

**Hazard Warnings and Compliance with Evacuation Orders:
The Case of Bangladesh's Cyclone Sidr**

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Introduction

On the night of 15 November 2007, Bangladesh was devastated by a severe tropical cyclone, called Sidr.¹ It swept across the southwestern coast and ripped through the heart of the country from south-west to north-east with 155 mph (230 kph) winds, triggering up to 20 feet (6 m) tidal surges in several coastal districts (Figure 1).² Cyclone Sidr originated from a depression in the central Bay of Bengal on November 11, 2007, and quickly strengthened, reaching peak *sustained* winds of 135 mph (215 kmh). This storm eventually hit offshore islands and made landfall on the southern border of the Sundarbans Forest and almost one-third of this forest, a world natural heritage site, was totally destroyed.³ Sidr, a high-end Category IV cyclone, weakened quickly after landfall into a tropical storm. It dissipated on November 16, 2007 (GOB 2008).

Cyclone Sidr was one of the 10 most devastating cyclones that struck Bangladesh during the 131 years between 1876 and 2007. According to the latest official reports, the deaths attributable to this cyclone total 3,406, and over 55,000 persons suffered injuries due to impacts resulting from this storm event. About 27 million people from 30 districts were affected by Cyclone Sidr (GOB 2008). Many structures and roads were damaged or destroyed, and the cyclone also caused power outages that resulted in a near-countrywide blackout lasting over 36 hours (Natural Hazards Observer 2008). Cyclone Sidr destroyed over 500,000 homes and 900,000 more were heavily damaged (SCG 2007). The Joint Damage Loss and Needs Assessment (JDLNA) Mission, led by the World Bank (WB), estimated losses caused by Cyclone Sidr at US \$1.7 billion, which is about three percent of the country's GDP (GOB 2008).

Objectives

While Bangladesh is highly vulnerable to catastrophic cyclones, both response to and effectiveness of early warning systems, which have been in existence in this South Asian country for more than three decades, has not been systematically investigated since the cyclone of 1991. Cyclone warning systems are an obvious precautionary measure, but mere existence of these warning systems themselves is not a sufficient criterion for reducing risk; there also needs to be general compliance with such warnings (Haque 1995). Sidr has provided a valuable opportunity to study the effectiveness of cyclone warning and evacuation orders disseminated for residents of coastal areas in Bangladesh.

This study seeks to capture empirical data and personal accounts of Sidr victims who complied with evacuation mandates, as well as those who did not comply, in four coastal districts of Bangladesh severely impacted by the November 15, 2007 cyclone (GOB 2008). Information collected will focus on the warning dissemination process as well as the nature of responses to these warnings. The specific objectives of this study are to: (i) identify the communication channels utilized by public agencies to disseminate cyclone warning messages to Sidr victims, and determine how effective they were, (ii) explore the extent of compliance with evacuation orders, and (iii) investigate the factors which would explain why Sidr victims did or did not comply with evacuation orders. This study will also briefly compare public emergency response to Cyclone Sidr and Hurricane Katrina.

This research will aid the understanding of human behavior in response to an impending cyclone, as well as cyclone communication effectiveness. Such an understanding is vital to improve the preparedness and resiliency of people in coastal areas of Bangladesh, as well as relevant public authorities and agencies to better manage hazards posed by the cyclones. This research will not

only provide useful information to help public authorities administer emergency management personnel, but, more importantly, it will improve the designs for more effective cyclone preparedness and crisis communication programs.

After the devastating cyclone and associated tidal surge of November 1970, the Bangladesh government initiated a Cyclone Preparedness Program (CPP) and implemented several structural measures in an attempt to minimize the loss of life and property from cyclones. The next section of this study is devoted to briefly presenting this information and is followed by a section focusing on conceptual considerations of hazard warnings and evacuation mandates. These sections provide essential background information about emergency response and preparedness, the topic of this research project. Research methods employed by this study come thereafter, ending with a presentation of the results and conclusions reached by this investigation.

Background Information

Cyclone Preparedness Program

The CPP was established in 1972 with a mission to develop effective cyclone preparedness measures for the residents of offshore islands and coastal areas. It is jointly set up by the Ministry of Disaster Management and Relief (MDMR) of the Bangladesh Government and the Bangladesh Red Crescent Society (BDRCS). CPP activities are centered around three infrastructures: an early cyclone warning system, public cyclone shelters for pre-disaster evacuation, and shelters to provide protection to animals during tidal surges.

Cyclone Warning System: While the Bangladesh Meteorological Department (BMD) prepares all weather forecasts and disaster warnings, the CPP is responsible for dissemination of cyclone warnings to residents of offshore islands and coastal areas. Meteorological forecasting, including cyclone prediction, involves continuous observations of various weather parameters over a wide area. The Storm Warning Center (SWC), a specialized unit of the BMD located in Dhaka (the capital of Bangladesh) provides forecasting and issues warnings at the national level based on meteorological data received from both national and international sources (Chowdhury 2002).⁴

Following an evaluation of relevant data and an assessment of any impending threat, storm and cyclone warnings are disseminated to three areas: seaports, riverports, and the general public. The SWC sends warnings directly to the National Coordination Committee (NCC), chaired by the prime minister, with representatives from the CPP. The SWC also sends warnings to user agencies, such as health administration, relief and rehabilitation authorities, nongovernmental organizations (NGOs), the media, and local administrations. It issues Special Weather Bulletins soon after the formation of tropical depressions in the Bay of Bengal (Chowdhury 2002). Figure 2 illustrates SWC's cyclone warning message dissemination to the at risk population.

The CPP presently covers 11 districts in the coastal area, comprising 32 Upazillas (sub-districts) consisting of 274 Unions.⁵ There are 2,845 Units, also called teams, spread across this area, each of which covers one or two villages. The CPP has a total of 159 full-time personnel, and 28,450 male and 14,225 female trained volunteers. Each Unit team has 10 male and five female

members headed by a Team Leader. Unit teams function as first responders in the cyclone warning system with a mandate to disseminate cyclone warnings among villagers. These teams are equipped with basic warning equipment such as hand sirens, megaphones, and transistor radios (CPP and BDRCS 2007). Activities of the volunteers are supported by full-time offices based in 32 Upazillas; each office is equipped with a transceiver radio.

CPP volunteers are selected by villagers and they usually comprise school teachers, social workers, and community leaders. These volunteers disseminate the warnings, assist people in the evacuation process, execute rescue operations, provide first aid, and help in distributing relief goods. Since CPP establishment in 1972, a total of 173 depressions have formed in the Bay of Bengal, 18 of which intensified into severe cyclonic storms. The CPP has faced all these events with determination and courage, and has gradually achieved great success in moving coastal people to shelters – thus saving their lives (CPP and BDRCS 2007).

Public Cyclone Centers: A program to construct cyclone shelters was initiated in Bangladesh in 1972 to save the lives of coastal and offshore island residents from cyclones and associated tidal surges. These shelters are multi-storied buildings, raised above ground-level to resist storm-surges, and they can accommodate between 500 and 2,500 people (Paul et al. 2002). Figure 3 illustrates a typical shelter. This shelter construction program was interrupted several times and only 3,976 cyclone shelters were built till the mid-1990s, in 15 coastal districts. Of these, 1,576 have been damaged by river erosion or abandoned due to dilapidated conditions resulting from the lack of proper maintenance and repair (Debnath 2007).

Clearly the number of shelters established in the cyclone-prone coastal districts is not enough to accommodate all people in these areas. Moreover, in some coastal zones these shelters are located at a distance of more than 3.5 miles (5 km) apart. Experts state that an additional 3,000 shelters are needed to provide adequate shelter for residents in coastal districts from the destruction wrought by major cyclonic events. Studies have shown that unless a cyclone shelter is within one mile (1.6 km) of residence, it may be too far for the coastal residents to travel at the time of emergencies (Amin 2007).

Killa: Raised earthen platforms called *Killas* have been constructed in the cyclone-prone areas to safeguard livestock from storm surges. The average size of a killa is 20 feet (6 m) high with dimensions of 152.3 feet x 91.3 feet (45.7 m x 27.4 m) for the bottom and 81.3 feet x 61.0 feet (24.4 m x 18.3 m) for the flat top. A killa can provide shelter to 300-400 livestock (Talukder et al. 1992). In some cases, the killa sites have been found inaccessible and undesirable. The maintenance of these facilities was very poor, and most of them are full of bushes and have become habitat for snakes and harmful insects.

Other Preparedness Programs

Coastal Embankment: Bangladesh is bordered on the south by the Bay of Bengal and is interlaced with a myriad of deltaic tidal channels. A vast area in the coastal region is low in elevation and subject to flooding from tidal action even under normal circumstances, and is always vulnerable to storm surges. Coastal embankment projects were initiated in Bangladesh in the 1960s to increase crop production by preventing intrusion of saline ocean water into crop

fields located near the coast (Choudhury et al. 2004). Later, after the benefit of embankments to reduce or prevent damage from cyclone and storm surges was demonstrated, the embankment/polder project was extended to cover all coastal regions. Unfortunately, because of poor maintenance, most of the sea-facing embankments are in very dilapidated condition with numerous cuts or portions partially or completely eroded.

Coastal Afforestation: After the 1966 cyclone, the government initiated an afforestation program along the coastal zone on newly accreted land, the riverine coastal belt, and abandoned embankments to create a green belt. Coastal forests not only provide protection residents and environment against tidal surges, but also act as a natural barrier to reduce wind velocities (GOB 2008). However, the program was not systematically implemented and vast areas have been cleared undermining the effectiveness of the forest barrier to storm surges.

Response to Hazard Warnings and Evacuation Orders: Conceptual Considerations

Existing literature on hazard warning response is very relevant in understanding decision-making processes and factors influencing compliance with evacuation mandates. This literature reveals that two separate considerations must be addressed prior to the development of messages intended to assist people in making informed decisions in the event of an emergency: the communication environment, as well as the design and content of messages appropriate to that environment. The development of an appropriate message depends on the communication environment within which messages occur. Specifically, content and stylistic features of a hazard warning message must be tailored to the elements of a person's communication environment. The message should confirm and personalize a threat so that potential disaster victims can take protective action (Mileti 1999).

The communication environment consists of affective, cognitive, cue-oriented, and cultural responses to an impending emergency. Appropriate emergency response to a cyclone requires a substantial amount of information (e.g., time of landfall, wind speed, height of surges, and duration of storm). Bandura's Social Cognitive Theory (SCT) provides a basis for understanding the personal and environmental factors that shape individual behavior toward an extreme natural event (Bandura 1986). In context of a cyclone, SCT's personal factors include how lay people cognitively represent the storm's severity and duration, their perceived susceptibility to harm, skills required to avert harm, their confidence in performing necessary actions, their goals at the time of the emergency, and their expectations of surviving the emergency.

In addition, questions representing SCT's environmental factors will likely provide an understanding of the knowledge, attitudes, and practices of family, friends, neighbors, co-workers, and others in a person's social network as they deal with the crisis (i.e., social environment) and the extent of information individuals possess about what to do, where to go, and what steps to take to avert harm. Such questions, taken together, should provide a basis for understanding differences in the cognitive representation of the storm and its effects among people who evacuate versus those who do not.

Finally, SCT presents a balanced and optimistic view of the human condition: people and their behaviors are shaped by their environments, and people also shape their environments through

their behavior and expectations. The social cognitive perspective on crisis management is that individual behavioral changes can be facilitated by modifying people's personal factors and by altering environmental factors to encourage more appropriate behavior with regard to future emergencies.

Since the emergency involved threats to life and property, perceived fear often poses problems for managing an emergency. Terror Management Theory (TMT) provides a mean of investigating people's response to evacuation orders (Pyszczynski et al. 1999). Feelings of fear induce prospective disaster victims to comply with the orders. Some individuals, on the other hand, reduce fear by denying their vulnerability to threat, distorting its immediacy, distracting themselves from it, derogating the source of information about it, and/or minimizing it (Pyszczynski et al. 2003). The specific defense mechanisms in which an individual will engage may depend on cognitive information s/he has about the emergency. If an individual judges the threat as real but does feel that the recommended response cannot be carried out effectively, the individual may feel that staying at home would be a better alternative.

In addition to SCT and TMT, several risk communication models, such as Sorensen and Mileti's (1987) General Risk Communication Model (GRCM) and Blanchard-Boehm and her colleagues' (2004) General Hazards Risk Communication Model (GHRCM), have focused on socio-economic, psychological, demographic, and geographic variables influencing public response to hazard warnings and evacuation. Other factors, such as education, occupation, and past experience with disaster also play a vital role in whether warnings are acted upon (Trainor et al. 2006).

Similar to SCT, risk communication models, in general, consider individual response to a hazard warning as a social process because people often involve interactions with groups in making decision to stay or not to stay at home (Blanchard-Boehm et al. 2004; Mileti and Peek 2000). After receiving a hazard warning, people typically go through a social psychological process to form personal assessments of the risks they face and accordingly take action. Mileti (1995) maintains that warning systems that are not designed to take the social psychology of public warning responses into account are less likely to foster pre-disaster public protection action. Believing or accepting a hazard warning message depends on many factors, such as source of the warning, message characteristics, and compatibility with the receiver's existing beliefs, and receiver characteristics.

Heuristic cues affect behavior. Heuristic cues refer to short-cuts in the decision-making process that can influence behavior (Chaiken 1987). For example, a person may fail to heed a warning because it was issued by an untrustworthy source, or because neighbors, friends, and/or relatives were not evacuating. The customs, values, and preferences of the audience also are likely to affect the behavior of people faced with a cyclone. Consequently, a profile of receiver characteristics is required to understand why someone might be likely to heed (or fail to heed) the hazard warning to evacuate (Sorenson and Mileti 1987). In such a profile, information is developed about the receiver's level of acculturation, immigrant status, socio-economic condition, racial/ethnic membership, gender, home/pet ownership, interpersonal and political trust, geographical location of the residents, and potential barriers to evacuation, such as lack of

transportation, and distance to shelter and conditions of shelter as perceived by the prospective evacuees (Witte 1995).

In a culturally homogeneous country like Bangladesh, some characteristics of hazard warning message receiver, such as immigrant or ethnic status, should not have any bearing in shaping evacuation decision making. Similarly, home ownership is not an important factor of decision-making because almost all residents of rural areas own a house. Rather, quality of the structure is important because brick-built houses can withstand cyclone impact more than thatched-roof houses. While pet ownership has been found to be an important factor in compliance with evacuation orders in the United States (e.g., Dow and Cutter 2000), animal ownership as a 'pet' is still an alien concept in rural areas of many developing countries. Cattle ownership, on the other hand, has been reported as having a strong influence on the evacuation decision-making process among coastal residents in Bangladesh (Haider et al. 1991; Haque 1995; Talukder et al. 1992).⁶

Research Design

The primary source of data was a questionnaire survey administered among Sidr victims of four severely impacted districts approximately three months after the cyclone. Field visits, and formal and informal discussions with participating emergency responders, local leaders, government officials, and NGO workers were also used to collect relevant information along with pertinent reports and documents published regarding Cyclone Sidr.

Study Area, Subjects, and Survey Instrument Selection

For conducting the questionnaire survey, 13 villages were chosen from four coastal districts: Bagerhat, Barguna, Patuakhali, and Pirojpur (Figure 4). Among the impacted districts, the Bangladesh government identified these four as the worst-affected districts (GOB 2008). Because of constraints in time and resources as well as road conditions which restricted access to all impacted areas, individual villages were selected on the basis of a purposive sampling procedure. It is important to mention that all the selected villages are located within the CPP command area, and all experienced storm surges.

In this study, an individual household was considered the primary sampling unit (PSU).⁷ A complete listing of all households in the selected villages was not available prior to administering the questionnaire survey. This situation compelled the use of a systematic sampling procedure to select respondents for the survey. Prior to survey administration, it was decided that the number of households to be selected from each village should be proportional to its size. Therefore, the sampling interval differs from one selected village to another. From each selected household, the household head was interviewed. A household head is defined as the person who makes the major economic, social, and household decisions, irrespective of this individual's age and gender.

As indicated, the information was collected through a pre-tested structured questionnaire administered by two interviewers. The questionnaire recorded, among other things, details regarding cyclone warning messages and evacuation orders, communication channels used to disseminate the messages and orders, household response, and other pertinent information.

Respondents' socio-economic and demographic characteristics and other relevant information were also collected through the questionnaire.

Data Analysis

Analysis of survey data was made using frequencies, percentages, and relevant descriptive statistics. In order to identify important determinants of respondent compliance with cyclone warning messages and evacuation orders, a total of nine independent variables were selected on the basis of existing literature and relevant theories discussed in the previous section. These variables are: level of education, occupation and age of the head of household, landholding size, annual household income, presence of children under five years and/or over 64 years of age in the household, cattle ownership, trust regarding cyclone warnings, and distance from respondent's home to nearest public cyclone shelter. Despite relevancy, several variables such as past cyclone experience, and conditions at the nearest cyclone shelter as perceived by the respondent were not included because such data either were not collected or collected only for the non-evacuee respondents. As noted, several other variables were deliberately excluded because of their irrelevancy in context of Bangladeshi culture. Pearson chi-square testing was used to determine the significance of association between respondent compliance status and selected variables.

Respondent Profile

Table 1, which presents socio-economic and demographic characteristics of the respondents by selected districts, shows that a total of 257 individuals functioning as household heads were successfully interviewed. This table further shows that nearly 70% of all respondents were landless. Although this figure is about 30% higher than the national proportion, the reported percentage truly represents the land ownership patterns in the coastal regions of Bangladesh. Slightly over one-fourth of all respondents owned small landholding size (up to 2.5 acres or 1.0 ha), and the remaining respondents owned between 2.5 and 7.49 acres (1.0 and 3.0 ha). Only two households owned more than 7.49 acres (3.0 ha) of land. These households were merged with the medium landholding size group (i.e., 2.5-7.49 acres or 1.0-3.0 ha) (Table 1).

Table 1 further shows that fishing was the primary occupation for 35% of all respondents, followed by farming (20%). Slightly over 13% respondents were engaged in business and the overwhelming majority of these businessmen were associated with the buying and selling of fish. The same is also true for the day laborers. Thus, nearly two-thirds of all respondents surveyed were employed, directly or indirectly, in fishing-related jobs -- not a surprising finding for people living in a coastal area. Other occupations reported by respondents were: others (14.40%) and service (5.45%). The first group primarily includes homemakers and retired persons.

Survey data indicate that the largest proportion of respondents (64.20%) belonged to the 30-45 years age group and with the exception of three, all respondents were married at the time of the field survey interview. With respect to respondent level of education, only slightly over 6% of all respondents had studied beyond the 10th grade. This low level of education and relatively high illiteracy rate (40%) among respondents surveyed is typical of coastal regions in Bangladesh. Table 1 indicates that only 23 (8.95%) of the 257 households were headed by a female member.

Three of these women were widowed and husbands of the remaining female respondents were away -- engaged in maritime fishing activities -- at the time of questionnaire interview. All respondents were asked to report their annual household income. About one-fourth of the respondents earned Taka (Tk.) 36,000 (US \$515), while only nearly 9% earned more than Tk. 72,000 (US \$1,030).

All the socio-economic characteristics of the respondents included in this study clearly indicate the existence of a higher level of poverty and a lower level of education in the coastal areas studied than the rest of Bangladesh. Thus, these coastal residents are more vulnerable to any natural disaster, particularly to cyclones, compared to people in other parts of the country. Although not statistically significant, respondents of the districts of Barguna and Patuakhali seem economically less affluent than respondents of the Bagerhat and Pirojpur districts.

Results

Dissemination of Cyclone Warnings and Evacuation Orders

The Bangladesh government started providing advance warnings five days before the landfall of Cyclone Sidr, and issued emergency evacuation orders and hoisted the highest danger signal almost 27 hours before Sidr reached the coast. In addition to warnings continuously broadcast via radio and television, government officials, local administrators, CPP volunteers, and some villagers themselves disseminated cyclone warning and evacuation orders via megaphones, handheld bullhorns, bicycle-mounted loudspeakers, and house-to-house contacts. They also advised people in coastal areas under evacuation orders to take refuge in cyclone shelters specifically built for them.

Contrary to the reports published in Dhaka-based daily newspapers immediately after occurrence of Sidr, not all people in the coastal areas were informed regarding the approach of Cyclone Sidr. The questionnaire survey reveals that 201 (78.20%) of the 257 respondents were aware of the cyclone warnings and evacuation orders prior to the landfall of Sidr. This is somewhat misleading. Twenty respondents from all selected districts were either fishing in the sea or estuary channels and they did not hear the warnings prior to the landfall of the cyclone. When their wives, who stayed at home, were asked whether they heard warnings, all of them answered affirmatively. This translates to about 86% households being aware of warnings prior to the landfall of Sidr. It was, however, difficult for those women whose husbands were fishing to make the decision to leave their homes for safer places.

When only the respondents who heard the warnings are considered, nearly 60% of them heard it two hours before the landfall, while the remaining respondents received the warnings at least three hours before the landfall. Ten respondents reported that they received the warnings at least 48 hours before the cyclone hit the coast. But some of the respondents who received the warnings claimed that the public authorities began issuance of evacuation orders about 24 hours before landfall of Cyclone Sidr. Nearly 41% respondents received such orders less than an hour prior to landfall.

It was revealed from conversations with respondents and key personnel that more respondents from the Bagerhat and Pirojpur districts received cyclone warnings compared with respondents from the Barguna and Patuakhali districts. Respondents of the former two districts also received warnings earlier than their counterparts live in the latter two districts. These findings are not surprising since Sidr made landfall adjacent to the southwestern border of the Bagerhat district and the Pirojpur district is a neighbor of the Bagerhat district. For this reason, cyclone warnings and evacuation orders were disseminated more widely and closer in time to landfall in the Bagerhat and Pirojpur districts relative to the Barguna and Patuakhali districts.

Analysis of survey data suggests that 73.13% of all interviewees who received cyclone warnings and evacuation orders cited the announcements made by the CCP volunteers as their source of storm-related information. Similar announcements were also made by local administrations in several of the study sites. Radio and television were the sources of information regarding Cyclone Sidr for 16.42% and 8.46% of all survey respondents, respectively. These two media sources were not used widely by respondents because most respondents did not own either a television or a radio. Nearly 20% of respondents surveyed received warnings from personal sources, such as friends, neighbors, relatives, local level government officials, and NGO workers.

As indicated, nearly 22% respondents did not hear cyclone warnings and evacuation orders. This suggests that there were lapses in cyclone warning and evacuation procedures. In some areas, agencies responsible for assuring dissemination of warning messages fell short of this important responsibility. For example, no warnings were issued or announced by CPP volunteers (or others) in one of the two selected study villages within the Patuakhali district. Most residents of this village are poor and had no radio and television. Despite a public cyclone shelter located in the center of this village (Char Khali), because of no warnings was issued, no one took refuge in this facility. Seventy four people of this village of 1,043 died from Cyclone Sidr. Early warnings could likely have been saved most of these lives.

It is, however, worth mentioning that several residents of the village in Patuakhali district and all of the respondents who were fishing in the sea suspected the occurrence of a cyclone, but never imagined the magnitude Sidr deployed. They suspected a cyclone might be eminent after observing that sky was becoming dark and wind was becoming more violent. They used these as environmental cues for impending danger. Two interviewees from the village in Patuakhali also claimed that prior to the storm, water of the adjacent river Buriswar receded. Three respondents who were at sea noted fishes were jumping above the water and catches were unexpectedly large. All these 'signs' are considered by coastal resident early warnings for impending cyclone.

Several respondents of the Barguna district claimed that they did not hear cyclone warnings and evacuation orders because they were not aligned with the direction of the wind. Sound produced by the megaphones and microphones used by CPP volunteers travels best downwind and in a direction parallel to the wind; those to the side or upwind had a lesser chance of hearing such warnings. Dilip Chandra Shill, a CPP volunteer from the Barguna district, reported that many megaphones and microphones were not used due to the loss of power and/or a lack of workable

batteries. It was not possible to buy such batteries because they are available only in larger cities and time and circumstances did not permit travel to such places. Alternatively, CPP volunteers used the battery-operated microphones available in some local mosques. Further, due to the lack of electricity, some CPP volunteers could not use sirens to caution coastal residents of the impending danger.

Non-issuance of cyclone warnings in the Patuakhali district and problems with disseminating warnings as reported in the Barguna district were not mentioned by any respondents or others in the Bagerhat or Pirojpur districts. This implies that the communication channels utilized by public agencies to disseminate cyclone warning messages were more effective in the latter two districts than the former two districts. This is also evident from the field survey results. Forty-one (73.21%) of the 56 respondents who did not hear cyclone warnings were from the Barguna and Patuakhali districts. This can also be expressed in another way. Thirty-four percent of all respondents from these two districts did not receive cyclone warnings and evacuation orders either from public or private sources, while the corresponding percentage is only 11 for the Bagerhat and Pirojpur districts.

Although not all coastal residents under the threat of Cyclone Sidr received early warnings and evacuation orders, dissemination of these alerts was more intensive compared to the last cyclone of similar magnitude that occurred in 1991 along the Chittagong coast. An empirical study conducted among respondents of the coast reported that about 60% heard a warning (Chowdhury et al. 1993). This implies that the early warning system worked reasonably well and definitely better than in 1991. However, there were some problems with the Sidr warning messages. No one knew exactly when or where the storm would hit, what the storm's estimated strength was, what surge heights to expect nor the approximate duration of the expected surge (also see Black 2008; Hossain et al. 2008).

Extent of Compliance with Evacuation Orders

Respondents were asked whether any member of their households sought shelter at any location other than their own homes after receiving evacuation orders. Thirty-three percent of all respondents answered this question affirmatively. This figure is somewhat consistent with government estimates for all coastal districts impacted by Sidr. The Bangladesh government reported that some 3.2 million (40%) of 8.0 million coastal residents evacuated their homes in advance of the storm's arrival (Robinson 2007). Although this cannot be considered as massive evacuation, more people were evacuated due to Sidr than the 1991 cyclone in which 30.5% of all respondent households were evacuated after receiving evacuation orders (Chowdhury et al. 1993).

Table 2 shows that of the places used as refuge, nearly 20% were public cyclone shelters, nearly 9% were a neighbor's house, and nearly 5% were public buildings, such as mosque, schools and colleges, and government office buildings (Figure 5). The remaining respondents did not take any deliberate emergency action after receiving evacuation orders, and stayed in their own residences. Among respondents who stayed at home, 51 family members of these respondents climbed a strong tree and tied themselves to it. They used blankets and clothes to protect

themselves, particularly their faces, from flying debris. Most of these respondents were from the Barguna district and all of them were adult males. Similar strategies were also practiced during the 1991 cyclone (Haque 1995; Ikeda 1995).

Table 2 further shows that the proportion of respondents who stayed in their own homes differs remarkably by study sites. As many as 85% of all respondents in the Pirojpur district remained in their homes. The corresponding figure is slightly over 37% of all respondents in the Bagerhat district. This is surprising finding since the Pirojpur district is closer to the Cyclone Sidr landfall location than either the Barguna or Patuakhali sites. About half of the all non-evacuee respondents of the Pirojpur sites mentioned that cyclone shelters are located too far from their respective neighborhoods. In these study sites, public shelters are located on average 5 miles (7.5 km) apart.

The questionnaire survey reveals that 27.33% of all respondents who did not comply with evacuation orders stated that the lack of a shelter in their locality did not allow them to evacuate their homes. Nearly 17% respondents rushed to shelters, but had to return back to their homes because many of these facilities were already full and/or overcrowded. Another 20% indicated that the distance from their homes to the nearest cyclone shelter was the main reason for their non-evacuation. These findings clearly suggest that the number of shelters available was inadequate to accommodate all coastal residents.

Studies (e.g., Ikeda 1995; Karim 2008) have shown that unless a cyclone shelter is within one mile (1.6 km) of a house, it may be considered too distant, a reflection of the fact that people postpone their withdrawal to shelter to the eleventh hour. Six villagers from one of the study sites in the Pirojpur district stated that they decided to take refuge in the nearest public shelter after water entered in their courtyard. Unfortunately, they could not reach the shelter because of high winds, rushing water, and the torrential rain. Nearly 12% of all non-evacuee respondents did not use the nearest public shelters because they suspected that these facilities would not withstand the impending cyclone. Several of these respondents also noted that roads to some of these shelters were not elevated enough and were covered with water early on. While some adults did manage to swim to shelters, for the elderly, children, and handicapped, this presented a formidable, if not impossible, obstacle.

Conversations with non-evacuee respondents also revealed that many attributes of existing cyclone shelters discouraged them from using these facilities. These attributes include: the lack of latrines, no provision of drinking water or a separate room for women, crowding, and darkness. One respondent in the Barguna district complained that the lone cyclone shelter in his village had been used as a place of defecation and as cowshed. Another respondent from the Bagerhat district reported that cyclone shelters constructed in their locality by NGOs might not be high enough to withstand up to 20 feet (6 m) high surge.

Twenty four non-evacuee respondents (13.95%) did not comply with evacuation orders either because of issuance of evacuation orders long before the storm's landfall or because of incompleteness in the content of warning messages. On mid-day of November 14, 2007, people were evacuated to the cyclone shelters, particularly from study sites in the Bagerhat district, with the anticipation that would make landfall by noon. When the people who took shelter saw that the cyclone had still not come, they thought that it would not materialize and left the shelter for

their homes(also see Hossain et al. 2008). Sidr made landfall the following day around 10:30 pm. The BMD came under heavy criticism for having forecasted the fall of Cyclone Sidr so prematurely.

As noted, hazard literature duly acknowledges that the probability of risk comprehension tends to increase, among other things, on content of warning messages as well as whether messages are delivered by credible and multiple sources (Turner et al. 1979). Instead of using multiple sources, the Bangladesh government has made a deliberate attempt to disseminate cyclone warnings primarily through CPP volunteers. Languages used by the CPP volunteers to provide warnings were understood by the coastal residents, but the message was incomplete in the sense that it did not include specific information regarding wind speed and wind direction, possible surge height, and the extent of damage expected. Several respondents knew the cyclone was predicted, but simply hoped it would not hit their area. This perspective is illustrated by the following quote: “I never had too much worries about it because I just thought it was going to go westward to hit Indian coast, wishful thinking I guess.”

However, three respondents from the Pirojpur district reported that the CPP volunteers requested through megaphones for residents to seek safer shelter. But did not specify what or where that might be. Another respondent from the Barguna district mentioned that he wish he had known how Sidr would compare to other storms in a way that was meaningful to him rather than based on signal numbers he and others only vaguely understand. Despite these shortcomings, it appears that coastal residents followed and understood the weather bulletins, which were not broadcast in the local dialect. Of course, those who listened to these bulletins have a radio and/or a television, and thus belong to a relatively high socio-economic class and are accustomed to the standard Bengali dialect used in radio and television broadcasts.

Of the respondents who did not take refuge, nearly 19% said that they did not believe the cyclone warnings because of a false tsunami warning issued two months before Sidr. On September 13, 2007, a 7.8 magnitude earthquake off the coast of Sumatra prompted Indonesian authorities to issue a tsunami warning, which it later withdrew. In Bangladesh, however, the warning remained in force, and more than a million coastal residents were evacuated to safer places (Heath 2007). Further investigation showed that nearly 20% of all non-evacuees did not believe this warning either because of their fatalistic attitudes or because the number 10 warning (which means “great danger”) had been issued on several occasions prior to this event, with no cyclone occurring.

Nearly 15% non-evacuee respondents had no past experience with a cyclone and therefore they did not evacuate to a safer place. Another 15% stated that they stayed homes because they feared that thieves might ransack their belongings from their empty homes. Twenty (11.63%) non-evacuee respondents claimed they were confident that their houses would withstand the cyclone and storm surges, and for this reason they remained at home. Moreover, they allowed neighbors to take shelter in their homes. Finally, 10% of all non-evacuee respondents, the majority of whom were from the Barguna district, reported that embankments constructed along estuary rivers to protect people from storm surges provided a false sense of security. With the hope that these embankments would protect them from such an extreme event, these respondents did not evacuate.

It is evident from the field survey that no respondent moved further north, to the inland, to escape the potential destruction of Cyclone Sidr and associated storm surges. Given that only 33% of the all respondents complied with the evacuation orders, evacuation efforts of the government should not be considered a success. However, as mentioned, the government's emergency response was better compared to its efforts taken in the 1991 cyclone.

Factors Associated with Evacuation Order Compliance

As noted, nine factors were selected as determinants of compliance with evacuation orders. These factors are listed in Table 3 by evacuation status of the respondents; this status is dichotomized as evacuated and not evacuated. All respondents who took refuge in public shelters and other safer places noted earlier are treated as evacuees. Others are considered non-evacuees.

Table 3 shows that of the four socio-economic factors considered in this study, only two of them (annual household income and occupation) have statistically significant influence on decision to stay or leave homes for safer shelter. It is interesting to note that the evacuation rate (14%) was the lowest among households belonged to highest income category. This implies that relatively wealthy residents of Sidr-impacted areas did not take refuge in public cyclone shelters in large numbers, because their houses are structurally much stronger than houses of households belonging to low and medium income groups. The field survey reveals that households of highest income (Tk. >60,000) category not only felt that their houses could withstand the cyclone, but also allowed their structurally strong homes to provide safe shelters for their neighbors, friends, and relatives.

Table 3 further shows that nearly 27% of all respondents who are farmers, fishermen, or day laborers left their homes for safer shelters. The percentage for respondents of other occupations is nearly 46% and the calculated chi-square value is statistically significant. A careful review of the field data reveals that respondents who are employed in business and work in service sectors are more educated compared to other respondents, and have access to more information because of their interactions with people of different professions. This might be associated with higher evacuation rate among businessmen, service holders, and others relative to farmers, fishermen, and day laborers.

None of the two demographic factors (age, and percentage of children under 5 and people over age 64) considered in this study appear as a significant determinant of compliance with evacuation orders. As expected, cattle ownership is inversely associated with evacuation rate. The rate is nearly 27% for respondents who owned one or more head of livestock before the landfall of Cyclone Sidr as opposed to 40% for those who did not own any livestock (Table 3). This difference is statistically significant. Households owning cattle, in general, were reluctant to evacuate to a cyclone shelter, at least before putting their cattle in a safe place. Since public shelters and killas are not located at the same compound, people find it disadvantageous and time-consuming to keep livestock in one place and move to another place for their own protection. Moreover, respondents do not consider the open-air killa as a safe shelter for cattle during cyclones.

It is evident from Table 3 that slightly over 56% of all respondents lived within a mile distance from the nearest public cyclone shelter. The evacuation rate was slightly over 52% for these respondents, while the corresponding rate was only 8% for those respondents who lived more than one mile from the nearest cyclone shelter. This difference in evacuation rates between evacuees and non-evacuees is highly significant statistically. This empirical evidence supports the findings of previous studies (e.g., Amin 2007; Karim 2008) that unless a cyclone center is within one mile (1.6 km) of residence, it may be too far for coastal residents to travel to in times of emergency. The questionnaire survey shows that almost all respondents who complied with evacuation orders went to safer shelters on foot. Given the fact that majority of the respondents generally evacuate at the eleventh hours, traveling more than one mile in adverse weather conditions is extremely difficult.

As noted, opinions regarding many aspects of the cyclone warning messages were not collected from all respondents. These aspects include: whether or not warning was issued in a timely manner, and completeness and wording of the warning message. However, all respondents were asked about warning message credibility. In this context, only 94 (36.58%) of the 257 respondents reported that they trusted the warning. Some of these respondents reported initial skepticism about the warning message, but ultimately believed the storm was coming. Environmental and other cues, such as formation of unusually dark clouds in the north-eastern sky, constant change of wind direction, high humidity, loud barking of dogs, movement of ants and rats, and flying of birds from south to north, made them believe that a cyclone was imminent. However, the remaining 63.42% respondents did not trust the message for the reasons noted earlier.

Table 3 shows that evacuation rate was much higher among respondents who trusted the warning message compared to those who did not. This difference is highly statistically significant. The results of chi-square tests provided in Table 3 clearly show that trust on warning message was the most important determinant in the decision by respondents to take refuge in safer shelters. Among all nine factors analyzed, it has the most significant chi-square value, followed by distance to shelter, income, occupation, and cattle ownership, respectively. Thus the warning/evacuation message, shelter attributes, and personal characteristics appear as significant determinants of the decision to evacuate by respondents prior to landfall of Cyclone Sidr. This implies that several aspects of existing theories developed based on the experience of disaster victims in developed countries discussed previously, are equally applicable in the context of Sidr survivors in coastal Bangladesh.

Katrina and Sidr: A Comparison of Warnings and Evacuation Mandates

One of the worst natural disasters to impact the United States was Hurricane Katrina, which first struck the low-lying delta area along the southeast Louisiana coast as a Category 3 storm on Sunday August 28, 2005. Increasing in intensity, in the early morning hours of August 29, the eye of Hurricane Katrina passed over the city of New Orleans. Katrina was the eleventh named storm, the fifth hurricane, and only the second Category 5 hurricane of the 2005 Atlantic hurricane season. This hurricane was associated with a storm surge of waters 15 to 20 feet (4.6 to

6.1 meters) high along the coastlines of Louisiana, Mississippi, and Alabama. Katrina destroyed or damaged roughly 300,000 homes, causing the displacement of approximately one million Gulf Coast residents. It caused over 1,836 deaths. This event is estimated to be responsible for over \$115 billion in damage, making it the costliest natural disaster ever hit in the United States (Elliot and Pais 2006).

In the context of public emergency response, there were differences as well as similarities between Hurricane Katrina and Cyclone Sidr. In contrast to Cyclone Sidr, all Katrina victims had knowledge of the impending hurricane. To some degree this supports the notion that advance warnings were issued in a timely manner (Trainor et al. 2006). This is, however, not true in the case of issuance of evacuation orders. For example, state and city leaders in New Orleans were admittedly late in issuing evacuation orders. Similarly, emergency response officials in Mississippi only issued mandatory evacuation orders when Katrina was just hours away from landfall. Further, there was no contingency planning for evacuation of residents in the affected areas. There was also inadequate communication between federal and state officials and within the federal government itself. The response of the state government and city officials was also less than adequate. In contrast, coordination was effective and adequate among government agencies and NGOs involved in providing warning and evacuation orders before the landfall of Cyclone Sidr.

Plans to evacuate residents of New Orleans before the city flooded, and to rescue them after, were incomplete and inefficient. Most of the individuals who were trapped in New Orleans could not leave because they had no money, no means of transport, and nowhere to go. Nearly 33% of New Orleans residents did not own a car, yet the official emergency plan called for people to evacuate by car. Even if they had a car, many individuals, particularly single mother-headed households, were unable to manage the logistics of leaving (including lacking money for gas or hotel rooms if they did leave). Notably, Hurricane Katrina hit at the end of the month, when paychecks were already spent. Some did try to leave, but were turned back – the roads blocked with traffic (Butterbaugh 2005).

Despite shortcomings, available studies (Harrington et al. 2006; Travis 2005) suggest that 80% people from Katrina impacted areas were evacuated before its landfall. This starkly contrasts with the 40% evacuation rate in Sidr impacted areas. Unlike the case of Cyclone Sidr, poverty and race played substantial roles before, during, and in the aftermath of Hurricane Katrina (Elliott and Pais 2006; Lavelle and Feagin 2006). Beyond the inadequate emergency response, Katrina has highlighted the continuing significance of class and race in America. For many Katrina survivors, issues of race and class were central to their evacuation experiences. The rate of evacuation was nearly 20% higher among Caucasians compared to African-Americans. Almost 90% of all evacuees that took shelter at both evacuation sites in New Orleans and Houston were African Americans. In obvious contrast, law enforcement, support, and volunteer staff were predominantly white. Some evacuees reported feelings of discrimination throughout their evacuation and shelter experience (Barnshaw 2005).

In their desperation, some survivors of Katrina started looting supermarkets and grocery stores throughout New Orleans to obtain food, water, ice, and other necessities. And, as to be expected, criminals among them started looting electronic shops, and departmental and jewelry stores. Reports of murders, carjacking, thefts, and rapes flooded the news. National Guard and federal troops were mobilized and sent to Louisiana along with a number of local law enforcement

agents from across the country. As a consequence, some of the focus of the post-hurricane effort shifted from relief and rescue to maintaining law and order. Unfortunately, not enough law enforcement agents were available in New Orleans to maintain civil order, particularly before September 4, 2005. All, or at least most of these events could have easily been avoided if survivors had promptly been supplied with food, water, and other essential items. A similar situation did not emerge in coastal Bangladesh after the landfall of Cyclone Sidr.

Both events, however, share some similarities in the sense that in both, domestic and foreign military forces participated in post-disaster emergency efforts, and numerous NGOs, both domestic and international, provided emergency supplies to the disaster victims. While emergency response of the Bangladesh government was praised by donor nations, international agencies, and the mass media (Black 2008; Heath 2007), it is widely believed that response to Hurricane Katrina was slow and inadequate. Newspapers in the United States and abroad have accused the U.S. government for failing to take the crisis seriously enough to avoid preventable chaos and suffering. A report prepared by an 11-member all Republican, Congressional panel also acknowledges leadership failures before, during, and after Katrina struck the Gulf Coast. In the words of Jenson (2005, 195): “Federal, state, and local government responses in the initial hours and days following Katrina were characterized by disorder, chaos, and ineffective coordination.” .

Conclusion

This study has examined the Cyclone Sidr warning dissemination process and assessed coastal residents’ response to warning and evacuation orders issued before the landfall of the cyclone. Despite sincerity and concerted efforts by Bangladesh government, there were lapses in cyclone warning and evacuation procedures, and much more could be done in order better prepare coastal residents. In some areas, such as one study site in Patuakhali district, public agencies responsible for assuring safe, timely warnings and evacuation fell short of these important responsibilities. Moreover, cyclone warning dissemination suffered from the simple lack of serviceable microphone batteries and sirens did not work in several places due to the loss of electricity. Warning messages were also incomplete. Trust in these warnings, which appeared as the most influential determinant of respondent compliance with evacuation orders, is not widespread. Public authorities should consider these points when planning to improve the existing cyclone warning system for future events.

This study clearly shows that the lack of nearby safer refuge -- reflected by distance to the nearest cyclone center -- inhibited coastal residents from properly responding to evacuation orders. It is therefore necessary to increase the number of shelters in cyclone risk areas of Bangladesh. These new shelters should be constructed within one mile of every village in the coastal zone and should be constructed near elevated roads to provide maximum accessibility. A denser network of smaller public shelters would be preferable to less numerous larger shelters, because such a network would reduce the house-to-shelter distance, allowing not only greater

utilization, but also better protection of property. There is also a need for upgrading existing shelters. In both cases, the responsible authorities should seriously consider the attributes of shelters which coastal residents desire, such as separate floor space for males and females, and adequate light.

Locating killas and public cyclone shelters in separate places appeared to be a barrier for a decision in favor of evacuation for residents who own cattle. This study also indicates that access to information may differ by occupation and economic class. To make all coastal residents more aware of the severity of the cyclone hazard and of precautionary options available, an educational campaign need to be implemented and cyclone mitigation policies should be integrated with national development plans and programs.

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Notes

1. The word 'Sidr' refers to 'hole' or 'eye' in Sinhalese language. In Arabic, it is a name of a tree found in Oman belonging to the genus *Ziziphus*
2. A district is the second largest administrative unit in Bangladesh, with an average population of two million.
3. Comprising about 2,316 square miles (6,000 square km), the Sundarbans is the world's largest mangrove forest. It covers southwestern Bangladesh and southeastern coasts of West Bengal, India. Two-thirds of this forest lies within Bangladesh. Experts believe that re-growth of the damaged portion of the Sunderbans will take more than two decades.
4. The SWC receives US NOAA (National Oceanic and Atmospheric Administration) data and satellite imagery via an earth station in Chittagong, and the Japanese satellite GMS-4 via the Bangladesh Space Research and Remote Sensing Organization (SPARRSO). The World Meteorological Organization network also provides data to the BMD.
5. An Upazilla is the lowest administrative unit in Bangladesh and it is comprised of several Unions.

6. It is worth mentioning that killas are not located near public cyclone shelters. This acts as barrier for compliance with evacuation orders for residents who own cattle.
7. A household is a group of people in a dwelling unit living together as a family and sharing the same kitchen. A complete listing of all households in the selected villages was not available prior to

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Table 1. Selected Characteristics of the Respondents (N=257)

Characteristic	Number	Percentage
Landholding Size		
Landless	176	68.48
Small	66	25.68
Medium	15	5.84
Occupation		
Fishing	90	35.46
Farming	50	19.46
Business	34	13.22
Service	14	5.45
Day Laborer	32	12.45
Others	37	14.40

Education (years of schooling)		
Illiterate	103	40.67
1-5	77	29.96
6-10	61	23.74
>10	16	6.23
Income (in Takas)		
<Tk. 36,000	68	26.46
Tk. 36,000-60,000	139	54.09
Tk. 60,001-72,000	27	10.50
>Tk. 72,000	5	8.95
Age (in years)		
<30	14	5.45
30-45	165	64.20
46-64	50	19.46
>64	28	10.90
Gender		
Male	234	91.05
Female	23	8.95

Table 2. Respondent response to cyclone warning and evacuation orders (n=257)

Study Site	Stayed Home Number (%)	Went to Neighbor's House Number (%)	Went to Cyclone Shelter Number (%)	Went to School/Public Building Number (%)	Total Number (%)
Bagerhat	29 (37.18)	5 (6.41)	40 (51.28)	4 (5.13)	78 (100.00)
Pirojpur	50 (84.75)	7 (11.86)	2 (3.39)	-	59 (100.00)
Patuakhali	20 (74.07)	-	2 (7.41)	5 (18.52)	27 (100.00)
Barguna	73 (78.49)	10 (10.75)	7 (7.53)	3 (3.23)	93 (100.00)
TOTAL	172 (66.93)	22 (8.56)	51 (19.84)	12 (4.67)	257 (100.00)

Table 3. Respondent evacuation status by selected factors

Factor	Yes (%)	Sought Shelter		Total (%)
		Yes (%)	No (%)	
Land Ownership Status				
Land Owned	30 (37.04)	51 (62.96)	81 (100.00)	
Do not Own land	55 (31.25)	121 (68.75)	176 (100.00)	
Chi-square=0.839 (d.f.=1)				
Annual Household Income (in Taka)				
<Tk. 36,000	23 (33.82)	45 (66.18)	68 (100.00)	
Tk. 36,000-60,000	55 (39.57)	84 (60.43)	139 (100.00)	
>Tk. 60,000	7 (14.00)	43 (86.00)	50 (100.00)	
Chi-square=10.892 (d.f.=2)**				
Years of Education				
0	30 (29.13)	73 (70.87)	103 (100.00)	
1-5	24 (31.17)	53 (68.83)	77 (100.00)	
>5	31 (40.26)	46 (59.74)	77 (100.00)	

Chi-square=2.647 (d.f.=2)

Occupation

Farming, Fishing, and Day Labor	46 (26.74)	126 (73.26)	172 (100.00)
Others	39 945.88)	46 (54.12)	85 (100.00)

Chi-square=9.419 (d.f.=1)**

Age (Years)

45 and less	55 (30.73)	124 (69.27)	179 (100.00)
>45	30 938.46)	48 (61.54)	78 (100.00)

Chi-square=1.469 (d.f.=1)

Population

<5 and >64 Years of Age	35 (31.53)	76 (68.47)	111 (100.00)
Other Age Groups	50 (34.25)	96 (65.75)	146 (100.00)

Chi-square=0.0210 (d.f.=1)

Cattle Ownership

Owned Cattle	35 (26.52)	97 (73.48)	132 (100.00)
Do Not Own Cattle	50 (40.00)	75 (60.00)	125 (100.00)

Chi-square=5.277 (d.f.=1)*

Distance to Shelter (in miles)

One or Less	76 (52.41)	69 (47.59)	145 (100.00)
>1	9 (8.04)	103 (91.96)	112 (43.58)

Chi-square=73.790 (d.f.=1)**

Trust on Warning

Yes	69 (73.40)	25 (26.60)	94 (100.00)
No/Others	16 (9.82)	147 (90.18)	163 (100.00)

Chi-square=108.9040 (d.f.=1)**

Figure Caption:

Figure 1. Path of Cyclone Sidr.

Figure 2. The Storm Warning Center's (SWC) Warning Dissemination to at Risk Population.

Figure 3. A Multi-purpose Cyclone Shelter, Bagerhat (Photograph by Munshi Khaled).

Figure 4. The Study Area.

Figure 5. A College in Bagerhat used as a Cyclone Shelter (Photograph by Munshi Khaled).

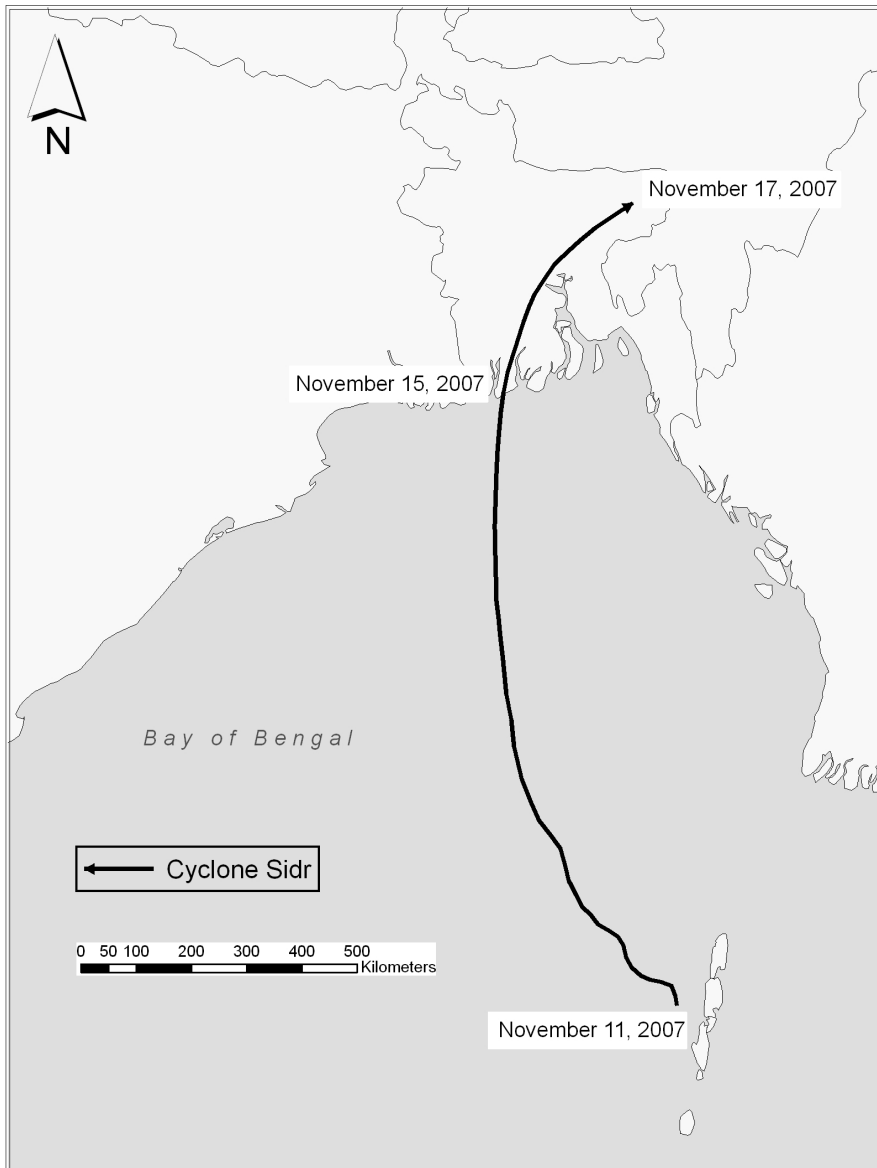


Figure 1.

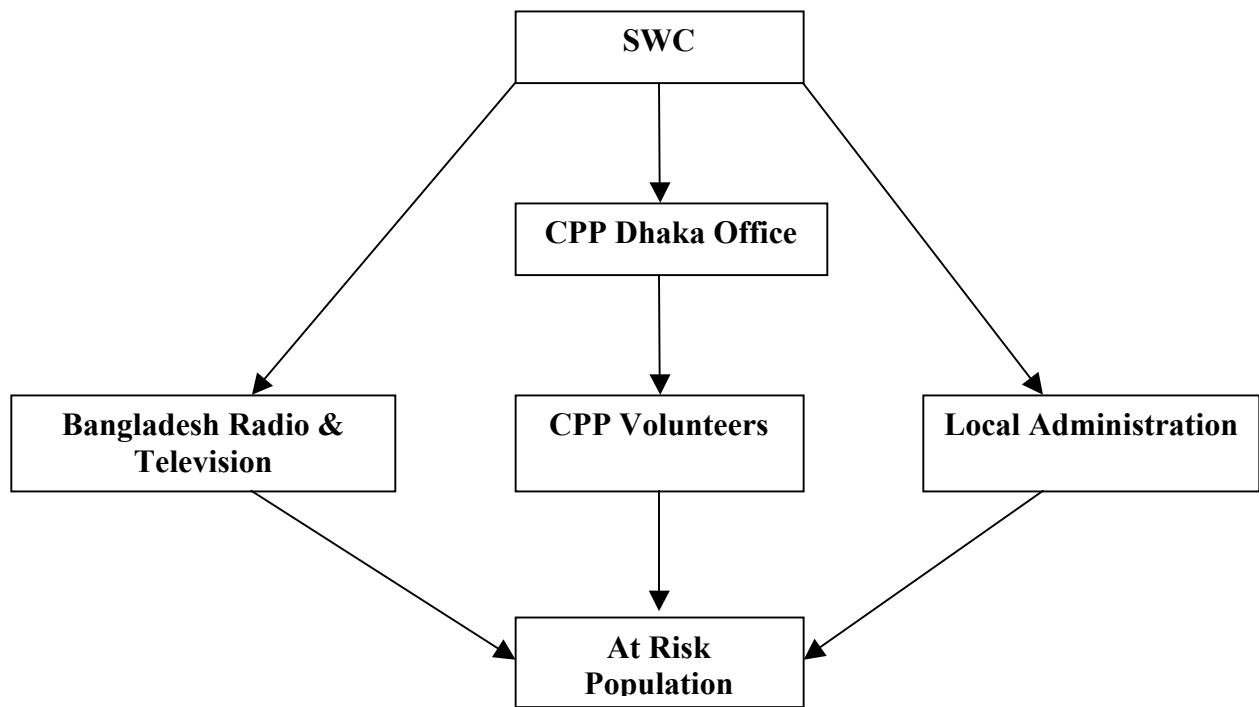


Figure 2.



Figure 3.

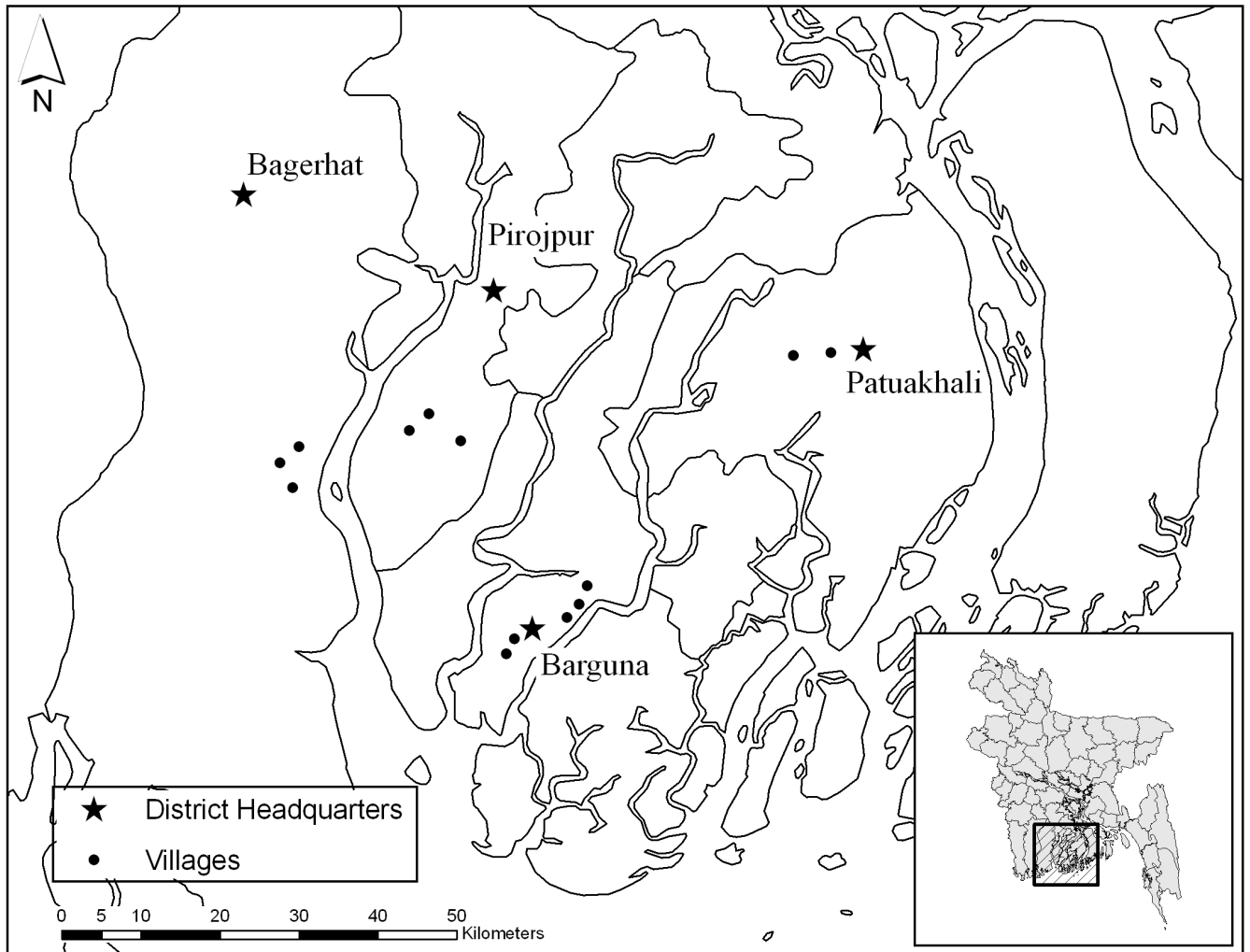


Figure 4



Figure 5.