experienced four major tropical cyclones since 1970.

Table 3.1. Capacity building over time.

Cyclone name (year)	No. of cyclone shelters	CPP volunteers	No. of killas
Cyclone Bhola (1970)	44	-	-
Cyclone Gorky (1991)	445	20,000	-
Cyclone Sidr (2007)	3,573	42,675	196
Cyclone Aila (2009)	3,751	49,365	202

Source: GoB, 2010.

3.3. Evacuation Decision Making Process: Conceptual Considerations

A myriad of overlapping theories and perspectives in the hazard literature addresses the response of at-risk people to early warnings and evacuation orders. Selecting the most relevant

[13] Within 50 km from the seashore
[14] Within 51–75 km from the seashore
[15] Within 76–100 km from the seashore
[16] Beyond 100 km from the seashore

theories within this set, we can construct a general overview to understand why victims did or did not comply with evacuation orders issued in advance of devastating cyclones making landfall. This literature suggests that evacuation decisions are substantially governed by the features of hazard warnings and the risk perceptions of people at risk (Dash & Gladwin, 2007; Haque, 1997; Paul, 2012; Paul & Dutt, 2010).

The effectiveness of hazard warnings revolves around several factors, such as message content and features, source credibility, and the recipient's level of understanding of and previous experiences with hazard warnings (Paul et al., 2010). Even if people receive the same hazard warning, they may not comprehend the core meaning in the same way. The reaction to a warning depends on how people interpret the content of its message (Paul, 2008; Wilson & Tiefenbacher, 2012). Hence, there is a high positive correlation between the rate of evacuation and the understanding of a hazard warning, which indicates that if warnings are heard and trusted, they are very likely to result in evacuation (Dash & Gladwin, 2007; Paul, 2009). From this perspective, hazard warnings can be considered a social process consisting of interconnected activities: warning messages, information dissemination, message reception, previous experiences, preparedness, and response (Mileti, Drabek, & Haas, 1975; Nigg, 1995).

Risk perception encapsulates all effects (the immediate results) and impacts (short- and long-term results) of being exposed to calamitous events, such as the wind speed of a cyclone, the height of a storm surge, and the rapidity of a flood's inflow (Stein, Dueñas-Osorio, & Subramanian, 2010). Knowledge of a hazard, however, will lead to life-saving actions only if people can translate available information into a meaningful apprehension of impending havoc (Stein et al., 2013). The societal dimension of risk perception addresses the process that people adopt to interpret warning messages: in other words, this interpretation is filtered through their own cultural context. People may interpret the same information using different avenues of understanding (Paul & Dutt, 2010; White, 1988). Thus, a person's level of understanding is likely to be the key element for his/her risk perception of natural hazards.

Literature addressing evacuation has emphasized the intrinsic characteristics of people who evacuate and those who do not (Baker, 1991; Dow & Cutter, 1998; Drabek, 1999; Fischer, Stine, Stoker, Trowbridge, & Drain, 1993; Paul, 2012; Paul & Routray, 2013), along with impediments during evacuation (Mileti & Sorensen, 1990). Some studies focus on evacuation compliance at the household level along with the decision-making process (Chowdhury et al., 1993; Lindell, Perry, Prater, & Nicholson, 2006; Whitehead et al., 2000). In this regard, effective evacuation

to safe havens during natural hazard emergencies is considered to involve several pivotal components: response pattern (e.g., compulsory or voluntary), enforcement, logistic support (e.g., transportation modes and evacuation routes), and physical infrastructure (Hyndman & Hyndman, 2010; Paul, 2012; Paul et al., 2010).

Table 3.2. Issues addressed under diverse themes and locations regarding warning systems and evacuation decision-making.

Issues	**Theme**	**Locational focus**	**Source(s)**
Understanding of warning features, risk perception, and determinants of evacuation	Psychological	USA	Dash and Gladwin (2007)
Components of early warning systems	Socio-technical	Global	Garcia and Fearnley (2012)
Emergency preparedness, role of media and public officials in warning dissemination, risk perception and communication process, government directives, false alarm, and evacuation compliance	Socio-political, -economic, -technical, geographic, and psychological	USA	Perry, Greene, and Lindell (1980); Dow and Cutter (1998); Stein et al. (2010); Burnside et al. (2007); Stein et al. (2013); Mileti and Sorensen (1990); Burnside (2006); Blanchard-Boehm (1998); Dow and Cutter (2000)
Impact of logistic issues on evacuation decision-making	Socio-technical, -political and psychological	USA	Lindell et al. (2011)
Impact of demographic features on evacuation decision-making	Socio-demographic and psychological	USA	Smith and McCarty (2009)
Warning, perception, and evacuation behavior	Psychological	Canada	Durage, Kattan, Wirasinghe, and Ruwanpura (2014)
Response to early warning and evacuation orders	Socio-economic	Japan	Chiba (2011)
Early warning systems, dissemination of warnings, preparedness and response to cyclonic hazards, extent of evacuation, evacuation routes and reasons for non-evacuation	Socio-demographic, -political, -economic, cognitive, geographic, and psychological	Bangladesh	Paul et al. (2010); Akhand (2003); Paul (2012); Haque (1997); Paul and Dutt (2010); Haque and Blair (1992); Bern et al. (1993); Paul and Routray (2013)
Indigenous coping strategies to cyclonic risks	Social and psychological	Bangladesh	Paul and Routray (2011)

A number of empirical studies have applied sociological, psychological, geographical, demographic, technical, and economic parameters in different geographical locations to

investigate people's risk perceptions and response patterns to rapid-onset hazards and associated warnings and their compliance with evacuation orders, as shown in Table 3.2.

Regardless of geographical location, people generally seek shelter based on four criteria: efficacy, cost, time requirements, and barriers to implementation (Mileti, 1999). Again, to address environmental hazards, vulnerability and political economy paradigms focus on social, psychological, economic, geographic, and demographic parameters that affect people's responses to hazard warnings and evacuation orders (Mileti & Sorensen, 1990; Wisner, P. Blaikie, T. Cannon, & I. Davis, 2004).

3.3.1. Conceptual framework: Bangladesh context

In addressing the complex nexus among diverse factors that finally result in evacuation decisions, so far the most comprehensive model is the Protective Action Decision Model (PADM) developed by Lindell and Perry (2012), which was introduced in Chapter 2 (Section 2.5). It is a multistage model, as shown in Figure 3.1, capable of describing overlapping processes that are likely to expedite people's evacuation compliance during imminent hazards. In the language of Lindell and Perry (2012), the relevant decision-making process for protective response starts with environmental cues, social cues, and warning messages. Environmental cues include sights, smells, and sounds indicating an impending threat, while social cues include observing others' behavior. Warning messages consist of necessary information on an impending hazard and directives that are transmitted from a credible source via channels to recipients, which affect actions of the recipients subject to their characteristics. These actions bring about changes in the beliefs and behavior of the recipients, while their characteristics are shaped by their physical (i.e., strength), psychomotor (i.e., vision and hearing), and cognitive (i.e., language and mental schema) abilities and economic (i.e., financial solvency and logistics), and social (i.e., peer network) resources. A series of pre-decisional processes is initiated on the basis of different cues (e.g., environmental, social, and warning messages), which literally evoke core perceptions of environmental threats, alternative protective responses, and necessary directives for stakeholders. These perceptions form the platform for the decision-making process for protective actions, the result of which connects situational facilitators and impediments to generate behavioral responses. In general, such responses can be information searching, protective responses, or emotion-oriented coping. Sometimes there may be a feedback loop as additional environmental or social cues are observed or warnings are received (Lindell & Perry, 2012).

A careful review of the PADM reveals that this model is not entirely applicable in the context of Bangladesh. It is indicated that the nature of a warning network has significant impacts on protective responses (i.e., evacuation decisions) and that the network has a broad range of communication channels: print media such as newspapers, magazines, and brochures; electronic media such as commercial radios, televisions, telephones, route alerts (i.e., broadcasting from a moving vehicle), tone alerts, sirens, and the Internet; and face-to-face conversations. However, in Bangladesh, most of these electronic channels are not available and thus are not applicable to the country. As mentioned in Section 2.3 of Chapter 2, alert and warning are not the same by definition: alert indicates the "possibility of a hazard" while

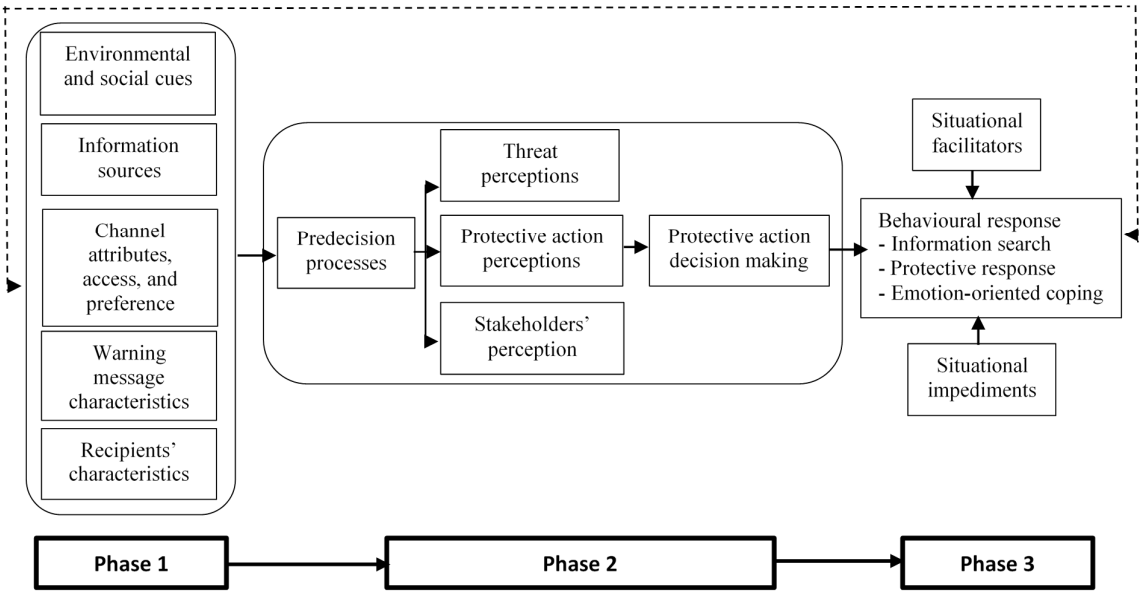

Figure 3.1. Process of information flow in the PADM.
Source: Adapted and customized from Lindell & Perry (2012).

warning indicates "immediate action" (NHC, 2004). In Bangladesh the warning flags can be considered as alerts, while signals (e.g., danger signal, great danger signal) containing specific messages can be considered warning messages apart from messages from the media and volunteers (GoB, 2011b, 2014). The PADM furthermore emphasizes resource-oriented attributes (e.g., cost and skill requirements) and situational facilitators (e.g., personal vehicle ownership) in adopting protective responses. In Bangladesh, however, these two determinants do not play any significant role in evacuation decision-making processes because the coastal areas are not well connected by road networks and evacuees generally walk to the nearest public cyclone shelters, which are located within 3–4 km from their homes.

Considering situational impediments in the context of coastal Bangladesh, people at risk commonly decide to evacuate at the very last moment, and it becomes very difficult and time-consuming for them to travel even a short distance to a shelter in extremely adverse weather conditions (Paul, 2009). Although evacuees are to incur no cost to travel to cyclone shelters, they need to exert a substantial degree of effort to overcome the spatial gap between their homes and shelters. This fact reasonably agrees with the conclusions of the previous studies by Paul and Routray (2013), Chowdhury et al. (1993), Ikeda (1995), and Paul et al. (2010) reporting distance as an important situational impediment to evacuation decision-making in coastal Bangladesh. Furthermore, home ownership, which appears to be an important element of socioeconomic status in developed countries, is not relevant for evacuation decision-making in Bangladesh. Instead, the type of structure is more important, as strong structures (e.g., brick-built houses) can withstand the strong winds of cyclones much better than weak structures (e.g., mud-built houses). Again, the concept of pet ownership is not a crucial factor in evacuation decision-making in Bangladesh, as opposed to developed countries (e.g., the United States); rather, cattle ownership is reported to have a significant influence over decision making in coastal Bangladesh, especially among the poor and marginalized households (Haque, 1995; Talukder et al., 1992), which rely on cattle for their livelihoods.

In light of the similarities and contrasts of the PADM in the context of coastal Bangladesh, in this study we adopt a customized version of the PADM attuned to factors affecting the evacuation decisions of people at risk. Figure 3.1 shows the processes of the PADM that are considered under three phases. In this customized PADM, the evacuation decision is assumed to be a proxy of the protective response under the behavioral responses that are affected by situational facilitators and impediments in Phase 3; different perceptions, pre-decisional processes, and protective action decision making in Phase 2; and the remaining components (e.g., different cues, channel access, warning message, and recipients' characteristics) in Phase 1, where warning message includes both alerts and warnings.

3.4. Research Design

3.4.1. Profile of the study location

A case study approach was chosen to realize the study objective mentioned at the end of the introduction. We placed a spatial focus on the Koyra upazilla[17] (22°12′–22°31′ N, 89°15′–

[17] Sub-district

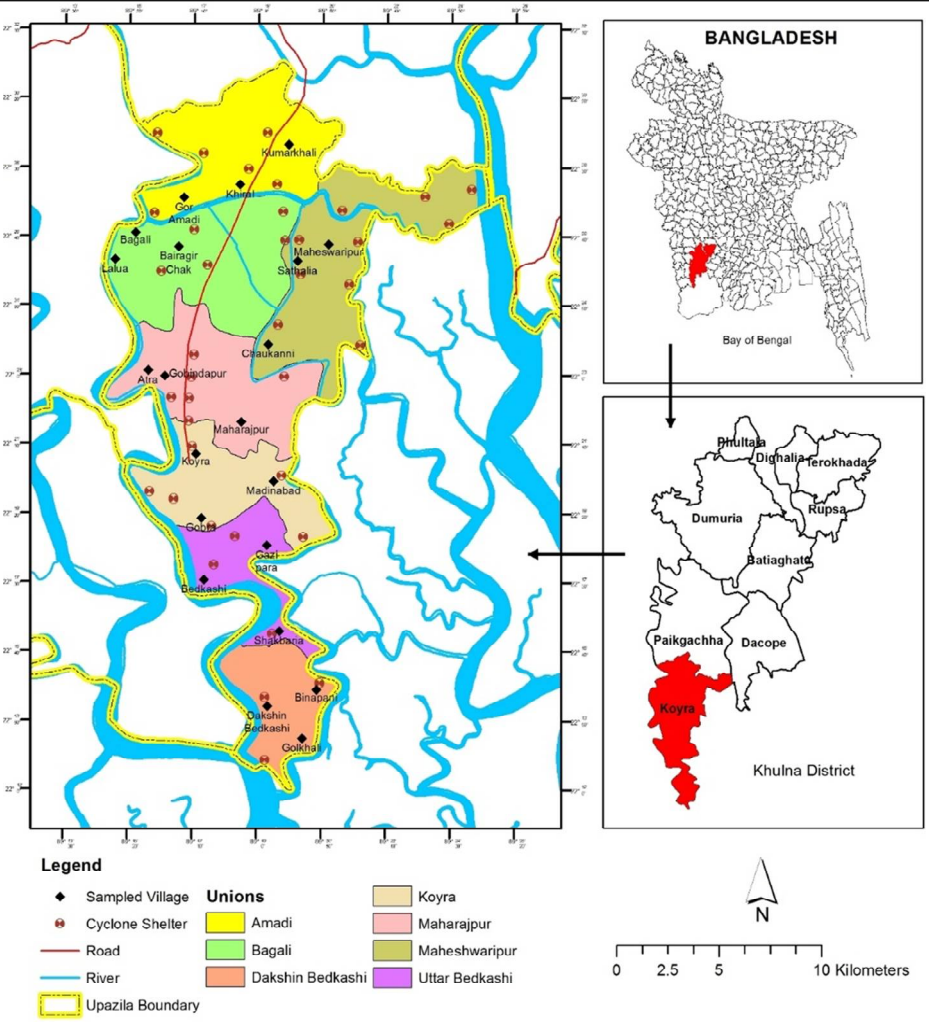

Figure 3.2. Map of Koyra (prepared with the data provided by the GIS Unit of the Local Government and Engineering Department (LGED) of the Government of the People's Republic of Bangladesh [2010]; GoB, 2009).

89°26′ E), situated southwest of Khulna District in Bangladesh (Figure 3.2). With an area of about 1,800 km^2, Koyra was established as a *Thana* (a kind of sub-district) in 1980 and later was converted into an upazilla. The administrative setup of this upazilla consists of seven union *Parishads*[18], 72 *Mouzas*[19], and 131 villages (Bangladesh Bureau of Statistics [BBS], 2011). According to the latest population census, the total population of Koyra is about 194,000, with a male–female ratio of 0.96 and a population density of 109 per km^2 (BBS, 2013).

The elevation of *Koyra* is about 2 m above mean sea level in its northern territory and about

[18] Office of the lowest tier in local government

[19] Clusters

1 m in the south ("Koyra upazilla," in Banglapedia, 2006). The ground composition of this upazilla consists of flat land with a natural ground slope, and it is surrounded by the world's largest mangrove forest—the *Sundarbans* (a UNESCO heritage site)—and the Bay of Bengal from the southeastern and southern sides, respectively. This region belongs to an immature deltaic slope, where a long belt of land is hardly above sea level (Takagi, Oguchi, Zaiki, & Matsumoto, 2005). The Koyra River is the main flow in this upazilla. Due to natural tidal action, the Shibsa, Pasur, Sakbaria, Kobatak, and Dharla Rivers have significant influence on both surface and groundwater quality (PDO-ICZMP, 2003). We carried out this study in all seven unions of Koyra: Amadi, Bagali, Koyra, Maharajpur, Maheshwarpur, Uttar Bedkashi, and Dakshin Bedkashi. The justification for choosing Koyra as the study location was twofold. First, this area is situated within the exposed coastal region; second, this area was recently hit by two consecutive devastating tropical cyclones: Sidr in 2007 and Aila in 2009. The locations of the sample villages selected for the household survey and the existing cyclone shelters are presented in the map of Koyra (Figure 3.2).

3.4.2. Data collection techniques, sampling method, and analytical approach

Figure 3.3 presents different stages of the data collection, including associated data types, research methods, and operations.

3.4.2.1. Data collection techniques and sampling method

For this study, primary data were collected at the first stage by applying Focus Group Discussions (FGDs) and at the second stage by applying a face-to-face household-level questionnaire survey. One FGD was conducted in each union of Koyra, for which the discussants were invited from diverse

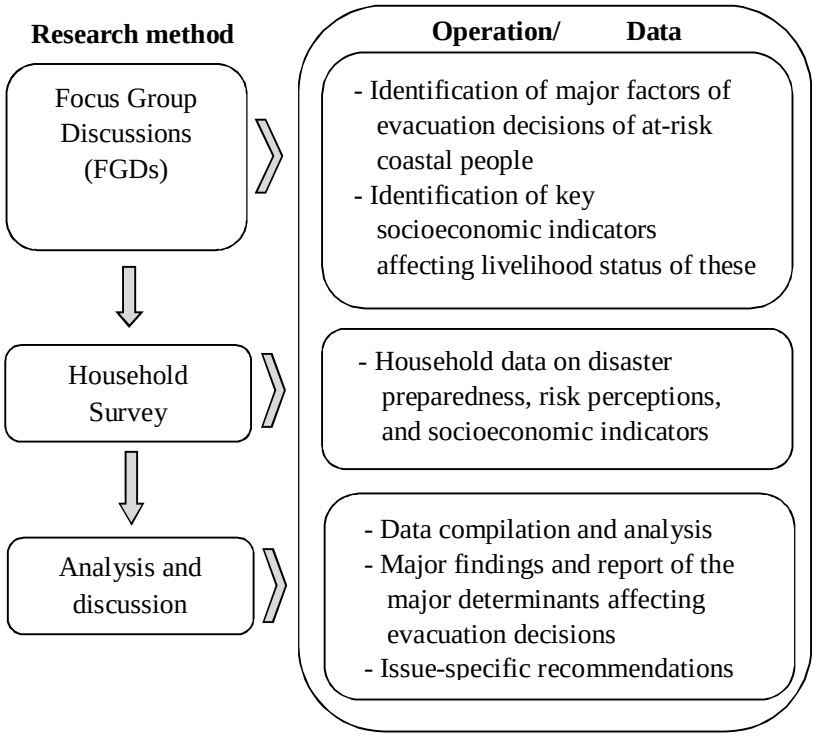

Figure 3.3. Stages of data collection, data type, research methods, and operations.

groups of the society such as farmers, laborers, the self-employed, local elites[20], and officials from governmental organizations and NGOs. More than 90% of the FGD participants were Aila victims from the studied locality. Utilizing informal discussions, these FGDs helped not only to determine possible influential determinants on the decision to evacuate, but also to gain an overall idea of the socioeconomic status of the households in the study area. The discussants were divided by occupation, so that they could contribute as representatives of their specific occupations. A panel consisted of five members: one from a local government, one as the representative of local NGOs, one from Khulna University (a local public university), one from the regional UNDP office, and one of the authors, who took part in facilitating the discussions in the FGDs. All of the FGDs were completed before conducting the household survey, and necessary precautions were ensured during the FGDs to avoid bias while finalizing the FGD outcomes.

A set of standard rules suggested by the United Nations Statistical Division (United Nations [UN], 2008) was followed to prepare for and administer the household survey. The questionnaire was designed through an iterative process where the first draft was prepared after seven FGDs and subsequent discussions with local experts (local government officials, NGO workers, priests, and teachers from schools and colleges). During the pretesting of the questionnaire, the downstream areas (i.e., southern unions) were inundated due to embankment breaches caused by Tropical Cyclone Aila, and several questions needed to be redesigned for the households in these areas. Thus, two successive rounds of pretesting were conducted in order to confirm the uniformity of the questionnaire for all of the sample respondents (in both the upstream and downstream areas) in the study location. After conducted the pretesting, the final version of the questionnaire that was prepared contained 32 main questions, with one general section and two specific sections. The questions in the general section focused on each household's basic socioeconomic information (income, consumption, asset portfolio, settlement condition, utilities, and sanitation). The specific sections focused on a set of recall-type questions on disaster preparedness and evacuation decisions during Cyclone Aila. Most of the questions were closed-ended; only two were open-ended. The latter type of questions provided qualitative information, which was used to cross-check the major findings from the FGDs (see Appendix D-1).

[20] Social elites comprise community leaders (e.g., teachers and the chief of the local mosque committee) and people with political power (e.g., village chairman and political leaders).

Three villages from each union were randomly selected, and 20 households were also randomly chosen from each village. Each household was considered a primary sampling unit. Therefore, from 21 villages (in seven unions), a total of 420 households were selected as samples for the questionnaire survey, as shown in Figure 3.3. Due to the incidence of two consecutive cyclones (Sidr in 2007 and Aila in 2009) within less than two years, there was a high rate of migration, both in and out, in the study location; therefore, the local government office could not provide us with an updated list of households. Under the circumstances, we applied the "random walk" (World Health Organization [WHO], 2011) method by selecting the road direction from the central marketplace of the localities (commonly known as *Hut/Bazar* in Bengali) to choose respondent households, with every twentieth household along a randomly chosen road in a particular locality being approached for a face-to-face survey. Each survey took about 30 minutes to complete. Senior undergraduate students from the Economics Discipline of Khulna University were deployed as surveyors for household-level data collection. These students were thoroughly trained through a week-long workshop in order to confirm uniformity in the household survey. These household surveys were administered in December 2009 and January 2010.

3.4.3. Analytical approach

We structured the analysis plan into three stages. First, we distinguished between evacuee and non-evacuee households by several key characteristics such as sociodemographic features, the understanding level of warning messages, and distance to the nearest safe haven. Second, we applied principal component analysis (PCA) to determine the major dimensions of the evacuation decision-making process (e.g., threat/risk perception), which appeared to be explained by a set of variables. Third, we assimilated the empirical findings based on the differences between the evacuee and non-evacuee households on some key factors, the PCA results, and the FGDs' outcomes to structure our discussion. We used relevant descriptive statistics to present important characteristics of the sample respondents. We also conducted quantitative assessments by applying relevant parametric and nonparametric test statistics (z-test, chi-square test, and correlation) to show the differences between the groups (i.e., evacuees vs. non-evacuees), along with the degree of association among relevant determinants. The reason for choosing PCA over other tools was to determine, out of a large number of variables, the relevant variables that as a cluster were likely to explain a specific dimension of evacuation decisions. To choose relevant variables for the PCA, we first carried out a partial correlation

among 46 variables and then finally selected 20 variables (as mentioned in Table 3.5) with a correlation value of at least 0.60. These variables were finally used in the PCA to obtain factor loadings and constitute a factor loading matrix, which presents the correlations between the principal component and the original variables. Typically the principal components, reflecting specific dimension of evacuation decision in this study, are named after the cluster of variables with which they are highly correlated (i.e., variables with higher loadings). These variables with higher loading are treated as factors under a specific principal component. Each component is extracted on the basis of a set of variables that constitute orthogonal linear combinations of those variables capturing the common information most successfully. In other words, each component actually reflects a "hidden organization" or "latent variable" that captures common information from a set of variables. In principle, for a dataset with significant collinearity, the principal components with an Eigenvalue greater than or equal to one capture the maximum amount of information through applicable observed variables. In this case study we proceeded with a goal of obtaining the most influential characteristics of evacuation decisions at a household level, and we do not claim that our approach is the most "appropriate" as there may be other econometric methods that possess superior statistical properties. Nonetheless, given the current dataset and study objective, we consider PCA as the method to capture the common characteristics of variable sets. In this study, we named the components on the basis of empirical results matching relevant parts of the PADM mentioned in the conceptual framework (Section 3.1). Both "variables" and "factors" are used interchangeably in explaining the PCA results in this Chapter. A statistical software package, Stata (Version 13), was used to perform all of the statistical operations.

3.5. Major Findings and Discussion

The descriptive statistics (Table 3.3) shows that a majority of the respondents in the sample survey were male. The average size of the sampled households was 4.85, which is slightly higher than the average (4.24) shown by the latest census for Koyra. A similar trend was found for the male–female ratio (sample ratio: 0.99, census ratio: 0.97; BBS, 2011, p. 34). A substantial number of people were involved in diverse agricultural activities such as cropping, fishing, and poultry, which is consistent with the latest census results for the region. Nearly 10% of the respondents did not have any paid job (i.e., unemployed). Consequently, around 73% of our sampled households were found to depend on various natural resources for their livelihoods.

For the poverty threshold level (defined in Table 3.3), we used consumption expenditures, as the incomes of the respondents were very volatile after Cyclone Aila. The descriptive statistics show that around 72% of our sampled households were living under the poverty threshold, which is consistent with the poverty map jointly prepared by the World Bank, the Bangladesh Bureau of Statistics, and the World Food Programme (BBS, 2009). The relevant socioeconomic parameters in Table 3.3 clearly reflect a higher incidence of poverty and a lower standard of living, in terms of sanitation and necessary utilities, in the coastal communities. These factors all together appeared to make the coastal people more susceptible to natural hazard shocks.

The major findings from the FGDs also demonstrated that the majority of the population in Koyra was income poor and substantially depended on climate-sensitive sources for their livelihoods. The participants in different FGDs opined about the following issues, in general, as key determinants for evacuation decision-making by people at risk: characteristics of cyclone

Table 3.3. Summary statistics of socio-economic characteristics of sampled households in Koyra (N = 420).

Households' characteristics		**Value**	
Male respondents (%)		83.3	
Household size		4.85	
Male–female ratio		0.99	
Respondents' average age (median value)		41	(40)
Respondents' religion (%)	Muslim	88.3	
Households with literate heads* (%)		38.3	
Respondents' occupation (%)	Fishing	27.7	
	Cropping	20.2	
	Poultry	16.0	
	Daily laborer	14.5	
	Self-employed/Others	12.9	
	Unemployed	9.7	
Households dependent on NRDI** (%)		72.7	
Households below poverty threshold*** (%)		71.6	
Squared poverty gap		0.054	
Income inequality [Gini coefficient] (min–max)		0.29	(0.21-
Households with a sanitary latrine (%)		12.4	
Households with a tube-well (%)		6.9	
Households with electricity connection (%)		19.3	

* A household head is considered as literate if he/she has at least four years of academic schooling.
** Natural resource dependent income (NRDI) is considered to be income obtaining from cropping, fishery, and forest resource collection
*** The poverty threshold was calculated in 2005 (and accordingly adjusted for year 2008-09) by applying the cost of basic needs (CBN) consumption as a poverty threshold value, which was US$202/capita/year in 2008–09 (BBS, 2005, 2010, 2011). The CBN consumption consists of both food and non-food items required to maintain the minimum living standard.
Source: Field survey, 2010.

shelters (e.g., location, space inside, and killa availability), perception of hazard risk (e.g., indigenous knowledge and previous experiences), factors associated with warning messages and receiving channels (e.g., formal language, understandable information, and accessibility to available channels), participation in cyclone preparedness training (e.g., frequency and duration), socioeconomic conditions of households at risk (e.g., income, dependency ratio, and asset portfolio), and social customs (e.g., separate premises for males and females in public shelters). The FGD participants also mentioned that immediately after a cyclone, stakeholder agencies tend to focus more on disaster relief and rehabilitation for affected people, which help them to recover from the damage they incurred; however, the impacts of such recovery often last only for a short period (e.g., three months).

3.5.1. Preparedness during Cyclone Aila

Bangladesh experienced several tropical cyclones within the span of less than two years, from November 2007 to May 2009. After the devastation caused by Cyclone Sidr in 2007, coastal Bangladesh experienced Cyclones Rashmi in October 2008 and Bijli in April 2009 (UNDP, 2010). Cyclone Aila made landfall on 25 May 2009 in the area covering southwestern coastal Bangladesh and some parts of West Bengal in India. The relevant agencies of the Bangladesh government started disseminating warnings on 23 May 2009, when a depression was turning into a strong cyclone and proceeding toward a north–northwestern part of the Bay of Bengal. The BMD advised to hoist danger signal number four[21] in a local maritime port known as Mongla. Twenty-six hours before Aila's landfall, it was advised to hoist danger signal number seven[22] in the same port, and all applicable agencies were asked to disseminate an immediate evacuation order (Nirapad, 2009). Besides the available media (radio and television broadcasting), government and local administrators, CPP volunteers, NGO workers, and

[21] A number four danger signal implies that the port is threatened by a storm (wind speed of 51–61 km/hour) but the danger does not yet appear sufficiently great to justify extreme precautionary measures.
[22] The port will experience severe weather from a storm of light or moderate intensity (wind speed of 62–88 km/hour) that is expected to cross over or near the port.

villagers themselves also took the initiative to disseminate the cyclone warning by communicating the danger signal number and evacuation orders through handheld sirens, megaphones, bicycle-mounted loud-speakers, and house-to-house knocking. They advised at-risk people to evacuate to safe havens, preferably to cyclone shelters or brick-built, elevated buildings.

3.5.2. Compliance pattern with warning and evacuation orders: evacuee vs. non-evacuee

The heads of the households were asked if they sought shelter at any place other than their own houses after having received the evacuation order. Only around 33% of them replied affirmatively, which is somewhat consistent with the initial report on aid assistance for Aila (in which slightly over 35% of households were reported to have evacuated) by the IFRC (IFRC, 2009). The sampled households that took refuge in cyclone shelters or other safe havens (e.g., brick-built buildings) are considered evacuees; the others are considered non-evacuees in this study. Among the evacuee sampled respondents (i.e., households), around 88% took shelter in public cyclone shelters and the remaining 12% stayed in their neighbors' or relatives' houses.

The statistical comparison in Table 3.4 shows that the non-evacuee households are located, on average, farther away from their nearest cyclone shelters than the evacuee households. This finding is consistent with the interview survey results, in which about 47% of the non-evacuee households reported that the cyclone shelters were too distant for them to reach within a reasonable time period. In addition, more than 32% of the households from the non-evacuee group went to their nearest cyclone shelter and found that there was not enough space inside for them to take refuge. Table 3.4 also indicates relatively higher rates among the evacuee households in both the percentage of early warning recipients and the understanding level of early warnings. In addition, more evacuee households had participated in cyclone preparedness training before Aila. They also reported making more frequent contact with CPP volunteers than their counterparts. All of these differences between the evacuee and non-evacuee households were found to be statistically significant and systematic[23] (see Table 3.4).

Household size did not vary considerably between the groups. However, the number of dependent members was higher for the non-evacuee households. The literacy rate (expressed as years of schooling) varied between the groups. These differences were also found to be

[23] This implies the power of the repetitive-measures design. In this case, we divided the whole sample into two groups (evacuee and non-evacuee), where "systematically" refers to the effect size (i.e., power) of the repetitive measure, which is demonstrated by Point-Biserial (*r*). For a detailed explanation, see Field (2005).

statistically significant and systematic in most cases, as shown in Table 3.4. Again, although the incidence of physical injury was higher for the non-evacuee group, the value of the respective test statistic for such injury was not significantly or systematically different from zero between the evacuee and non-evacuee households.

The results from Table 3.4 also suggest significant and systematic differences between the

Table 3.4. Contrast between evacuee and non-evacuee households on warning, preparedness, socioeconomic issues [N = 420].

Issue	Evacuee	Non-evacuee	Test-statistics (p value) [effect size]
Distance to nearest cyclone shelter from household (km)	2.08	3.66	14.03[a] (p <0.000) [0.57[c]]
Household's participation in preparedness training before cyclone Aila (%) [†]	63.77	22.70	67.69[b] (p <0.000) [0.04[c]]
Households could understand warning messages (%) [†]	49.28	26.24	21.97[b] (p <0.000) [0.11[c]]
Households connected with CPP volunteers [†]	73.77	48.25	7.084[b] (p <0.008) [0.22[c]]
Households receiving early warnings (%) [†]	89.20	74.47	16.89[b] (p <0.000) [0.21[c]]
Households with cattle ownership (%) [†]	52.90	71.99	14.98[b] (p <0.000) [0.33[c]]
Mean age of household heads (years)	42.62	39.98	2.004[a] (p <0.045) [0.10[c]]
Household size (number)	4.92	4.81	0.601[a] (p <0.548) [0.03[c]]
Literacy of household heads (schooling years)	4.97	4.31	2.01[a] (p <0.045) [0.09[c]]
Average number of adult female members in household (age >14 years)	2.1	3.4	3.66[a] (p <.000) [0.39[c]]
Average number of dependent members in household (age < 14 and > 64 years)	1.66	2.30	4.99[a] (p <0.000) [0.24[c]]
Households depending on natural sources for livelihood (%) [†]	63.77	76.60	7.63[b] (p <0.006) [0.40[c]]
Physical injuries in household (number)	0.65	0.75	1.21[a] (p <0.225) [0.06[c]]
Households living below poverty threshold (%) [†]	58.70	80.85	23.39[b] (p <0.000) [0.41[c]]
Households living in concrete buildings (%) [†]	12.63	7.88	29.16[b] (p <0.003) [0.21[c]]
Households with membership of GO/NGO operated safety net programs (%) [†]	53.62	75.18	19.81[b] (p <0.000) [0.35[c]]
Economic damage incurred by households due to cyclone (US$)	160.62	165.36	2.56[a] (p <0.010) [0.13[c]]
Households' living duration with same community (years)	41.35	37.89	2.30[a] (p <0.022) [0.11[c]]

[†] Dichotomous response where 1 = Yes, 0 = No

[a] Z-statistics for mean difference test

Table 3.4. Contrast between evacuee and non-evacuee households on warning, preparedness, socioeconomic issues [N = 420].

Issue	Evacuee	Non-evacuee	Test-statistics (p value) [effect size]

[b] Chi-squared statistics
[c] Point-Biserial (*r*) where 0.2, 0.5, and 0.8 refer to small but not trivial, medium, and high effect size, respectively (Field, 2005)

evacuee and non-evacuee households in the percentages of households living under the poverty threshold, living in weak settlements, and safety-net membership, as well as economic damage (measured in US$) incurred due to cyclones and living duration within the same community (as a proxy of social capital). Compared to the latter group, fewer households in the former group belonged to the poorer section of the society, more of them lived in concrete buildings, fewer were users of the safety-net program and incurred economic damage due to cyclones, and more lived longer in their current community.

3.5.3. Factors affecting evacuation decision

Spontaneous responses from the FGDs and the face-to-face household survey provided crucial insights into the decisions of households affected by Aila on evacuation. We conducted a principal component analysis (PCA) to figure out the extent of the influence of different factors (i.e., the variables) on the obtained principal components, in light of relevant parts of the PADM, that affect the evacuation decisions of people at risk in Koyra. As a rule of thumb for the PCA, we considered five principal components with an eigenvalue of more than one, which all together explain about 74% of the total variation. The Kaiser-Mayer-Olkin (KMO) test indicated slightly over 72% accuracy for sampling adequacy. The Bartlett's test of sphericity was also significant (χ^2 (190) = 1,483.29, p <0.000). Cronbach's alpha for this PCA was about 74%, which is good enough. The average communality for the variables presented in Table 3.5 was calculated as 0.68, which is also satisfactory, considering our sample size (Field, 2013). We applied the Oblimin rotation method with Kaiser Normalization for this PCA in order to align the factor axes as closely as possible to the clusters of the original variables. Table 3.5 presents the communalities and factor loadings for the studied variables, with only loadings above 0.3 reported. We apply the word principal component and factor interchangeably in the following part.

Based on the absolute values of the studied factor loadings in Table 3.5, the first principal component/factor, explaining just over 23% of the total variation, denotes the features of

warning messages, information sources, and access to channels through variables such as the understanding level of early warning signals (EWS), CPP volunteer connections, reliability of warnings and signals, and possession of a mobile phone. In this case, the affected peoples' participation in preparedness training can be considered as their preference, as per the processes indicated in Phase 1 of the PADM, in Figure 3.1. The second factor entails factors associated with the situational impediments and facilitators in Phase 3 of the PADM, which are translated into variables such as distance to the nearest cyclone shelter, separate toilets for different genders, availability of clean water, and availability of killas in the neighborhood. This factor explains slightly over 20% of the total variation. The third factor, explaining around 15% of the variation, revolves around the recipients' characteristics, including socioeconomic features such as household size, male–female ratio, and the number of dependent members within households at the time when evacuation decisions are made (Phase 1 of the PADM in Figure 3.1). Explaining around 10% of the variation, the fourth factor refers to the perception of threat (i.e., risk) by households through factors such as indigenous knowledge, previous hazard experience, fear of household belongings being looted if evacuated, and a false sense of security (Phase 2 of the PADM in Figure 3.1). The fifth factor, comprising around 6% of the total variation, also demonstrates the risk perception features of the households. The relevant factors' correlation matrix exhibits a high degree of correlation (0.743) between the fourth and fifth factors, and the score-plot and loading-plot demonstrate several factors, as shown in Table 3.5, in common with both the fourth and fifth factors. All of the obtained factors demonstrate different processes of the PADM, as mentioned in Table 3.5. Specifically, the first and third factors imply the commencement of the pre-decisional process of protective action (Phase 1 in Figure 3.1). In addition, the fourth and fifth factors indicate the threat perceptions that lead to behavioral responses (Phase 2), while the second factor denotes the situational impediments (or facilitators) that affect protective responses (i.e., making evacuation decisions) as one of the behavioral responses (Phase 3). Interestingly, several factors (i.e., variables) seem to overlap and hence appear to be common within more than one factor. For example, the variable(s) addressing indigenous knowledge under threat perception can also be considered as environmental cues, because people at risk usually construct a threatening message by observing movements of creatures such as fish and ants, even though we did not consider such overlapping issues as being within the scope of the theoretical framework applied in this study. In the same way, factors indicating situational impediments can be situational facilitators for some people (e.g.,

distance to a cyclone shelter). Table 3.5 shows that the factors implying information sources, channel access, and preferences are exhibited through the component with the maximum variance (i.e., 23% of the total variation) and are very similar with the FGD participants' opinions on factors associated with cyclone preparedness, warning messages, and access to channels while deciding to evacuate. As presented in Table 3.4, the non-evacuee households participated in preparedness training on fewer occasions.

Table 3.5. Results of PCA [N = 420].

Variables	Communalities	Factors					Factor addressing process(es) of the PADM
		1	2	3	4	5	
Participation in cyclone preparedness training [a]	.791	.831					Information sources, channel access and preferences, and warning message
Understanding of EWS [b]	.803	.514		−.30			
CPP volunteer connection [c]	.627	.797					
Reliability of signal/warning [c]	.733	.691					
Mobile phone ownership [d]	.381	.321					
Distance to nearest cyclone shelter from household [e]	.701		.699				Situational impediments and facilitators
Space availability inside shelter [f]	.778		.744				
Separate toilets for women and men [f]	.618		.322				
Clean water supply [f]	.587		.519		.321		
Availability of killas in shelters' neighborhood [f]	.901		.710				
Household size (number)	.851			.871			Recipients' characteristics
Male–female ratio	.530			.603	−.317		
Dependency ratio	.791			.509			
Literacy of household heads (schooling years)	.409			.301			
Cattle ownership [d]	.477			.609			
House structure type [g]	.783			.811			
Danger perception through indigenous knowledge [c]	.684				.833	.408	Threat/risk perceptions
Previous experience of large-scale hazards (in terms of damage incurred) [d]	.558				.407	.311	
Fear of being looted if evacuated [c]	.714				−.527		
False sense of security [c]	.809				.614	.345	

[a] 4 = More than five times in lifetime, 3 = Four to five times, 2 = Two to three times, 1 = Only once, 0 = Never participated

[b] 5 = More than 80% of the content, 4 = 80–70%, 3 = 70–60%, 2 = 60–50%, 1 = Less than 50%, 0 = Do not understand at all

[c] 5 = Very frequently/always, 4 = Frequently/most occasions, 3 = Sometimes, 2 = Rarely, 1 = Very rarely/never

[d] 1 = Yes, 0 = No.

[e] 5 = More than 5 km, 4 = Within 4–5 km, 3 = Within 3–4 km, 2 = Within 2–3 km, 1 = Less than 2 km

[f] 5 = Most important, 4 = More important, 3 = Important, 2 = Less important, 1 = Not important

[g] 4 = Brick-built with concrete roof, 3 = Brick-built with tin-shed roof, 2 = Non brick-built with tin-shed roof, 1 = Non brick-built with straw-shed roof

A plausible consequence of such lower participation can be translated into their poorer understanding level of the warning messages (χ^2 (5) = 84.80, p <0.001). Aside from this scenario, people's lower degree of contact with CPP volunteers (including communication through a mobile phone) also appeared to restrain them from relying on warning messages (χ^2 (5) = 245.97, p <0.000). The aforementioned differences between the evacuee and non-evacuee households were found to be statistically significant and systematic. Table 3.4 reveals that a substantial percentage of both evacuee and non-evacuee households received early warnings before Cyclone Aila made landfall. Furthermore, slightly over 97% of the sampled households confirmed that CPP volunteers had warned and advised them to evacuate at least six hours before the landfall of the cyclone; nonetheless, nearly 75% of them did not evacuate. These households were skeptical about the messages, since they had received similar warnings and evacuation orders on several occasions (especially in the events of Cyclones Rashmi and Bijli) after Cyclone Sidr in 2007, in which the intensities of the hazards were not as devastating as foretold. For example, around 44% of the non-evacuee sampled households could apprehend the upcoming hazard using their indigenous knowledge; however, almost 70% of this group did not evacuate due to their immediate previous experience with warnings during Cyclones Rashmi and Bijli, which seemed to have created a false sense of security with them. Moreover, around 73% from the same group feared that their houses might be looted if abandoned. These results are consistent with the study findings of Paul and Routry (2013), Paul (2012), and Paul and Dutt (2010), carried out mostly in the southern coastal part of Bangladesh, as well as those of Haque (1995), conducted in the southeastern coastal part of the country and revealing determinants of people's skeptical attitudes toward information encouraging evacuation decisions.

The locations of the cyclone shelters were a pivotal factor for evacuation decision-making, as shown in Table 3.5. In conjunction with the findings from Table 3.4, the non-evacuee households were found to be located significantly and systematically farther away from cyclone shelters than the other group. Around 55% of the non-evacuee sampled households reported that they had no public shelter in their immediate vicinity (i.e., within 2 km from their houses) and that a considerable amount of time was required to reach shelters, even when they were not sure if there was enough space left for them to take shelter inside (see Figure 3.2 for the locations of existing cyclone shelters in the study area). Previous studies suggest that the optimal distance to the nearest cyclone shelter from a household should be 1.5 km at a maximum (Chowdhury

et al., 1993; Haque, 1995; Ikeda, 1995); in contrast, this distance was 3.14 (± 1.31) km on average for our sampled households and even longer for the non-evacuee households (Table 3.4). Therefore, the distance to shelters appeared to be a decisive factor that may have dissuaded the sampled households from evacuating. As for the space-finding (i.e., the capacity of a shelter) issue, over 77% of the non-evacuee sampled households mentioned the insufficiency of space inside the public shelters during emergencies. Such claims seem to be justified if the statistics on public shelters during Cyclone Aila are considered. The relevant statistics reveal that only 42 public cyclone shelters were available in Koyra upazilla, which could provide space only for about 41,000—merely 21% of the total population of this upazilla (BBS, 2013; GoB, 2013).

When cattle ownership is an issue, the decision to evacuate was also governed by the availability of killas in the neighborhood of the public cyclone shelters, as suggested in Table 3.5. Table 3.4 shows that cattle ownership was significantly and systematically higher with the non-evacuee households. The decision not to evacuate appeared to be a result of the unavailability of killas in the proximity of the existing cyclone shelters, which is consistent with the comments of the FGD participants. In Koyra upazilla, only 12% of the cyclone shelters have killas adjacent to them in which to keep livestock animals (i.e., cattle and poultry) safe during emergencies (Upazilla Parishad Office of Koyra, 2010). Households for whom these animals had been a source of income would leave no stone unturned to secure such income-generating asset(s). Informal conversations with the non-evacuee respondents suggested that as soon as they found that their homesteads were very likely to be either blown away by gusty winds or submerged by storm surges, they abandoned their houses and started heading to safe havens, taking their livestock with them. In some cases, the cattle were set free during previous cyclones, although these animals were the most commonly reported to be killed by flying debris and storm surges. This scenario is also consistent with the findings by Paul and Dutt (2010).

Due to social custom, women in rural Bangladesh observe a norm of *purdah*, which indicates "a curtain" and is used figuratively to indicate the separation of women from men (Ikeda, 1995). Following this tradition, women strongly prefer to use separate spaces and toilets in cyclone shelters, instead of sharing them with men. The relevant statistics indicate that only around 14% and 43% of the existing shelters in Koyra have gender-segregated spaces and toilets, respectively (GoB, 2011c). Hence, in many cases, the evacuation decision seemed to be governed by the availability of separate spaces and toilets, especially if households observe the norm of *purdah* very strictly, which is also consistent with our FGD findings. More than 36%

of the non-evacuee respondents mentioned that this reason influenced their decision. In addition, the evacuee households desired a sufficient supply of clean water at the shelters, especially among households with more dependent members (children and older adults). Eventually more than 64% of the shelters were equipped with clean water supplies (GoB, 2011c). These findings are in line with findings by Paul and Dutt (2010).

The relevant outcomes from Tables 3.4 and 3.5 indicate that socio-demographic features (e.g., the message recipients' characteristics) had a crucial influence on evacuation decision-making. For instance, children under 5 years old and adults over 64 years old constitute a dependent segment within households, whose presence appeared to exert significant influence on evacuation decision-making, as the non-evacuee households had significantly and systematically more dependent members (Table 3.4). In the same way, the number of adult female members in a household also appeared to affect the evacuation decision-making process, as Table 3.4 exhibits that households with a higher number of adult females seemingly complied with the norm of *purdah*, which was likely to impede their evacuation process. Finally, while the literacy levels were significantly and non-systematically lower among the non-evacuees (Table 3.4), with a higher standard deviation (± 3.21) in the sampled household heads' years of schooling, this factor was found—although with a lower factor loading—to be substantial for evacuation decision-making, as presented in Table 3.5.

3.5.4. Regression analysis

With a view to assessing the connection of the five factors with evacuation status, we conduct a logistic regression. Table 3.6 presents the result of this logistic regression where five factors predicted the evacuation status (i.e., dependent variable), which is a dichotomous variable. The results suggest that except for the fifth factor, all other factors were likely to persuade the sampled households to evacuate to cyclone shelters.

In other words, within the first factor, households with preparedness training, an understanding of early warning messages, a connection with CPP volunteers, reliability on the received warning/signal, and owning a mobile phone were more likely to evacuate during cyclone. Within the second factor, households considered distance to nearest cyclone shelter, required space inside the shelter, separated toilets for male and female, pure drinking water supply, and killa availability in the neighborhood of the shelter were more likely to evacuate. Within the third factor, households focused on their size, male-female and dependency ratio, household head's literacy level, cattle ownership, and strength of their house-structure were

more likely to evacuate during the cyclone. Finally, within the fourth factor, households relying on their indigenous knowledge to detect hazard threats, former experience from hazard events, and that were less driven by a false sense of security were more likely to evacuate at the time of a cyclone. Interestingly, as was already mentioned, no significant result was obtained for the fifth factor although in Table 3.5, both the fourth and fifth factors (i.e., components) imply the same issue of threat/risk perception of households behind their evacuation decision.

Table 3.6. Logistic regression results for factors and evacuation status

Factors with Specific Variables	Evacuated (1= yes, 0= otherwise) Coefficients (SE)
First Factor (Variables: preparedness training participation, understanding of EWS, CPP volunteer connection, reliability of signal/warning, and mobile phone ownership)	3.033*** (0.300)
Second Factor (Variables: distance to CS, space availability, gender-segregated toilet, clean water supply, and killa availability)	0.255** (0. 074)
Third Factor (Variables: household size, male-female ratio, dependency ratio, literacy of household head, cattle ownership, and house structure type)	1.008*** (0.221)
Fourth Factor (Variables: danger perception through indigenous knowledge, previous hazard experience, fear of being looted, and false sense of security)	0.298* (0.244)
Fifth Factor (Variables: danger perception through indigenous knowledge, previous hazard experience, and false sense of security)	-0.235 (0.229)
Constant	1.452*** (0.246)
Model fit statistics	
Number of observations (N)	420
Log-likelihood (for model)	-72.841
Likelihood-ratio Chi-squared (p-value)	388.9 df = 5 (p<0.000)
McFadden's adjusted R-squared	0.705

*** p<0.01, ** p<0.05, * p<0.1

3.6. Concluding Remarks

This Chapter investigates the decisional aspects of people at risk while responding to cyclone warnings and evacuation orders issued prior to the landfall of Tropical Cyclone Aila in southwestern coastal Bangladesh. One of the key findings is that the evacuation rate was

substantially beneath a satisfactory level, despite the utmost efforts by the Bangladesh government and applicable agencies, especially since Cyclone Sidr hit the country in 2007. In line with the findings of the previous studies by Paul and Routry (2013), Paul (2012), Paul and Dutt (2010), Haque (1995), and Akhand (2003), this study also found, based on the findings from the FGDs and the household survey in light of the relevant processes of the PADM, that non-compliance by at-risk people with evacuation orders seems to be attributable to the following determinants: the distance to the nearby safe havens (i.e., cyclone shelters), insufficient space inside the shelters, the unavailability of gender-segregated toilets and spaces in the shelters, the unavailability of nearby killas, a poor understanding level of warning messages and signals, a relatively larger dependent segment within a household, and social customs for adult women. Unlike past studies, this study found significant and systematic absenteeism among non-evacuee households from various opportunities for cyclone preparedness training, whereas such trainings appears to be a crucial factor associated with the understanding of early warnings ($r = 0.77$, $p < 0.021$), connection with CPP volunteers ($r = 0.79$, $p < 0.000$), literacy level ($r = 0.61$, $p < 0.042$), and reliance on warning messages ($r = 0.82$, $p < 0.001$). This result is consistent with our FGD findings, as well as with the study findings by Islam and Walkerden (2015) and Nadiruzzaman and Paul (2013) on the post-Cyclone Sidr situation, revealing that stakeholder agencies focus more on postcyclone relief and rehabilitation support than on sufficient hazard preparedness training. This finding indeed calls into question the effectiveness of various recent awareness programs conducted by the Bangladesh government, together with its partner agencies, for seemingly not reaching out sufficiently to people at risk in coastal areas. In other words, this result implies problems with the stakeholder agencies' perceptions used to formulate sustainable and realistic strategies to keep people at risk alert and optimally responsive during impending hazards.

As a final methodological remark, we would like to emphasize that the results presented in this paper are based on observed association by using linear correlations and PCA procedures, in conjunction with relevant processes of the PADM. Thus, an important question remains as to how well the observed empirical results address the nonlinear causal relationship and to which direction this relationship may persist, subject to the incorporation of all of the processes suggested in the PADM. This is because the PADM was originally designed and intended to be applied to industrialized countries, and can only partially be applied to developing countries like Bangladesh, where a number of factors in the existing PADM framework do not fit the local

context due to a number of differences (e.g., culture, socioeconomic infrastructure, and logistical support). Furthermore, no variables in the dataset used in this study addressed the nexus between the structure of a society and the evacuation response, which can be considered as a limitation of this study. Thus, we suggest developing an extended deterministic model that includes more relevant variables to address the complete set of processes of the PADM in the context of developing countries to further test the nonlinear causal relationships and their directions in future studies.

4. Role of Preparedness Training on Households' Socioeconomic Resilience toward Hazard Shocks

4.1. Introduction

One of the findings in the previous Chapter (Chapter 3) suggests that preparedness training significantly affected the evacuation compliance of the at-risk households in coastal Bangladesh. In this light, the current Chapter focuses on the role of preparedness training in making those households socioeconomically resilient toward hazard shocks. As the natural hazard risk management frameworks have experienced a paradigm transition in contemporary times from an emergency response to an all-inclusive disaster risk management approach (UNISDR, 2015b), the impetus for this transition is spurred through emphasizing the formation of hazard-resilient communities by enhancing the coping capacity of vulnerable people to the impact of natural hazards (Akter & Mallick, 2013).

Within the domain of disaster risk management, the concept of disaster risk reduction (DRR) focuses on strategies of reducing disaster risk by considering factors propagate disasters, such as causal factors associated with hazard exposure, peoples' vulnerability, and preparedness for extreme events (Begum, Sarkar, Jaafar, & Pereira, 2014). On the other hand, the concept of climate change adaptation (CCA) focuses on relevant adjustments to natural and/or human systems in response to external shocks that may either invoke the adverse effects or utilize the beneficial opportunities (Burton, 1997; Smit, McNabb, & Smithers, 1996). Within the broad objectives, both DRR and CCA target the common strategies of vulnerability reduction and enhancing resilience while dealing with extreme events.

Although the concept of vulnerability is applied in multifarious fields and disciplines such as ecology, disaster management, development studies, economics, anthropology, sociology, health science, global, and environmental studies (Cutter, 1996), there is no commonly accepted precise definition of "vulnerability" in the scientific community. Evidence of this fact is that all definitions by different organizations such as UNISDR (2009), IPCC (2012a), the Food and Agricultural Organization [FAO] (2002), and IFRC (2013) are different. Generally the disaster risk literature defines socioeconomic vulnerability as susceptibility that precedes and follows disasters with different intensity and subsequently affects social, economic, political, and institutional components through the combination of sensitivity, exposure, and adaptive capacity (Adger, 2006; Cutter, Mitchell, & Scott, 2000; Finch, Emrich, & Cutter, 2010; Gallopín, 2006; IPCC, 2012b; Lee, 2014). While vulnerability focuses on the conditions making

humans susceptible to adverse phenomena, resilience deals with adapting to (or coping with) and recovering from exogenous shocks (e.g., hazard shock), absorbing unanticipated adverse states, and learning to bounce back to a steady state/normal-functioning state through different trajectories (Folke, 2006; Gallopín, 2006; Holling, 1973; Wildavsky, 1988). The concept of "resilience" emerged in the knowledge domain of ecology between the late 1960s and the early 1970s. The entry of the term "resilience" in the disaster discourse has been treated as a new paradigm in the disaster risk reduction concept since the World Conference on Disaster Reduction (WCDR) in 2005 (Manyena, 2006). In this study we use the term "socioeconomic resilience" as the ability of communities to cope with exogenous perturbations and stresses resulting from socioeconomic, sociopolitical, and socioecological change, which is in line with the definition of social resilience proposed by Adger (2000).

Both socioeconomic vulnerability and socioeconomic resilience can be considered as distinct but overlapping concepts (Cutter et al., 2008b; Gallopín, 2006). Vulnerability associates with structural changes of a system, such that the pre-event (e.g., predisaster) factors contribute to the degree of risk of being exposed and harmed for the system, while resilience associates with the transition of a system's states to absorb, cope with, and adapt to exogenous shocks (e.g., hazards) (Cutter et al., 2008a; Gallopín, 2006). From this perspective, vulnerability and resilience are assumed to be interlinked through adaptive capacity, which is considered a core component of vulnerability (Gallopín, 2006; Nelson, Adger, & Brown, 2007). Some scholars treat and apply resilience and vulnerability interchangeably (Adger, 2006; Smit & Wandel, 2006). The adaptive capacity, decomposed as anticipatory and reactive by Huq and Reid (2004), implies a sustainable mechanism that can adjust a system's sensitivity to and exposure from shocks (Adger et al., 2011; Gallopín, 2006; Turner et al., 2003).

Literature addressing socioeconomic vulnerability postulates a high degree of affinity between the socioeconomic status and vulnerability of a household (Adger, 1999, 2006; Ahsan, 2010; Ahsan & Warner, 2014). This implies that at a given level of socioeconomic status, the poor and marginalized people of a society are more likely to live in weak settlements in hazard-prone locations, which eventually makes them more exposed and sensitive to hazard shocks. However, such exposure and sensitivity can be diminished if these people can acquire required adaptive strategies through their emergency preparedness (Hajito, Gesesew, Bayu, & Tsehay, 2015; Hossain, 2015). This means that the intensity of immediate effects (e.g., loss of life and assets), short-term impacts (e.g., structural, physical and financial damage), and long-term

impacts (i.e., less income and consumption, fewer economic opportunities, and lower standards of living) from natural hazards can be well-managed within reasonable tolerance limits if necessary adaptive measures are executed properly.

A previous handful of empirical studies addressing socioeconomic resilience mostly took into account either pre- or posthazard situations by considering a specific adaptive strategy (Cox & Hamlen, 2015; Hajito et al., 2015; Helgeson, Dietz, & Hochrainer-Stigler, 2013; Hossain, 2015; Lee, 2014; Lei, Wang, Yue, Zhou, & Yin, 2014; Mohapatra, Joseph, & Ratha, 2012; O'Brien & O'Keefe, 2010; Parvin & Shaw, 2013; Paul & Routray, 2011; Razafindrabe, Kada, Arima, & Inoue, 2014). Therefore, the number of studies focusing on socioeconomic resilience by considering both pre- and posthazard adaptive strategies is still too low to provide comprehensive knowledge in this regard. Against this backdrop, the most interesting and pioneering work is conducted by Akter and Mallick (2013), who focused on the nexus among poverty, vulnerability, and resilience in a cyclone-affected coastal community in Bangladesh. Utilizing primary data, Akter and Mallick (2013) showed that the poor were more vulnerable and consequently encountered higher economic, physical, and structural damage; nevertheless, such a higher degree of vulnerability did not necessarily manifest through a lower level of resilience, as the poor households exhibited a better ability to withstand perturbations and stresses than their nonpoor neighbors in terms of income growth shock and maintaining previous employment. Results from other studies suggest that cyclones and their catastrophic cascading effects[24], such as storm-surge, flood, water-logging, and infrastructure (e.g., embankment) collapse, invoke significant adverse impacts for coastal people at risk. As a reaction to these adverse impacts, the affected people may apply common adaptive strategies (i.e., responses) such as personal loans from informal sources, remittance, and the sale of livestock; however, these strategies result in a lower standard of living for an uncertain period for them.

As the risks from extreme events have increased around the world, and the new paradigm of DRR has emerged with an emphasis on forming resilient societies, it is important to develop and enrich a knowledge base on the mutual links between socioeconomic resilience and adaptive strategies in connection with vulnerability (Akter & Mallick, 2013; Aldunce, Beilin, Howden, & Handmer, 2015; Begum et al., 2014; Bergstrand, Mayer, Brumback, & Zhang,

[24] As mentioned in Chapter 1, “cascading effects” refers to the drivers triggering relatively minor hazards into significant socioeconomic impacts on living standards of the affected people.

2015; Birkmann & Teichman, 2010; Howe, 2011). In line with the study by Akter and Mallick (2013), which is the very first attempt at profound evidence-based analyses of household behavior in coastal Bangladesh considering vulnerability-resilience dynamics in connection with poverty, this current paper also follows their hypotheses and framework on those dynamics by utilizing a new dataset and model, but specifying the focus on the emergency preparedness aspect of households. This subject was a part of Akter and Mallick's (2013) analyses, but deserves further emphasis. Therefore, for a better understanding of the mutual links between socioeconomic resilience and adaptive strategies considering vulnerability, three specific questions need to be investigated: (i) what is known about the different adaptive strategies (both anticipatory and reactive) to cope with adverse impacts of extreme events (e.g., cyclones)?, (ii) what are the patterns of socioeconomic resilience in relation with emergency preparedness training for the people at risk in a community?, and (iii) what type of policy recommendation is necessary to enhance the resilience among communities? This Chapter reports an empirical case study that investigated these three questions by utilizing primary data collected from a household survey in a hazard-prone and low-income community in southwestern coastal Bangladesh. In the realm of the very limited well-established framework for resilience assessment, Akter and Mallick (2013) applied the State-and-Transition model to portray the vulnerability-resilience nexus by considering both pre- and posthazard situations. This model was originated in the discipline of applied ecology and mostly applied to address ecosystem dynamics. In this paper we applied a customized version of the "Access model," which was originated in the Social Science domain to address resilience patterns of people at risk by considering the disaster-risk-vulnerability nexus. Investigating socioeconomic resilience before and after a disaster caused by a natural hazard event, we examined mutual links among the different components of vulnerability and resilience for the people who did and did not participate in emergency preparedness training in at-risk coastal communities. Thus, in this Chapter we use "participant" and "nonparticipant" to indicate the people who did and did not participate in preparedness training, respectively. As a part of disaster preparedness, which is continuous and integrated action-oriented strategies as mentioned in Chapter one, training for disaster preparedness has emerged within the framework of community-focused DRR activities (IFRC, 2001). In this context, we consider only the workshops, symposiums, and drills that were arranged for the at-risk households within the scope of preparedness training in this

Chapter. In general, such training happened to be arranged by the stakeholder agencies every three months.

To proceed with our analysis, the remainder of this Chapter is structured as follows: Section 4.2 outlines a theoretical framework applied for resilience assessment; Section 4.3 presents the context of the case study with relevant descriptions on the study location, data collection, and analytical approach; Section 4.4 presents major findings (results); Section 4.5 focuses on discussion of results; and Section 4.6 wraps up with concluding remarks.

4.2. Theoretical Framework

This section introduces a theoretical framework applied to adaptive capacity-resilience nexus in this study. Therefore, we first overview several existing frameworks, followed by discussion on the Access model.

4.2.1. Existing frameworks

Available resilience assessment frameworks differ, depending on their orientation toward the outcome (i.e., end-result) or process (i.e., series of reformations) oriented approach (Akter and Mallick 2013). FAO (2013) structures the measurement of resilience as outcome through a number of socioeconomic indicators: income and food access, access to basic services, assets, social safety nets, and the stability of adaptive capacity. Each of the aforementioned socioeconomic indicators is again defined by a set of attributes and is assigned a specific weight. Together, these weighted indicators provide a composite index value known as a "resilience score." Using the same indicators, resilience score can be calculated for two different time periods and hence, resilience for a specific community can be obtained for two time periods. Using this approach, FAO (2013) compares the resilience scores among different locations. In contrast, the MOVE[25], a process-oriented framework, sketches the nexus among vulnerability, risk, and social responses as mentioned by Birkmann et al. (2013), where resilience is sketched as a common attribute for both coping and adaptive capacity. This framework defines resilience in connection with societal response capacity in terms of access to and utilization of common-pool resources while responding to an identified perturbation and stress. Hence, the MOVE framework's definitional spectrum includes pre-disaster risk reduction, coping capacity during a disaster, and post-disaster response measures for the affected communities with a notion of

[25] Methods for Improvement of Vulnerability Assessment in Europe; www.move-fp7.eu

learning from past experience(s) and accordingly applying those learning experiences to handle future hazards (Birkmann et al., 2013).

In the resilience index framework by FAO (2013), the pre- and post- disaster situations lie between two extremes in terms of deviation from the steady state of livelihood of the target group, while the resilience in the MOVE framework (Birkmann et al., 2013) deals only with pre-disaster features and post-disaster response (not recovery) of the target group. Therefore, neither of the models addresses the full paradigm of all the existing scientifically accepted approaches on disaster resilience, which is also true for other relevant models such as the DROP (Disaster Resilience of Place) model suggested by (Cutter et al., 2008b), the "4 Rs" (risk recognition, resistance, redundancy, and rapidity) model suggested by Forgette et al. (2008), and DFID's (2011) reaction model to a shock. In this backdrop, the State-and-Transition model explaining ecosystem dynamics, which was developed by Westoby, Walker, and Noy-Meir (1989), covers a broader spectrum of resilience dynamics, and a customized version of this model was applied by Akter and Mallick (2013) in their study in light of socioeconomic resilience to natural disaster. They portrayed the vulnerability-resilience dynamics in connection with poverty by applying the State-and-Transition model and identified determinants that explained resilience heterogeneity among their respondent households, which are quite policy-relevant empirical findings. In the current paper, by considering a number of similar variables from Akter and Mallick's (2013) study, we adopt a more disaster-focused model explaining a socioeconomic phenomenon during a disaster situation, and thus we opt for the Access model, introduced first by Blaikie, Cannon, Davis, and Wisner (1994) and further developed by Wisner, Piers. Blaikie, Cannon, & Davis (2004) and Wisner, Gaillard, & Kelman (2012), because it accommodates a wider spectrum of adaptation-resilience dynamics. We customized the Access model to apply it for better understanding of socioeconomic resilience to natural hazard impacts.

4.2.2. Access model

The Access model was developed by Blaikie et al. (1994) and upgraded further by Wisner et al. (2004) and Wisner et al. (2012) and related to the Pressure and Release (PAR) model, which is a political economy approach to address disaster causes and impacts. The PAR model postulates that disaster risk is formed by the interaction (known as the pressure point) between the progression of vulnerability (root causes, dynamic pressure, and unsafe conditions) and a hazard. However, the PAR model does not provide a detailed analysis of dynamics at the

pressure point. The Access model deals with the details of what takes place at the pressure point between catastrophic events and expected immediate, short-term, and long-term social processes. Hence, this model presents how households' resilience in a community is affected by differences in access to economic or political resources (e.g., income/consumption, employment, and acquaintance with local elites such as community leaders and people with political power) required to maintain a steady livelihood or normal state. Resource accessibility is the key challenge for households to recover their livelihoods, make themselves stable, increase their resilience to hazard shocks, and gain the capacity to restore livelihoods to the previous normal state.

Following the customized framework of the State-and-Transition model used by Akter and Mallick (2013) in their study, we also divided the customized Access model for our paper into five major phases in accordance with a common logic used in a conventional disaster management cycle: pre-disaster normal state, anticipatory adaptive capacity, transition to disaster, and reactive adaptive capacity in post-disaster abnormal and quasi-normal states (Figure 4.1). The pre-disaster normal state (boxes with white background in Figure 4.1) refers to the features indicating the initial (original) state of well-being at time *t* with the livelihood of households given exposure and sensitivity to natural hazards (e.g., cyclones, floods). The iterative features of livelihood are suggested by repeated cycles denoting livelihood decisions, and each on one box, arranged in the diagram behind each other, implies cyclic decision-making during different time periods (at time *t* and *t+1*, respectively). The anticipatory adaptive capacity resembles the trajectory that operates the transition between normal and disaster states. Pre- and post-disaster states are differentiated by a threshold level, which consists of a simultaneous decrease in both Access profile and Access qualification, where Access profile is viewed in terms of resource-access phenomena such as peoples' degree of access to sanitation, water and electricity, structure of their settlement, and their nonland asset portfolio, while their Access qualification implies socioeconomic welfare phenomena such as household consumption and employment opportunity (Blaikie et al. 1994, Wisner et al. 2004). Crossing this threshold invokes the transition to disaster at time *t+1* (boxes with dashed lines and grey background in Figure 4.1). Beyond the transition to the disaster phase (i.e., post-disaster abnormal state), the reactive adaptive capacities (i.e., response) in connection with recovery by households commence and, thus, the post-disaster quasi-normal state is obtained, which is temporary and inferior to the initial state of well-being. Successful adoption of necessary

disaster-risk reduction actions by households may necessarily lead them to bounce back to their pre-disaster normal state at *t+1*; otherwise, their livelihood is very likely to be collapsed and eventually the households would encounter a new cycle of a new disaster at time *t+1*. Social relations and the structure of domination in this customized model lead to social integration (e.g., social capital) and acquaintance with local elites, respectively. Different components and subcomponents during time *t* and *t+1* in Figure 4.1 are assumed to be interlinked.

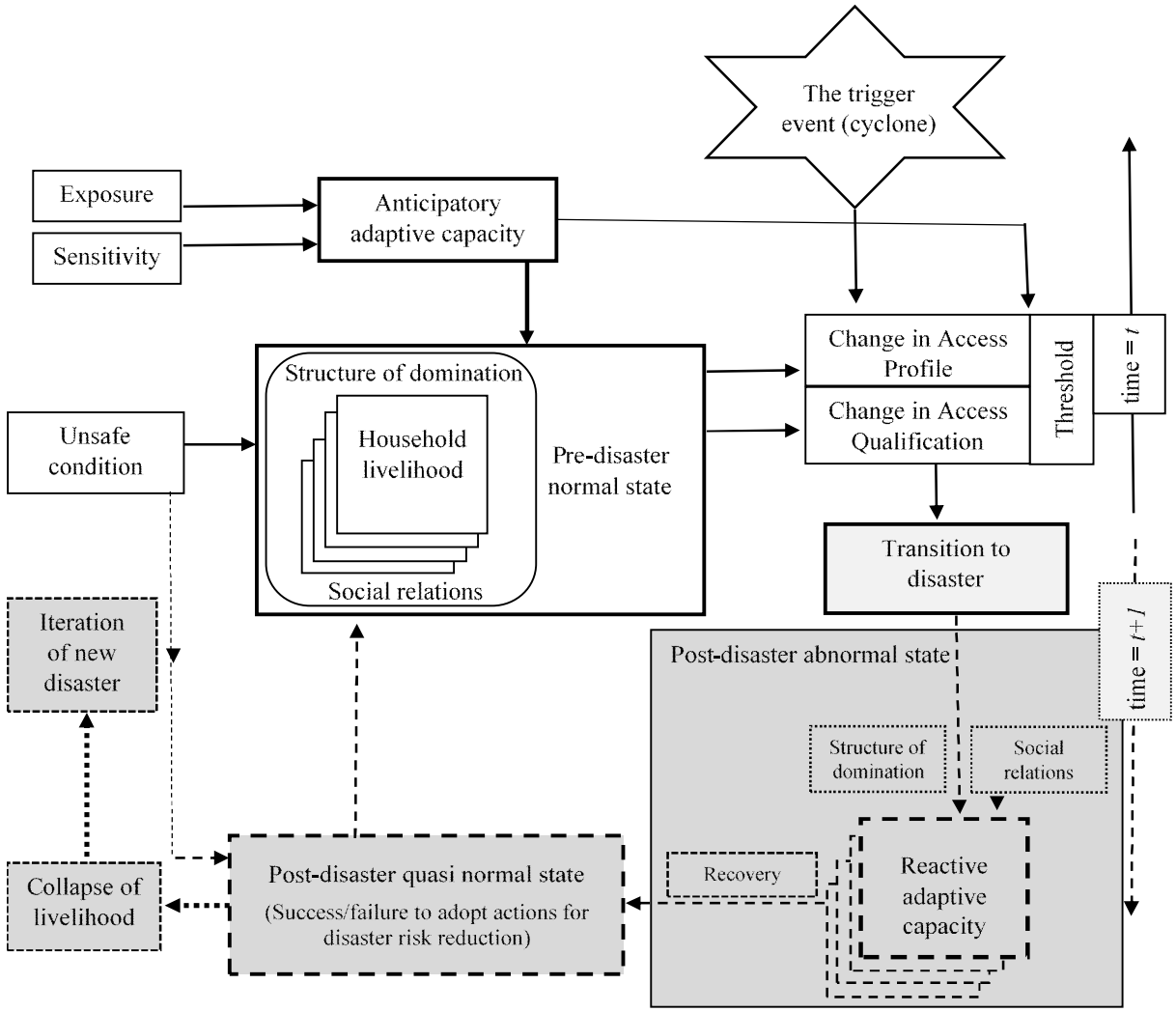

Figure 4.1. Access model for assessing socioeconomic resilience towards natural hazard-led disasters (Adapted and customized from Blaikie et al. (1994), Wisner et al. (2004), and Akter and Mallick (2013)).

Previous studies on socioeconomic vulnerability revealed mutual links among exposure, sensitivity, and adaptive capacity by focusing on the resilience status of the people at risk. However, the mutual links between vulnerability and disaster (i.e., cyclone) preparedness, in

consideration with resilience discourse, that contribute to sketch the pre-disaster features to post-disaster status have been addressed by Akter and Mallick (2013) partly, but not in a comprehensive way. In this context, we directed our attention to the pre- and post- states in the current study by following an analytical approach similar to Akter and Mallick (2013). Therefore, first we assessed the intercorrelations among the factors of sensitivity, exposure, and anticipatory adaptive capacity in the pre-cyclone normal state (subsection 4.4.2) followed by intercorrelations among factors of recovery and reactive adaptive capacity in post-cyclone abnormal and quasi-normal states (subsection 4.4.3). Next we distinguished between preparedness training participants and nonparticipants through a cross-sectional comparison (subsection 4.4.4). Finally we examined the deterministic associations among factors of recovery, different adaptive capacities, and specific household characteristics by considering the effects of welfare indicators and training participation, respectively (subsection 4.4.5).

4.3. Materials and Methods

4.3.1. Study location and data collection

For our case study presented in the current Chapter, the study location and data collection method are same as in Chapter 3 (subsections 3.4.1 and 3.4.2.1; Figure 3.2).

4.3.2. Analytical approach

Table 4.1 provides a summary of indicators used in this study to address the components of vulnerability and resilience. As mentioned in subsection 4.2.2 that in this Chapter we would follow an analytical framework similar to Akter and Mallick (2013), we designed the analysis plan with three stages. First, we conducted intercorrelations among factors considered in this study for pre- and postcyclone states. Second, we performed a crosssection comparison between the households who did (i.e., participant) and did not (i.e., nonparticipant) participate in cyclone preparedness training on the basis of different factors associated with sensitivity, exposure, anticipatory adaptive capacity, reactive adaptive capacity, and recovery by applying linear correlation, relevant parametric, and non-parametric tests to understand whether comparisons varied significantly and/or systematically. Third, a number of deterministic models were estimated to determine the "pre versus post" comparison on welfare and adaptive capacities outcomes. These deterministic models were formulated into two stages: first, the pre-post difference was assessed by considering two major threshold indicators—consumption growth ($C_{t+1,t}$) and asset-profile growth ($A_{t+1,t}$)—as proxies for Access qualification and Access profile,

respectively, by applying Ordinary least square (OLS) regression models (equation 1 and 2). Second, an ordered logit model (equation 3) was applied to estimate the effect of disaster training participation on adaptive capacities and recovery, where X_i, Y_i, and Z_i were treated as variable sets representing anticipatory adaptive capacities, reactive adaptive capacities, and recovery, respectively, for all three equations (see details in Table 4.1); φ was considered as a vector of socio-demographic characteristics of the households (e.g., age, literacy, household size, and location) having an impact on the threshold indicators as well as training participation, while ε was treated as idiosyncratic error. Hence, while estimating the deterministic models at the first stage, we adopted the following general form of specification similar to Akter and Mallick's (2013) study, but with different dependent variables (i.e., consumption growth and asset-profile growth) than those of Akter and Mallick (2013). We used consumption because the income of the respondent households was found to be very volatile, especially in the post-cyclone period.

$$\Delta C_{t+1,t} = \alpha_c + \beta_c X_{(c)_i} + \gamma_c Y_{(c)_i} + \delta_c Z_{(c)_i} + \theta_c \varphi_c + \varepsilon_c \quad \ldots \quad \ldots \quad \ldots (1)$$

$$\Delta A_{t+1,t} = \alpha_a + \beta_a X_{(a)_i} + \gamma_a Y_{(a)_i} + \delta_a Z_{(a)_i} + \theta_a \varphi_a + \varepsilon_a \quad \ldots \quad \ldots \quad \ldots (2)$$

Where $\Delta C_{t,t+1}$ and $\Delta A_{t,t+1}$ denote consumption growth (i.e., the difference in a household's yearly consumption between the post- and pre-cyclone periods) and asset-profile growth (i.e., difference between the post- and pre cyclone periods in monetary value of all non-land assets owned by the households for a year), respectively; α denotes constant; β, γ, δ, and θ are coefficients to be estimated for consumption and asset profile, accordingly. Both consumption and asset profile were measured in 2009-2010 US dollars.

In continuation with the first stage model estimation, an ordered logit regression model was applied at the second stage to estimate the relationship of an ordered dependent variable (i.e., training participation) with threshold indicators, recovery, and adaptive capacities. The following general form of equation was used in this case.

$$T^* = ln\left(\frac{P_i}{1-P_i}\right) = \omega_T S_i + \beta_T X_i + \gamma_T Y_i + \theta_T \varphi_T + \varepsilon_T \quad \ldots \quad \ldots \quad \ldots (3)$$

where T^*, the dependent variable, denotes an order or rank of participation in cyclone preparedness training. This order/rank constitutes a scale of 0 to 4, where 0 refers to "never participated," 1 refers to "only one-time participation," 2 refers to "maximum three times participation in lifetime," 3 refers to "maximum five times participation in lifetime," and 4 refers to "more than five times participation in life time." P_i refers to the probability of training

participation. S_i is a variable set referring to the threshold indicators (i.e., Access qualification and profile growth), while X, Y, and φ were the same set of variables used in equations 1 and 2, and ε was treated as idiosyncratic error, and ω, β, γ, and θ are coefficients to be estimated. For this ordered logit regression model (equation 3), the coefficients are known as ordered log-odds, which indicates a rate of contribution of one unit increase of an independent variable such as X to the increase of the dependent variable T*. In other words, one unit increase/decrease in an independent variable (in this case, variables X, Y, and φ representing threshold indicators, recovery, and adaptive capacities) would result in a certain degree (as shown by the coefficient) of increase/decrease in the likelihood of the dependent variable (i.e., the order of training participation T*), holding other independent variables constant. Consistent with the conventional interpretation of an ordered logit regression model, in this study we also explain the coefficient in the same way, such that a higher positive coefficient of an independent variable would imply a higher order (i.e., higher frequency) of preparedness training participation. As we mentioned in the introduction of this Chapter that preparedness training consists of workshop, symposium, and drill, in this Chapter we considered all the stated actions altogether as preparedness training. Hence, if a household participated in at least one of the actions, it was considered a participant. In such case, if a household participated in each of the actions only once before Cyclone Aila, then the participation frequency for that household was calculated as three.

A statistical software package, Stata (Version 13), was used to conduct all of the statistical operations for this study.

4.4. Major Findings

We report major findings (i.e., results) in this section, which comprises five subsections. Sub-section 4.4.1 presents major descriptive statistics of the sample respondents in the study location. Then subsections 4.4.2 and 4.4.3 exhibit the intercorrelations among the representative factors of sensitivity, exposure, and anticipatory adaptive capacity in pre-cyclone normal state, and then factors of recovery and reactive adaptive capacity in post-cyclone abnormal and quasi-normal states. Subsection 4.4.4 explains the contrast between participants and nonparticipants on different indicators of sensitivity, exposure, and adaptive capacities (both anticipatory and reactive). Subsection 4.4.5 presents the nexus among recovery, anticipatory, and reactive-adaptive capacities focusing the major drivers of change behind threshold indicators (as specified

Table 4.1. Components and indicators of vulnerability/resilience.

Components	**Indicators**	**#**	**Measurements**	**Source for indicators**
Sensitivity	Sex ratio	I	- Female-male ratio in household	Chambers and Conway (1992)
	Natural resource dependency	II	- Dependency of household on natural sources (fisheries, agriculture) for their livelihood	Lee (2014)
	Dependency ratio	III	- Proportionate number of children (0-14 years) and elderly (60+ years) in household	Cutter et al. (2008b)
	House type	IV	- Material used for constructing the house before Cyclone Aila (a: mud; b: bamboo; c: wood; d: straw; e: dry *nipa palm*; f: concrete; g: tin/tally)	
	Location of cyclone center	V	- Distance of nearest cyclone center from household location (km.)	
Exposure	Distance from the eroded river	VI	- Distance calculated using GPS coordinates of household's location	Brouwer et al. (2007)
Anticipatory adaptive capacity	Hazard identification and recognition	VII	- Household participated in cyclone preparedness training before the cyclone	Forgette et al. (2008); Lei et al. (2014); Nicholas and Durham (2012)
		VIII	- Household's understanding of early warning message	Ahsan et al. (2016)
		IX	- Early warning received by the household	
	Literacy	X	- Schooling level of the household head	Démurger and Fournier (2011)
	Social capital	XI	- Living duration with same community	Ahsan and Warner (2014)
	Safety net	XII	- Household is a member of any GO/NGO operated safety net program	
	Acquaintance with CPP volunteers	XIII	- Connection with CPP volunteers	Ahsan et al. (2016)
	Acquaintance with local elites[†]	XIV	- Connection or affinity with local elites	Pelling and High (2005)
	Evacuation decision	XV	- Household evacuated for safe haven after receiving early warning and advisory	Forgette et al. (2008)

Reactive adaptive capacity	Relief requirement, rapidity of reaching for relief and rehabilitation aid	XVI	- Households required emergency relief as external aid (food, shelter, medical support) after the cyclone	McCubbin et al. (2015); Collins (2014); Nicholas and Durham (2012); Forgette et al. (2008)
		XVII	- Time elapsed to reach emergency reliefs (days)	
		XVIII	- Households received housing materials as rehabilitation aid	
	Microfinance	XIX	- Household borrowed money after the cyclone	
Recovery	Financial damage	XX	- Value of financial damage (in US$)	Forgette et al. (2008)
	Structural damage	XXI	- Settlement (house) damage (in %)	
	Fishery	XXII	- Loss of fishery after Cyclone Aila	Akter and Mallick (2013)
	Livestock	XXIII	- Loss of livestock after Cyclone Aila	
	Land	XXIV	- Loss of land used for income generation after Cyclone Aila	Ahsan and Warner (2014)
	Death or injury of household member(s)	XXV	- Number of household members injured or killed during Cyclone Aila	

† In this study we consider local elites as community leaders (e.g., teachers and the chief of the local mosque committee) and people with political power (e.g., village chairman and political leaders).

in subsection 4.2.2.) in relation with participation in cyclone preparedness trainings.

4.4.1. Socioeconomic status of the respondents

The major socioeconomic parameters of the sampled households suggest a relatively lower living standard for the inhabitants in Koyra, where people are mostly involved in diverse agricultural occupations such as cropping, fishing, and poultry for their income. Nearly 13% of respondents did not have any paid job (i.e., unemployed). The majority of the respondents were found to be male and married in this study. The household size, male-female ratio, and dependency ratio were found 4.85, 0.99, and 0.37 respectively, which are nearly consistent with the census of Koyra (BBS, 2011, p. 34). A large number of the respondents (around 73%) were completely dependent on the various natural resources for their livelihoods. Relevant descriptive statistics imply that the incidence of poverty (income inequality) was relatively high, which is consistent with the poverty map prepared by a consortium of the World Bank, the Bangladesh Bureau of Statistics (BBS), and the World Food Program (BBS, 2009). Regarding the hazard preparedness of the sampled respondents, statistics show a poor involvement of these households with relevant training, as just over 36% of households replied affirmatively regarding this issue. All of the aforementioned issues seem to make these coastal households very susceptible to catastrophic shocks, as also suggested by the findings in Table 3.3 in Chapter 3.

4.4.2. Sensitivity, exposure, and anticipatory adaptive capacity in pre-cyclone normal state

Table 4.2 presents intercorrelations among key indicators of sensitivity, exposure, and anticipatory adaptive capacity during pre-cyclone normal state (i.e., the pre-disaster period). The empirical results suggest that a good number of anticipatory adaptive capacity indicators (numbers VIII-XV) were significantly correlated with several indicators of sensitivity (numbers I-V) and exposure (number VI). The hazard identification indicators were significantly and positively correlated with social capital, safety-net membership, connection with both Coastal Preparedness Programme (CPP) volunteers and social elites, and evacuation decisions. Interestingly, households living near the exposed zone (i.e., eroded river) possessed significant inverse correlation with both safety-net membership and connection with social elites. Again, safety-net membership showed significant positive correlation with connection with CPP volunteers, social elites, and evacuation decision. Literacy level of the household heads was also significantly positively correlated with degree of early warning receiving and understanding. The locations of cyclone shelters showed a significant inverse correlation with households' proximity with exposed zone and evacuation decision. All of the results postulate that households that

possessed a high degree of anticipatory adaptive capacities experienced relatively a lower degree of adverse impact from the sensitivity and exposure indicators in the pre-cyclone normal state.

4.4.3. Recovery and reactive adaptive capacity in post-cyclone abnormal and quasi-normal states

Table 4.3 shows intercorrelations among key indicators of recovery and reactive adaptive capacity during post-cyclone abnormal and quasi-normal states (i.e., the post-disaster period). The empirical findings suggest that most of the reactive adaptive capacity indicators (numbers XVI-XIX) were significantly correlated with indicators of the recovery (numbers XX-XXV). Households that suffered higher financial damage, together with loss of fishery and livestock, opted more for external relief. Nearly 76% of the respondents were in need of emergency relief in any form to cope with the immediate as well as short-term shock after Cyclone Aila. Again, households that incurred different damages and losses seemed to be quicker in reaching for emergency relief and aid. These same households were more likely to receive housing materials as rehabilitation aid. In the post-cyclone period, about 71% of households that suffered house damage and land loss were more likely to borrow credit from various microfinance institutions. Households that suffered loss of fishery and livestock together with the death of a family member also incurred higher financial damages. A statistically significant difference was observed between the likelihood of borrowing credit and the degree of financial ($z = 4.72$, $p<0.000$, effect-size = 0.23), settlement ($z = 10.26$, $p<0.000$, effect-size = 0.49) and physical ($z = 5.09$, $p<0.001$, effect-size = 0.24) damage, respectively.

4.4.4. Contrasts among sensitivity, exposure, and adaptive capacities in terms of preparedness training participation

In this subsection we consider the participation in cyclone preparedness training as the key indicator to show contrast among sensitivity, exposure, and adaptive capacities in pre and post – cyclone periods. In this regard, we divide the sample respondents of this study into participants and non-participants in cyclone preparedness training before Cyclone Aila (i.e., pre-disasterr period).

Table 4.4 presents distinctions between cyclone preparedness training participants and non-participants on the indicators of sensitivity, exposure, and anticipatory adaptive capacity, in the pre-cyclone normal state, and recovery and reactive capacity in the post-cyclone abnormal and quasi-normal states. Only 36% of respondents reported participating in preparedness training before Cyclone Aila. Interestingly, none of the indicators of sensitivity and exposure differed

Table 4.2. Intercorrelations among selected indicators of sensitivity, exposure, and anticipatory adaptive capacity during pre-cyclone normal state.

		I	II	III	IV	V	VI	VIII	IX	X	XI	XII	XIII	XIV	XV
I	Sex ratio	1.000													
II	NRDI	-0.03	1.000												
III	Dependency ratio	0.21	0.22	1.00											
IV	House type	-0.09	0.09	0.04	1.000										
V	CS location	0.39	-0.30	0.01	0.02	1.000									
VI	Distance to river	-0.33**	-0.23	0.02	-0.07	-0.30*	1.000								
VIII	EW understand	-0.57	0.11	0.05	0.014	-0.03	0.09	1.000							
IX	EW received	-0.55	0.10	-0.03	0.83*	0.016	0.21*	0.44**	1.000						
X	Literacy	-0.17*	-0.009	0.17**	-0.03	0.04	0.21	0.81**	0.43**	1.000					
XI	Social capital	0.19	0.012	0.20**	0.01	0.023	0.42**	0.16**	0.07	0.08	1.000				
XII	Safety-net member	0.41	-0.002	0.027	0.102	0.041	-0.19**	0.22**	0.29**	-0.04	0.07	1.000			
XIII	CPP volunteer	-0.054	0.10	-0.01	0.04	-0.029	0.03	0.87**	0.42**	0.11	0.68**	0.29**	1.000		
XIV	Elite connection	0.11	-0.06	-0.02	-0.0006	0.03	-0.17*	0.18**	0.08	-0.102	0.07	0.88**	0.56**	1.000	
XV	Evacuation	0.02	0.18	0.09	0.28	-0.73*	-0.41	0.77**	0.51*	0.31	-0.22	0.45**	0.79**	0.37	1.000

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4.3. Intercorrelations among selected indicators of recovery and reactive adaptive capacity during post-cyclone abnormal and quasi-normal states.

		XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	XXV
XVI	External help	1.000									
XVII	Time reaching to	-0.47***	1.000								
XVIII	Rehabilitation	0.46***	-0.46***	1.000							
XIX	Borrowing	0.06	-0.05	-0.07	1.000						
XX	Financial	0.34***	-0.29***	0.33***	0.003	1.000					
XXI	House structure	0.03	-0.13**	0.48***	0.41***	0.002	1.000				
XXII	Fishery loss	0.41***	-0.42***	-.03	-0.03	0.26***	-0.001	1.000			
XXIII	Livestock loss	0.35***	-0.41***	0.35***	0.05	0.30***	-0.004	0.31	1.000		
XXIV	Land loss	0.03	-0.11**	0.001	0.28***	0.01	0.30***	-0.03	-0.03	1.000	
XXV	H.member dead	-0.07	-0.24	-0.08	0.01	0.23***	-0.06	0.13	0.10*	0.03	1.000

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

significantly and systematically between the participant and non-participant households in the pre-cyclone normal state. These findings demonstrate that the socioeconomic and sociodemographic factors for both training participant and non-participant households were almost alike in the study location. However, during pre-cyclone normal state, all of the indicators of anticipatory adaptive capacity, except literacy level and social capital, differed significantly and systematically between the participant and non-participant households, while in the post-cyclone abnormal and quasi-normal states a majority of the indicators of reactive adaptive capacity and recovery were found significantly and systematically different between them. In this case, borrowing credit (an indicator of reactive adaptive capacity) and settlement damage (an indicator of recovery) were neither significantly nor systematically different, although households' involvement in safety-net programs, operated either by local government or NGOs, escalated the likelihood of receiving rehabilitation aid (chi-squared = 3.16, $p<0.078$). Combining the pre- and post –cyclone scenario, the time elapsed to reach emergency relief, while controlling for the proximity to the exposed zone (i.e., eroded river) and cyclone shelters, exhibited a significant negative correlation with financial damage, settlement damage, and physical injury or death of a household member ($r_{financial} = -0.19$, $p<0.004$; $r_{settlement} = -0.29$, $p<0.001$; $r_{physical} = -0.17$, $p<0.000$).

Table 4.4. Contrast between participants and non-participants on selected indicators of sensitivity, exposure, adaptive capacities, and recovery (N = 420).

Components	Indicators	Participants[a]	Non-Participants[a]	Test-statistics (p value) [effect size[d]]
Pre-cyclone normal state				
Sensitivity	Households lived in weak (non-concrete) settlements (%)	33.99	35.21	0.06[b] (p<0.801) [0.01[d]]
	Female-male ratio in the household	1.01	1.00	0.06[c] (p<0.949) [0.003[d]]
	Dependency ratio	0.375	0.368	0. 388[c] (p<0.70) [0.02[d]]
	Distance from the nearest cyclone center (km.)	3.333	3.334	0.005[c] (p<0.995) [0.0002[d]]
	Households depend on natural sources (fishery, forestry and agriculture) for livelihood (%)	44.44	39.33	1.052[b] (p<0.305) [0.05[d]]
Exposure	Distance from the eroded river (km.)	3.37	3.19	0.937[c] (p<0.349) [0.05[d]]
Anticipatory adaptive capacity	Households evacuated during Cyclone Aila (%)	64.05	15.36	104.2[b] (p<0.000) [0. 49[d]]
	Early warning received by the households (%)	81.70	25.47	123.8[b] (p<0.000) [0.54[d]]

Components	Indicators	Participants[a]	Non-Participants[a]	Test-statistics (p value) [effect size[d]]
	Households could understand the early warning message (%)	79.74	23.60	124.4[b] (p<0.000) [0.54[d]]
	Schooling years of the household head	4.72	4.41	0.93[c] (p<0.349) [0.05[d]]
	Living duration within the same community (years)	39.32	38.86	0.31[c] (p<0.756) [0.02[d]]
	Member of any GO/NGO operated safety net program (%)	75.82	34.08	67.8[b] (p<0.000) [0.40[d]]
	Households' acquaintance with local elites (%)	75.08	64.23	5.07[b] (p<0.025) [0.11[d]]
	Households evacuated	64.05	15.36	104.17[b] (p<0.000 [0.50[d]]
Post-cyclone abnormal and quasi-normal states				
Reactive adaptive capacity	Households required emergency relief as external aid (food, shelter, medical support) (%)	91.5	21.72	190.1[b] (p<0.000) [0.67[d]]
	Time elapsed to reach emergency reliefs (days)	1.6	2.9	16.88[c] (p<0.000) [0.64[d]]
	Households received housing materials as rehabilitation aid (%)	83.01	17.6	171.5[b] (p<0.000) [0.64[d]]
	Households borrowed credit after cyclone (%)	67.32	72.28	1.15[b] (p<0.283) [0.05[d]]
Recovery	Financial damage (US$)	102.5	220.01	11.01[c] (p<0.000) [0.47[d]]
	Settlement damage (%)	60.17	62.02	1.01[c] (p<0.315) [0.05[d]]
	Number of household member(s) killed or injured	0.06	0.18	2.66[c] (p<0.009) [0.13[d]]

[a] Households' preparedness training status before Cyclone Aila.

[b] Chi-squared statistics.

[c] z-statistics for mean difference test.

[d] Point-biserial (r) where 0.2, 0.5 and 0.8 refer to small but not trivial, medium and high effect-size respectively (Field 2005).

Source: Field Survey, 2010.

4.4.5. Nexus among recovery, adaptive capacities, and cyclone preparedness

This subsection presents the results of the deterministic association of recovery and adaptive capacities (both anticipatory and reactive) from the perspective of Access-qualification and Access-profile thresholds, and participation in cyclone preparedness training. In this regard, first we made a contrast of Access-qualification and -profile threshold conditions between the

pre-cyclone normal state and the post-cyclone states (i.e., both abnormal and quasi-normal). We then identified the major drivers for these thresholds through regression results.

4.4.5.1. Access-qualification and Access-profile thresholds

For this case study, we selected a set of household-level socioeconomic features as determinants of the Access-qualification and Access-profile thresholds. These determinants are likely to vary in accordance with locational contexts. In this study, we considered consumption, poverty, and employment status as determinants of the Access-qualification threshold. Simultaneously, for the Access-profile threshold, we considered settlement structure, land possession, and access to pure drinking water, sanitation, and electricity. Table 4.5 compares households' pre- and post-cyclone situations.

Table 4.5. Access-qualification and Access-profile thresholds before and after Cyclone Aila (N = 420).

Determinants	**Before (2008)**	**After (2009)**	**Test-statistics (p value) [effect size]**
Access qualification			
Households below poverty line[a] (%)	71.6	79.29	160.49[b] (p<0.000) [0.10[d]]
Yearly average household consumption (US$)	887.00	755.45	5.70[c] (p<0.000) [0.26[d]]
Per capita consumption (US$)	185.52	152.12	7.33[c] (p<0.000) [0.39[d]]
Unemployment (%)	12.86	45.00	75.74[b] (p<0.000) [0.35[d]]
Access profile			
Households possessed either self-owned or leased land for income generation (%)	83.19	61.67	16.33[b] (p<0.001) [0.42[d]]
Weak settlements (%)	65.24	63.81	10.45[b] (p<0.001) [0.12[d]]
Access to sanitation (%)	71.67	36.90	19.97[b] (p<0.000) [0.35[d]]
Access to pure drinking-water source (%)	77.38	25.71	5.06[b] (p<0.024) [0.52[d]]
Access to electricity (%)	25.71	21.19	297.31[b] (p<0.000) [0.15[d]]

[a] Similar method of poverty threshold calculation as of Table 3.3 in Chapter 3 is used in this table.
[b] Chi-squared statistics.
[c] Z-statistics for mean difference test.
[d] Point-biserial (r) for effect-size.

Source: Field Survey, 2010.

It is evident that Cyclone Aila had detrimental effects on the capability of the households in terms of poverty, and total and per capita consumption levels. The proportion of the households below the poverty line escalated from 72% to 79% after the catastrophic event. Interestingly, a majority of the poor (64%) did not participate in the preparedness training before Aila. The poor households that participated in training during pre-cyclone period exhibited a higher average yearly consumption-expenditure than the poor nonparticipants by around US$158 in post-cyclone period ($z = 12.91$, $p<0.000$, effect-size = 0.70). Around 49% of the training

participants not only maintained their employment in the post-cyclone period but also attained a higher consumption-expenditure by about US$42.30 than the non-participants ($z = 3.22$, $p<0.002$, effect-size = 0.22).

The percentage of the households that possessed a piece of land (either self-owned or leased) for income generation decreased significantly and systematically after the cyclone. A very small improvement was noted in terms of settlement conditions; less than 2% of the weak settlements were reconstructed with rehabilitation materials in the post-cyclone period. Considering settlement resilience, a significant and systematic difference was observed between the participant and non-participant households (chi-squared = 71.58, $p<0.000$, effect-size= 0.59). In addition, the households exhibiting a higher settlement resilience significantly and systematically suffered a higher yearly average consumption-expenditure (US$ 20.96) compared to those whose settlement condition remained weak in the post-event period in contrast with the pre-event period ($z = 2.19$, $p<0.030$, effect-size = 0.11). The households' accessibility to sanitation, pure drinking water, and electricity diminished significantly and systematically after the catastrophe. The degrees of access to sanitation and clean water sources were associated significantly and systematically, suggesting that the households that had less access to clean water sources were more likely to have poor access to sanitation (chi-squared = 39.44, $p<0.000$, effect-size = 0.12). The households with poor access to sanitation experienced significantly and systematically higher settlement damage ($z = 28.53$, $p<0.000$, effect-size = 0.82). No significant association was observed between training participation status and access to sanitation (chi-squared = 0.12, $p<0.727$, effect-size = 0.02), pure drinking water sources (chi-squared = 2.17, $p<0.142$, effect-size = 0.07), and electricity (chi-squared = 2.27, $p<0.132$, effect-size = 0.08). Interestingly, training participant households were more likely to receive rehabilitation aid for their damaged houses in the post-cyclone period if they happened to be more acquainted with safety-net programs (chi-squared = 118.71, $p<0.000$, effect-size = 0.64) and local elites (chi-squared = 93.88, $p<0.000$, effect-size = 0.69).

4.4.5.2. Key drivers behind change

This subsection deals with regression results. The regression methods were applied in two stages. First, the Ordinary least square (OLS) regression method was applied to estimate Eq. (1) and Eq. (2), and the results are presented in Table 4.6; second, the Ordered Logit method was applied to estimate Eq. (3) and the results are presented in Table 4.7.

In the following part, we focus on the relationship between consumption growth (i.e., difference in households' total consumption between the pre- and post- cyclone state) and a set of indicators representing recovery, anticipatory-, and reactive- adaptive capacity together with some fixed characteristics. Thereafter we focus on the relationship between asset-profile growth (i.e., the difference in (non-land) asset values between the pre- and post- cyclone state) and the same set of indicators. Tests of multicollinearity (i.e., variance inflation factor) for Eq.(1) and Eq.(2) provide values of 2.46 and 2.44, implying that neither of the models encountered collinearity problems.

Out of the recovery indicators, both the loss of fishery and livestock exhibited a statistically significant negative impact on consumption growth and (non-land) asset-profile growth, respectively, indicating that households that incurred fishery and livestock loss suffered significantly lower consumption and asset-profile in the post-cyclone abnormal and quasi-normal states, respectively, compared to the pre-cyclone normal state (Table 4.6). No significant difference was observed between consumption growth and loss of livestock. The mean coefficient of financial damage was not significantly different from zero for both consumption growth and (non-land) asset-profile growth for the households, although the signs were the same, as expected. For anticipatory adaptive capacity, the households with safety-net membership were more likely to experience positive consumption growth, implying only that these households seemed to experience higher consumption in post cyclone situation on average, with other factors held constant. A similar trend was obtained for the households who were early warning recipients. As anticipated, households evacuated for safe havens were more likely to experience a higher (non-land) asset-profile growth in the post-cyclone states (i.e., both abnormal and quasi-normal). No statistical significant relationship was found for understanding of early warnings, social capital, and acquaintance with CPP volunteers as well as social elites in either consumption growth or asset-profile growth. Among the set of reactive adaptive capacity components, the associated coefficients of necessity of emergency relief suggest that the households that required emergency relief after Cyclone Aila were more likely to experience higher consumption growth in the post-cyclone period. Furthermore, the mean coefficient of rapidity was found significantly different than zero, implying that households that needed more days to reach emergency relief experienced a negative growth in consumption in the post-cyclone period. Coefficients of necessity and rapidity of relief for asset-profile growth were not statistically significant. Again, for microfinance (i.e., credit)

1 Table 4.6. OLS regression results for drivers of household consumption- and asset-profile- growth.

Variable name	Variable description	Eq. (1) $\Delta C_{t+1,t}$	Eq. (2) $\Delta A_{t+1,t}$
		Coefficients (SE)	**Coefficients (SE)**
Indicators of recovery			
Financial damage[a]	Monetary value of total damage for non-land asset (in US$)	-0.0178 (0.0119)	-0.0102 (0.0174)
Fishery	Loss of fishery =1, otherwise =0	-12.89*** (3.070)	0.361 (4.479)
Livestock	Loss of livestock =1, otherwise =0	-3.183 (3.095)	-11.23** (4.516)
Indicators of anticipatory adaptive capacity			
Acquaintance with CPP volunteers	Household's connection with CPP volunteers before Aila =1, otherwise =0	5.279 (5.765)	2.819 (8.411)
Safety-net member	Household is a member of any GO/NGO operated safety net program =1, otherwise =0	8.653* (5.138)	2.236 (7.496)
Early warning recipient	Household received early warning and advisories =1, otherwise =0	9.793*** (3.038)	0.902 (4.432)
Early warning understanding	Household understood warning message =1, otherwise =0	1.032 (5.689)	8.926 (8.300)
Evacuation status	Household evacuated for safe havens once received early warning and advisory =1, otherwise =0	2.319 (3.321)	27.32*** (4.845)
Acquaintance with local elites	Household's connection with local elites =1, otherwise =0	-2.336 (2.907)	3.343 (4.241)
Social capital	Living duration of household within current community (years)	0.0281 (0.159)	0.170 (0.232)
Indicators of reactive adaptive capacity			
Necessity of emergency relief	Households required emergency relief after Cyclone Aila = 1, otherwise = 0	9.307*** (3.266)	0.893 (4.765)
Rapidity of reaching to relief	Time elapsed to reach emergency relief (days)	-6.048*** (1.581)	-2.300 (2.307)

Variable name	Variable description	Eq. (1) $\Delta C_{t+1,t}$	Eq. (2) $\Delta A_{t+1,t}$
		Coefficients (SE)	**Coefficients (SE)**
Microfinance	Household borrowed money after Aila = 1, otherwise = 0	-3.350 (3.058)	-0.344 (4.462)
Socio-demographic characteristics of households			
Age	Age of household head (years)	-0.147 (0.180)	-0.309 (0.263)
Literacy	Schooling of household head (years)	0.0155 (0.433)	-0.358 (0.632)
Household size	Total number of members within the household	-0.502 (0.785)	0.480 (1.145)
Mobile phone	Household head owned a mobile phone =1, otherwise =0	4.404 (5.493)	20.64** (8.014)
Household's location	Location of household within two kilometers from eroded river =1, otherwise =0	-1.964*** (0.757)	-2.048* (1.104)
Constant		42.54*** (8.462)	10.30 (12.35)
Observations		415	415
Adj R-squared		0.374	0.271

*** p<0.01, ** p<0.05, * p<0.1

[a] Five observations containing outlier values for financial damage were excluded from the dataset.

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the coefficients were not significant for consumption growth or asset-profile growth. Having conducted the propensity score matching[26] to estimate the difference for consumption growth between the participant and non-participant households, we observed that the participants could maintain significantly higher consumption (by US$ 27.03 on yearly average) during the post-cyclone period than the non-participants. Likewise, the participants could maintain significantly higher asset-profile[27] (by US$ 14.78 on yearly average) during the post-cyclone period than their counterparts. For the socio-demographic characteristics of the households, we obtained some interesting results. The coefficient of the (non-land) asset indicator (i.e., ownership of a mobile phone) significantly influenced the households' asset-profile growth. This is probably because the households became aware of the impending catastrophe through their peer network over mobile telephones, and accordingly they were able to take precautionary measures for moving their assets (e.g., fishing gear) to a safer location well in advance of the cyclone's landfall. For consumption growth, no such evidence was obtained in case of mobile phone ownership. In addition, households that lived near to exposed zones (i.e., eroded river) were more likely to suffer negative consumption as well as asset-profile growth in post-cyclone period. Age, literacy, and household size did not have significant influence on either consumption or asset-profile growth.

Table 4.7 presents results obtained from an Ordered Logistic Regression model applied for Eq.(3), where likelihood of the degree of participation in cyclone preparedness training was estimated for threshold indicators along with selected indicators of recovery, anticipatory, and reactive adaptive capacity. The dependent variable in Eq.(3) is training participation, which comprises a scale of 0-4 where 4 refers to more than five times of training participation in lifetime, 3 refers to four to five times of participation, 2 refers to two to three times of participation, 1 refers to only one participation, and 0 indicates no training participation in the entire lifetime.

As anticipated, households that experienced a positive consumption growth in the post-cyclone abnormal and quasi-normal states were likely to have participated in a higher number of preparedness training. For asset-profile growth, however, no such result was observed.

[26] Propensity scores in regions of common support were estimated where the Average Treatment effect on Treated (ATT) estimation using the radius method (100 replications) provided a value of 27.03 with a *t*-statistic of 5.26 and a bias-corrected 95% confidence interval of 12.34 to 33.71.

[27] Applying the similar method of ATT, a value of 14.78 was obtained with a *t*-statistic of 2.14 and a bias-corrected 95% confidence interval of 3.39 to 28.66.

Households were less likely to incur financial damage (an indicator of recovery) if they participated in training on a higher number of occasions, although no significant regression result (Table 4.7) was found for physical injury or death of household members, despite a significant correlation with number of times of training participation ($r = -0.13$, $p<0.008$). Out of indicators of anticipatory adaptive capacity, safety-net members, early warning recipients, and evacuee households seemed to attend a higher number of preparedness training sessions. Among the indicators of reactive adaptive capacity, households that needed emergency relief after the cyclone event were more likely to participate in a higher number of preparedness training. Furthermore, households that exhibited rapidity (i.e., within fewer days) to reach emergency relief seemed to attend a higher number of preparedness training. Out of demographic characteristics, households that owned a radio were likely to participate in preparedness training on more occasions.

4.5. Discussion

The sample respondents, irrespective of preparedness training participation, seemed to experience almost a similar degree for sensitivity and exposure (Table 4.4). However, their vulnerability profiles showed a considerable degree of deviation between the participant and non-participant households once the adaptive capacity components were incorporated in both pre- and post- cyclone periods. A majority of the indicators considered in anticipatory and reactive adaptive capacity were significantly and systematically different between the training participants and non-participants, where the participants group was ahead of their counterparts.

Indicators of anticipatory and reactive adaptive capacities were likely to affect the resilience profiles of the respondents. For example, the preparedness training participants exhibited better reactive adaptive capacity over their counterparts during the post-cyclone states (abnormal and quasi-normal), which seemed to be helpful for them to avoid higher financial damages and a higher number of deaths or injuries of household members. Furthermore, in the immediate aftermath of the cyclone, the training participant households exhibited better performance in terms of necessity for and rapidity of emergency relief. Results from Table 4.6 for threshold indicators (i.e., consumption growth as a proxy of Access qualification and asset-profile growth as a proxy of Access profile) exhibited some interesting scenarios. For example, loss of fishery and loss of livestock were found to be responsible for negative consumption- and asset-profile-growth respectively for the respondent households.

1 Table 4.7. Ordered logit model results for preparedness training participation.

Variable name	Variable description	Eq. (3) Training participation[a] Coefficients (SE)
Threshold indicators		
Consumption growth	Difference between pre vs. post consumption expenditure for respondent household (in US$)	0.0618*** (0.00722)
Asset profile growth	Difference between pre vs. post (non-land) asset value for respondent household (in US$)	0.00430 (0.03254)
Indicators of recovery		
Financial damage[b]	Monetary value of total damage for non-land asset (in US$)	-0.0140*** (0.00283)
Physical injury or death of household member	Number of household member(s) injured or dead	-0.360 (0.472)
Indicators of anticipatory adaptive capacity		
Safety-net member	Household is a member of any GO/NGO operated safety net program =1, otherwise =0	1.118** (0.568)
Early warning recipient	Household received early warning and advisories =1, otherwise =0	0.612* (0.340)
Evacuation status	Household evacuated for safe haven once receiving early warning and advisory =1, otherwise =0	1.159*** (0.345)
Social capital	Living duration of household within current community (years)	0.0127 (0.0102)
Indicators of reactive adaptive capacity		
Necessity of emergency relief	Households required with emergency relief after Cyclone Aila = 1, otherwise = 0	2.088*** (0.423)
Rapidity of reaching to relief	Time elapsed to reach emergency relief (days)	-0.786*** (0.206)
Rehabilitation materials	Households received housing materials as rehabilitation aid after Aila = 1, otherwise = 0	0.561 (0.356)
Literacy	Schooling of household head (years)	0.00150 (0.0427)

Variable name	Variable description	Eq. (3) Training participation[a] Coefficients (SE)
Radio	Household owned a radio =1, otherwise =0	0.701** (0.300)
Mobile phone	Household head owned a mobile phone =1, otherwise =0	-0.185 (0.582)
Constant		-
Model fit statistics		
Number of observations (N)		415
Log-likelihood		-208.731
Likelihood-ratio Chi-squared (p-value)		512.3 df = 14 (p<0.000)
McFadden's adjusted R-squared		0.512

*** p<0.01, ** p<0.05, * p<0.1

[a] 4 = More than five times in lifetime, 3 = Four to five times, 2 = Two to three times, 1 = Only once, 0 = Never participated

[b] Five observations containing outlier values for financial damage were excluded from the dataset.

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The indicators belonging to anticipatory adaptive capacity, such as safety-net membership and receipt of early warning, seemed to contribute positively to consumption growth, while evacuee households were likely to experience a positive asset-profile growth in post-cyclone period. Introducing the participation issue with these indicators shows significant positive correlations ($r_{safety\text{-}net}$ = 0.37, p<0.000; $r_{w.recipient}$ = 0.54, p<0.000; $r_{evacuation}$ = 0.50, p<0.000). Among these households, the training participants exhibited a higher resilience in terms of necessity for ($r_{necessity}$ = 0.67, p<0.000), rapidity to ($r_{rapidity}$ = -0.64, p<0.000), reaching to rehabilitation materials ($r_{rehab.mat}$ = 0.64, p<0.000) as emergency relief in the post-cyclone period. In addition, these participants in pre-cyclone period were less likely to incur loss of both fishery and livestock due to the devastation of a cyclone (r_{fish} = -0.51, p<0.000; $r_{livestock}$ = -0.52, p<0.000). By introducing a scale of participation in preparedness training, the threshold indicators and selected components of recovery, anticipatory, and reactive adaptive capacities were further assessed (Table 4.7). Results from this assessment implied that most of the indicators of anticipatory and reactive adaptive capacity exhibiting better performances were likely to be affected by households' higher participation in training.

Results from Tables 4.2, 4.6, and 4.7 would seem to suggest that in the pre-cyclone normal state the preparedness trainings were more likely to make the sampled households well prepared in terms of precautionary actions or anticipatory adaptive capacity (e.g., connection with CPP volunteers, receiving early warnings, evacuation, etc.) toward unforeseen adverse effects and impacts from cyclones. These precautionary actions seemed to enhance the degree of reactive adaptive capacity (e.g., the necessity for and rapidity to emergency relief), which led them to incur a lower degree of damage by the cyclone in the post-cyclone abnormal and quasi-normal state as exhibited by the results from Tables 4.3, 4.6, and 4.7. These notable results of anticipatory and reactive adaptive capacity eventually reflected a higher degree of resilience capacity of the respondent households after the cyclone. This finding is consistent with the study by Akter and Mallick (2013) at a different location of the same region.

Interestingly, literacy of the household heads showed a high degree of significant positive correlation with both receiving and understanding early warnings (Table 4.2) but showed no significant effects on either the threshold indicators (Table 4.6) or the degree of training participation (Table 4.7). Similarly, social capital, having a high correlation with understanding of early warnings and acquaintance with CPP volunteers, did not show significant effects on the threshold indicators and degree of training participation. Furthermore, the ownership of a

mobile phone exhibited significant correlations with financial damage ($r = -0.19$, $p<0.001$), reception of an early warning ($r = 0.22$, $p<0.000$), acquaintance with CPP volunteer ($r = 0.32$, $p<0.000$), and rapidity to reach emergency relief ($r = -0.31$, $p<0.000$); however, such ownership was not likely to contribute to either consumption growth or degree of training participation, but only asset-profile growth. Conversely, having a radio seemed to be advantageous in terms of financial damage ($r = -0.12$, $p<0.017$), evacuation ($r = 0.20$, $p<0.000$), reception of early warning ($r = 0.14$, $p<0.000$), acquaintance with CPP volunteer ($r = 0.21$, $p<0.000$), and rapidity to reach emergency relief ($r = -0.24$, $p<0.000$); along with a higher degree of training participation.

This empirical evidence shows that cyclone preparedness training in pre-cyclone period seemed to enhance the resilience capacity of the respondents in both the pre-cyclone period—through better anticipatory adaptive capacity—and in post-cyclone period, through better reactive adaptive capacity together with better recovery (i.e., avoiding different damages).

4.6. Concluding Remarks

This Chapter investigated and explored mutual links in vulnerability and resilience discourse from the perspective of cyclone preparedness. In this regard, the main objective of this Chapter was to enrich our understanding of the mutual links between adaptive capacities (both anticipatory and reactive) and socioeconomic resilience in connection with the vulnerability, where participation in cyclone preparedness training was considered as a key determinant to test the links. In line with the findings of existing literature on disaster risk domain, the empirical findings from our study suggest that tropical cyclones significantly exacerbated suffering in coastal people's lives and livelihoods in terms of consumption, poverty, employment, and access to basic utilities like clean water and sanitation. An established economic theory on consumption postulates that consumption is a function of income (Friedman, 1957; Keynes, 1936). Hence, based on the empirical findings on consumption growth (Table 4.5) in our study, we can conclude that the coastal communities were very likely to suffer an income shock after the cyclone, which was reflected through their consumption growth. This result is consistent with the finding by Akter and Mallick (2013). Both the current Chapter and Akter and Mallick's (2013) study have considered a number of similar variables (although different in measurement in some cases) such as financial/economic damage, physical injury/death, safety-net membership, acquaintance with social elites, social capital, microfinance/credit, age, and literacy. Both studies applied regression models, although with

different dependent variables, where all of these variables except safety-net membership exhibited not-significant relationships with the dependent variables. In addition, the current Chapter, in line with the study by Akter and Mallick (2013), did not find any significant correlation of elite connection with external help (i.e., relief) and rehabilitation aid ($r_{ext.help}$ = 0.10, $p<0.076$; $r_{rehab.aid}$ = 0.08, $p<0.082$). Thus, both studies confirmed similar findings for some of the variables considered in the analyses. In this current study, despite the fact that the people at risk possessed almost identical sensitivity and exposure profiles, it was their anticipatory and reactive adaptive capacities that mainly determined their vulnerability status toward hazard shocks. Furthermore, these adaptive capacities were shown to be strongly correlated with preparedness training participation, where such training seemed to enhance the participant households' resilience capacity in terms of responding to, coping with, and recovering from hazard shocks compared to those of non-participant-households. Although the pioneering study by Akter and Mallick (2013) in the southwestern coastal region reported that cyclone preparedness training had no significant correlation with physical injury/death and financial damage, the results of this current study found an opposite result in this case ($r_{fin.damage}$ = -0.47, $p<0.000$; ($r_{injury/death}$ = -0.13, $p<0.008$). Furthermore, in explaining socioeconomic resilience heterogeneity, Akter and Mallick (2013) found loss of human life and capital assets, unfavorable credit scheme, and proximity to the forest resources to be the key determinants; however, this study found participation in cyclone preparedness training, through enhancing different adaptive capacities, to be the key factor behind the better resilience of the at-risk households. This implies that different factors were likely to explain the socioeconomic resilience of the people at risk in the two studies. This difference in the two studies in nearby locations would indicate the importance of regional or local peculiarities in community level response characteristics, and deserve further investigation on the critical factors resulting in such differences.

Finally, it is important to note that no significant result was obtained for literacy, acquaintance with social elites, and social capital in the regression models in Table 4.6, although they exhibited significant positive correlation with understanding of early warning, which was likely to be an outcome of participating in preparedness training. In this study we did not address the reason behind this result. Furthermore, at different locations of the same region of southwestern coastal Bangladesh, similar dynamics between sensitivity and vulnerability were obtained by this study and Akter and Mallick's (2013) study, although factor(s) explaining socioeconomic

resilience were different for these studies, as previously mentioned.. Therefore, we suggest a more comprehensive deterministic model in future studies that includes more carefully selected representative variables to address the nexus among societal issues, socioeconomic vulnerability and resilience, and emergency preparedness.

5. Disaster Preparedness Actions at the Community Level

5.1. Background

In previous Chapters (2-4) the issues related with preparedness actions, especially evacuation decision and preparedness training, are broadly focused on the household level. Those Chapters reveal why households did or did not respond to the warning and advisories during tropical Cyclone Aila and how preparedness training before Aila made them more responsive as well as resilient toward hazard shocks. In practice, the preparedness actions are integrated with not only at-risk people (i.e., households) but also stakeholder agencies. Therefore, in order to obtain a comprehensive scenario of disaster preparedness, the responses of the community level disaster managers and their associates are also important. Against this backdrop, the current Chapter presents the opinions of community level disaster managers and their associates on specific preparedness actions, pros and cons of these actions, the role of the adopted actions in escalating knowledge and/or awareness of the people at risk about disaster risk, different organizations working with preparedness actions, challenges of implementing the actions, and the key driver(s) behind the challenges. In previous Chapters (2-4) only Koyra upazilla is considered, however, in the current Chapter three additional upazillas adjacent to Koyra are considered: Dacope, Shyamnagar, and Assasuni. This is to obtain the community level scenario at a broader level, as preparedness strategies practiced as DRR actions are similar for all areas in tropical cyclone-prone coastal Bangladesh.

5.2. Method

With a view to covering the majority of the stakeholders involved at the local level disaster risk management, we performed Key Informant Interviews (KII) with six specific stakeholder groups in four Upazillas under two districts. By applying convenience sampling, forty respondents were selected, as shown in Table 5.1. These selected respondents were from different stakeholder groups (e.g., local disaster management committees, GOs, and NGOs), who were directly involved with local level disaster management actions. The applicable Upazilla Office provided respondents' contact details. A structured questionnaire was used to conduct the interviews (see the questionnaire in Appendix D-2). Eight local persons with previous experience helped the local experts who work with local level DRR activities. Data

collection was performed during February-March 2016 in four Upazillas. The spatial locations are shown in Figure 5.1

Table 5.1. Sampling matrix.

Sl.	Stakeholder group	Method	Area/survey location with sample quantity				Total	% of sample
			District: Khulna		District: Satkhira			
			Upazila: Dacope	Upazila : Koyra	Upazila: Shyamnagar	Upazila: Assasuni		
1	UDMC representative (LG Chairman/Member)	KII	2	2	2	2	8	20
2	UDMC representative (Except LG)	KII	1	1	1	1	4	10
3	CPP Volunteer	KII	1	1	1	1	4	10
4	Social Representative (teacher, imam)	KII	2	2	2	2	8	20
5	NGO worker	KII	1	1	1	1	4	10
6	Household level (representation from affected/vulnerable community)	KII	3	3	3	3	12	30
			10	**10**	**10**	**10**	**40**	**100**

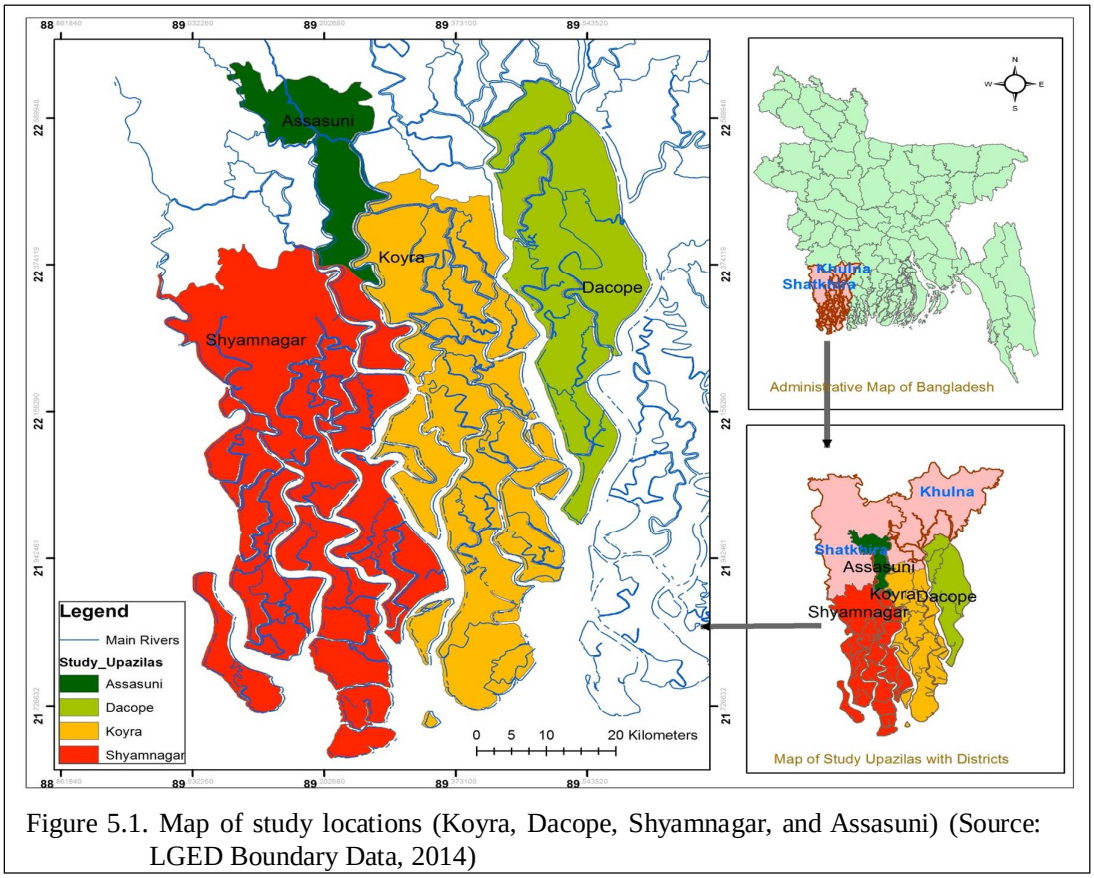


Figure 5.1. Map of study locations (Koyra, Dacope, Shyamnagar, and Assasuni) (Source: LGED Boundary Data, 2014)

5.3. Major Findings

Respondents from diverse stakeholder groups discussed different preparedness actions practiced in connection with DRR in the southwestern coastal areas of Bangladesh. These actions are performed to enhance the awareness of disaster risk of the people at risk. The following subsections present findings on different issues.

5.3.1. Actions adopted in the last five years to enhance awareness of disaster risk

The respondents were asked about the various measures and steps adopted in their areas in the last five years to enhance the awareness of disaster risk. These adopted measures, on the basis of the response by either the disaster managers or their associates, can be primarily divided into two categories: infrastructural and non-infrastructural. A total of 15 infrastructural and 16 non-infrastructural measures were obtained on basis of the respondents' replies. Among the

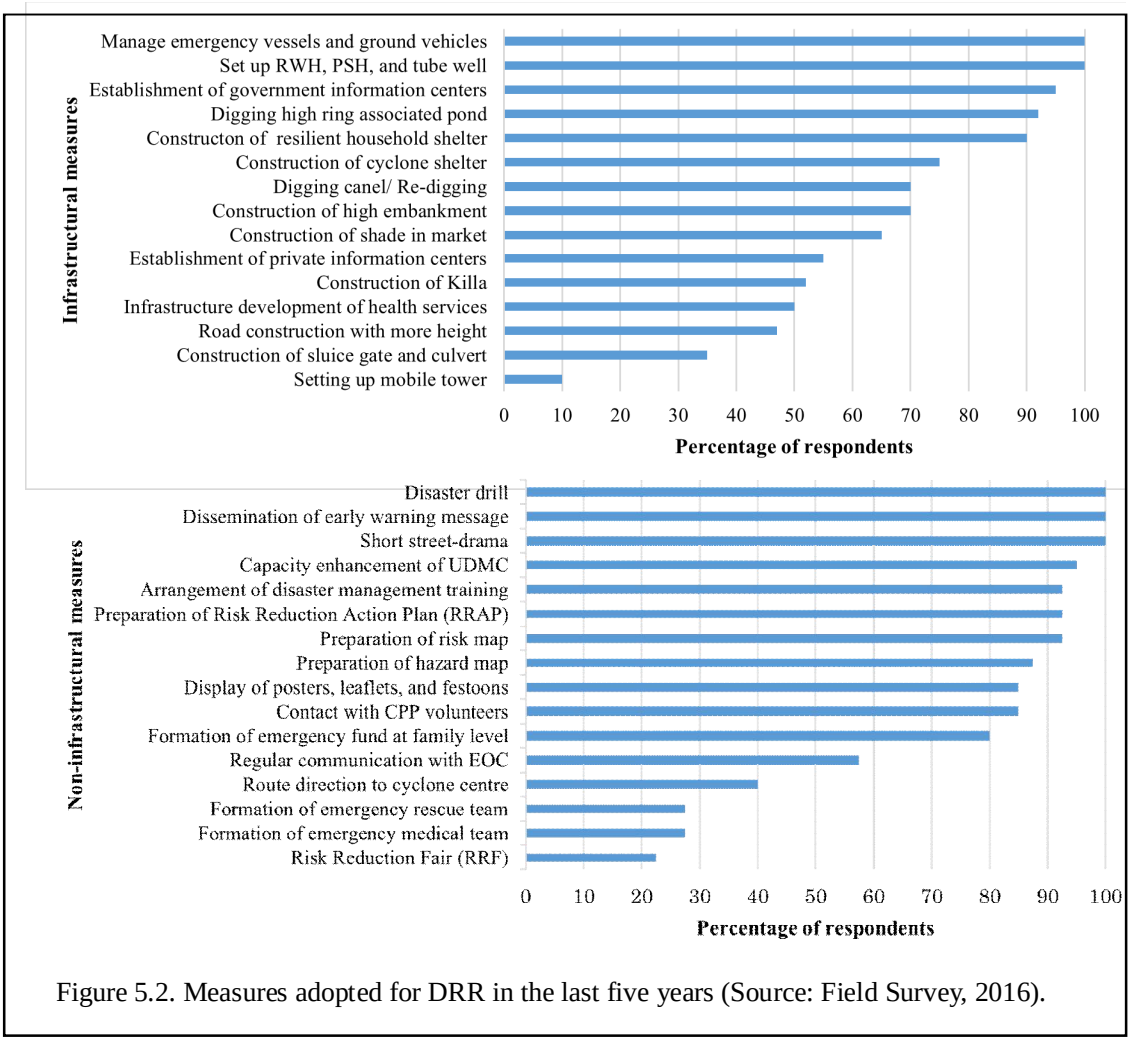


Figure 5.2. Measures adopted for DRR in the last five years (Source: Field Survey, 2016).

infrastructural measures, eight specific measures (≈ 53%) are mentioned by at least 70% of the respondents as DRR actions, as shown in the top panel of Figure 5.2. On the other hand, among the non-infrastructural measures, 11 specific measures (≈ 69%) are mentioned by at least 70% of the respondents (bottom panel of Figure 5.2). Interestingly, two infrastructural (vehicle and vessel, water reserve) and three non-infrastructural (street-drama, warning message, disaster drill) measures are mentioned by all of the respondents.

5.3.2. Specific groups considered for DRR actions

While considering the target group(s) for DRR actions, a number of classifications were identified. These groups are primarily classified into six categories: age specific, household level, community level, local level, institution level, and others. Findings for the age-specific category imply that DRR actions especially were targeted for very old people (65+ years), woman, and children. At the household level, actions targeted basic necessities (e.g., food, nonfood, education, food for mothers and children, financial solvency), household utilities (e.g., water, sanitation, structure), and livelihood-related issues (e.g., IGA, training). Among the occupation groups, DRR actions targeted croppers, fishermen, honey collectors, wood collectors, and civil society. At the local level, actions targeted canal digging/re-digging, road and culvert construction, bridge construction, digging ponds with high embankments, food for work, cash for work, Pond Sand Filter (PSF), and Rain Water Harvest (RWH). At the institutional level, actions targeted schools, cyclone shelters, colleges, temples, mosques, madrashas (religious academic institutions), and UDMC. In the "others" category (mostly social-vulnerable groups), actions targeted divorced and separated women, tiger-widows, and widows.

5.3.3. Methods applied to inform or warn at-risk people about imminent hazards, with advantage(s) and disadvantage(s)

During April-May and October-December, cyclones are more likely to make landfall in the coastal areas of Bangladesh. Community level disaster managers and their associates in coastal areas applied two types of methods to inform and warn at-risk people about the disaster(s), respectively: (a) early warning related methods, and (b) awareness-building methods (non-early warning-related methods) (Figures 5.3 and 5.4). Table 5.2 shows that 11 early warning related methods were deployed to inform people at risk during previous cyclones; methods were warning messages from radio and television, flags, mosques' mikes, hand-sirens, hand-mikes,

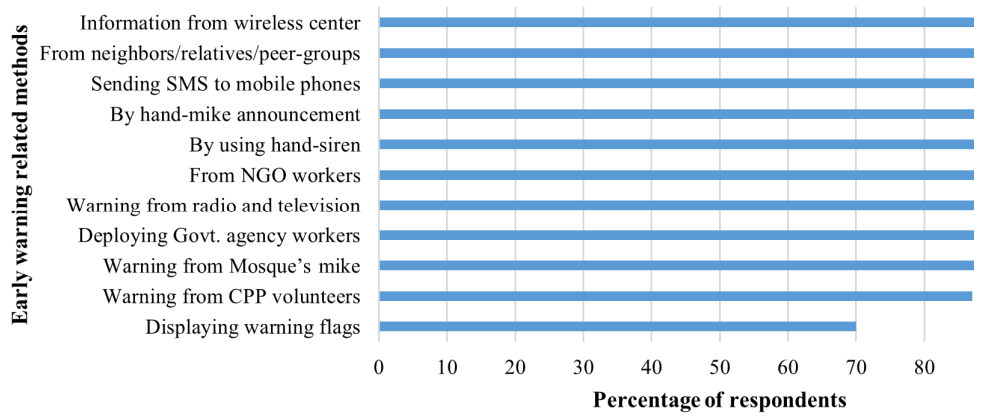


Figure 5.3. Warning-dissemination methods (Source: Field Survey, 2016).

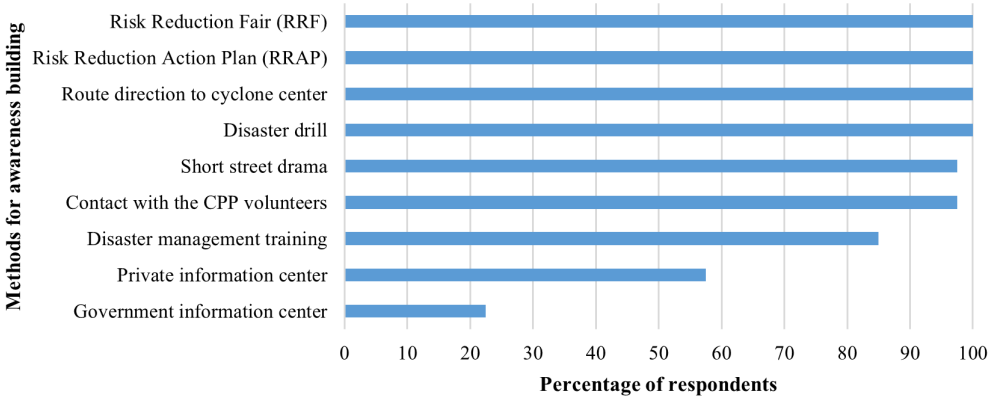


Figure 5.4. Awareness-enhancement methods (Source: Field Survey, 2016).

relatives and peer-groups, and wireless centers were most common. To build awareness of disaster risk, disaster management training, disaster drills, short street dramas, and Risk Reduction Fairs (RRF) were the most commonly applied methods. However, all of the above-mentioned methods have advantage(s) and disadvantage(s), as shown in Table 5.2. Figure 5.5 shows respondents' opinions about advantages and disadvantages of methods for warning and building awareness. It is interesting to note from Figure 5.4 that all of the methods, except information from wireless centers and RRFs, have some degree of both advantages and disadvantages. Among the early warning-related methods, warning by CPP volunteers, hand-sirens, hand-mike announcements, and mobile phone SMS had similar degrees of advantage and disadvantage. For other methods (i.e., non-early warning) government and private information centers, disaster management training, CPP volunteer contact, and Risk Reduction Action Plans (RRAP) possessed similar degrees of advantage and disadvantage as opined by the respondents. For RRFs, no advantage or disadvantage was reported. For information from

wireless centers, only disadvantage was reported. Interestingly, for route directions to cyclone shelters and short street dramas, disproportionate advantage and disadvantage were reported (see Figure 5.5).

Table 5.2. Advantage and disadvantage for different early-warning and other methods to forewarn and/or raise awareness of people at risk.

	Advantage/ Methods / Disadvantage	Advantage(s)	Disadvantage(s)
Early warning related	Warning from radio and television	Quick information to prepare	Unable to work without electricity
	Displaying warning flags	Easy to understand	Difficult to see from distant locations
	Warning by CPP volunteers	Message is delivered at community cluster level	Only active during cyclones
	Warning from mosque's mike	Everyone within a certain radius gets the message	Beyond a certain radius, no one gets the information
	From workers of government agencies	Reliable information	Insufficient manpower and logistics
	From NGO workers	House-to-house delivery of information	Only beneficiary households get information
	By using hand-siren	Easy to operate	Limited coverage and works only toward the wind direction
	By hand-mike announcement	Easy to communicate the information	Battery capacity has certain limitations, and limited coverage
	Sending SMS to mobile phones	Phone owner gets detailed information on hazard	SMS contents may not always be understandable
	From neighbors/relatives/peer-groups	Information can be easily conveyed among groups	Information is sometimes not trustworthy
	Information from wireless center	-	-
Capacity building related	Government information Center	Sufficient information	Number of centers is insufficient
	Private information center	Participants can learn about coping strategies	Number of centers is insufficient
	Disaster management training	Very effective to build capacity on DRR	Lack of coordinated segments in the training
	Contact with the CPP volunteers	Updated hazard information can be received	Not available during normal time
	Short street drama	Easy to understand practical to-dos	Lack of expert performers to convey message effectively
	Disaster drill	Knowledge on required	Lack of coordination in

Methods \ Advantage/ Disadvantage	Advantage(s)	Disadvantage(s)
	actions is enhanced	drills
Route direction to cyclone center	Easy to find the way to the safe haven	Difficult to understand if no prior orientation with symbols and no literacy
Risk Reduction Action Plan (RRAP)	Easy identification of risk zones	No practical application during emergency
Risk Reduction Fair (RRF)	-	-

Source: Field survey, 2016.

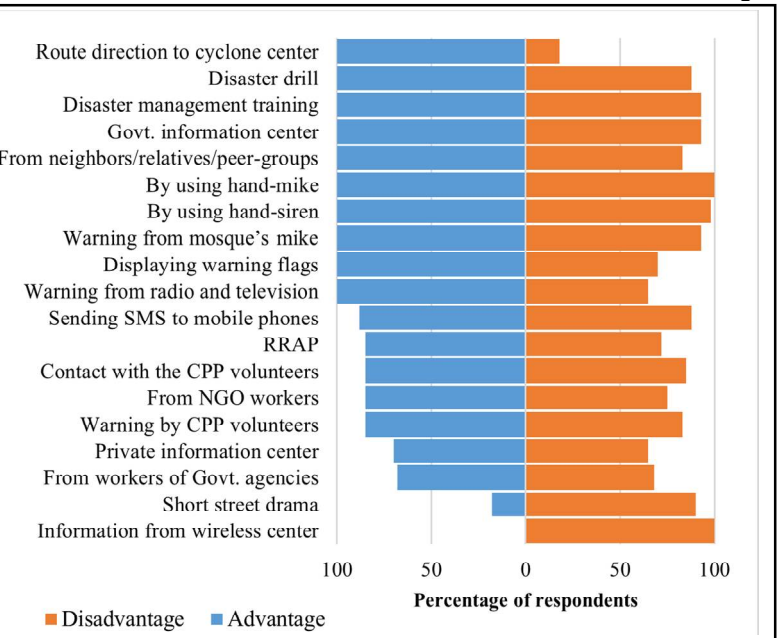


Figure 5.5. Degree of advantage and disadvantage of different methods (Source: Field Survey, 2016).

Different sources of early warning, on the basis of respondents' opinion, imply that radio, television, mosque mike, hand-siren, hand-mike, neighbors/relatives/peer-groups, and warning flags more commonly disseminate information and advisories 72-48 hours before a cyclone's landfall. Interestingly, during the 24-12 hours before a cyclone's landfall the use of those sources for information dissemination is relatively lessened and new sources, such as CPP volunteers, GO/NGO workers, GO/NGO information centers, and hand-mikes, are used most commonly. Figure 5.6 depicts this scenario.

5.3.4. New action(s) for disaster information dissemination

Respondents were asked whether the currently practiced strategies were different from those practiced five years before in their own area and close proximity. In this context, 20% of respondents reported different strategies: drumming, actions by village police, actions by UP-ward members, and applying indigenous knowledge. In case of imminent hazard (i.e., cyclone),

once the people at risk get confirmation of possible landfall of a cyclone, they start disseminating the news by drumming. In such situations, the village police also knock door-to-door to convey the information. Furthermore, the UP-ward members also deploy their local resources (e.g., volunteers, local clubs) to warn people at risk about the cyclone. Apart from the above-stated strategies, local people commonly apply their indigenous knowledge (e.g., movements of ants and fisheries, roar of the wind) to detect upcoming hazards.

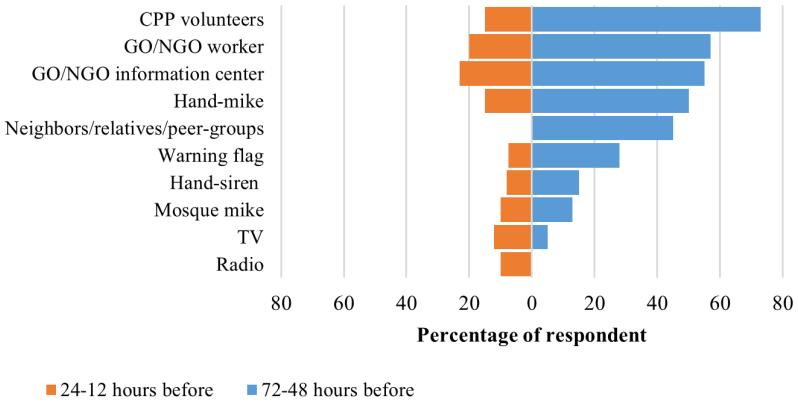


Figure 5.6. Different sources of cyclone early warning (Source: Field Survey, 2016).

5.3.5 Key factors of success and failure of the preparedness actions for DRR

As mentioned in subsection 5.3.1, a number of preparedness actions, especially for reducing risks from cyclones, were reported by the community level disaster managers and their associates. Over the last five years, the overall success rate of preparedness actions in reducing disaster risk was reported as 65(±6.2) %. This subsection reports the key factors behind the success and failure of the adopted and implemented DRR actions.

Fourteen key factors were reported as reasons behind the success of preparedness actions for DRR in the southwestern coastal region, as shown by Figure 5.7 (top panel). The percentage for each factor indicates how many of the forty respondents opined for the specific factor. Among the success factors, construction of cyclone shelters, strengthening of early warning systems, and government support in disaster management seem to be substantial factors.

It is interesting to note that the rest of the key factors also contributed at a similar trend. The findings, based on the opinion of the respondents, imply that all of these factors behind the success of preparedness actions for DRR worked in a homogeneous way.

Twenty-four key factors were reported as reasons behind the failure of preparedness actions, as shown in Figure 5.7 (bottom panel). Based on the responses of the disaster managers and their associates, poor road networks, fewer numbers of cyclone shelters (with unhealthy environments), and the absence of required financial support during disasters were the substantial factors of failure. In addition, poor livelihood options, weak economic conditions, training and drill-related problems, local disaster management committees' ineptness, and insufficient logistic supports were reported as other key factors for failure.

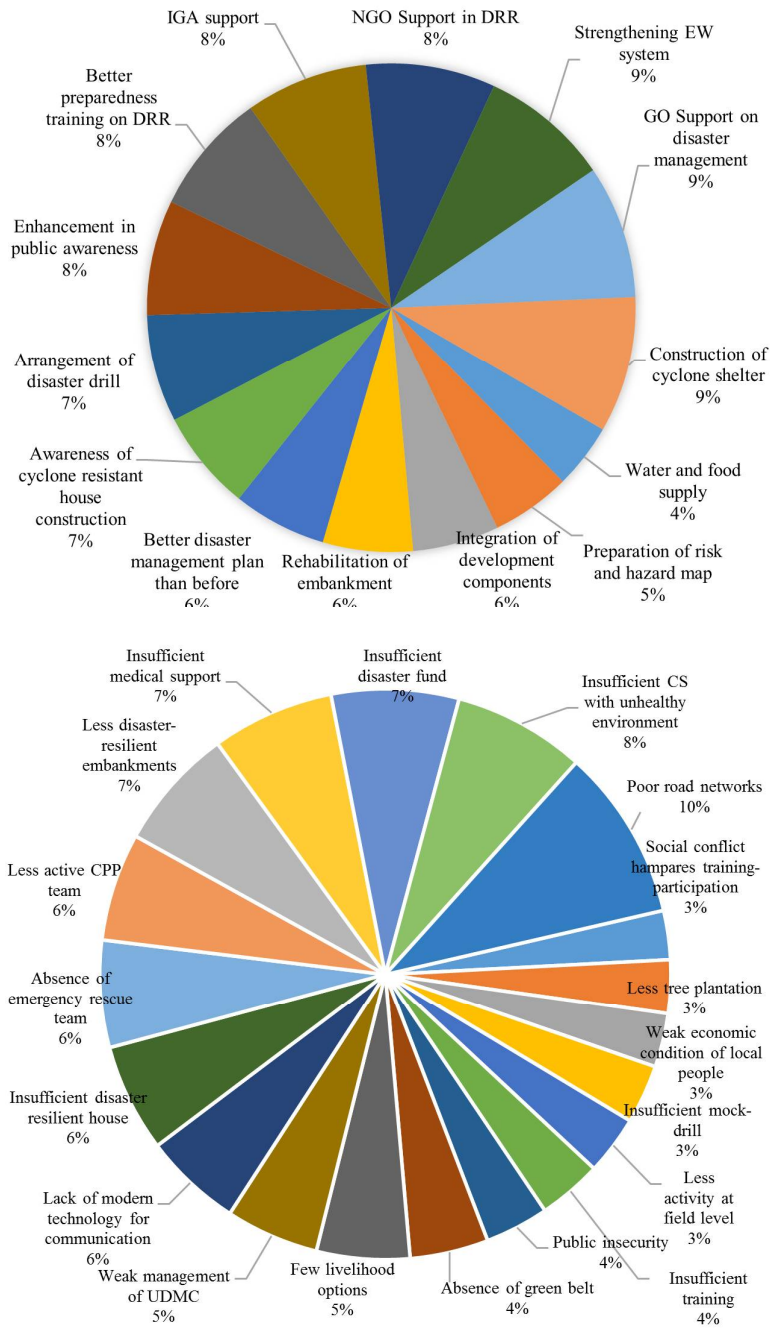


Figure 5.7. Key factors of success (top panel) and failure (bottom panel) for preparedness actions in southwestern coastal Bangladesh (Source: Field Survey, 2016).

5.3.6. Contribution of DRR actions in improving awareness on socioeconomic consequences of natural hazards

Two opinions were obtained on the contribution of DRR actions in enhancing awareness on natural hazard-triggered socioeconomic consequences: around 48% respondents mentioned that a moderate level of awareness was obtained due to the DRR preparedness actions, while around 52% of respondents mentioned that a good level of awareness was obtained. Eight specific causes were identified behind such level of awareness in this coastal region, which are presented in the following tabular forms with the percentages of respondents.

Cause 1: Sending timely pre-disaster warning

Time line / Response	48-72 hours before cyclone	24-48 hours before cyclone	12-24 hours before cyclone	6-12 hours before cyclone	6 hours before cyclone	less than 6 hours cyclone
% Yes	95	11	60	60	60	60

Cause 2: Regular contact with CPP volunteers

Communication frequency / Response	Once a month	Once every two months	Once every three months	During cyclone time	Irregular communic-ation	No communic-ation
% Yes	8	10	30	53	0	0

Cause 3: Disaster preparedness workshops arranged by local organizations

Arrangement frequency / Response	Once a month	Once every two months	Once every three months	During cyclone time	Irregular arrangement	No arrangement
% Yes	3	0	48	45	5	0

Cause 4: Disaster drill status

Arrangement frequency / Response	Once a month	Once every two months	Once every three months	During cyclone time	Irregular arrangement	No arrangement
% Yes	3	0	68	25	5	0

Cause 5: Government agencies' actions

Action status / Response	Regular adoption and implementation of plans	Regular adoption of plans but irregular implementation	Irregular adoption and implementation of plans	No coordination in adoption and implementation of plans	Irregular adoption of plans and no implementation	No action in this regard
% Yes	0	18	68	15	0	0

Cause 6: Nongovernment agencies' actions

Action status / Response	Regular adoption and implementation of plans	Regular adoption of plans but irregular implementation	Irregular adoption and implementation of plans	No coordination in adoption and implementation of plans	Irregular adoption of plans and no implementation	No action in this regard
% Yes	48	53	0	0	0	0

Cause 7: Increase in the number of the cyclone shelter in the last five years

Action status / Response	80-90% of local population can stay in shelter	70-80% of local population can stay in shelter	50-70% of local population can stay in shelter	30-50% of local population can stay in shelter	Less than 30% of local population can stay in shelter
% Yes	0	0	0	13	88

Cause 8 Improvement of road network (for transportation) in the last five years

Action status / Response	Road network is constructed to cope completely with disasters	Road network is constructed to cope fairly with disasters	Road network is constructed to cope barely with disasters	Road network is constructed using inferior quality materials	Road network is constructed using inferior quality materials and without coordination	No new road network is constructed
% Yes	0	0	0	18	50	33

5.3.7. Emergency response and recovery capacities

5.3.7.1. Response capacity

Around 83% of respondents mentioned that in case of emergency response, a moderate level of capacity is obtained by the people at risk as a consequence of different preparedness trainings in the last five years.

Thirteen factors, as shown by Figure 5.8 (top panel), were reported that played key roles behind the current status of the response capacity of the people at risk. Of these factors, successful early warning dissemination, necessary advisories for households in disaster time, route directions to cyclone shelters, training on the DRR process, necessary stock of dry food and water in advance, and the listing of necessary mobile phone numbers were reported to be more substantial in escalating peoples' response capacity toward disaster risk.

Figure 5.8 (bottom panel) also presents 18 specific actions suggested by the respondents to enhance response capacity. Interestingly, nine out of these 18 (i.e., ≈ 50%) actions were suggested by all of the respondents. These highly suggested actions comprise communication-

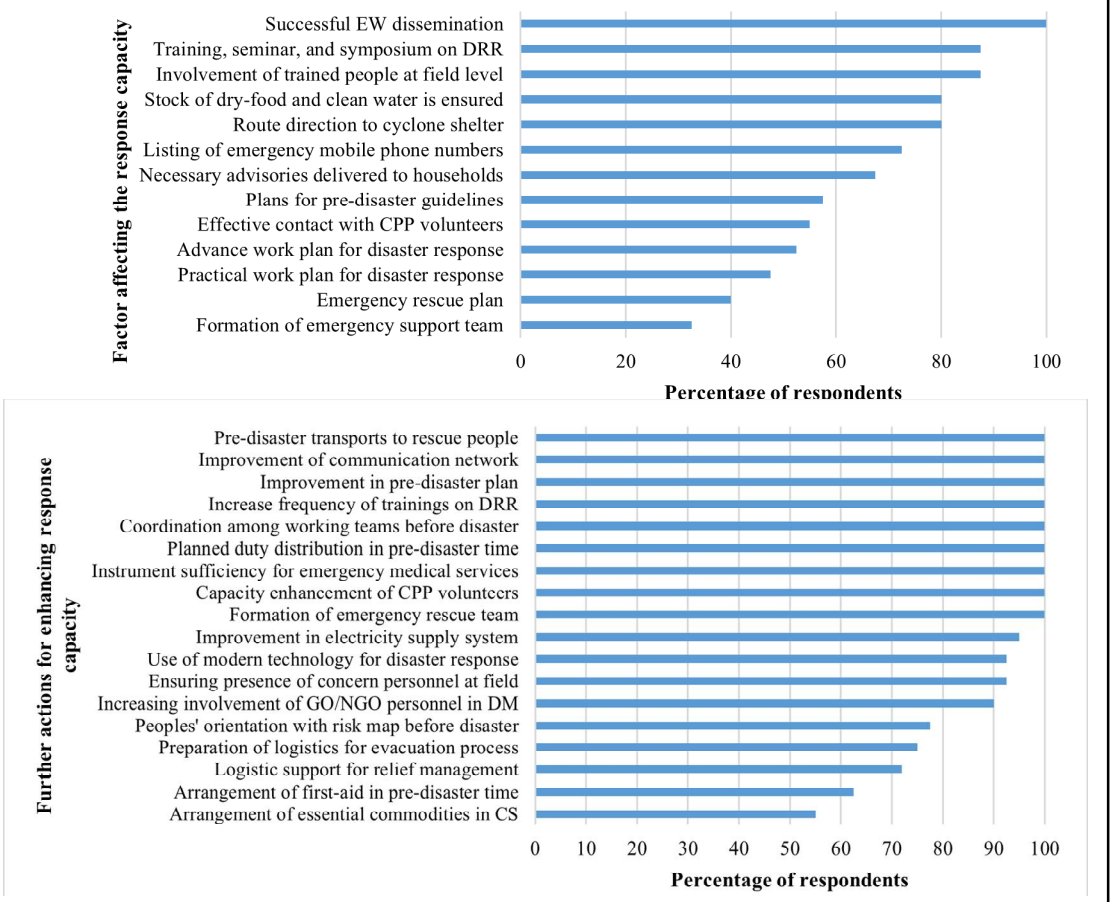


Figure 5.8. Key factors of response capacity enhancement (top panel) and further actions required for enhancing response capacity (Source: Field Survey, 2016).

related issues, logistic support, capacity building of the relevant personnel, preparedness training, and effective coordination among the working team at the field level. In addition, GO-NGO coordination and preparation along the orientation of risk maps are also emphasized as required actions to enhance the response capacity of the people at risk.

5.3.7.2. Recovery capacity

For the people at risk, a moderate level of capacity has been obtained according to 90% of respondents in their actions for recovery. Likewise response capacity, the recovery capacity of the people at risk, has been affected by preparedness training over the last five years.

Seven factors were reported to affect the recovery capacity of the people at risk in the southwestern coastal areas, as shown by Figure 5.9. Interestingly, all respondents mentioned that knowledge of local early warning dissemination mechanisms seemed to a key factor in recovery. It was revealed that people get information on relief and rehabilitation aid (e.g.,

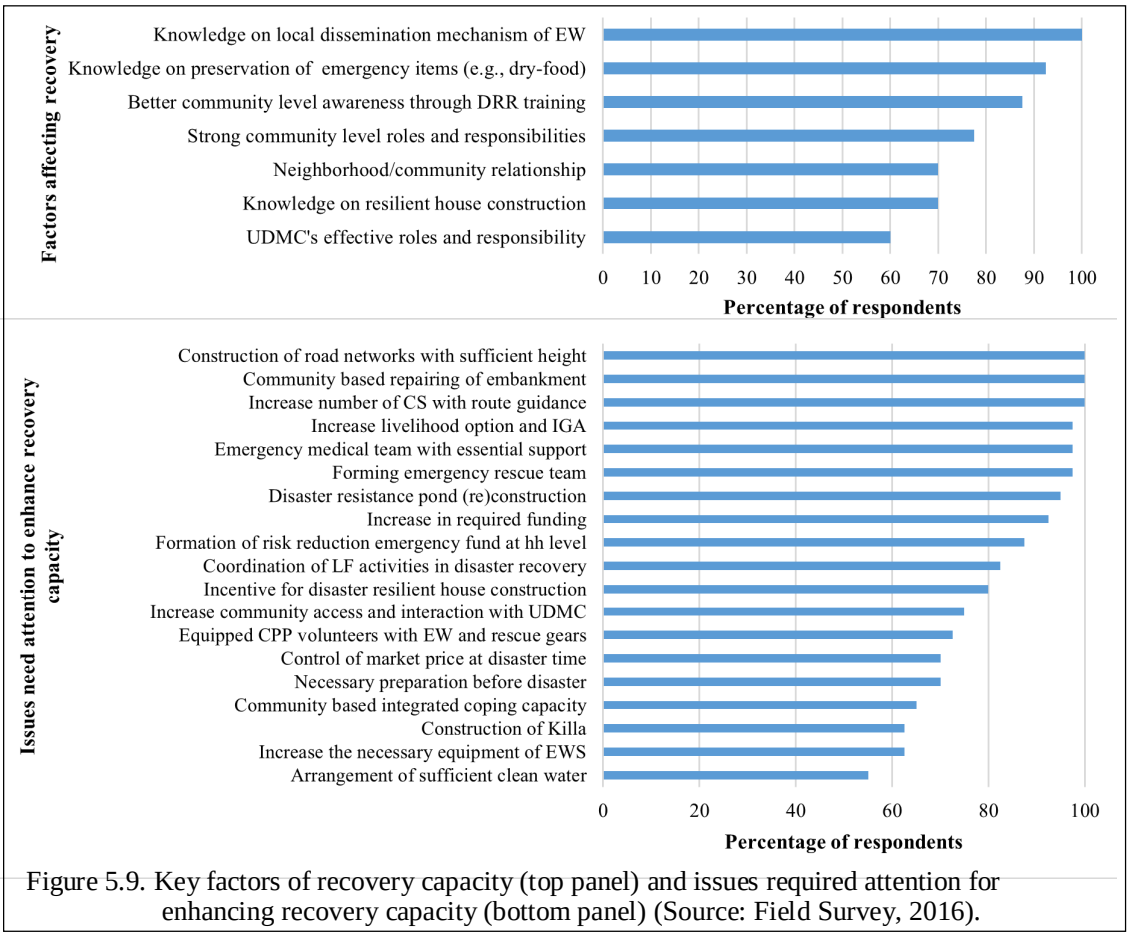


Figure 5.9. Key factors of recovery capacity (top panel) and issues required attention for enhancing recovery capacity (bottom panel) (Source: Field Survey, 2016).

housing materials) from the local sources that also disseminate early warnings. Therefore, having a good knowledge of such sources is likely to provide opportunities to get information about relief materials. Aside from this issue, practical knowledge on preserving necessary items during emergencies, better community level awareness of disaster risk, and community relationships also seemed to be important factors to enhance recovery capacity.

The respondents suggested 19 specific issues that might be very helpful to enhance the current level of recovery capacity of the people at risk in southwestern coastal Bangladesh. A number of these issues urge the development of physical infrastructure such as road networks, disaster-resilient housing structures, new cyclone shelters, and embankment repairing. Some of these issues indicate logistical as well as financial support for the teams working at the field level, which will likely directly and indirectly influence people's recovery capacity.

5.3.8. Role of organizations in enhancing awareness on DRR through preparedness

Different organizations such as Union Parishad (as LG), UDMC (not as a part of LG), CPP

units, local mosques, schools, and NGOs have adopted a number of preparedness actions to enhance awareness of disaster risk in the southwestern coastal areas in the last five years. Among the currently practiced actions, risk sharing, risk finance, training and workshops, posttraining evaluations, and killa construction dominate over microcredit and risk insurance. The following 10 actions are performed by the aforementioned organizations to enhance awareness of disaster risk for vulnerable communities in the coastal areas:

i. Awareness activities on DRR;
ii. Community involvement in decision-making on DRR activities;
iii. Strengthening the coping mechanism for local communities;
iv. Training on mitigating disaster risks;
v. Committee formation to support both pre- and post-disaster situations;
vi. Responsibility distribution of the personnel engaged in DMC;
vii. Post-training evaluation;
viii. Killa construction;
ix. Building awareness of hazards; and
x. Financial incentives for constructing disaster-resilient house structures

In the southwestern coastal areas, a number of GO and NGOs have been working over the last few decades to target vulnerable and marginal communities due to disasters. These organizations are likely to contribute directly and indirectly to adopting and implementing different preparedness actions along with DRR strategies at the community level. A list of currently working organizations is presented in Table 5.3.

Table 5.3. List of different organizations working on DRR in southwestern coastal Bangladesh.

Name of Organization	Type	Activities
LGED	GO	- Construction of embankment
Union Parishad	GO	- Financial support for old men/women - Financial support for widows - Financial support for people affected by tiger attacks - Early warning dissemination - Providing DM training to local people
Akti Bari Akti Khamar (One house, one farm)	GO	- Providing IGA support
BRAC	International NGO	- Providing DM training to local people - Providing cattle to marginal farmers - Arrangement of social meetings
ASA	National NGO	- Community risk assessment
Heed Bangladesh	National NGO	- Community risk assessment - Repairing embankments

Name of Organization	Type	Activities
Shushilan	National NGO	- Providing IGA support Model village setup - Killa setup RWH chamber setup - Providing food support Repairing embankments - Providing financial incentives - PSF setup - Increasing livelihood option - Repairing road networks - Pond excavating - Canal excavating
Adra	National NGO	- Providing DM training to local people - Repairing embankments - RWH chamber setup - Hygienic sanitation system setup - Facilitating safe drinking water supply system (water purification) - Pond excavating
Islamic relief	National NGO	- Canal excavating - Providing emergency relief - Tree planting - Providing economic support - Providing household materials
Rupantar	National NGO	- Training on early warnings - Providing DM training to local people - Hygienic sanitation system setup - Performing 'Street song' - Tree planting
Prodipan	Local NGO	- Community risk assessment - Providing support on business development - Repairing embankments
JJS	Local NGO	- Providing DM training to local people - Providing educational support - Support on infrastructural development of houses - Providing agricultural support - Providing IGA support - Hygienic sanitation system setup
Ullashi	Local NGO	- Providing DM training to local people - Hygienic sanitation system setup
Caritas	Local NGO	- Providing DM training to local people - Working on RRAP
FAO	International Organization	- Agricultural extension - Food safety and nutrition
Red Crescent Society	International Organization	- Providing DM training to local people - Capacity building on EW
World Bank	International Organization	- Financial support to make embankments
IPAC	International Organization	- Coastal afforestation

Source: Field Survey, 2016.

5.3.9. Major challenges of implementing DRR actions at the community level

A number of challenges were mentioned by the respondents in implementing preparedness actions in connection with DRR strategies. Figure 5.10 presents these challenges where

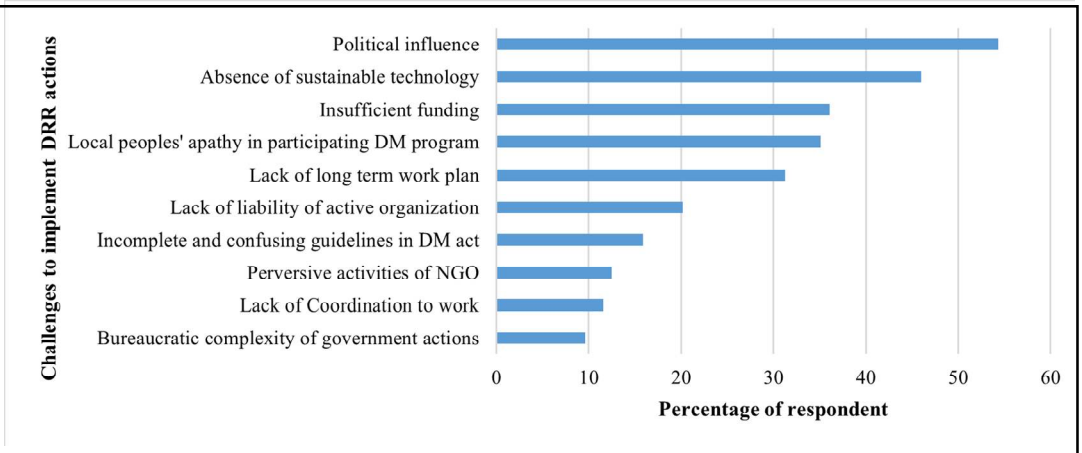


Figure 5.10. Challenges for different stakeholder agencies in implementing DRR actions (Source: Field Survey, 2016).

bureaucratic complexity and political influence seemed to be dominating. Although in previous sub-sections a good number of preparedness actions are presented, which people were acquainted with during different training sessions, the participation rate of people in those training sessions is not sufficient, which is reflected by one of the challenges (i.e., apathy of people to participate) mentioned by the respondents. Some of the stated challenges imply that the co-function and collaboration of GOs and NGOs in disaster management activities seem to affect the overall progress of the preparedness actions.

Findings from the previous sub-sections reveal actions that have been practiced over the last five years to reduce disaster risk through awareness building of the people at risk. These actions were largely carried out by different stakeholder agencies, namely GOs and NGOs. It is also revealed that the successful adoption and implementation of DRR actions at the community level is largely governed by collaboration between GOs and NGOs (see Table 5.3). However, this collaboration is sometimes not consistent for disaster management. Findings from sub-sections 5.3.3, 5.3.5, and 5.3.7 suggest that the existing weakness in implementing different necessary DRR actions is mainly driven by the problem in co-functioning of GOs and NGOs in the domain of disaster management. For example, in collaborative actions, mutual understanding is very important for working together and such understanding depends on mutual concerns. In Bangladesh, although GOs and NGOs are working either side by side or in collaboration in different locations, both organizations often express different points of view about each other, as shown in Table 5.4. In disaster management, mistrust and rivalries between GOs and NGOs was found in the opinion of the respondents. The triggering factors behind such

a situation are summarized here. First, over the last few decades NGOs have emerged as robust actors in socio-economic and socio-political arena of the country, which sometimes become a challenge for GOs. Second, donor-backed funding for NGOs often challenges the capacity of GOs to adopt and implement necessary projects within the government's jurisdiction. Third, donor agencies generally are in favor of NGOs in implementing development actions. Fourth, NGOs' pseudo-involvement in local politics, elections, and business often challenges the government's mechanisms. The above-mentioned factors seem to hinder consistent policy formulation and implementation by the stakeholders in the area of disaster management in coastal Bangladesh.

Table 5.4. General concerns over GO-NGO activities in Bangladesh.

Point of view / View about	GOs' point of view
NGOs	▪ Lack of inter-NGO coordination invokes overlapping and unnecessary adoption of development activities ▪ High cost of operating activities ▪ Least accountability to the government ▪ High dependency on external funding, especially on foreign sources ▪ For microcredit, high interest rates are charged from beneficiaries ▪ Success stories are very often exaggerated in different media ▪ Sometimes undertake very sensitive programs, which may create societal unrest ▪ Get involved in implementing political manifestos with a label of a nonpolitical organization
	NGOs point of view
GOs	▪ GOs are rigid, highly bureaucratic, and overregulating toward NGO activities ▪ GOs persuade with different mission and vision, which are not harmonized with those of NGOs ▪ Highly bureaucratic prior approval for donor-funded projects ▪ Very little acknowledgement and appreciation of different approach and project management by NGOs ▪ No distinction between NGOs with better performance and poor performance ▪ No apparent action against politically biased NGOs ▪ Rarely adopt need-based projects in time

Source: Field survey, 2016 in compilation with findings by Alam (2007).

5.4. Concluding Remarks

This Chapter presents different preparedness actions of DRR that have been practiced in the southwestern coastal areas over the last five years, methods of disseminating early warnings, pros and cons of these actions, the role of these actions in enhancing the knowledge and awareness of people, different stakeholders involved in the DRR issue in the study location, key challenges of implementing different preparedness actions, and the critical drivers behind

these challenges. Findings of this Chapter are obtained by summarizing information from Key Informant Interviews (KII) conducted with community-level disaster managers and their associates.

Findings suggest that over the last five years a good number of infrastructural and non-infrastructural actions (Figure 5.2) have been implemented as DRR strategies that seem to escalate the awareness of disaster risks among the people at risk. For enhancing awareness and capacity, six groups were targeted in the study location, such as: age-specific group, household level, community level, local level, institution level, and others. Radio and TV, warning flags, hand-operated mikes and sirens, wireless centers, and relatives/friend/peer groups were found to be more common methods for early warnings. For awareness enhancing, preparedness training, disaster drills, RRFs, RRACs, and government information centers are reported. Each action under early warning and awareness building methods possesses advantages and disadvantages, which are presented in Table 5.2. For early warning before 72-48 hours of a cyclone's landfall, roles were played by radio, TV, mosque-mikes, sirens, and warning flags. On the other hand, for warning dissemination 24-12 hours before a cyclone's landfall, CPP volunteers, GO/NGO workers, GO/NGO information centers, and hand-mikes are more commonly used. For disaster information dissemination, some new actions are reported in the study locations, such as drumming, door-to-door knocking by village police, and application of indigenous knowledge. These issues are found to escalate both awareness of hazard risks and access to different sources of early warnings for the people at risk.

A number of key factors behind the success and failure of preparedness actions are reported in both panels of Figure 5.7. Interestingly, the number of failure factors is 1.7 times higher than success factors, implying that the number of challenges is higher for successful implementation of preparedness actions. Contributions from a number of DRR actions are reported as very crucial for improving awareness of the socioeconomic consequences of natural hazards. These DRR actions include sending early warnings, regular contact with CPP volunteers, disaster preparedness workshops, disaster drills, actions by GOs and NGOs, increases in the number of cyclone shelters, and improvement of road networks. The preparedness workshops/trainings and disaster drills are found to affect the risk perception of the people at risk. For example, the knowledge obtained from these trainings and/or drills helps people to look for necessary hazard information, perform necessary actions at home before evacuation, and reach safe havens in time. In the case of response and recovery capacity, findings suggest that a moderate level of

capacity has been obtained by the people at risk. Likewise success-failure factors, the number of factors affecting response and recovery capacities, are less than those requiring attention to enhance response and recovery capacities.

Findings on organizational roles on awareness building suggest that both GOs and NGOs have played roles in carrying out different goals of disaster preparedness at the community level (Table 5.3). Nevertheless, the existing weakness in implementing different DRR actions at the community level seems to be affected by overlapping actions by different stakeholders, political influence, bureaucratic complexity in government actions, and problems in GO-NGO collaboration. Of those weaknesses, the GO-NGO co-functioning and collaboration are important factors for implementing disaster preparedness actions at the community level, because over time NGOs have become more influential development stakeholders in DRR in Bangladesh. There exists a mistrust between the GOs and NGOs that currently hampers the progress of efficient disaster management in coastal Bangladesh. This mistrust is driven by a number of triggering factors, as mentioned in sub-section 5.3.9. But for a sustainable disaster management practice at the community level, there is no option other than to maintain a well-planned and well-coordinated GO-NGO collaboration, for which there are some clauses in the existing Disaster Management Act 2012 (GoB, 2012) in Bangladesh, but with the least application in the case of stakeholders' collaboration.. Therefore, we present a Strength-Weakness-Opportunity-Threat (SWOT) matrix in Table 5.5 which can be considered for bringing all stakeholders together to participate in efficient disaster management practices. A good number of issues mentioned in the SWOT matrix are consistent with the suggestions by Ali (2013) and Ullah, Newell, Ahmed, Hyder, and Islam (2006) for effective GO-NGO collaboration in Bangladesh.

Table 5.5. SWOT matrix for GO-NGO collaboration in the area of disaster preparedness in Bangladesh.

Strengths	Weakness	Opportunity	Threats
Mutual link perspective ▪ Enhanced the capacity of disaster preparedness programs at the community level ▪ Created a platform of sharing knowledge, expertise, and resources between GOs and NGOs	Policy perspective ▪ Although the current legal frameworks do not impose any restriction on collaboration, there is still no policy intervention for GO-NGO collaboration	Policy perspective ▪ Recent government policy has created an effective GO-NGO collaboration for disaster preparedness	Process perspective ▪ Noncooperation from some NGOs ▪ Due to absence of direct policy option for collaboration, sometimes GO executives at the field level are indifferent about collaboration with NGOs
Coverage perspective ▪ Parallel DM oriented actions by GOs and NGOs have increased the coverage ▪ Co-utilization of knowledge and abilities of collaborating agencies ▪ Opportunities for equal distribution of relief and rehabilitation aid for the affected people	Process perspective ▪ GO's funding depends on domestic resource mobilization and NGO's funding depends on external sources ▪ Difficult for GOs to select collaborating NGO partners due to abundance of NGOs within the same jurisdiction and areas ▪ Concerns of NGOs for exposing GOs	Practice perspective ▪ Application of global experiences on effective GO-NGO collaboration for disaster preparedness ▪ Support from international organizations and donors in cases of GO-NGO collaboration	▪ Lack of legal sustainability for GO-NGO collaboration in disaster preparedness
Efficiency perspective ▪ Co-management of disaster risk by GOs and NGOs has improved institutional capacity by sharing knowledge and experience ▪ Good opportunity for GOs to learn participatory management	▪ Absence of mutual trust between GOs and NGOs ▪ Less interest of some NGOs to collaborate with GOs in some cases	Outlook perspective ▪ GOs consider NGOs as development partners and crucial stakeholders in disaster preparedness	Outcome perspective ▪ Rigid controlling over NGOs' flexible activities by the government ▪ Frequent changing of government executives at the field level hampers the pace of ongoing disaster preparedness actions
Quality perspective ▪ Overall coordination in managing disaster situations has improved ▪ Sharing experiences and knowledge has provided opportunities to overcome challenges in quality of managing disasters			

6. Integration of Findings into Local Policy

6.1. Summary of Major Findings

6.1.1. Major factors affecting evacuation compliance

In Chapters 2 and 3 of this dissertation we performed a systematic literature review and empirical case study, respectively, to identify influential factors that either motivate or dissuade at-risk people from evacuating at the time of cyclones in coastal Bangladesh. Findings from the literature review suggest the following three issues:

(i) there is a credibility problem with warning messages (e.g., not trusting the message due to previous false alarms);

(ii) a knowledge gap exists in understanding risk perception (e.g., objective vs. subjective perception); and

(iii) there is a lack of comprehensive study on sociocultural determinants (e.g., norm of Purdah).

The findings from the data-based empirical case study suggest that four issues affect at-risk peoples' evacuation decisions:

(i) warning message-related issues (e.g., information sources, channel access, and preferences);

(ii) situational impediments and facilitators (e.g., distance to the cyclone shelter);

(iii) message recipients' characteristics (e.g., house structure, dependency ratio inside house); and

(iv) threat/risk perception (e.g., movement of ants and fishery, roar of the wind).

This case study also has focused on critical factors behind the noncompliance with evacuation orders/advisories by at-risk people in coastal Bangladesh. Relevant results in this case imply that the distance to safe havens (i.e., cyclone shelters), space insufficiency inside the shelters, the unavailability of gender-segregated toilets and spaces in the shelters, the unavailability of nearby killas, poor understanding of warning messages and signals, a relatively larger dependent segment within a household, and social customs such as purdah for adult women are responsible for noncompliance with evacuation advisories. The unique finding from this empirical study revealed that cyclone preparedness training helped the people at risk to understand early warnings, connect with CPP volunteers, and rely on warning messages.

6.1.2. Role of preparedness training on resilience capacity

In Chapter 4 we examined the role of preparedness training on the socioeconomic resilience of at-risk households. Major results from this Chapter imply that:

(i) the degree of socioeconomic vulnerability of at-risk households is determined by their anticipatory and reactive adaptive capacities (e.g., EW receiving, evacuation status, necessity and rapidity to emergency relief);

(ii) the adaptive capacities seem to be governed by at-risk peoples' participation in preparedness training;

(iii) preparedness training participants exhibited better reactive adaptive capacity (e.g., necessity and rapidity to emergency relief) over the non-participants during the post-cyclone states;

(iv) training participants could significantly avoid higher consumption and asset shocks, financial damage, and a higher number of deaths or injuries of household members;

(v) participants evacuated to nearby safe havens at a higher rate than their counterparts during tropical Cyclone Aila.

All of these phenomena collectively showed better socio-economic resilience for the training participant households.

6.1.3. Disaster preparedness actions at the community level

Chapter 5 focused on different actions of disaster preparedness at the community level. Major findings from this chapter imply that:

(i) over the last five years a good number of infrastructural (e.g., establishment of information centers) and non-infrastructural (e.g., disaster drills) actions have been implemented as preparedness strategies;

(ii) the aforementioned actions seemed to escalate the awareness of disaster risks among the people at risk;

(iii) radio and TV, warning flags, hand-operated mikes and sirens, wireless centers, and relatives/friend/peer groups were found to be common methods of early warning;

(iv) preparedness training, disaster drills, RRFs, RRACs, and government information centers were reported for awareness enhancing;

(v) gaps in proper coordination between GOs and NGOs, which are due to least execution of the existing Disaster Management Act, impeded effective implementation of different preparedness actions.

Issues mentioned in i-iv were found to help the at-risk people not only to become more aware about the hazard risks but also to respond (e.g., seeking information, performing necessary actions before evacuation) properly before, during, and after a hazard, while the issue mentioned in v implies challenges in the proper adoption and implementation of necessary preparedness actions.

6.2. Analyses and Syntheses of Findings into Solutions to Local Issues

The aforementioned findings may be not new in the area of disaster preparedness, but these findings provide some empirical evidence-based scenarios for Koyra sub-district. These local level findings can be very useful for local level policy formulation with coastal areas with characteristics similar to Koyra. In the following part, we integrate the aforementioned major findings from the household and community levels and then we offer possible solutions to the local issues.

6.2.1. Evacuation compliance at the local scale

6.2.1.1. Key challenges

During emergencies, the evacuation compliance of people at risk is governed by both their individual/household characteristics and stakeholder agencies' functions. In Koyra, for example, compliance with evacuation advisories at the household level depends on people's own intrinsic characteristics such as dependency ratio, household size, cattle ownership, house structure type, previous hazard experiences, false sense of security, threat perception, and fear of burglary (see details in sub-section 3.5.3 in Chapter 3). In addition, distance to the nearest cyclone shelter was found on average to be 3.14 (± 1.31) km in Koyra, whereas the desired distance should be within 1.5 km. Such a long distance became a hindrance to evacuation compliance for households. Again, the availability of killas (mud hillocks to protect animals during cyclones and storm surges) become crucial factors in evacuation compliance, as households with cattle are unlikely to comply with an evacuation advisory unless they find a suitable place (e.g., killa) to keep their animals. Relevant statistics suggest that in Koyra nearly 90% of households own cattle for income generation purposes (BBS, 2013, p-49). Therefore, the availability of killas in the immediate vicinity of cyclone shelters plays a critical role in

evacuation compliance for at-risk households. For stakeholder agencies at the community level, the methods commonly applied to disseminate evacuation advisories have a number of drawbacks. For example, using a mosque's mike, hand-operated siren or mike, or warning flags, and deploying GO and NGO workers for door-to-door knocking, have limited coverage up to a certain degree in terms of distance (see details in Table 5.2 in Chapter 5). Apart from household and community levels issues, the state-operated actions, such as warning-message dissemination from radio and television, also encounter the challenge of accessibility by a majority of the at-risk people.

6.2.1.2. Solutions

To address the aforementioned challenges for evacuation compliance, it is necessary to make all of the parties (i.e., households, local governments, and stakeholder agencies) function in a synergistic fashion during emergencies. Specifically, the average distance between households and cyclone shelters must be reduced to within two km. And apart from the existing 42 shelters, construction of additional shelters is essential. Similarly, setting up killas close to cyclone shelters is also essential, as a majority of households that own cattle in Koyra often do not comply with evacuation advisories by leaving their homes without their cattle. In order to overcome the challenge of message dissemination, the community radio known as "Radio Sundarban," which is accessed by both one-band small radio and mobile phones, can be utilized (Bangladesh NGOs Network for Radio and Communication [BNNRC], 2000). The coverage area of this radio is 17 km, including all seven unions of the Koyra sub-district.

6.2.2. Disaster preparedness training on the local scale

6.2.2.1. Key challenges

Disaster preparedness training comprising workshops, seminars, and drills seemed to enhance the socio-economic resilience capacity of at-risk households in Koyra. The training participant households exhibited better anticipatory and reactive adaptive capacities during pre- and post – cyclone situations, respectively, which helped them to avoid consumption and asset-profile shock after the cyclone. Thus, participating in training helped households to be more socio-economically resilient toward hazard shocks. Interestingly, only 36% (≈151) of our sampled households participated in various trainings before Cyclone Aila (see details in sub-section 4.4.1 in Chapter 4). Hence, a majority of the sampled households were out of the scope of preparedness training. This finding clearly indicates the weakness in designing, as well as

arranging, preparedness training by community-level stakeholder agencies in Koyra. For example, such training (either workshops or seminars or drills) is arranged more frequently during disaster times (see details in sub-section 5.3.6 in Chapter 5) and not on a regular basis. Furthermore, the coordination among different stakeholder agencies (GOs and NGOs) in Koyra and its vicinity is not consistent in implementing DRR-focused training activities. Specifically, short street dramas and mock drills are effective ways to communicate to at-risk people regarding their practical "to dos" during cyclones. However, such dramas are often performed by inept actors/actresses, as reported by community-level respondents. As a result, on many occasions the core message from such dramas is not effectively communicated to the at-risk people.

6.2.2.2. Solutions

The Union Disaster Management Committee (UDMC) can take a key role in addressing the challenges of ensuring training participation by a majority of local people, along with well-coordinated functions by stakeholder agencies. Against this backdrop, the UDMC may first coordinate actions among the stakeholder agencies in Koyra for designing the training. Then, to ensure the maximum participation of at-risk people in different communities, such training sessions can be arranged immediately before or after religious festivals, as people are more likely to stay with their families during festivals. Otherwise, the poor and marginalized segments of society, which are often at the highest risk, are likely to prioritize their mandatory involvement in securing their livelihoods, impeding them from participating in training during other times, apart from the aforementioned festivals.

6.2.3. Community level preparedness actions on a local scale

6.2.3.1. Key challenges

For the community level preparedness actions in Koyra and its adjacent area, aside from rivalry between GOs and NGOs triggering overlapping activities, two key challenges were reported as dominant: political influence and bureaucratic complexity in the government's actions (see details in sub-section 5.3.9 in Chapter 5). Such challenges eventually make the implementation of different preparedness schemes too challenging to function in a sustainable approach. Therefore, even after significant attention and investment by the government in the DRR scheme in Bangladesh since 1991, community-level preparedness actions do not seem to motivate at-risk people to respond properly, especially concerning cyclone evacuation

compliance and attending preparedness training in Koyra . The empirical results suggest that only 33% and 36% of sampled respondents participated in evacuation and training, respectively.

6.2.3.2. Solutions

Such organizational hindrances in implementing preparedness actions in Koyra can be addressed by making the UDMC more powerful in terms of exercising its own discretionary power. Standing Orders on Disasters (SOD), the most comprehensive guidelines to deal with disaster situations in Bangladesh, clearly define the role and responsibilities of the UDMC in pre-disaster, during disaster, and post-disaster times. By exercising the clauses mentioned in article 3.5.4 in the SOD (GoB, 2010; p. 38-40) in Koyra, preparedness actions can be well-coordinated and effective, which is likely to make the people at risk comply with evacuation advisories and training participation to a greater extent.

6.3. Policy Recommendations

Based on the empirical findings from Chapters 2-5, we propose the following four policy recommendations:

(a) construction of additional cyclone shelters and killas;

(b) upgrade of the existing cyclone forecasting system;

(c) efficient warning message dissemination; and

(d) well-coordinated preparedness training programs.

Depending on the degree of involvement, these recommendations are mainly suggested for the Ministry of Disaster Management and Relief (MoDMR), the Disaster Management Bureau (DMB), and the Union Disaster Management Committee (UDMC). Final focus through these recommendations is projected at the national level by considering local level scenarios. The specific roles of different stakeholder agencies, including the aforementioned ones, are also incorporated in these recommendations. Furthermore, expected time frames (i.e., short, mid-, and long-term) for specific actions and/or strategies are also suggested here. In the following sub-sections we elaborate on the aforementioned policy recommendations with a view to mitigating the existing challenges in implementing disaster preparedness actions.

6.3.1. Construction of additional cyclone shelters and killas

We suggest constructing additional cyclone shelters in an optimal proximity, especially in high-risk and risk zones, so that people can reach shelters by traveling less than two kilometers. Apart from the 3,751 existing cyclone shelters, the construction of an additional 2,000 shelters

is proposed in the coastal zone (GoB, 2011c). Of this proposed number of shelters, 230 new shelters have been constructed, and 240 of the existing shelters were rehabilitated by 2013 (World Bank, 2013). In the case of new construction, it is strongly recommended that shelters be equipped with separate toilets and spaces for separate genders, sufficient lighting, an adequate supply of clean water, and emergency food.

As the existing shelters can accommodate only 15% of the total coastal population (Shamsuddoha & Chowdhury, 2007), the target should be to provide shelters to the highest possible number of the most vulnerable people in high-risk and risk zones. Against this backdrop, it is worth discussing the construction of a closely-knit network of small cyclone shelters instead of a small number of large shelters, as such a network would decrease the distance between houses and shelters, which would also allow the refugee households to have optimal supervision of their property.

To accomplish the construction of additional cyclone shelters, we suggest that the Ministry of Disaster Management and Relief (MoDMR) has to take medium- and long-term strategies in collaboration with the Disaster Management Bureau (DMB), the Local Government Engineering Department (LGED), international donor agencies (e.g., the World Bank, JICA), and the local disaster management committee (e.g., UDMC). A consortium of aforementioned agencies can either construct new shelters or rehabilitate/renovate existing shelters for people living in specific risk areas and accordingly prepare and update evacuation route maps for them to get to the designated shelters quickly and safely in emergencies. For new shelter construction, we suggest joint monitoring and evaluation by the MoDMR and donor agency to ensure the quality of the work. We also suggest labeling the shelters' roofs with distinctly visible marks so that they can be easily detected by remote sensing imagery (e.g., IKONOS). These approaches are expected to catalyze the available situational facilitators in evacuation compliance.

Along with construction of additional cyclone shelters, killa construction is equally important, so that refugee households—for whom livestock (cattle and poultry) are sources of income—can keep their livestock safe and monitor it accordingly during an emergency. Along the exposed coastal zone of Bangladesh, if a majority of the at-risk households own livestock (in Koyra, around 90% of households own livestock), then they are unlikely to comply with evacuation advisories due to the unavailability of a killa in their nearest cyclone shelter. Currently in the coastal zone of Bangladesh there are 196 killas, which is nearly 4.5 times less

than the required number of killas (GoB, 2008, 2011c; Karim, 2006). As killa construction does not incur a similar cost to a cyclone shelter, and only low-lying and exposed areas need killas, the local government through the UDMC may take short- and medium-term initiatives for such construction. In this case, we suggest the involvement of LGED to construct killas where necessary by utilizing local resources under the intervention of local units of the Bangladesh Red Crescent Society, DMB, and MoDMR.

6.3.2. Upgrading the existing cyclone forecasting system

Currently the BMD utilizes three consecutive steps for cyclone forecasting:

(a) collection, interpolation, and analysis of wind data;

(b) determination of steering airflow; and

(c) forecasting the cyclone trajectory and intensity (Roy et al., 2015).

These steps are again assimilated by using two techniques: (a) Storm Track Prediction (STP), and (b) Steering and Persistence (STEEPER) (Asian Disaster Reduction Center [ADRC], 2005; Debsarma, 1999). Technically, neither of the stated forecasting methods is sufficiently advanced to generate forecasts with accuracy for more than 12 hours ahead (Gopalakrishnan et al., 2011; Roy et al., 2015). Therefore, we suggest the introduction of the cyclone-forecasting version of the Weather Research and Forecasting (HWRF) model (Gopalakrishnan et al., 2011), which would be able to generate a more precise long-term cyclone track along with intensity forecasts in support of other required logistics, such as Global Telecommunication System (GTS) and NOAA's high resolution satellite images (Roy et al., 2015). Furthermore, as BMD is already operating WRF to forecast rainfall, an adoption of HWRF would be compatible with the meteorologists' regular forecasting, and no additional training or cost or logistics would be needed (Roy et al., 2015). Cyclone forecasting, therefore, by using HWRF is likely to enhance the credibility of the content of warning messages. In addition, the likelihood of a false alarm would also be decreased.

Such upgrades can be a mid- and long-term strategy by the BMD in direct intervention of MoDMR. In the long term, we suggest technical collaboration of the MoDMR with specialized agencies such as the Regional Specialized Meteorological Center in Delhi, NOAA, and JAXA for high resolution satellite images of cyclones. In addition, we suggest installing rainfall measurement facilities along the coastal region of Bangladesh.

6.3.3. Efficient warning message dissemination

In order to overcome the challenge of successful warning information/message dissemination, we suggest utilizing the existing countrywide mobile phone network, as mobile phones are owned by a good number of households in coastal communities. The role of mobile phones was found to be not only as a medium to connect with CPP volunteers but also as an information source from peer networks (e.g., friends, co-workers) prior to hazards. Hence, by sending voice messages in local dialects instead of text messages to the mobile phones in the at-risk areas, people can be forewarned easily, as they are mostly illiterate and cannot figure out the meaning of a text message.

At the same time, customized one-band FM radios can be distributed to households, either for free or at a nominal cost, so that people can regularly follow forecasts from state and community radio stations, which are now available and popular in coastal Bangladesh (BNNRC, 2000). In this case, we also suggest preparing regular forecasts in local dialects, as forecasts by state radio and television broadcasting usually contain formal words or jargon that people at risk may find difficult to understand. Furthermore, the content of cyclone warning messages in different media can be designed similarly and in an easy-to-understand way for all of these people.

The aforementioned suggestions on a mobile phone network and community radio can be adopted as short- and mid-term strategies by the applicable stakeholder agencies. For example, the MoDMR, in collaboration with an international donor agency (e.g., World Bank), may take the initiative to distribute one-band FM radios among selected households within a community so that warning information can be dispatched to other households in the community within the shortest possible time. Again, the BDM, under direct supervision of the MoDMR, can prepare the warning message in Bengali and in different local dialects. In preparing such messages in local dialects, the BMD can get help from different local radio broadcasting centers (i.e., state-operated radio) and existing community radios across the coastline. Once the warning message is prepared, the BMD may immediately ask the mobile phone operators, radio, television, and localized government/non-government information centers to disseminate it.

6.3.4. Well-coordinated preparedness training programs

The existing preparedness training programs do not appear to ensure the participation of the majority of people at risk in Koyra, as indicated in Chapter 4 (Section 4.4). Part of this situation seems to be reflected through the very slow increase in evacuation compliance in coastal

Bangladesh over the last two and half decades (see details in Section 2.4 in Chapter 2). Therefore, the scope and effectiveness of the preparedness training programs need to improve by reaching out to a higher number of at-risk households through short- and mid-term strategies. In such cases, the local disaster management committees (e.g., the UDMC), in collaboration with existing stakeholder agencies in the locality (e.g., GOs, NGOs, and international agencies), may set short- and mid-term targets to make at-risk local people aware of disaster risks.

Furthermore, to minimize the considerable overlapping actions by different stakeholder agencies, especially GOs and NGOs, as described in Chapter 5 (sub-section 5.3.9), the UDMC may use its discretionary capacity, empowered by the SOD and Disaster Management Act, to assign specific responsibilities to the active stakeholder agencies in its locality. To enhance people's awareness at the community level, as indicated in Chapter 5 (sub-sections 5.3.1, 5.3.3, and 5.3.7), street dramas lasting less than a half hour might be a good approach to show people practical "dos and don'ts" during emergencies: especially how to read symbols by showing them their meanings, what to prepare before leaving for a cyclone shelter, how to recognize the symbols to go to the cyclone shelter, and so on. Furthermore, the history of previous tropical cyclones, especially the degree of damage, experience, and lessons learned,; can be communicated to the people at risk through various preparedness trainings, as such an initiative is not yet incorporated into preparedness actions. To ensure the participation of the poor and marginal inhabitants of a locality, the UDMC in cooperation with stakeholder agencies may offer incentives for participants such as cash, emergency kits (e.g., torch light), etc.

7. Conclusions

7.1. Major Contributions of the Dissertation

7.1.1. Spatial focus

This dissertation has mainly focused on the Koyra sub-district and its adjacent areas, which are situated within the exposed coastal region of Bangladesh. Those areas in this region possess identical geophysical patterns: interplay of tidal regimes (i.e., high tide and low tide), salinity intrusion, and cyclone-triggered storm surge. Such identical geophysical patterns have created a different lifestyle for the area's inhabitants, with a higher incidence of poverty, lower living standard, and very limited livelihood opportunities.

This area often suffers diverse natural hazard threats and vulnerability, especially cyclone threats that affect the livelihood of the local people. Recently two consecutive cyclones—Sidr in 2007 and Aila in 2009— battered this area, which resulted in significant damage to economic and noneconomic assets. Such damage creates detrimental impacts on the economic prospects of this area, where such prospects consist of proximity to the seashore and the ecosystem benefits from the world's largest mangrove forest, *Sundarbans*. For example, people highly depend on fishery, fry-collection, timber, *golpata* (nipa-palm), and honey collection for their earnings, and for these activities they depend on the shoreline and the *Sundarbans.* In addition, Koyra has become a popular gateway of tourism with the *Sundarbans,* which is an income prospect for the local people. In the recent past a number of studies have pointed out Koyra as one of the hotspots of climate change-triggered extreme events, with a domination of tropical cyclones (Ahsan & Warner, 2014; UNDP, 2010). The cascading effects of tropical cyclones historically have hindered all such prospects for the local people at risk, at the cost of damaging their assets and lives.

7.1.2. Thematic focus for a local-level preparedness analysis

Considering disaster preparedness as a key countermeasure to lessen the immediate effects and the mid- and long-term impact from diverse hazards, especially cyclones, this dissertation has focused on local-level preparedness schemes in the Koyra sub-district. This dissertation accommodates both individual household and community-level empirical investigation by considering disaster preparedness as the main focal point. Against this backdrop, this dissertation considers evacuation decisions (in Chapters 2 and 3) and preparedness training (Chapter 4) as two important components of preparedness at the household level. Existing

preparedness actions at the community level are taken into account in Chapter 5. Structured questionnaires (see Appendix D1 and D2) have been utilized to collect data from households and community-level disaster managers in Koyra. At the household level, data are collected from 420 respondents from seven unions of Koyra, while at the community level 40 respondents are chosen who were either disaster managers or their associates in Koyra and its adjacent areas.

7.1.3. Methodological contribution

This dissertation is mainly based on primary data collected from face-to-face interviews with households and community-level disaster managers and their associates. Structured questionnaires (see Appendix D1 and D-2) were used to collect the data. In line with the dissertation's objectives, the collected household level data are analyzed by introducing different theoretical frameworks.

This dissertation starts with a systematic review of relevant literature on factors affecting evacuation decision-making in Bangladesh, where the selected documents were obtained by a number of searches in two academic literature databases: Scopus and Web of Science (see details in Section 2.2 in Chapter 2). In addition, a qualitative analysis was also performed to extract the core message from each theme of early warning, risk perception, and evacuation decision-making.

In continuation with the findings from the systematic review, a primary data-based empirical study was conducted in Chapter 3. In order to investigate important factors affecting evacuation decisions at the individual household level, the Protective Action Decision Model (PADM) developed by Lindell and Perry (2012) was adopted as a theoretical framework. To analyze the households' preparedness training participation issue in Chapter 4, the Access Model developed by Wisner et al. (2004) was considered as a theoretical framework. As analytical tools, parametric (e.g., z-test, correlation) and nonparametric (e.g., chi-squared) tests, and Principal Component Analysis (PCA) were applied to chalk out important factors behind households' evacuation decision-making during cyclone hazards in Chapter 3. Along with the aforementioned parametric and nonparametric tests, Ordinary Least Squared Regression and Ordered Logistic Regression models were used as analytical tools to assess the role of preparedness training on building socio-economic resilience among cyclone-affected households in Chapter 4. Community level data, collected from disaster managers and their associates, were analyzed in Chapter 5 by applying simple descriptive statistics (e.g., bar

diagram, percentage, table) to explore the existing preparedness actions in Koyra and its vicinity.

7.1.4. Specific findings

Major empirical findings can be summarized from household and community perspectives. The findings corresponding to household-level evacuation decision-making in Chapter 3 suggest that warning message-related issues (e.g., information sources, channel access, and preferences), situational impediments and facilitators, message recipients' characteristics, and threat/risk perception are the pivotal factors that govern evacuation decision-making in Koyra. In addition, the distance to safe havens (i.e., cyclone shelters), space insufficiency inside the shelters, the unavailability of gender-segregated toilets and spaces in the shelters, the unavailability of nearby killas, poor understanding of warning messages and signals, a relatively larger dependent segment within a household, and social customs such as purdah for adult women are responsible for non-compliance with evacuation advisories. These empirical findings are supported by the findings from the systematic literature review on Bangladesh in Chapter 2 denoting three key issues: (i) credibility of early warning message; (ii) risk perception-related knowledge gap; and (iii) domination of socio-cultural factors in evacuation decision-making. An interesting finding from the evacuation-related empirical case study suggests that households that did not comply with evacuation advisories were significantly absent from participating in preparedness training, whereas training participation exhibited a higher degree of significant correlation with understanding of early warnings, connection with CPP volunteers, hazard literacy level, and reliability on warning messages.

Chapter 4 investigated the role of preparedness training comprising workshops, symposiums, and drills. Empirical results imply that such trainings seemed to enhance adaptive, response, and recovery capacities of at-risk people that eventually helped the participants to avoid a higher degree of financial damage, consumption, and asset-profile shocks after the cyclone. The preparedness training participants evacuated to the nearby safe havens proportionately more than their counterparts during tropical Cyclone Aila. These phenomena collectively showed better socio-economic resilience for the training participant households. Interestingly, only 36% of sampled households were participants in such training.

Such trainings were organized by the community-level stakeholder agencies and hence, in Chapter 5 explored different preparedness actions performed by the existing agencies (GO, NGO, and international organizations). Major findings suggest that over the last five years,

multifarious preparedness actions helped the at-risk people in Koyra to become aware about the disaster risk and became more responsive than before to dealing with before, during, and after hazard situations. However, a lack of proper coordination among different stakeholder agencies, especially between GOs and NGOs, hinders effective implementation of different preparedness actions.

7.1.5. Policy recommendations for local challenges

Addressing the local issues, we suggest policy recommendations for three specific avenues: evacuation compliance, preparedness training participation, and coordination of local stakeholder agencies. To motivate the evacuation compliance of local at-risk people, we have suggested the construction of additional cyclone shelters so that the average distance between household to cyclone shelter becomes less than two km. In addition, we also have suggested construction of killas (animal shelters) close to cyclone shelters, as a majority of households in Koyra own livestock. For warning message dissemination, we suggest broadcasting through the local community radio to overcome the challenges of applying other methods with limited capacity (e.g., hand-mikes, hand-sirens). For preparedness training, we suggest carrying out specific methods, such as short street dramas and mock drills, by employing competent performers and moderators, respectively. This is because expert resource personnel can facilitate the aforementioned methods in such a way that the target group can learn and capture its required course of action during emergencies. Finally, to ensure proper coordination among all of the stakeholder agencies in Koyra and its adjacent areas, we suggest that UDMC should play the key role by exercising the legitimated clause of the SOD and Disaster Management Act so that applicable stakeholder agencies perform their respective actions effectively and efficiently to better prepare at-risk people for future hazards.

The findings and policy recommendations in this dissertation may not be completely new. Nonetheless, this dissertation has added a very important practical example of preparedness actions through a real case that encourages local site-specific studies that are badly needed to improve local disaster risk reduction schemes across the world.

7.2. Conclusions

This is the first empirical data-driven study in the Koyra sub-district that accommodates both the household and community-level capacities and strategies within a scheme of disaster preparedness from the lens of behavioral as well as societal perspectives. Considering

evacuation decisions and preparedness training participation as two important elements of disaster preparedness strategies in coastal Bangladesh, this dissertation navigates three objectives: (1) identification of factors affecting evacuation decisions and actions at the household level, (2) identification of the impact of preparedness training in making at-risk people socioeconomically resilient; and (3) an overview of community-level preparedness actions in reducing disaster risks.

The first objective is realized by a systematic literature review in Chapter 2, followed by an empirical case study in Chapter 3. Major findings from the literature review suggest that evacuation decisions during cyclones are driven by the different factors of early warning, risk perception, and evacuation decision-making processes. Findings from the empirical case study suggest that the factors related to warning messages, the attributes of cyclone shelters, risk perception, and socioeconomic issues of the households affect their evacuation decision-making. An interesting finding from Chapter 3 suggests that preparedness training is significantly correlated with the understanding of early warnings, connection with emergency volunteers, hazard literacy level, and reliability on warning messages.

Chapter 4 proceeds with the second objective to investigate the role of preparedness training on the resilience capacity of at-risk households. Major findings for the second objective suggest that despite the detrimental impacts in terms of consumption shock, financial damage, and limited access to basic utilities due to tropical cyclones, the participation in cyclone preparedness training seems to improve the resilience capacity of people at risk, as reflected in their better adaptive capacities both before and after the cyclone event, response capacity, and recovery actions. All of this empirical evidence exhibits a convincing degree of association between training participation and better resilience capacity, although the existing preparedness training scheme failed to ensure the participation of the majority of at-risk population in different trainings.

The third objective in Chapter 5 focuses on the pros and cons of the existing practices of disaster preparedness actions carried out by disaster managers and their associates at the community level. These existing preparedness actions at the community level are found to help at-risk people not only to become aware about the hazard risks but also to respond (e.g., seek information, perform necessary actions before evacuation) properly before, during, and after hazards. Nonetheless, some considerable degrees of overlapping activities by different stakeholder agencies (GOs and NGOs) were found in Koyra and its adjacent areas due to rivalry

and mistrust between GOs and NGOs together with political influence and bureaucratic complexity in the government's actions. These impediments affect the smooth implementation of required preparedness actions in this region.

In light of the empirical findings, we have suggested a number of short-, medium-, and long-term policy recommendations at the national level by considering the local experience. The main recommendations focus on enhancing the effectiveness of warning message credibility and dissemination and forecasting accuracy, formulating a strategy to increase participation of at-risk people in preparedness training, and execution of the existing disaster management act to ensure synergistic functions among different stakeholder agencies currently working in Koyra and its adjacent areas.

7.3. Future Research

The disaster preparedness actions take into account the cyclone hazard and its cascading effects, pre- and post- phases of a cyclone, all stakeholders, and all impacts related to disaster risk. This dissertation illustrates both the household and community-level capacities and strategies within a schema of disaster preparedness through behavioral and societal perspectives. A number of empirical findings have been examined, which are significantly helpful for understanding the local context of disaster preparedness in southwestern coastal Bangladesh. Nonetheless, the following issues can still be considered for similar future studies:

A more comprehensive and holistic deterministic model can be applied to assess the behavioral pattern and trend for cyclone evacuation in a particular region. In this context, most representative variables can be incorporated into the model. At the same time, whether a single and/or multiple intermediary variable(s) also affect(s) evacuation decision-making can also be investigated. Results from different regions can then be compared to see if there is/are issue(s) that may lead at-risk people in different regions to behave differently in an emergency. In addition, comparing these regional findings on a global scale may provide an integrated picture of diverse evacuation decisional patterns and the triggering factors in different geographical locations of the globe.

Future research should investigate the cause-effect relationship of preparedness training participation in connection with evacuation compliance. In this area, prospective research should also look into the issues that govern objective and subjective perceptions of risk and whether there is any common driving element that affects the aforementioned perceptions

simultaneously. Results from such research may provide some practical policy recommendations for best designing preparedness trainings on a local scale that can still be integrated with regional and global scales.

As the seemingly linear relationships among different preparedness components actually function in a nonlinear way, future research can also address how evacuation decision-making and training participation explain disaster preparedness in both linear and nonlinear approaches. Prospective research may also investigate the degree to which observed relationships of multifarious disaster preparedness actions are explained or unexplained so that necessary policy interventions can be adopted in a realistic way. At the same, prospective research should address how to ensure effective collaboration among emergency stakeholder agencies in implementing preparedness strategies. Against this backdrop, future research may also look into how the community level (i.e., from the stakeholders' side) sociopolitical and socio-economic determinants affect the individual behavior of households, and how community and household-levels analyses can be integrated in a meaningful way.

Appendix A: Author's Resume

Academic Qualifications

2013-2016 [Expected]	Ph.D. **Disaster Management**; National Graduate Institute for Policy Studies (GRIPS), Tokyo, Japan
2008-2010	MSc. **International Development Studies**; Wageningen University, Wageningen, the Netherlands
1999-2003	BSS (Hons.) in **Economics**; Social Science School, Khulna University, Bangladesh

Employment History

Oct, 2013-Sep, 2016	**Research Assistant**; International Centre for Water Hazard and Risk Management (ICHARM), Tsukuba, Japan
July 2012-Present	**Associate Professor**, Economics Discipline, Khulna University, Bangladesh
July 2008-July 2012	**Assistant Professor**, Economics Discipline, Khulna University, Bangladesh
July 2005-July 2008	**Lecturer**, Economics Discipline, Khulna University, Bangladesh
May 2004-July 2005	**Research and Development Officer**, Sharifa Printers and Packagers (Pvt.) Ltd., Khulna, Bangladesh

Research Experience

Sep, 2011-Mar, 2012	**Research Assistant**, A study titled "*Cost-Benefit Analysis on Shrimp Aquaculture versus Agriculture and other Natural Resource Management (NRM) for Community Based Adaptation in Vulnerable Coastal Areas of Bangladesh"* sub-project under the "Mainstreaming Environment for Poverty Reduction: TA - 6422 (REG)" project of ADB
Aug, 2010-Nov, 2010	**Research Assistant**, A study titled "*Investment Climate Research Project in South-western Bangladesh,*" International Finance Corporation (IFC)
Sep, 2009-Dec, 2009	**Intrant and Researcher**, A project titled "*Promotion of Renewable Energy in Coastal Belt of Khulna Division*" Funded by EU, coordinated by the University of Bremen, Germany and Khulna City Corporation (KCC) Bangladesh

Publications

Journal Articles

1. **Ahsan, M. N**., Takeuchi, K., Vink, K., and Ohara, M. (2016). A systematic review of the factors affecting the cyclone evacuation decision process in Bangladesh. *Journal of Disaster Research, 11*(4), 742-753. doi:10.20965/jdr.2016.p0742

2. **Ahsan, M. N.**, Takeuchi, K., Vink, K., and Warner, J. (2016). Factors affecting the evacuation decisions of coastal households during Cyclone Aila in Bangladesh. *Environmental Hazards, 15*(1), 16-42, DOI: http://dx.doi.org/10.1080/17477891.2015.1114912

3. **Ahsan, M. N.** (2014). Effects of livelihood strategies on mangrove-forest resource: Does the consumption behaviour of households jeopardise the forest resource base? *Management of Environmental Quality- An International Journal, 25*(6). DOI: http://dx.doi.org/10.1108/MEQ-05-2013-0048

4. **Ahsan, M. N.** and Warner, J. (2014). The socioeconomic vulnerability index: A pragmatic approach for assessing climate change led risks-A case study in the south-western coastal Bangladesh. *International Journal of Disaster Risk Reduction, 8*, 32-49. DOI: http://dx.doi.org/10.1016/j.ijdrr.2013.12.009

5. **Ahsan, M. N**., N. Nasrin, et al. (2013). Effects of climate induced vulnerability on household consumption expenditure: Evidence from the South Western Region of Bangladesh. Plan Plus, 6(1), Khulna.

6. **Ahsan, M. N**., M. F. Ahmed, et al. (2011). Climate change induced vulnerability on living standard- A study on south-western coastal region of Bangladesh." *Journal of Innovation and Development Strategy*. *5*(3): 24-28. URL: http://ggfagro.com/books/JIDS/v5i3/MIN-248%20%2824-28%29%20FINAL%20%28OK%29.pdf

7. **Ahsan, M. N.**, N. Nasrin, et al. (2011). Foreign aid, corruption and economic development: An empirical analysis on selected Asian and African countries. *Journal of Innovation and Development Strategy Toronto, 5*(3): 1-8. URL: http://ggfagro.com/books/JIDS/v5i3/MIN-233%20%281-8%29%20FINAL%20%28OK%29.pdf

8. **Ahsan, M. N.** and R. Haque (2010). Climate change and income inequality: A study on some selected areas of the coastal region in Bangladesh. *Journal of Socioeconomic Research and Development (JSERD, 7*(2): Dhaka; pp. 830-836**;** (URL: http://gscience.gurpukur.com/product_info.php?cPath=4_168_170&products_id=913)

9. ***Ahsan, M. N.** (2008). The construction of Khan Jahan Ali Bridge: Its effects on income and household ownership patterns during different time periods. Business Review (A journal of Business Administration Discipline, Khulna University, Bangladesh) Jan-Dec; 6 (1 & 2), Khulna.*

10. ***Ahsan, M. N.** (2008). Ecotourism in Bangladesh: A new tool for economic development. Journal of Socioeconomic Research and Development (JSERD), 5(3): Dhaka; pp. 299-304, [URL: http://gscience.gurpukur.com/product_info.php?products_id=265]*

11. ***Ahsan, M. N.*** *and T. Hashem (2009). Foreign aid dependency and development process in Bangladesh: A study on the last one and a half decades (1991-2005). AMDA Research Journal, 1(1): Dhaka. [URL: http://www.amda-rf.org/Journal%201st%20Issue.pdf]*

12. ***Ahsan, M. N.*** *and T. Siddiqua (2004). Mongla Seaport: Trade trends and efficiency. Business Review (A journal of Business Administration Discipline, Khulna University, Bangladesh) July-December: 4(1 & 2): Khulna.*

13. *Siddiqua, T. and* ***M. N. Ahsan*** *(2006). Major problems and prospects of Mongla Seaport. Journal of the Institute of Bangladesh Studies, 29*: University of Rajshahi, Rajshahi.

Book Chapter

1. **Ahsan, M. N**., Vink, K., and Takeuchi, K. (2016). Livelihood-strategies and resource dependency nexus in the Sundarbans. In R. DasGupta & R. Shaw (Eds.), *Participatory mangrove management in a changing climate: Perspectives from the Asia-Pacific.* Springer, Japan (Forthcoming).

Conference Paper/Extended Abstract/Poster

1. **Ahsan, M. N.** and Takeuchi, K. (2016). How does hazard-preparedness training enhance resilience for household at risk? *The 7th International Conference on Water Resources and Environment Research*; Kyoto, Japan (June 5-9) [Extended abstract].

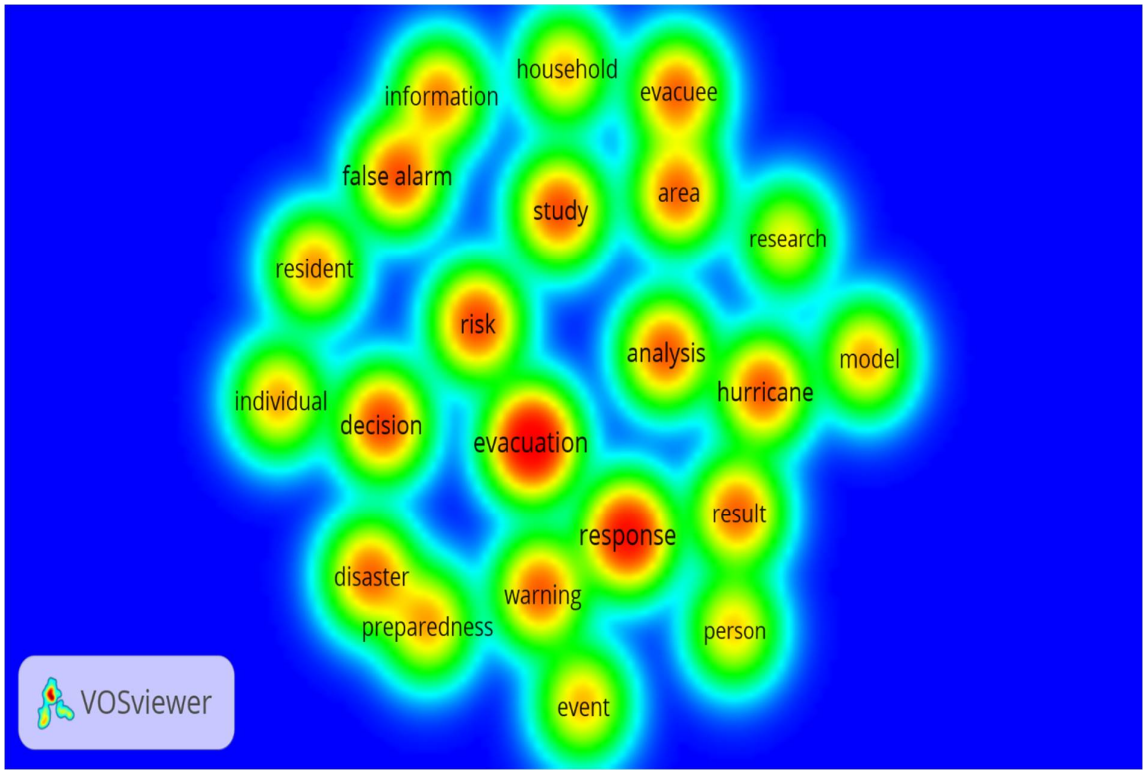
2. Vink, K. and **Ahsan, M.N.** (2016). The benefits of cyclones as ecosystem services. *The 7th International Conference on Water Resources and Environment Research*; Kyoto, Japan (June 5-9) [Paper].

3. **Ahsan, M.N.**, Takeuchi, K. and Vink, K. (2016). Challenges and opportunities of early warning in evacuation compliance: A case report from the Cyclone Aila in Bangladesh, *UNISDR Science and Technology Conference on the Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030*; Geneva, Switzerland (January 27-29) [Poster].

4. **Ahsan, M. N.** and Takeuchi, K. (2015). How do people decide to evacuate or not? A case report from the cyclone Aila, *World Conference on Disaster Risk Reduction Public Forum in Sendai UNESCO / GRIPS Symposium*; Sendai, Japan (March 14) [Paper].

5. Haider, M. Z., K. F. Mohsin, and **Ahsan, M. N.** (2011). Structural changes of the industrial sector: A study on the south-west region of Bangladesh. *National Conference on Contemporary Issues in Economics*. Shahjalal University of Science & Technology, Sylhet, Bangladesh (February 23-24) [Paper].

Appendix B: Map of Bibliographic Network of the Documents Selected for Systematic Literature Review



Explanation:

This is a map in which indicators are located in such a way that the distance between two indicators provides an indication of the number of co-occurrences of the indicators. In general, the smaller the distance between two indicators, the larger the number of co-occurrences of the indicators. Two indicators are said to co-occur if they both occur on the same line in the corpus file (a corpus file is a text file that contains on each line the text of a document). In addition to a corpus file, a scores file may also be provided. A scores file is a text file that contains on each line the score of a document. Based on the scores in a scores file, VOSviewer calculates a score for each indicator in the indicator map. The score of an indicator equals the average score of the documents in which the indicator occurs.

(Source: http://www.vosviewer.com/getting-started#VOSviewer manual)

1

Appendix C: List of Documents Used for Content Analysis

Themes	Dimension(s)	Factors	Documents selected for general contexts	Documents selected for Bangladesh contexts
Early warning	Psychological	a. Language b. Technical terms c. Threat information	Dash and Gladwin (2007); Huang et al. (2012)	Haque (1997); Paul (2012); Dove and Khan (1995)
	Socio-technical	a. Source b. Channel c. Recipients' knowledge level	Garcia and Fearnley (2012); Mileti and Sorensen (1990); Sorensen and Sorensen 2007); Mesa-Arango et al. (2013)	Paul and Dutt (2010); Paul and Routray (2011); Haque (1995); Roy et al. (2015)
	Psychological and Socioeconomic	a. Literacy level of the recipient b. Asset possession (e.g., TV and radio) c. Connection with peers	Mileti and Sorensen (1990); Mileti and O'Brien (1992); Lindell and Perry (2012); Hanson, Vitek, and Hanson (1979); Nigg (1995); Wilson and Tiefenbacher (2012); Dash and Morrow (2000)	Paul et al. (2010); Ikeda (1995)
Risk perception	Psychomotor	a. Vision (e.g., color of cloud) b. Hearing (e.g., roar of the wind)	Sorensen (2000); Dow and Cutter (1998)	Paul and Routray (2011); Paul (2009); Dove and Khan (1995)
	Cognitive and social	a. Language b. Family c. Peer-network	Baker (1991)	Paul (2012); Bern et al. (1993)
	Psychological	a. Credibility of warning message source b. Perceived hazard characteristics	Dash and Gladwin (2007); Sjöberg (2000); Weinstein (1988, 1989); Breznitz (1984)	Paul et al. (2010); Paul (2012)
	Quantitative, Cognitive, and Psychological	Specificity of risk information by warning message	Tierney (1994); Burton, Kates, and White 1978); Meissen and Voisard (2010); Sjöberg and Biel (1983); Mulilis and Duval (1997)	

Themes	Dimension(s)	Factors	Documents selected for general contexts	Documents selected for Bangladesh contexts
	Socioeconomic	Stakeholders' perception	Lindell and Perry (2012); Baker (1991)	
Evacuation decision-making	Situational context	a. Facilitators (e.g., personal vehicle) b. Impediments (e.g., ambiguous information)	Lindell and Perry (2012); Baker (1991); Mileti and Sorensen (1990); Lindel, Kang, and Prater (2011); Dow and Cutter (1998)	
	Social	a. Gender issue b. Social norm		Ikeda (1995); Alam and Collins (2010); Paul (2009); Dove and Khan (1995)
	Socioeconomic and psychological	a. Dependency ratio in the household b. Pet ownership c. Income-generating cattle ownership d. Literacy level of the key decision-maker of household e. Number of disabled members in household f. Fear of burglary	Huang et al. (2012)	Paul and Dutt (2010); Paul (2012); Paul and Routray (2013); Haque and Blair (1992); Haque (1997); Ahsan et al. (2016); Dove and Khan (1995)
	Logistic	a. Distance to the safe haven (i.e., cyclone shelter) b. Space sufficiency in safe haven	Baker (1991); Lindel, Kang, and Prater (2011)	Paul and Dutt (2010); Dhar and Ansary (2012); Paul (2009)

Appendix D-1: Sample Questionnaire for Household Survey

Sl. No.:

Union:

1. Name of the respondent:
2. Address:
3. Family information:

Number	**3.1** List names of all individuals in household (List household head first, use first names only)	**3.2** What is "_____"s relationship with household head?	**3.3** Sex: Male→1 Female→0	**3.4** Age	**3.5** What is "___''s marital status? Never married→0; Married→1; Divorced→2; Widow(er) →3	**3.6** Occupation	**3.7** Completed education level?	**3.8** How long have you lived in this community?
	Name	**Code**	**Code**	**Years**	**Code**	**Code**	**Code**	**Years**
1								
2								
3								
4								
5								
6								
7								

Code box for question 3.1

Head 01	Grandchild 08	Cousin 15
Wife/husband 02	Grandparent 09	Other relative..... 16
Son/daughter 03	Father-in-law/mother-in-law 10	Children from another family.. 17
Father/mother 04	Son-in-law/daughter-in-law. 11	Other relative..... 18
Sister/brother..... 05	Sister-in-law/brother-in-law 12	Renter 19
Stepson/stepdaughter .. 06	Nephew/niece 13	Other non-relative 20
Stepfather/stepmother . 07	Uncle/aunt..... 14	

Code box for question 3.6

Farmer-0	Govt. servant-5
Fishing-1	Private job-6
Daily labor-2	Honey collector-7
Trade-3	Others-

Code box for question 3.7

Illiterate, no schooling……1
Primary incomplete.....2
Primary complete.....3
Secondary incomplete. ……..4
Secondary complete.....5
Higher Secon. incomplete.....6
Higher Secon. complete.....7
University.....8
Other……..9

4. Income information of the household (In Tk.):

	Main income (tk/yr)			Auxiliary income (tk/yr)		
Q. no.	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**
Year	January 2008	January 2009	January 2010	January 2008	January 2009	January 2010
Amount						

5. Sources of income (In Tk.):

Sources		**January 2009**		**January 2010**	
		Monthly	**Yearly**	**Monthly**	**Yearly**
Agricultural	Cropping				
	Fishing				
	Live stock				
	Gher-rent				
	Land rent				
	Others				
Non-agri.	Business				
	House rent				
	Salary wage				
	Bank interest				
	Others				

6. Expenditure information (In Tk.):

Time period / Sectors		**January 2009**		**January 2010**	
		Monthly	**Yearly**	**Monthly**	**Yearly**
Family expenditure	Food				
	Clothes				
	Education				
	Fuel				
	Health+medical				
	Electricity				
	Recreation				
	Festival				
	Others				
Asset Exp.	Television				
	Mobile phone				
	Buy land				
	Buy houses				

7. Land use pattern (ha):

Purpose / Time period	**Living**	**Cultivation**	**Fishing**	**Other**	**Total**
January 2009					
January 2010					

7.1 Have you lost any land in last 5 years? [1] Yes [0] No

7.1.2 If yes, then what is the amount of land? _____

8. Asset portfolio of the household:

Types / Time period	Nos. of trees		Cattle		Poultry		Pond/fisheries		Other	
January 2009		Value		Value		Value		Value		Value
January 2010		Value		Value		Value		Value		Value

8.1 Have you suffered any damage or loss of any capital goods in last 5 years? [1] Yes [0] No

8.1.2 If yes, then what assets and approx. value (in Tk.):

8.2 Have you lost any of your HH member(s) in last 5 years due to disaster? [1] Yes [0] No

8.2.1 If yes, then how many and when?

9. Residence ownership pattern of household

[0] Self Owned [1] Rented [2] Inherited [3] Sharing [4] Sub-let [5] Other

10. Type of house: [0] Not-brick built [1] Brick-built

10.1 If not brick built, then the type of house:

[0] Squatter [1] Mud-built [2] Semi-brick built [3] Wood and Straw [4] Other

11. Does the household use a sanitary latrine? [1] Yes [0] No

12. What is the primary source of water for this household?

[0] Municipality water supply [1] Other than municipality supply

12.1 If other than Municipality supply, then what is the source?

[1] Private well [2] Pond [3] Canal/River [4] Rain/stream [5] Other

13. What type of lighting source does the household use?

[0] Electricity from public source [1] Alternative energy from private arrangement

13.1 In case of private arrangement, the source is-

[0] Lamp [1] Kerosene lantern [2] Solar module [3] Candle [4] Other

14. Have you migrated to this area? [1] Yes [0] No

14.1 If yes, then how many years ago? _____

15. Did you vote in last national-level election? [1] Yes [0] No

15.1 Do you have any contact with local elites? [1] Yes [0] No

16. Have you contributed (as a household) free labor for construction of embankment or similar activity? [1] Yes [0] No

17. Do you have any previous experience of powerful cyclones (like Sidr/Aila)? [1] Yes [0] No

18. During Cyclone Aila, did you perceive the upcoming danger? [1] Yes [0] No

18.1 If yes, then how? _____

19. Within how many days after Aila could you get emergency aid? _____ days.

20. Did you go to a cyclone center when you heard about a possibility of a cyclone hit to your area?

[1] Yes [0] No

21. If no, then what are the reasons? Put tick. (Multiple response is possible)

Uncertainty of getting space in shelter		Fear of being looted	
No killa near shelter		Warning signals are not reliable	
More dependent member in the house		Other (specify)	

22. What is the distance of a cyclone shelter from your home? _____ k.m.

23. What characteristics do you consider as important for a cyclone shelter to have?

(a) Separate place for female (b) Separate toilet for female (c) Electricity (d) Supply of drinking water (e) Storage facility of food

24. Is there any provision of a killa near the cyclone shelter? [1] Yes [0] No

25. To what extent do you understand the warning message?

(a) More than 80% (b) 61-80% (c) 41-60% (d) 21-40% (e) Do not understand

26. Do you have contact with CPP volunteers? How frequent? [1] Yes [0] No

27. What is the source of your getting warning/information about cyclones?

(a) Radio (b) Television (c) CPP volunteer (d) Community leader (e) Other (_____)

28. Have you participated in disaster preparedness training in the last year? [1] Yes [0] No

If yes, then number of times. _____

29. Do you always get shelter in a cyclone center or in a neighbor's house during any disaster?

[1] Yes [0] No

30. Do you get any credit from any local GO or NGO? [1] Yes [0] No

20.1 If yes, then the amount and interest rate (per year):

31. Do you sell your agricultural produce to the local market? [1] Yes [0] No

21.1 If yes, then what is the distance of the local market from your house? _____ Km.

32. What is your opinion about the overall after-disaster preparedness by different organizations?

_____

Signature of the interviewee with date

Appendix D-2: Sample Questionnaire for Survey at the Community Level

In recent decades, significant development has been obtained in the area of disaster management in Bangladesh. Specifically, the coastal areas of Bangladesh have suffered a very low rate of mortality in the last decade during cyclones. However, the number of physical injuries, cattle loss, and property damage has still been substantial. This suggests remaining challenges for the disaster preparedness scheme for people at risk in the cyclone-prone areas. In this light, this survey is an attempt to assess the disaster preparedness in south-western coastal Bangladesh from the local disaster managers' perspectives.

The information from this survey will be used solely for academic purposes.

1. Is your locality prone to disasters? If yes, then what kind of extreme events (i.e., natural hazards) more frequently took place in your area in the last five years? Of these extreme events, which ones were more devastating? **(Table 1)**

Rank the damage (highest to lowest) done by the different hazards in your locality in the last five years (**Table 2**).

Table: 1

Name of Disasters	**Frequency (approximately)**	**Name of Disesters**	**Frequency (approximately)**
Cyclone		Temperature fluctuation	
Flow tide		North- western	
Water logging		River erosion	
Flood		Hailstorm	
Salanity inclusion		*Kalboishakhi* (tornado)	
Heavy rainfall		Others (Specify)	

Table: 2

Sequences (highest to lowest)	**Name of hazard**	**Sequences (highest to lowest)**	**Name of hazard**
1st		7th	
2nd		8th	
3rd		9th	
4th		10th	
5th		11th	
6th		12th	
(1) Cyclone ; (2) Tidal surge; (3) Water logging; (4) Flood; (5) Salanity intrusion; (6) Heavy rainfall; (7) Temperature fluctuation; (8) River erosion; (9) Hailstorm; (10) Kalboishakhi (i.e., tornado); (11) Others			

2. Measures adopted in the last five years in enhancing awareness on DRR in your locality.

Table: 3

Adopted measures			
Put (✓) mark	2.1Infrastructural	Put (✓) mark	2.2 Non-infrastructural
	2.1.1Establishment of Government operated data centers		2.2.1 Short street drama
	2.1.2 Establishment of private data centers		2.2.2 Communication with CPP volentaries
	2.1.3 Construction of cyclone shelters		2.2.3 Dissemination of early warning message
	2.1.4 Construction of earthen mound for domestic animals (killa)s		2.2.4 Preparation of Risk Map
	2.1.5 Construction of high embankment		2.2.5 Preparation of hazard map
	2.1.6 Infrastructure development of health services		2.2.6 Disaster drill
	2.1.7 Construction of shade in markets		2.2.7 Route direction (text/picture) to cyclone centers
	2.1.8 Digging canal/ Re-digging		2.2.8 Build risk reduction action plan (RRAP)
	2.1.9 Manage emergency vessels and Ground vehicles		2.2.9 By disaster management training
	2.1.10 Road construction in high ground/Communication development		2.2.10 Formation of emergency medical team
	2.1.11 Constructon of Resilient HH Shelter		2.2.11 Formation of emergency rescue team
	2.1.12 Construction of swithch gate and culvert		2.2.12 Manage various kind of poster, leaflet ,festoon for mitigation of disester risk
	2.1.13 Set up Rain Water Harvestor (RHW), Pond Sand Filter (PSF) and ubewell		2.2.13 Risk reduction fair (RRF)
	2.1.14 Digging high fring associated pond		2.2.14 Maintence of emergency fund at family level
	2.1.15 Set up mobile tower		2.2.15 Communication with emergency operation centre regulerly
	2.1.16 Manage emergency vessels and Ground vehicles		2.2.16 Capacity enhancement of UDMC
	2.1.17 Others (specify)		2.2.17 Others (specify)

3. In your locality, adopted DRR actions were targeted for whom/which levels (i.e., age specific, household level, community level, locality level, and institution level)?

Table: 4

Age specific	Household level	Community level	Locality level	Institution level	Others

Age specific	Household level	Community level	Locality level	Institution level	Others
□ Old men/ women □ Women □ Children	□ House □ Water □ Food □ Non-food □ Money □ Cloth □ Health education □ Toilet □ Training □ Food for mother and baby □ Preserve rain water □ IGA	□ Farmer □ Fisherman □ Honey collectors □ Wood cutters □ Handicapped □ Civil society □ Imam (Muslim priest)	□ Canal □ Road □ Culvert □ Bridge □ Bemri dam □ Food for work □ Cash for money □ Digging high embankment pond □ PSF □ RHW	□ School □ Cyclone center □ College □ Market-shed □ Mosque □ Temple □ Madrasa □ UDMC	□ Divorced □ Tiger-widow □ Separated □ Widow

4. In the context of actions/measures mentioned in Table 3, what was/were the mode(s) of communicating to the people at risk to warn them about hazards? What is your practical experience about the strength and challenges of the existing communication mode(s) (please provide specific examples)?

Table: 5

Put (✓) mark	**Methods**	Put (✓) mark	**Methods**
	4.5.1 Early warning related		**4.5.2 Others issues**
	4.5.1.1 Early warning through radio and television		4.5.2.1 Government operated information center
	4.5.1.2 Displaying the warning flags		4.5.2.2 Privately operated information center
	4.5.1.3 Disseminating warning through CPP volunteers		4.5.2.3 Disaster management training
	4.5.1.4 Announcement from Mosque's mike		4.5.2.4 Contact with the CPP volunteers
	4.5.1.5 Deploying workers from government agencies		4.5.2.5 Posters, leaflets, and festoons
	4.4.1.6 Deploying workers from Non-Government agencies		4.5.2.6 Disaster drill
	4.4.1.7 Using hand-siren		4.5.2.7 Route direction to cyclone center
	4.5.1.8 By hand-mike announcement		4.5.2.8 Short street drama
	4.5.1.9 Via mobile phone's SMS		4.5.2.9 Preparing Risk Reduction Action Plan (RRAP)
	4.5.1.10 Information from neighbors, friends, and peer groups		4.5.2.10 Risk Reducton Fair (RRF)
	4.5.1.11 From the wireless center		

Table: 6

4.6.1 Methods	4.6.2 Advantages	4.6.3 Disadvantages
Early warning through radio and television		
Displaying the warning flags		
Disseminating warning through CPP volunteers		
Announcement from Mosque's mike		
Deploying workers from Government agencies		
Deploying workers from Non-Government agencies		
Hand-siren sound system		
By hand-mike announcement		
Via mobile phone's SMS		
Information from neighbors, friends, and peer-groups		
From the wireless center		
Government operated information center		
Privately operated information center		
Disaster management training		
Contact with the CPP volunteers		
Disaster drill		
Route direction to cyclone center		
Awareness enhancement on disaster risk by displaying Posters, leaflets, and festoons		
Short street-drama		
Preparing Risk Reduction Action Plan (RRAP)		
Risk Reduction Fair (RRF)		
Others		

5. At present, is there any new or proposed initiative(s) in your region that differ(s) from what was done in the past five years (please provide specific example(s))? **(Other than specified in Table 3)**

Application of alternative methods? ☐ Yes ☐ No

If yes, then note down the methods in the following table:

Methods	Explanation

6. For building awareness of disaster risk, which specific preparedness strategy(ies) has/have been adopted or being adopted? To what extent has/have such strategy(ies) succeeded (in %)?

Mention the factors behind the success and/or failure of the adopted strategies. Please assign a weight for each strategy, applying a scale from 1 to 10 where 1= Least important and 10= Most important**)** [Multiple reasons can be provided on the same scale]

Table: 7

Causes of success	Causes of failure

7. Cyclone pre-preparation of awareness about risk mitigation in your area, local NGOs, non-governmental organizations, and civil-society roles and what steps? (**Types: 1= Local NGO; 2= National NGO, 3= Government agencies, 4= Private organizaiton without NGO; 5= Civil society 6= other)**

Table: 8

Name of Agencies	Types	Specific goal and Workplan

8. In your opinion, to what extent have the DRR strategies in your locality contributed to improving knowledge of the economic and noneconomic consequences from natural hazards?

(1) Does not create any awareness (2) Awareness has been negligible
(3) Moderate awareness creation (4) Good awareness has been created
(5) Has made a very good awareness

What do you think of the reasons behind your answer to the previous question? (On a scale from 1 to 10 where 1= Least important and 10= Most important**)** [Multiple reasons can be provided on the same scale]

Cause 1. Delivery of pre-disaster warning in time

	48-72 hours ago	24-48 hours ago	12-24 hours ago	6-12 hours ago	6 hours ago	less than 6 hours
% Yes						

Cause 2. Regular contact with CPP volunteers

	Contact once a month	Contact twice a month	Contact every three months	Contact during cyclone time	Irregular contact	No contact
% Yes						

Cause 3. Predisaster preparedness workshops organized by local bodies (GO and NGOs)

	Once a month	Once every two months	Once every 3-6 months	Once a year	During cyclone time	Never arranged
% Yes						

Cause 4. Disaster drill

	Once a month	Once every two months	Once every 3-6 months	Once a year	During cyclone time	Never arranged
% Yes						

Cause 5. Action frequency (adoption and implementation) by **g**overnment agencies

	Plans are being adopted and implemented regularly	Plans are made on a regular basis but implemented irregularly	Irregular plan and implementation	No coordination in adoption of plan and implementation	Plans are adopted irregularly but no implementation	There is no action in this regard

% Yes						

Cause 6. Action frequency (adoption and implementation) by NGOs

Realistic steps are being taken by non-government agencies	Implementation of measures are being made on a regular basis	Steps are being taken on a regular basis and being implemented	Irregular steps and implementation are being taken	Coordination and implementation of measures to be taken is irregular	Irregular steps to be taken and there is no implementation	There is no action taken
% Yes						

Cause 7. Increase in the number of cyclone shelters in the last five years

	80-90% of local people can take refuge in the shelters	70-80% of local people can take refuge in the shelters	50-70% of local people can take refuge in the shelters	30-50% of local people can take refuge in the shelters	Less than 30% of local people can take refuge in the shelters	No additional people can take refuge in the shelters
% Yes						

Cause 8. Road network improvement

	Road network has been developed to cope with disasters	Road network has been developed which can fairly cope with disasters	Road network has been developed which is not able to cope with disasters	Road network has been developed with inferior quality	Road network has been developed with inferior quality and no coordination	No development for road network
% Yes						

9. What was/were your (or your organization's) initiative(s) in the last five years to promote risk coping strategies for the people at risk in your region? Please provide specific examples. (On a scale from 1 to 10 where 1= Least important and 10= Most important**)** [Multiple initiatives can be provided on the same scale]

Table: 10

Name of initiatives	**Target group and strategies**
Micro credit	
Risk sharing	
Risk finance	
Risk insurance	
Training and workshops	
Post training evaluation	
Killa set up	
Others	

10. In your opinion, to what extent have the local communities gained the capacity to carry out emergency response and recovery activities in case of disaster over the last five years? (Please provide specific example(s))

a. In case of disaster response:

(1) No capacity is achieved (2) Achieved negligible capacity (3) Moderate level of capacity is achieved (4) Achieved capacity at a good level (5) Achieved capacity at a very good level

Table: 11

Capacity has been achieved so far	Capacity (ies) need(s) to be achieved

b. In case of disaster recovery:

(1) No capacity is achieved (2) Achieved negligible capacity (3) Moderate level of capacity is achieved (4) Sufficient capacity is achieved (5) Achieved capacity at a very good level

Table: 12

Recovery action already adopted	Required Recovery actions

11. Please provide some examples of challenges and/or constraints in this area for implementing initiatives for disaster preparedness (cyclone) in connection with enhancing awareness on disaster risk **(On a scale from 1 to 10 where 1= Unimportant and 10= Most important)** [Multiple reasons can be provided on the same scale].

Table: 13

Causes	Scale	Causes	Scale

12. Which recommendation do you suggest to cope with the disaster resilience mentioned under the consideration of the following problems? Please explain the specific example.

Table: 14

Scope	Proposed amedment
1. Risk identification	
2. Risk assessment	
3. Risk transfer	
4. Risk resistance	
5. Risk coping	
6.Cyclone evacuation compliance	
7. Early warning message	

13. Killa (Earthen high place for animal keeping) related questions:

13.1 Is there a killa in your locality? □ Yes □ No

If yes-

13.2 How many killas are currently available in the locality?

13.3 Average distance between killa and cyclone shelter _____ Km

13.4 What is the approximate height of the fence around the killa?

13.5 Which materials are used to construct the killa?

13.6 What is the approximate carrying capacity of the killa in your locality?

13.7 Do local people keep their animals in killas during cyclones? □ Yes □ No

13.8 What are the main reasons for people not keeping their animals in killas during cyclones?

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