Department of Civil and Environmental Engineering (CEE)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

IMPACTS ASSESSMENT AND INTERVENTIONS TO OVERCOME THE FREQUENT NATURAL CALAMITIES: A CASE STUDY OF SATKHIRA DISTRICT IN THE SOUTHERN PART OF BANGLADESH

BY

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A thesis submitted to the Department of Civil and Environmental Engineering (CEE) in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering

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CANDIDIATES 'DECLARATION

We hereby declare that the work in this thesis is our own except for quotations and summaries, which have been duly acknowledged.

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ABSTRACT

Today, approximately 3 billion people, about half of the world's populations live within 200 kilometers of a coastline. By 2025, this figure is likely to double. Up to 50 percent of the population in Bangladesh lives in coastal areas. Bangladesh is one of the most vulnerable countries often faced with natural calamity. The country is under serious threat as a result of climate change and the impact will be particularly felt in the coastal areas of Bangladesh. The people living in coastal areas are not only facing the burden of coastal flooding but also safe drinking water crisis because of salt intrusions. Every year people are migrating from coastal to urban areas because of environmental degradation in the form of frequent flooding, cyclones and storms, which makes their lives miserable. The southern part of Bangladesh faced an immense damage due to the destructive force of natural calamities. Communications were severely disrupted, water was contaminated by debris, many sources were inundated with saline water from tidal surges, eco-system and biodiversity severely affected, number of the landless poor farmers increased. The geophysical, environmental and economic impacts on Satkhira as a case study area which is situated in the southern part of Bangladesh will be assessed and intervention strategies will be recommended to overcome the intensity of natural calamities.

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ABBREVIATION

BBS	Bangladesh Bureau of Statistics
DFID	Development for International Development, UK
DPHE	Department of Public Health Engineering
ENSO	El-Nino-Southern Oscillation
FGD	Focus Group Discussion
GoB	Government of Bangladesh
IPCC	International Panel for Climate Change
LGED	Local Government Engineering Department
NGOs	Non-Governmental Organization
SoE	State of Environment
SPARRSO	Space Research and Remote Sensing Organization (Bangladesh)
IFRC	International Federation of Red Cross and Red Crescent Societies
DMB	Disaster Management Bureau
FDMM	Food and Disaster Management Ministry

CHAPTER 1
INTRODUCTION

1.1 Background

Bangladesh is a coastal country. Southern part of Bangladesh has the largest sea beach in the world. Hence Bangladesh is most vulnerable to natural calamities. This makes the life of the people of southern part miserable. The major disasters are the occurrence of flood, cyclone, storm surge, flash flood, drought, tornedo, riverbank erosion and landslide. These are the extreme events which adversely affect the coastal community each and every year threatens their livelihood. The geographical setup of Bangladesh is the main reason which makes it more vulnerable to natural disasters. The mountains and hills bordering northern and eastern part of the country, along with the funnel shaped Bay of Bengal in the south, have made the country a meeting place of life-giving monsoon rains, but also make it subjected to the catastrophic ravages of natural disasters. Its physiography and river morphology also contribute to recurring disasters. Abnormal rainfall and earthquakes in the adjacent Himalayan range add to the disaster situation. Effects of El-Nino-Southern Oscillation (ENSO) and the apprehended climatic change have a great impact on the overall future disaster scenarios.

Today, approximately 3 billion people, about half of the world's populations live within 200 kilometers of a coastline. By 2025, this figure is likely to double. Up to 50 percent of the population in Bangladesh lives in coastal areas. The country is under serious threat as a result of Climate change and the impact will be particularly felt in the coastal areas of Bangladesh. The people living in coastal areas are not only facing the burden of coastal flooding but also safe drinking water crisis because of salt intrusions. Every year people are migrating from coastal to urban areas because of environmental degradation in the form of frequent flooding, cyclones and storms, which makes their lives miserable. The southern part of Bangladesh faced an immense damage due to the destructive force of Cyclone Sidr in 2007. During Sidr 8.9 million people particularly from Bagerhat, Satkhira, Barguna, Patuakhali and Pirojpur districts were affected. In fact 3.363 people died, 55,282 were injured and 871 people were missing and over 5, 50,000 houses were fully damaged. Communications were severely disrupted, water was contaminated by

debris, many sources were inundated with saline water from tidal surges due to damage of 1.875 km long embankments, eco-system and biodiversity severely affected, number of the landless poor farmers increased.

1.2 Objective:

The objective of this research is to:

1. To look at the existing geophysical, environmental and economic conditions in the south-western part of Bangladesh.
2. Obtain the data from various frequent natural calamities and impact analysis.
3. Identify the most vulnerable areas in terms of frequent natural calamities and generation of a vulnerable map.
4. Identify necessary interventions to overcome the frequent natural calamity.
5. Prepare adequate policies as part of disaster mitigation plan.

1.3 Rationale of the Study

The rationale of the study is to increase understanding of the wider geophysical, environmental and economic conditions in the South –Western part of Bangladesh. The study focuses primarily on history of various frequent natural calamities of Bangladesh. The impacts of these disasters are analyzed. However, the study recognized the most vulnerable areas in terms of frequent natural calamities and vulnerable maps are created. Interventions necessary to overcome these frequent calamities and adequate policies as part of disaster mitigation plan are prepared to make the study effective one.

1.4 Limitations of the Study

The disaster prone areas in Bangladesh are too large to cover and it involves financial support. It will take years to collect data from all the vulnerable places which might have made the study more accurate and specific. The limitations are followings:

1. Due to the lack of time the study has been carried out from only at one place.
2. The case study area is far from the capital. So travel time consume a lot of valuable time.
3. People of the study area mostly are illiterate. Though they were very helpful they only gave an approximate data. They do not know the exact figure.
4. The Meteorological Department has detailed data related to this study. But they are too expensive to reach.

1.5 Organization of Thesis

Apart from this chapter, the remainder of the thesis consists of six chapters and an appendix.

Chapter 2 reviews the concepts of climate change and natural calamity in the context of Bangladesh.

Chapter 3 describes the methodology including collection and validation of relevant data.

Chapter 4 describes the study area with findings and observations in the context of natural disasters.

Chapter 5 describes the mitigation measures and interventions with respect to hard and soft components.

Chapter 6 focuses on the final outcome of the research in the form conclusions and recommendations.

Appendix gives the questionnaires prepared for the field survey, checklist of FGD, key issues for interview and findings of sample survey.

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CHAPTER 2

A LITERATURE REVIEW ON CLIMATE CHANGE, NATURAL CALAMITY

2.1 History and Perception of Climate Change

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions, or in the distribution of weather around the average conditions (i.e. more or fewer extreme weather events). According to IPCC (International Panel for Climate Change), Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and that persists for extended periods, typically decades or longer. Climate change is caused by factors that include oceanic processes (such as oceanic circulation), variations in solar radiation received by Earth, plate tectonics and volcanic eruptions, and human-induced alterations of the natural world; these latter effects are currently causing global warming, and "climate change" is often used to describe human-specific impacts. On the broadest scale, the rate at which energy is received from the sun and the rate at which it is lost to space determine the equilibrium temperature and climate of Earth. This energy is distributed around the globe by winds, ocean currents, and other mechanisms to affect the climates of different regions.

Factors that can shape climate are called climate forcing or "forcing mechanisms". These include processes such as variations in solar radiation, variations in the Earth's orbit, mountain-building and continental drift, clouds and changes in greenhouse gas concentrations. There are a variety of climate change feedbacks that can either amplify or diminish the initial forcing. Some parts of the climate system, such as the oceans and ice caps, respond slowly in reaction to climate forcing, while others respond more quickly.

Forcing mechanisms can be either "internal" or "external". Internal forcing mechanisms are natural processes within the climate system itself (e.g., the thermohaline circulation). External forcing mechanisms can be either natural (e.g., changes in solar output) or anthropogenic (e.g., increased emissions of greenhouse gases).

Whether the initial forcing mechanism is internal or external, the response of the climate system might be fast (e.g., a sudden cooling due to airborne volcanic ash reflecting sunlight), slow (e.g. thermal expansion of warming ocean water), or a combination (e.g., sudden loss of albedo in the arctic ocean as sea ice melts, followed by more gradual thermal expansion of the water). Therefore, the climate system can respond abruptly, but the full response to forcing mechanisms might not be fully developed for centuries or even longer.

IPCC (2007) predicted that in future, over most land areas, the frequency of warm spells or heat waves would very likely increase. Other likely changes are listed below:

- Increased areas will be affected by drought.
- There will be increased intense tropical cyclone activity.
- There will be increased incidences of extreme high sea level (excluding tsunamis).
- There will be extreme evaporation due to warmer oceans leading to increased precipitation.
- In Polar Regions, there will be reductions in glacier extent and the thickness of glaciers.
- Mountain areas in Europe will face glacier retreat.
- In Latin America, changes in precipitation patters and disappearance of glaciers are significantly affect water availability for human consumption, agriculture and energy production.
- Sea level is expected to rise by 18 to 59 cm by 2090-99

For Asia fresh water availability projected to decrease in central, south, east and south-east Asia by 2050; coastal areas will be at risk due to increased flooding; death rate from diseases associated with floods and droughts expected to rise in some regions.

2.2 Impact of Climate Change in Bangladesh

The impact of climate change in Bangladesh will include: rising of average weather temperatures; more extreme hot and cold spells; rainfall being less when it is most needed

for agriculture, yet more in the monsoon when it already causes floods; flash floods due to melting of glaciers in the Himalayan.

Temperature

According to IPCC (2007) Fourth Assessment Report, Asia is likely to get warmer by this century and warming in South Asia is likely to be above the global average at around 3.3ºC (Christensen, 2007). It has also been predicted all seasons to get warmer within the Ganges-Brahmaputra-Megna Basins, with an increase in extreme temperatures. Temperatures are expected to get warmer slightly slowly in Bangladesh than for other areas in the Ganges-Brahmaputra-Megna basin which is estimated to be 1.2ºC warmer by the 2020s and up to 2.4ºC by the 2050s. But warming is still predicted to be significant from 0.9 ºC to 1ºC by the 2020s and 1.6ºC to 2ºC by the 2050s. Increased temperatures in the water bodies of Bangladesh may impact on fisheries, such as by advancing the sexual maturation process of Hilsa fish and the timing of their spawning leading to a decline (Tanner, 2007). WARPO 2006 projected the climate change scenario in terms of increase in temperature and fluctuation of precipitation from the year 1990 as shown in table 2.1

Table 2.1 Projected climate change scenarios for Bangladesh.

Year	Sea level rise (cm)	Temperature increase (^{o}C)		Precipitation fluctuation compared to 1990 (%)	
		Monsoon	Winter	Monsoon	Winter
2030	14	+0.8	+1.1	+6	-2
2050	32	+1.1	+1.6	+8	-5
2100	88	+1.9	+2.7	+12	-10

(Source: Costal Development Strategy 2006, Water Resources Planning Organization, Ministry of Water resources, Bangladesh; Agarwala et al. Intergovernmental Panel for Climate Change (IPCC) Third Assessment Report. Report cited by Government of Bangladesh, 2005, National Adaptation Program of Action, Dhaka).

Rainfall

Experts are not sure on the amount of extra rainfall expected but they agree that the country will receive more rainfall during the monsoon. Likewise the studies also agree in predicting slightly less rainfall in winter months though it could slightly increase initially with estimated averages indicating that rainfall will increase slightly by around 3% in the 2020s, but decrease by around 3-4% by the 2050s (Tanner, 2007). The mean annual rainfall in Bangladesh is about 2300 mm, but there exists a wide spatial and temporal distribution. Annual rainfall ranges from 1200 mm in the extreme west to over 5000mm in the east and north-east (MPO, 1991). Generally, the eastern parts of the country enjoy higher rainfall than the western parts. Spatial distribution of rainfall is shown in Figure-1. Due to inter-annual variability sometimes the timing of onset of monsoon trough over the plains of the Indian sub-continent exhibit anomalies for a few days to weeks. Peak flows inside Bangladesh occurs depending on the timing of onset of monsoon over the vast GBM basins. In general, peak flows occur in July to August; the Brahmaputra exhibits its peak flows in July, while it occurs in the Ganges in August. The rivers attain their lowest flows during January and March. Since over nine-tenths of the surface flow is received from outside Bangladesh, the rise and fall of the water level in rivers is governed predominantly by the amount of rainfall beyond (upstream) the country's political boundaries (Ahmad, 1994).

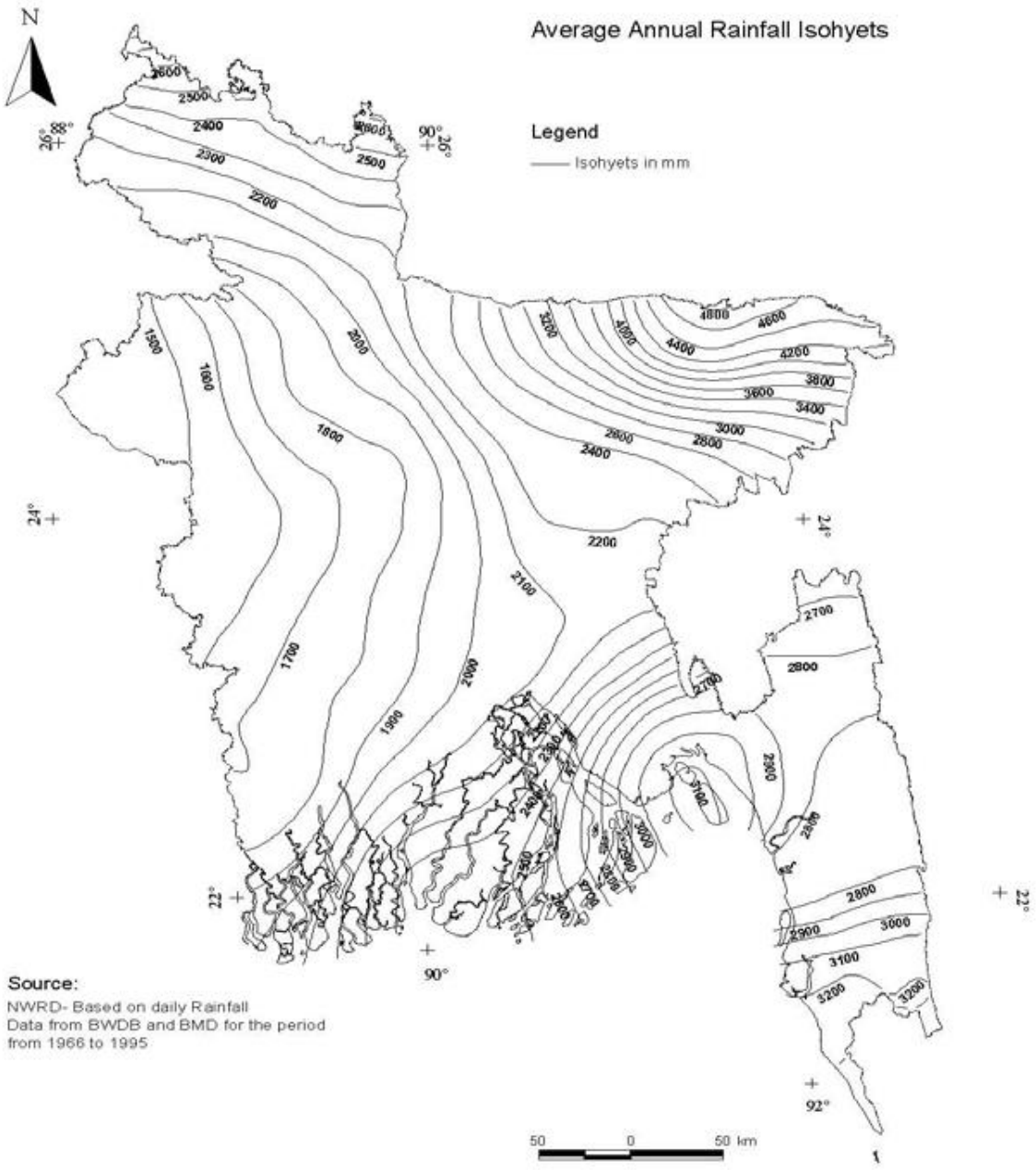


Figure 2.1: spatial and temporal distribution of average annual rainfall

Flooding

Bangladesh is situated on a low-lying flood plain made up of the lower reaches of the Ganges (known in Bangladesh as the Padma), the Brahmaputra (known in Bangladesh as the Jamuna) and the Meghna river. As about 60% of the country is lower than 6 meters

above sea level with an average river gradient of only 6 cm/km in the delta (Mirza, 2002). Bangladesh is extremely vulnerable to flooding with large volumes of water flowing down these rivers. Annually around 20% of the country is temporarily flooded but in extreme cases this may rise to as high as 70% of the country (Mirza, 2002). Severe and catastrophic floods have intensified and taking place more frequently. Over the last 15 years, Bangladesh has been ravaged by floods of catastrophic proportion in 1987, 1988, 1998, 2004 and 2007. In the past the seasonal floods were seen as a blessing bringing fertility in the form of deposited silt onto farmland, but due to population pressure the poorest-of-the-poor have been pushed onto flood prone land and environmental damage is making floods more severe. Floods have wreaked havoc in Bangladesh throughout history.

The catastrophic flood of 1987 occurred throughout July and August and affected 57,300 km^2 of land, (about 40% of the total area of the country) and was estimated as a once in 30-70 year event (Mirza, 2002). The flood of 1988, which was also of catastrophic consequence, occurred throughout August and September. The waters inundated about 82,000 km^2 of land, (about 60% of the area) and its return period was estimated at 50–100 years (Mirza, 2002). Dhaka, the capital of Bangladesh, was severely affected. The flood lasted 15 to 20 days. In 2004, around 30 million Bangladeshis affected by flood, and more than 40% of the capital city, Dhaka were the underwater. According to government statistics 298 people died and a total of 10,211,780 people were badly affected by it. 56,967 houses were damaged by the floods up to 13 August 2007 (Hossain, 2011).

River Bank Erosion

When the flow of water is high, it gives an extra pressure to the river bank. Due to climate change and global warming, flow of water in river increases which erodes the river bank and cause river bank erosion. Higher volumes of water flowing down rivers due to climate related changes such as increased rainfall and summer glacier melt will also increase the erosion of land beside Bangladesh's rivers. As most of the country is

made up of soft silt soils riverbanks are very washed away by river currents and wave action. River bank erosion includes channel shifting, the creation of new channels during floods, bank slumping due to undercutting and local scour from turbulence caused by obstruction (Ahmed, 2006)

The Bangladesh Water Development Board estimated that 1,200 km of riverbank has been actively eroded and more than 500 km has been facing severe problems related to erosion, and every year despite some deposition of silt, a net area of 8,700 hectares of land was being lost (Ahmed, 2006). The Christian Commission for Development in Bangladesh estimate that a million people are pushed off their land by river erosion each year and many of these end up permanently displaced (Christian Aid, 2006).

Sea Level Rise

The impact of global warming would result into the rise of sea level and coastal area of Bangladesh will be affected particularly as it is a densely populated coastal country of smooth relief comprising broad and narrow ridges and depressions (Brammer, 1993). Bangladesh has been ranked as the 3rd most vulnerable in the world to sea level rise in terms of the number of people and in the top ten in terms of percentage of population living in the low elevation coastal zone (McGranahan, 2006). If the sea level rises continues in near future the coastal areas in Bangladesh will go under sea water. Bangladesh will lose a large land area including the largest mangrove forest Sundarbans in the world, the habitat of a number of wild animals and species. (Nicholls, 1999) estimated that by the 2080s, sea-level rise could cause the loss of up to 22% of the world's coastal wetlands. When combined with other losses due to direct human action, up to 70% of the world's coastal wetlands could be lost by the 2080s. IPCC estimated that sea level rise would be 66 cm under business-as-usual conditions by 2100 with a range of uncertainty of 13 to 110 cm. World Bank (2000) showed 10 cm, 25cm and 1 m rise in sea level by 2020, 2050 and 2100; affecting 2%, 4% and 17.5% of total land mass respectively in table 2.2

Table 2.2: Sea level rises (SLR) in Bangladesh and its possible impacts

Year	2020	2050	2100
Sea level rise	10cm	25cm	1m (high end estimate
Land below SLR	2% of land (2500 km2)	4% of land (6300 km2)	17.5% of land (25000 km2). Patuakhali, Khulna and Barisal regions will be most affected.

(Source: Adapted from World Bank, 2000)

Cyclones

Cyclonic storms also known as typhoons, hurricanes or cyclones are common along the 700 km coastline of Bangladesh (Tanner, 2007) and severe cyclones currently occur at a rate of 1.3 per year with speeds as high as 275 km per hour (Chowdhury, 2002) . But although only 1% of the world's total cyclones happen in Bangladesh it has sustained over half of the world's deaths from cyclones. Most terrible was the 224 km/h cyclone on November 12th1970 that killed at least 300,000 people and more recently the 225 km/h cyclone on April 29th 1991 that killed 140,000 people (Chowdhury, 2002). Cyclones occur all along the coastal zone of the south and south-east of Bangladesh usually in late May and in early November but wind risk areas stretch far inland. Most recently Cyclone Sidr with 250 km/hr winds and a tidal surge of 5 meters killed over 3000 people on November 15th 2007and Aila with 100 Km/hr on May 25th, 2009 (Tanner, 2009). The country has been subject to tropical cyclones and storm surges at regular intervals over the past century (Table 2.3).

Table 2.3: Bangladesh Tropical Cyclone Data of the Past 50 Years

Date of Occurrence	Maximum wind speed (km/hr)	Height of tidal surge (m)	Deaths
9 Oct 1960	162	3	3000
30 Oct 1960	210	4.5-6.5	149
9 May 1961	146	2.4-3	11466
28 May 1963	203	4.2-5.1	11520
11 May 1965	162	3.6	19279
14 Dec 1965	210	4.5-6	873
1 Oct 1966	146	6-9	500000
14 Dec 1965	210	4.5-6	873
1 Oct 1966	146	4.5-9	850
12 Nov 1970	223	6-9	500,000
25 May 1985	154	3-4.5	11,069
29 Nov 1988	162	1.5-3	2,000
29 April 1991	225	6-7.5	140,000
29 Apr-3 May 1994	210	-	400
21–25 Nov 1995	210	-	650
19 May 1997	225	4.5	126
16–20 May 1998	150	4.5	-
19–22 Nov 1998	90	3.6	-

14 May 2007	-	-	-
15 Nov 2007 (Sidr)	250-280	-	3,199

(Source: Bangladesh Space Research and Remote Sensing Organization (SPARRSO), International Federation of Red Cross and Red Crescent Societies (IFRC), and Chowdhury, 1991).

2.3 Natural calamities in Bangladesh

The geographical setting of Bangladesh makes the country vulnerable to natural disasters. The mountains and hills bordering almost three-fourths of the country, along with the funnel shaped Bay of Bengal in the south, have made the country more prone to the catastrophic ravages of natural disasters. The disasters concerned here are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion, and landslide. The very common, impact of flood is represented here.

2.3.1 Impact of Aila

A relatively strong tropical cyclone, hit the south-western coast of Bangladesh on 25 May 2009. As per information from the food and disaster management ministry (FDMM), it left up to 190 dead, at least 8,208 more are missing and thousands marooned in the coastal areas of the six districts (DMB, 2010). Health officials in Bangladesh confirmed a deadly outbreak of diarrhoea on 29 May, with more than 7,000 people being infected and four died. An estimated of 20 million people were at risk of post-disaster diseases due to Aila.

A storm surge of 3 m (10 ft) affected western regions of Bangladesh, submerging numerous villages. Several rivers broke through embankments, causing widespread inland flooding. In one region alone, more than 50,000 people were left homeless. Despite warnings to remain at port, numerous fishing vessels sailed into the storm. Port officials stated that more than 500 fishermen had gone missing since the storm made

landfall. Around 25-km-long embankment in Moheshkhali was damaged and about 800 shrimp enclosures were washed away in the tidal surge. Several kilometres of flood-control embankments in Golachipa, Kalapara and Patuakhali Sadar was washed away by the tidal surge. Kuakata remained cut off from the rest of the country as three ferry terminals on Kalapara-Kuakata Highway got submerged. In Patuakhali, a dam broke and submerged five villages. As a result, numerous homes were destroyed by the subsequent flooding and tens of thousands of people were left stranded in the villages. In Chandpur, at least 800 people were injured by the storm and 2.6 million were affected. Unofficial reports indicate that the death toll in the country has reached 121. The country's southwestern Satkhira and Khulna districts and southeastern Noakhali district are the most-affected area. An estimated 58,950 animals were killed by the storm with up to 50,000 deer missing. On the island of Nizum dip, nearly all structures were severely damaged or destroyed, leaving roughly 20,000 people homeless. Thousands of thatched houses in Bangladesh's coastal area were washed away and hundreds of thousands of islanders marooned by 10-13 feet (3-4 meters) high surge, officials said. Damages to water embankments throughout the country was estimated at Tk. 1 billion (US$14.4 million) **(**DMB, 2010**).**

2.3.2 Impact of Sidr

Cyclone "SIDR" was one of the 10 strongest cyclones to hit Bangladesh between 1876 and 2007. "SIDR" developed in the Bay of Bengal in early November, 2007. The cities of Patuakhali, Barguna and Jhalokati District were hit hard by the storm surge that was over 5 meters (16 ft) in height. Fortunately, the cyclone made landfall when the tide was low, so the surge was not as high as it could have been. Most of the cyclones that have made landfall in Bangladesh in the past have caused thousands of deaths. "SIDR" was no exception.

The damage was extensive, including tin shacks flattened, houses and schools blown away and enormous tree damage. Some local officials have described the damage as

being even worse than that from the 1991 cyclone. About a quarter of the World Heritage Site "Sunderbans" was damaged. Researchers said mangrove forest Sunderban will take at least 40 years to recover itself from this catastrophe. The entire cities of Patuakhali, Barguna and the Jhalokati District were hit hard by the cyclone's surge of over 5 meters (16 ft).

There was extensive flood damage at Barisal and at Baniashanta, across from the port city, Mongla, as the cyclone's surge rolled in. In the town of Mothbaria, one of the towns in the very center of the devastation, there was hardly anything left standing, except of a few brick and concrete buildings. Houses and and schools were demolished. The storm's surge washed away all roads in the region. About 500 fishing boats were unaccountable and over 3,000 fishermen were reported missing (BUET, 2008).

The hardest-hit area was Barguna, where 423 people were reported to have been killed, according to local officials. Patuakhali was also hard-hit, with 385 deaths reported. Most of the deaths confirmed thus far were due to the winds, although 13 of them have been as a result of capsized boats in the Faridpur district of Bangladesh.

Much of the capital city of Dhaka was also severely affected due to the winds and the flooding, as electricity and water service were cut and significant damage was reported there due to winds and flooding. The agricultural industry of Bangladesh was devastated by the flooding which covered about1 million hectares of farmable land. In brief, "SIDR" affected about 2 million families comprising about 9 million people. More than 1.5 million homes were destroyed. Total damages came close to $450 million (BUET, 2008).

CHAPTER 3
METHODOLOGY

3.1 Data Acquisition

The study followed multiple stages which include participatory approaches of data collection, interpretation and sharing the study findings with project components and stakeholders.

Data collection can be accomplished through following steps:

a) Team mobilization;

b) Development of method and tools;

c) Organization of field team members;

d) Administrating of tools and formats;

e) Field data collection, cleaning, processing and analysis.

3.1.1 Development of Data Collection Tools

Multiple methods were used to collect primary data. These are as follows:

- Sample survey
- Focus Group Discussion (FGD)
- Interview

The sample survey was designed to gather information and data in a more structured format, the other methods including FGD and interview focused on open ended opinions and views of the target study groups.

3.1.1.1 Sample survey

The questionnaire generally focused on the health disorders, seasonal variations of the diseases, water supply and sanitation related problems, perception on climate change and its impacts on human health of the study sites etc. The questionnaire was designed in such a way that each question was accompanied by one or more answers. The respondents were allowed to choose from the given answers or he/she could give own opinion.

3.1.1.2 Focus Group Discussion (FGD)

Three FGDs were conducted in the area of Gabura. One with local health professionals (e.g. village doctors (locally called as kabiraj or palli chikitshak, homeopathic doctors and health workers of NGOs etc); Second one was conducted separately with locally well-known knowledgeable persons. The last one was conducted with women. Each FGD comprised of7 to 10 members. One of the field investigators presented the issue and the other two members of the team recorded the responses of the participants on specific issue. After the session of FGD, we reviewed the issue based responses and prepared the report on each FGD of the study.

3.1.1.3 Interview

The interviews were taken to collect the information on the specific issues on climate change and health impacts. It was conducted with two most well –known knowledgeable persons. Questions were asked by one of us and responses were written down by others.
Interview process has been conducted with five stakeholders groups:

1) Fishing community,
2) Staffs of forest office,
3) Teacher of madrasa,
4) Local residents, and
5) Non- government service holders etc.

3.2 Data validation and Analysis

The survey data have been edited and coded manually and processed through triangulation method that included interview, participatory exercise and sharing findings with stakeholders have been applied to validate the data.

3.3 Vulnerability Mapping

Vulnerable zone in natural disaster means the area or the zone which is in the maximum risk. The areas which are exposed to different natural events frequently and the impact is severe are vulnerable area. Maps of each event help to get the information of the affected area. The map shows the areas affected area so that the user can identify vulnerable mapping. These maps can be helpful at any research to know about the areas. This map can be helpful to know the number of people may be affected; the total areas of agricultural land can be flooded, tentative financial loss of people.

3.3.1 Overlapping of Maps

Based on the vulnerability concept we have made a vulnerable map. We have collected maps of flood and cyclone prone area (source: SPARRSO). These two maps individually show the vulnerable zone for the respective disaster. What we have done, we did the overlapping of maps and have got a single map which represents the information of those two maps.

To do the overlay manually at first we made print out of those two maps in tracing paper. Tracing paper is semitransparent which allows seeing through the paper. Secondly we overlapped these two maps. Because of the transparency of the paper, information of these two papers visible in a single frame. After the scanning and the printing of the frame we get a map which contains the vulnerable areas for both cyclone and flood.

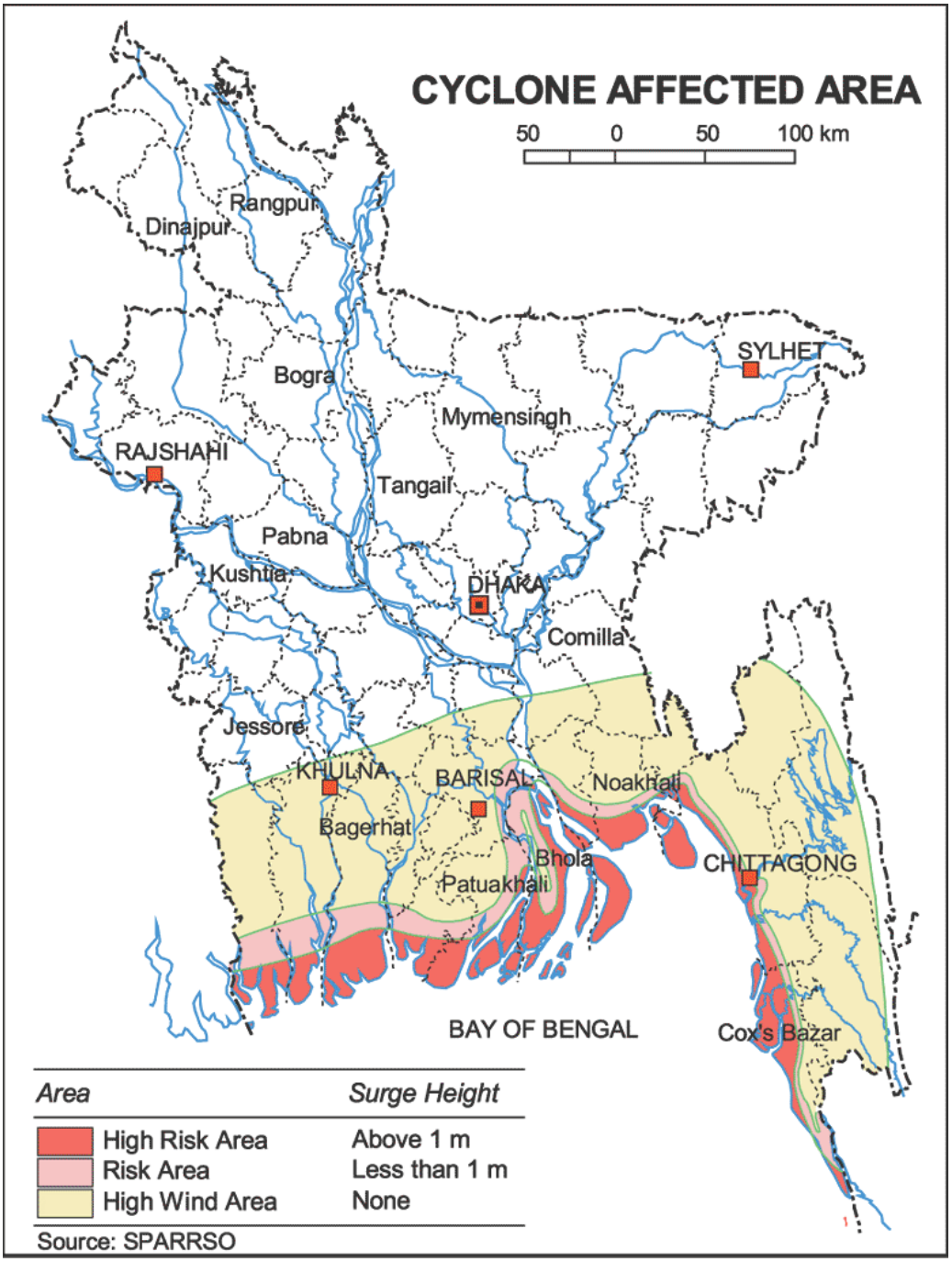


Figure 3.1: Map showing vulnerable area under cyclone

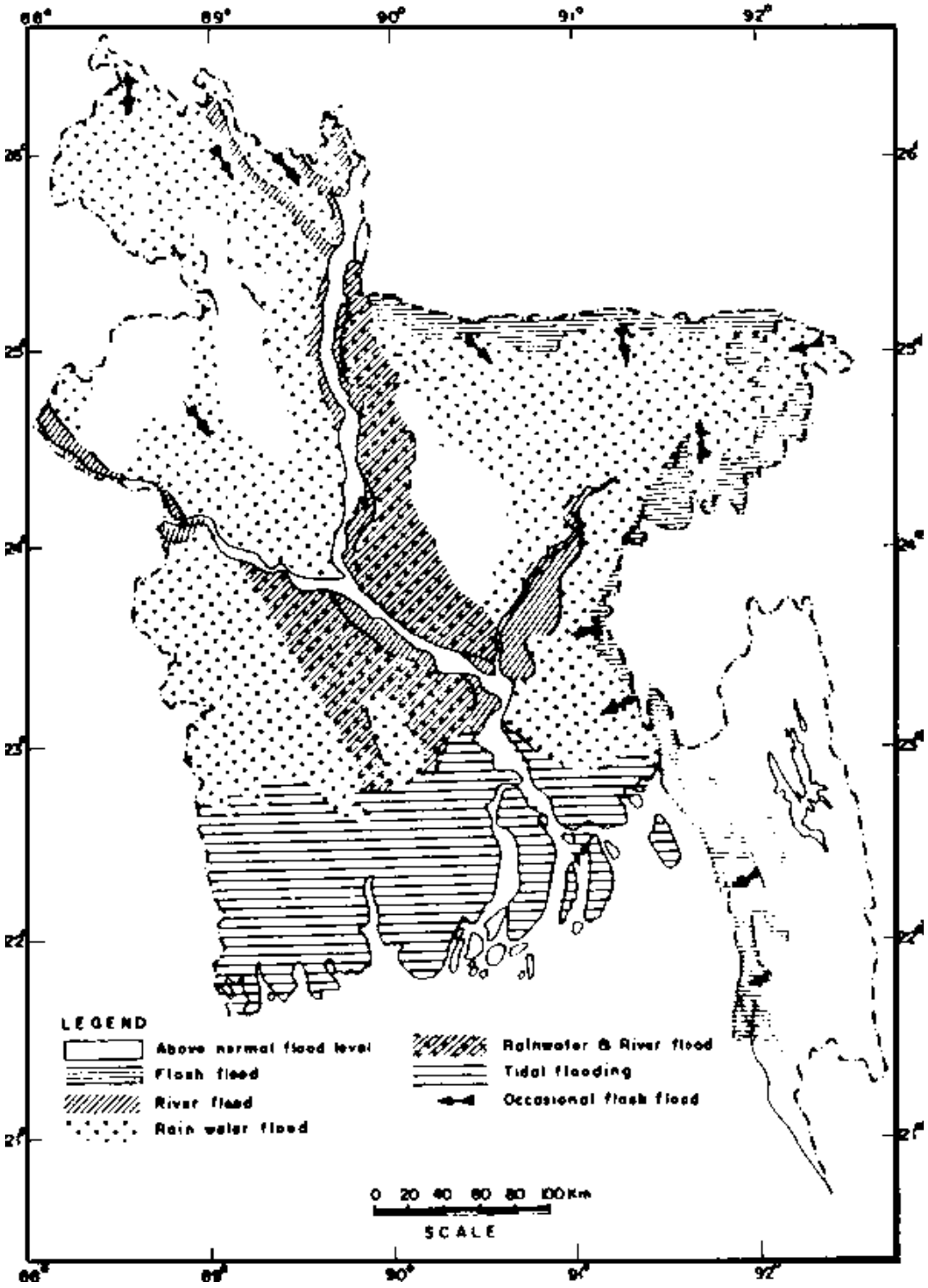


Figure 3.2: Map showing vulnerable area under flood

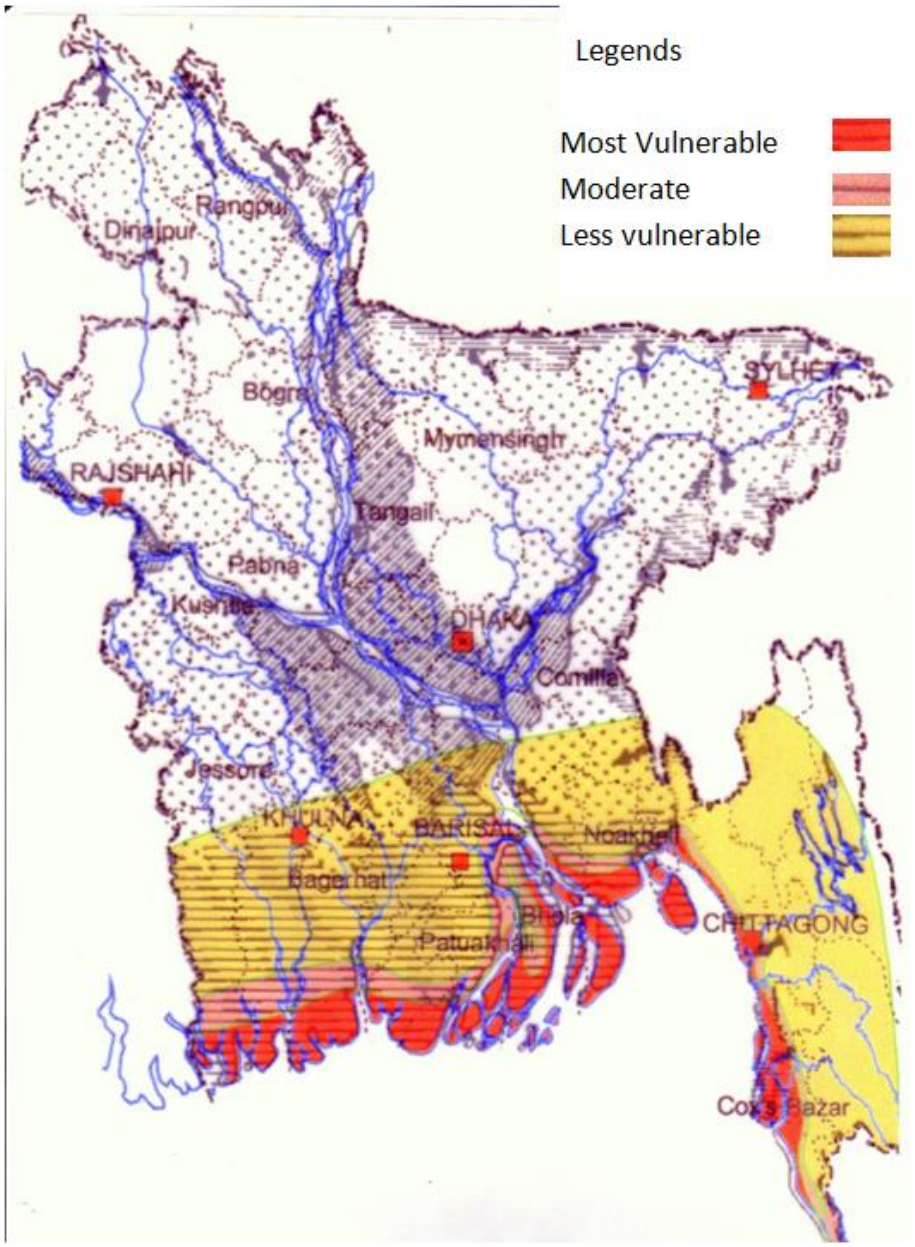


Figure 3.3: Map showing the overlapped vulnerable area

CHAPTER 4
CASE STUDY AREA

4.1Profile of the Study Area:

- Study area : Satkhira
- Area : 3858 km2
- Population : 19,49,899(approx.)
- Literacy : 53.32%
- No. of Upazila: 7
- No. of Union: 79
- No. of Pourashava: 2

(Source: PDO-ICZMP, 2003)

Location: a district in South-western Bangladesh, Part of the Khulna division, it lies along the border with West Bengal in India. It is bordered to the north by Jessore district, on the south by the Bay of Bengal, to the east by Khulna district and to the west by Pargana district of West Bengal. (Please see the map)

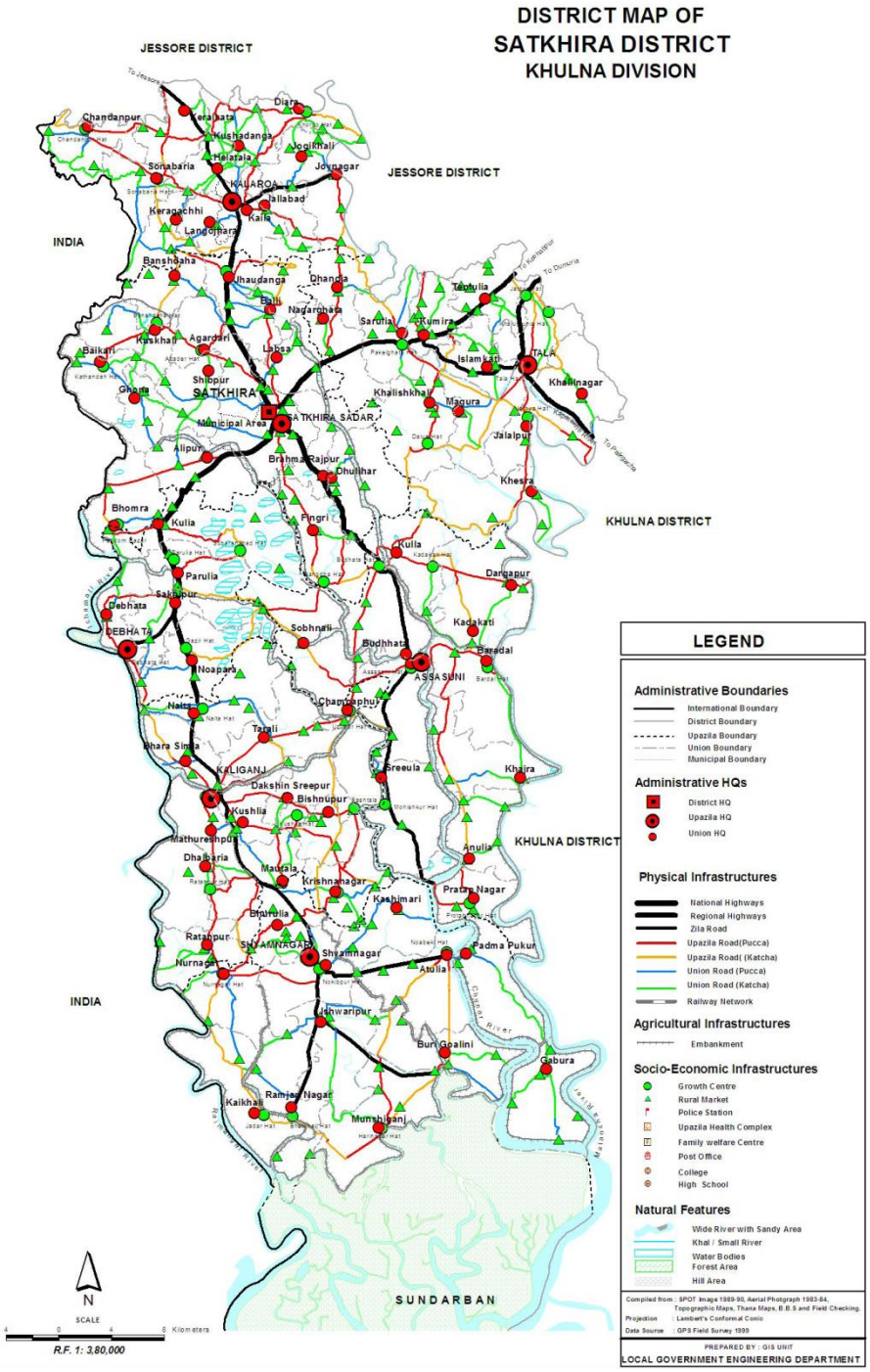


Figure 4.1: Map showing the Satkhira district
(Source: LGED)

4.1.1 Climate

The annual average maximum temperature reaches 35.5°C (95.9°F); and minimum temperature is 12.5°C (54.5°F). The annual rainfall is 1710 mm (67 in). The main rivers are the Kopotakhi River across dargapur union of assasuniupazilla, Morichap River, Kholpotua River, Betna River, Raimangal River, Hariabhanga River, Ichamati River, Betrabati River and Kalindi-Jamuna River (DoE, 2009).

The physical features of the study area have been dominated by surface water systems, the proximity of the sea in the south, the dynamic morphology that is greatly governed by sedimentation processes, and the human induced influence on the entire hydro-geophysical characteristics of the region.

Basically the climate of the Satkhira district is vulnerable compare to the other disaster prone areas. Other disaster prone areas normally face flood as a devastating disaster in each year or at a time interval, but Satkhira district turned to devastating disaster like flood, cyclone and as well as tidal wave. This is represented by below chart.

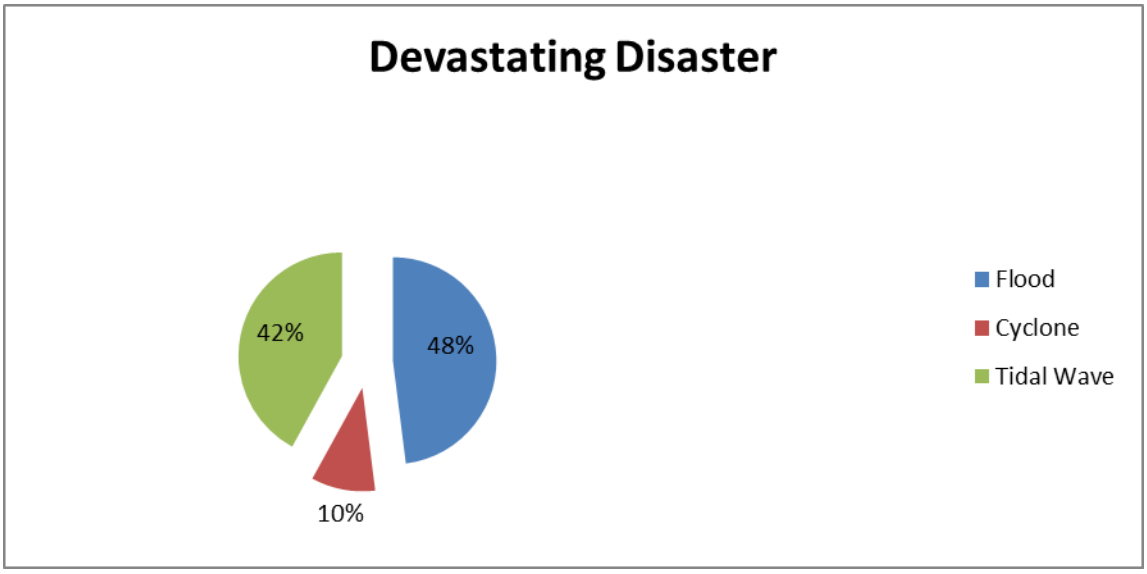


Figure 4.2: The area of Satkhira usually turns to devastating disasters like flood, cyclone and tidal wave

4.1.2 Topography

The Satkhira-Khulna-Jessore triangle belongs to the South-western Region of Bangladesh. Specially the satkhira district is aligned north to south, having the Sundarban mangrove forest located in the southern most reaches. Satkhira having extremely flat topography and located within 1-5 meters from the mean sea level. The Southwestern Region of Bangladesh has been subjected to a plethora of hydro-geo-morphological hazards which include poor drainage through its river systems, high rates of sedimentation on river beds, acute low flow conditions during the dry season, salinity ingress along the rivers, cyclonic storm surge, moisture stress in the dry season, rise in sea level, and to a lesser extent, flood (Halcrow-WARPO, 2001). The region is located in the coastal zone, and is significantly influenced by tidal effects. According to available statistics on Coastal Zone, majority of the land is within one meter from mean sea level, a significant proportion of which again falls below high-tide level (Islam, 2005).

However, along the southern reaches of the area, there are inter-tidal floodplains that are generally inundated twice diurnally. Moreover, the encircled embankments have been created since early 1970s to safeguard agricultural activities from tidal/saline influence. Embankments therefore have become a permanent feature on the land, which also have influenced sedimentation dynamics of the area.

The Sundarbans, located in the Southern most reaches of the SW region. It provides various ecosystem services to approximately one million households living in the SW region and the South-central region. Furthermore, the forest is the natural habitat for a number of endemic species such as Bengal Tiger (Panthra tigris). Due to its richness in biodiversity and its great ecosystem service to millions of people, it has been regarded as an UNESCO Global Heritage Site since 1996 (Agarwala, 2003).

After the disaster, the topographic condition becomes very critical because of soil erosion and land salinity. According to the field survey result, we observed that 88 percent of land turned to erosion.

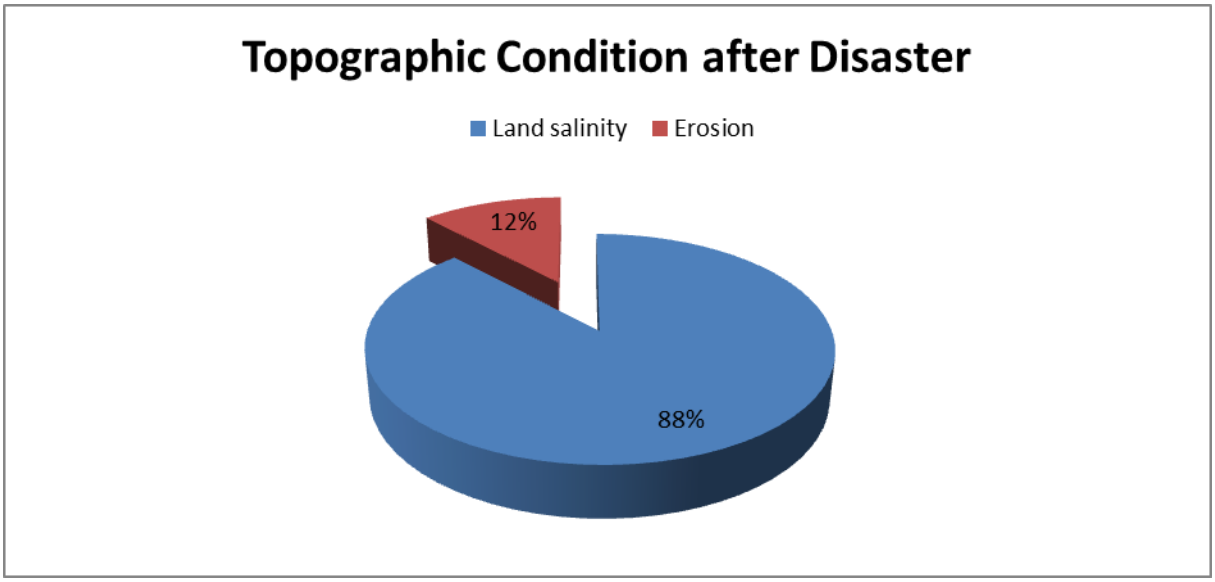


Figure 4.3: Topographic condition after disaster

4.1.3 Livelihood pattern

The population density is about 743 per square kilometer , as against the national average density of 839/km^2 (BCAS, 2010). In recent times, the region has undergone severe forms of environmental degradation, which devastated livelihoods of primarily the farming communities, and lately of those involved in other livelihoods. The general occupation of the inhabitants of the region had been farming, mostly based of paddy cultivation. The rather sudden change in environmental conditions has forced farmers to forfeit the dry season cropping opportunities due to increase in salinity, especially along the southern boundaries of Khulna and Satkhira Districts.

Household size and composition by sex ratio

The household size (the number of persons per Household) and sex ratio of Satkhira study area was 5.2. The household survey reveals that the numbers of male members of households were higher than the female. Male constituted 52.8 per cent of households members while 47.2 per cent were female (please see table 4.1).

Table 4.1: Distribution of household members by sex in study locations

Area	Sex (in percent)		
	Male	female	Both
Satkhira	51.8	41.2	100

(Source: Climate Change and Health Impacts in Bangladesh; JUNE'2009)

Education

It was found that 47 per cent of the household members (altogether) were illiterate shown in table 4.2 (According to field survey).

Table 4.2: Education level

Level of Education	Number (percent)
Primary	30
Ssc level	15
Hsc level or above	8
Can't sign name	47

It can also be represented by figure below

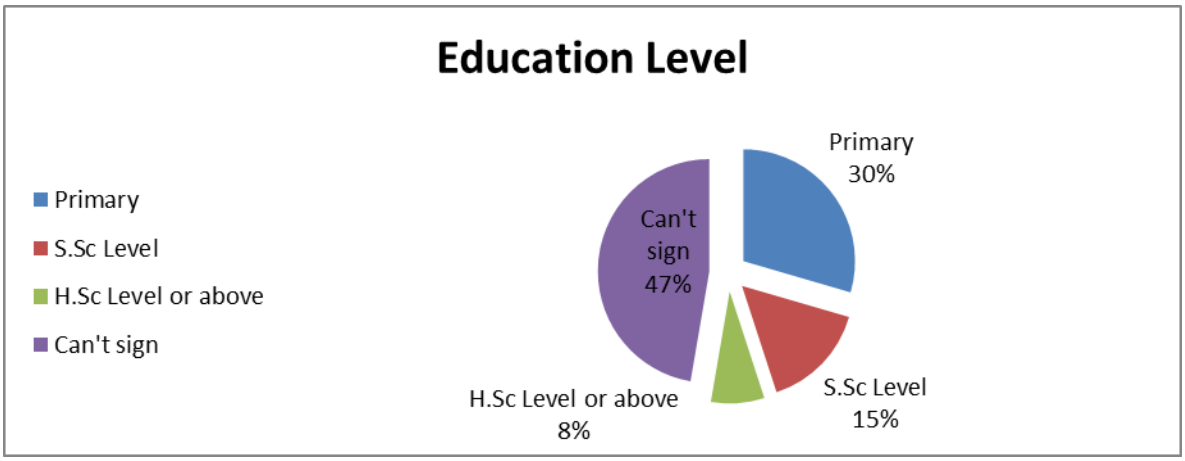


Figure 4.4: Level of education

Occupation

The occupation of household members was investigated under this survey. Among the total study population in each field are presented in table 4.3.

Table 4.3: Occupation type

Occupation	Percentage
Farmer	27
Businessman	11
Motorcycle driver	8
Student	15
Housewife	19
Teacher	8
Varities	12

Income

According to survey, it has found that 72.23 percent population's income range belongs below 5000 taka only which is a very dangerous threat to their livelihood and details are shown in figure below.

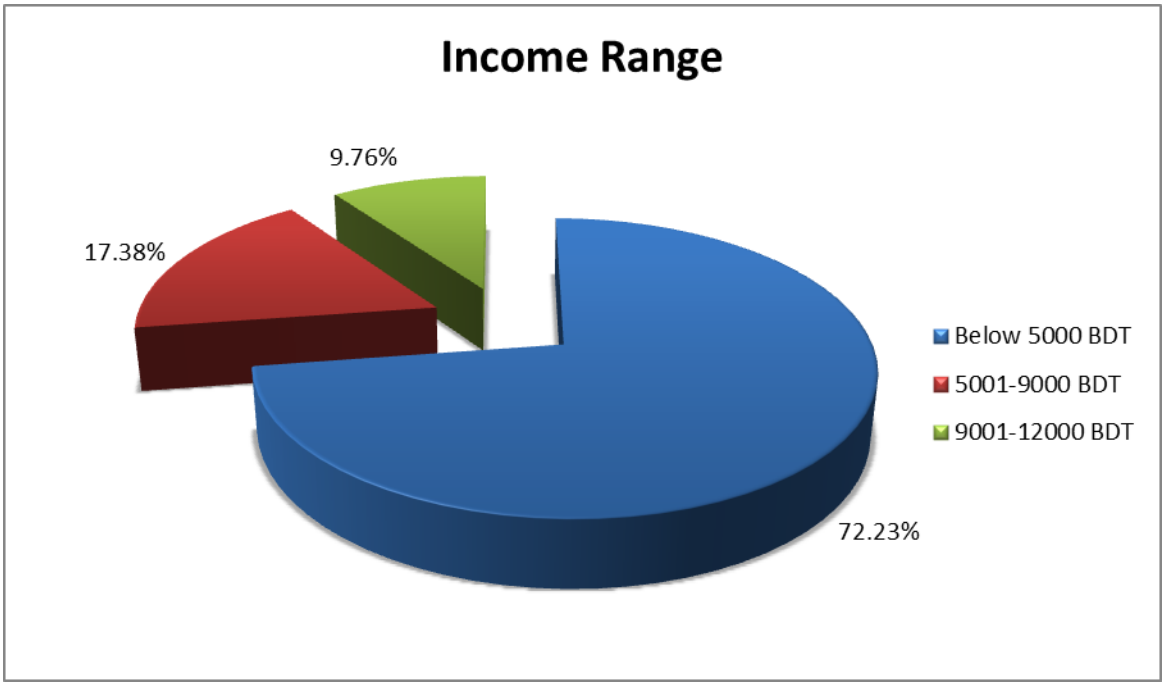


Figure 4.5: Income range

4.2 Present socio-economic and environmental impact in affected areas

4.2.1 Agriculture

The vast majority of the population of Shyamnagar are engaged with agriculture and fisheries and it is evident from the BBS (2001) statistics which estimates that about 64.98% households in this upazilla depend on agriculture including 38.16% on cropping, livestock, forestry and fishery, and 26.82% on selling agricultural labor. But after Aila attack, all the agricultural and associated livelihood activities were disrupted through damaging all agricultural settings in the region. Table (4.4) presents damage statistics in the agricultural sector at each union of the Shyamnagar Upazila.

Table 4.4: Damage in Agriculture and livestock

SL.NO	Affected Unions	**Damage description**			
		Crops (ha)	Cattle (no.)	Poultry (no.)	Shrimp farm (ha)
1	Vurulia	18.7	0	0	0
2	Kashimari	42.7	21	1036	2456.66
3	Shymnagar	21.1	4	0	660.6
4	Nurnagar	13.13	3	25	489.57
5	Koikhali	23	11	0	2185.95
6	Ramjanagar	18.5	19	45	2859.22
7	Munshiganj	16.5	28	5716	6095.09
8	Ishawripur	18.5	19	3121	788.4
9	Burigoyalini	10.2	129	2445	5504.14
10	Atulia	7.4	262	3366	1951.02
11	Padmapukur	3	57	4429	5346.08
12	Gabura	1	81	3095	4324.97

	Total	194	634	23278	32661.7
Damage in BDT		2368000	2368000	3491000.25	552396000

(Source:Upazila Nirbahi Office, Shyamnagar)

In Shyamnagar upazila total 194 ha of crop land was fully damaged by Aila which worth an estimated cost of 2.4 million BDT. Moreover, Aila incurred loss of about 550 million BDT in shrimp sector. .Table 4.4 depicts total loss in monetary value received from different sector in different unions of Shyamnagar upazila due to Aila. And, consequently a threat to food security emerges in the area.

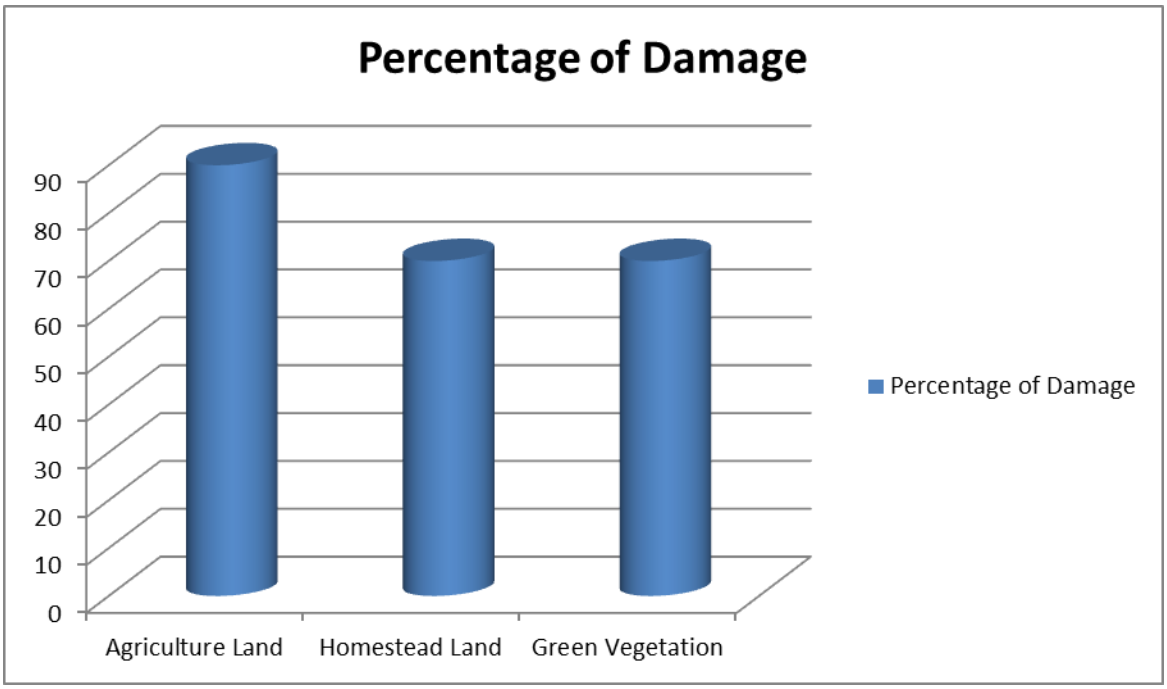


Figure 4.6: Percentage of damage in agriculture

In the study areas almost all the agriculture land (>90%) and homestead gardens (>70%) were flooded and 70% of the green vegetation were damaged. Most of the water sensitive fruit trees and vegetables died due to water logging. All the respondents in the study area argued that it would not be possible to produce vegetables in salinity contaminated field before two years and for fruit species they have to wait for another 6 years (Kumar, 2010).

Cyclone Sidr has severely affected more than one million hectares of cropland, washed away food storages and personal stockpiles, and destroyed fruit trees. The rice crop was the hardest hit among many affected central crops including pulses, vegetables (an important source of income and nutrition), and bananas.

4.2.2 Water Resources

The people of the study area received the highest amount of sufferings from drinking water shortage and destruction of sanitation facilities soon after Aila attack. However, still the affected people are suffering from shortage of pure drinking water, which is evident from all respondents' response and physical visit to the area. In the study area water supply and sanitation coverage was about 50-60% before Aila. However, Aila devastated all the drinking water sources (ponds and tube wells). During Aila, high tidal surges contaminated all fresh water sources with polluted saline water. Many people are compelled to drink such polluted water as they do not have any other option and consequently suffer from water borne diseases such as allergy, skin diseases, cholera and diarrhea. Currently, for curative measures affected peoples' medical cost has increased by 55%. Supply of drinking water has now become the most striking challenge for the study area (Kumar, 2010). Since most of the area is still water logged, they have to boil water for drinking which is not safe yet. The dropout rate, therefore, has increased sharply in the study area after Aila. Even though, some NGOs are distributing drinking water in the affected areas, however these attempts are pretty insufficient compared to demands. Moreover, disrupted communication system results into irregular supply. The primary impact of Cyclone Sidr on water supply and sanitation facilities was in rural areas. The Department of Public Health Engineering (DPHE) reported damage to 11,612 tube wells, 7,155 ponds and over 55,000 latrines. Damage for these totals BDT 157 million (US$ 2.28 million) and loss totals BDT 46 million (US$ 0.67 million). Drinking water sources (tube wells and ponds) in many communities were contaminated by saline water and debris and power outages affected water supplies in areas with piped water. In addition, in many areas groundwater sources were contaminated by arsenic and salinity in shallow

aquifers, and the non-existence of deep aquifers. The people of this area rely on pond water, and often use Pond Sand Filters (Kabir, 2009).

4.2.3 Threat to Health

The Cyclone Aila furiously hit the Satkhira and Khulna Districts of Bangladesh, entrancing immediate death of about 325 people including massive infrastructure damages. The total value of damage and losses in the health, nutrition, and family planning sector in the nine districts affected by Cyclone Sidr is estimated to be BDT 1,206 billion (US$ 17.5 million).

During this study people were asked about their usual food habit before and after Aila. It is found that almost all the people in the affected area are now taking food irregularly. All the respondents in the study areas used to take food 3 times a day before Aila. However, Aila reversed the situation and now many people have to content with 1 time food intake or hardly 2 times in a day. In Shyamnagar, area respectively 93%, respondents said that after Aila they are still with insufficient food and so, suffering from malnutrition. About 75% respondents identified reduced family income as the major cause of their insufficient food taking. However, all the respondents agreed that salinity ingress in their crop fields is impeding crop and vegetable production and it is lessening their daily food intake share (Kumar, 2010).

The cyclone caused total or partial destruction of public facilities worth BDT 168.8 million (US$ 2.45 million), while the estimate for losses is about BDT 1037.6 million. The cyclone can be blamed for 3,200 deaths and increased numbers of diarrhea, respiratory tract infection, eye infection, various skin diseases, and fever. Most of these were caused by a shortage of clean drinking water. The Government was prompt in deploying medical personnel to affected areas. Initially, medical personnel from public facilities in neighboring districts were sent. They were followed by nationally formed medical teams. In addition, the military set up their own medical camps to provide health care services, and NGOs, Development Partners, and other organizations also provided medical teams. The Government had procured emergency medicines and accessories

worth BDT 472 million(US$ 6.8 million) within a few days of the cyclone, using funds from the health sector-wide program (Kumar, 2010).

4.2.4 Fisheries and Livestock

So many river criss-crossed inside the study area. After all natural disasters fishes from all the pond mostly dies and washed away to river. Which cause an economic disaster in the society. The loss of vegetation in water is also remarkable. Which cause the lack of O_2in water which is essential for fisheries to live. When the salt water mix with pond water the fishes dies and loss of vegetation cause the permanent depletion of O_2. So after the disaster no fish can live and grow there. The people who were lived by catching fishes fall in great misery. Table shows the loss of fisheries in the Satkhira.

Table 4.5: loss of fisheries

Name of Upazila	Affected area			Flooded quantity	No. of Affected farmers
	No. of Affected Pond/Gher / Dighi	Qnty. of flooded fish(mt)	Qnty. of flooded shrimp (mt)	Qnty. of flooded fiingerlings (lakh)	
Sadar	10460	933	545	100	9002
Kolaroa	4392	1350	111	30	4860
Tala	11180	8153	1019	95	11180
Assasuni	937	319	198	-	2195
Debhata	1891	557	344	-	730
Total	**28,860**	**11,312**	**2217**	**225**	**27,967**

(Source: Department of Fisheries, Satkhira; December 2011)

Salt water washes away all green land so livestock cannot be fed properly. So the livestock raisers fall in serious problem. A severe damage in livestock and poultry has noticed. Which made the economic condition of the affected area so bad? The full extent

of damage to crops is yet to be officially established, however, reports from the Department of Agricultural Extension, Livestock and Fisheries in Satkhira district indicate extensive damages in Tala and Satkhira Sadar upazilas. The number of farmers affected is also high in these two upazilas, with 119,192 farmers affected in Satkhira alone (Shushilon, 2011). Following chart shows the damage to poultry and livestock.

Table 4.6: Loss of livestock

Upazilas	Category and number of affected animals/birds							Affected Farmers
	Cow	Buffalo	Goat	Sheep	Poultry	Duck	Other Birds	
Sadar	15200	-	15600	710	35000	424	240	8240
Kalaroa	7800	-	9200	50	12500	1220	70	5450
Tala	17000	-	18000	130	30000	500	300	10600
Assasuni	5200	60	3500	150	10000	950	50	5250
Debhata	5500	-	4100	40	8100	350	45	6150
Total	**50,700**	**60**	**50,400710**	**1,080**	**95,600**	**3,444**	**705**	**3,5690**

(Source: District Livestock Office, Satkhira; December 2011)

4.2.5 Ecosystem and Biodiversity

Southern part of Bangladesh is rich in ecological diversity. It has the largest mangrove forest in the world. Due to climate change and the rapid occurrence of natural disasters the ecosystem and biodiversity face severe impacts. After the last Sidr and Aila a large proportion of Sundarbans washed away by the powerful storm surge. Sundarbans blocked and reduced the effect of the disaster. It is a light of hope that the forest has almost recovered to its previous state by itself. But it affected the wildlife very much.

Climate change affects all aspects of biodiversity; however, the changes have to be taken into account vis-a-vis the impacts from the past, present, and future human activities, including increasing atmospheric concentration of carbon dioxide. For the wide range of IPPC emission scenarios, the Earth's mean surface temperature has been projected to

warm 1.4 to 5.8º C by the end of the 21st century, with land areas warming more than the oceans and the high altitudes more than tropics. Then globally, by the year 2080, about 20% of the coastal wetlands could be lost due to sea level-rise. The associated sea-level rise is supposed to be 0.09 to 0.88m (Bashar, 2011).

From micro to macro, flora to fauna all the elements of ecosystem are affected by natural calamities. So far the impact of climate change on biodiversity is concerned, it is to affect individual organisms, populations, species distributions, and ecosystem composition and function both directly (through increase in temperature and changes in precipitation and in the case of marine and coastal ecosystems also changes in sea-level and storm surges) and indirectly (through climate change the intensity and frequency of disturbances on species assemblage).

Coastal ecosystems are affected by both anthropogenic activities and climate change variability. Coastal developments, tourism management, land clearance, pollution, exploitation of species, habitat degradation, and depletion of coral reefs, mangroves, sea grasses, coastal wetlands and loss of beaches are due to anthropogenic activities. Climate change impacts affect physical, biological, and biochemical characteristics of the ocean and coastal ecosystems at different time and space scales. These modify their ecological structure and functions.

If sea-surface temperatures increase by 3°C in short term, and if this increase is sustained over several months, it will cause extensive mortality of corals. In addition, an increase in atmospheric CO_2 concentration and hence oceanic CO_2 affects the ability of the reef plants and animals to make limestone skeletons (reef calcification); a doubling of atmospheric CO_2 concentration could reduce reef calcification and reduce the ability of the coral to grow vertically and keep pace with rising sea level. The overall impact of sea-surface temperature increase and elevated CO_2 concentration could result in reduced species diversity in coral reefs and more frequent outbreaks of pests and diseases in the reef system. The effects of reducing productivity of reef ecosystems on mollusks, echinoderms, crabs, birds and marine mammals are expected to be substantial (Bashar, 2011).

4.3 Survey Findings of the Respondents of the Study Area and its Impact

People informed that everyday life is badly affected due to the increases in the frequency of cyclones and storms. The disasters make their food and social security fragile. They experience huge loss because they cannot take preparation to face it, as the disasters appear rapidly without any notice. So people cannot predict anything. As a result bad impacts are evident on agriculture and fisheries. Their houses and toilets are destroyed. Children are affected by different diseases like dysentery, jaundice, skin disease, cold and fever. In the past, the rivers were full of different fish species but nowadays many of them have become extinct. It would have happened due to the increase in salinity in the river.

Some participants reported that in the past they had observed appearances of storm in the month of Baishakh. However nowadays it can appear any time. They cannot predict anything so this cause more damages compared to the past. They are always annoyed when the cyclone appears and washes them away. They are noticed that the level of tide water used to remain low in the winter. But at the present level of tide water rise higher even in the winter.

According to the Response of the household survey, they mentioned that the nature of seasonality has changed a lot. There were six seasons a year. At the present they only feel, the present of three seasons (winter, summer and rainy). It does not rain sufficiently in the rainy season. In one side winter is not intensified and depressions are created very often because of too warming. The hailstorm damages the plants and crop and as a result tigers turn up in the village very often and attack on people.

They have also reported that incident of disasters have increased in last 20 years. The river was less wide in the past. Nowadays it has been expanding due to erosion. The homestead has been affected by salinity due to this and they cannot cultivate any vegetable. On the other hand, they have lost their land into the river. The fish population declined due to increases in salinity in the ponds. Fish are not available in the river like

past. The survey data shows how many of the populations acknowledge the signs due to climate change.

We have got some key information about the study area by the survey. As we have asked the local people a set of question, where there were three sections.

One is for personal information about the answerer like age, occupation, education etc. So that we can get an idea about authenticity of the information. Second portion was about the natural disasters and impact that affect the study area. And third part was about the loss and suffering of the answerer due to the disaster.

We have seen that the occupation of the people of the study area is seasonal mostly. They pick the suitable job for the different season. A pie chart is shown in fig. 4.7 to show their occupation pattern.

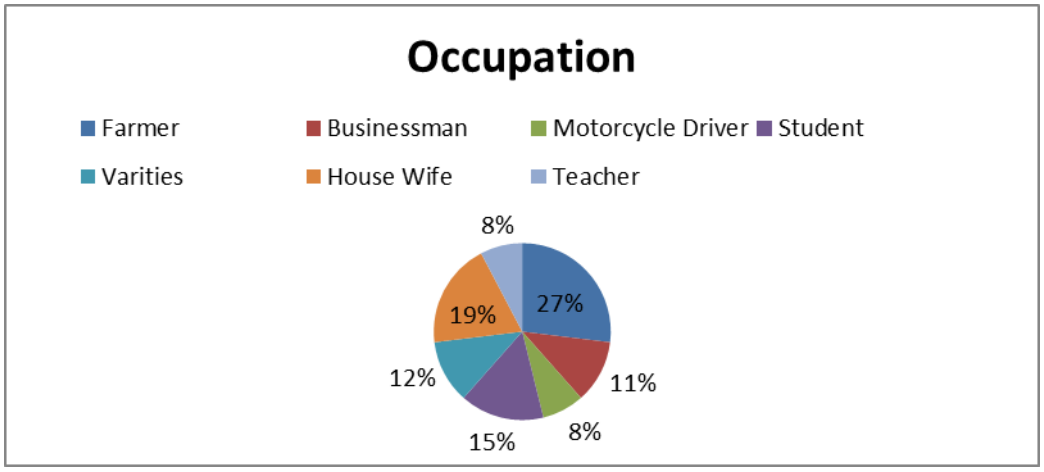


Figure 4.7: Occupation of the people in the study area

We have also noticed that 47% percent of the people cannot even sign their own name. The darkness of illiteracy is a curse to them and this is also a reason that makes them suffer a lot.

The major disasters are tidal wave, cyclone and flood. Among them flood is the most frequent and devastating. As they deprived of the modern technology they still get warning via old fashioned way like radio and local announcement system. Following fig.4.8 is showing the alarm medium in the study area.

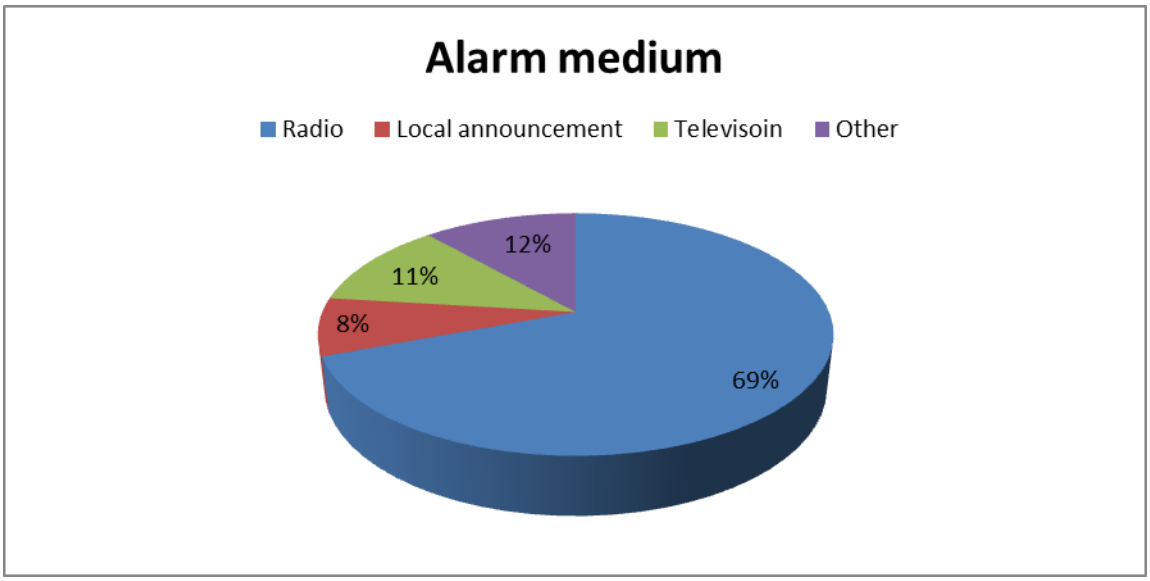


Figure 4.8: Warning medium in the study area

The impacts of the disasters are severe. It costs a lot resources and even human life. During the disaster people become cornered and cannot even get the basic needs. The after effect is even more devastating. The land becomes saline so no crop can grow for next few years which hamper the economy of the area. Fishes from the pond dies because of the contamination of sea water. Contamination of ground water with saline sea water make people suffer from scarcity of potable drinking water. Diseases like diarrhea and skin diseases spread like epidemic. People become homeless, the need food and treatment. Fig. 4.9 shows that people mostly suffer for safe shelter.

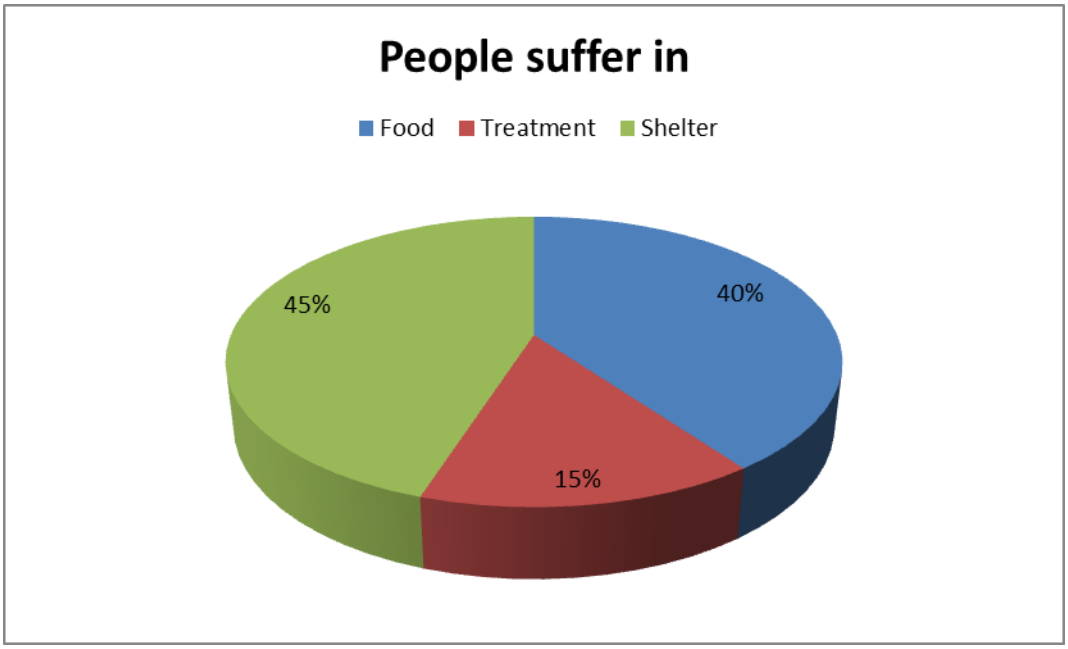


Figure 4.9: Type of suffering during and after disaster

It is a matter of hope that there are some NGOs who help the people by providing relief and health care. Still this is not enough. The participation of government is mandatory. But according to local people most of the relief from government never reach to the affected people. People get less medical attention than the need. The number of doctors and facilities are not enough.

People become homeless and helpless due to the natural disasters. They loose home, money, crop, fisheries and everything. Sufferings of them cannot be described in words.

When local people were asked about why the study area is affected so much by the disasters, they replied that the dam which is supposed to protect the area is not well functioning. The height of the dam is less than the required.

CHAPTER 5

MITIGATION AND INTERVENTION

5.1 Mitigation

Mitigation is the best form of adaptation. Adaptation is certainly no substitute for mitigation. Any delay in mitigation measures will only increase the need and cost of adaptation, and increase the vulnerability of disasters. Previously, disaster mitigation tended to be viewed as structural mitigation measures only. This concept has changed rapidly over the past few years. The modern concept is that there exists a whole process of risk minimization activities that have been identified to address crucial elements of disaster management, which include its prevention or mitigation, preparedness, response, recovery, and development. Based on this realization, and in order to design the institutional and functional arrangements for disaster management, the Government of Bangladesh (GoB) has taken initiatives to frame a disaster management policy. This policy would take care of all aspects, such as accurate definition of disaster threats, organizational arrangements required to prepare responses to and recover from disaster events, assessment of resources available to deal with threats, and recognition of ways for the national disaster management policy to interlock with other national development policies. The GoB gives equal importance at present to both structural and non-structural mitigation measures. It is strongly believed that non-structural mitigation measures need to be complemented by structural mitigation measures. Reconstructing the infrastructure and recovering the economy of affected areas requires a multipronged approach that restores assets and protects the most vulnerable members of society against future calamities. Experience shows that recovery efforts should start as soon as possible after a natural disaster, even though humanitarian assistance is still ongoing. This will mitigate the effect of dependency within the affected communities and ensure a more rapid return to normalcy. This also helps to reduce vulnerability to natural hazards by minimizing physical exposure and building community capacity to cope with and recover from disaster impacts. Government organizations and NGOs have been working to recover structural and non-structural damages in the Aila affected zones. For cyclone Sidr the Government, international community and local agencies addressed the post disaster shelter need in various ways. During the emergency phase they delivered cash grants and

shelter materials for rebuilding and repairing. Later on, core houses and transitional houses were built for targeted vulnerable families in the affected areas. However, this direct reconstruction assistance covered a limited need in comparison to that of the total shelter reconstruction needed. Assisting a larger number of affected households through shelter awareness and construction training could have accelerated the reconstruction process but this was undertaken by very few agencies.

5.1.1 Hard Component

The Government of Bangladesh has undertaken a Green Belt Project in the coastal areas. This is a participatory reforestation program aimed at reducing the adverse impacts of natural disasters, particularly cyclones and storm surges in the coastal regions. However, most of the embankments of study areas are still damaged and in some parts they fully disappeared and it is hardly possible to distinguish the locality from the water body. In every high tide, water enters into locality through breaches and there is a risk of further inundation of the whole area in case of 5 m high tide (Kumar, 2010).

The coastal zone of Bangladesh is high risk to cyclone and storm surge. Therefore, Environmental protection is essential for its recovery. Building of embankment is a high cost engineering and infrastructure solution, which is often beyond the scope of shelter providing agencies to implement. Building multi-purpose cyclone shelters are rather expensive solutions, which have been saving lives in the past disasters. Smaller number of population took refuge in cyclone shelter in the past as there were very few cyclone shelters and they are built in places for away from the affected community. Besides, privacy and lack of maintenance of cyclone shelter discourage people to move to cyclone shelter. Therefore, community inclusion for proper planning and maintenance of the cyclone shelters is a necessary risk reduction measure. On the other hand, planting trees and protecting the existing embankments are low-key interventions but can protect the coastal settlements from wind and storm surge as well as reducing carbon footprint from the construction work. Therefore it is essential to incorporate environmental management

with shelter program, which is yet to be done both by the government and the agencies working in the area.

Most agencies were unable to work for the landless due to the strict program timeframe set up by their donors. Although they realize that majority of the vulnerable and the poorest population are those who live outside the storm surge protection embankments with many living on government owned Khas land (some for more than twenty years). Only three implementers (including the Government) directly addressed the issue whilst the rest preconditioned their shelter recipients to produce any form of land agreement document (rental, tenant or owner) before they could receive any house. Currently, only one agency is continuing its advocacy work with the government to address shelter need of the landless population. They also mobilized the community with the help of local agencies working in the area to press the local leaders to address their need. They did this by saying that they will not vote for him unless their legal landownership process are not taken care of. This sets a good community empowerment example by using post-disaster time pressure and political interest in favor of urgent shelter need (Kabir, 2009).

5.1.2 Soft Component

At the initial stage, organizations were much more concerned with the emergency needs and responses. A number of NGOs provided food and non-food (cloths, wallet etc.) items to the affected families. Medical care, temporary shelter materials and wash kits were distributed by a numbers of local and international NGOs among the affected households. When we asked the people, they alleged that government support is insufficient. The vast majority of the affected people are still out of any formal and informal relief program. Even though many national and International NGOs are active in the area, however lack of co-ordination among themselves and between Government and NGO driven programs has been identified as major problem in recovery work, as claimed by many of the respondents in the study area. Our study reveals that worse affected people of Gabura are not getting any micro-credit opportunity from NGOs. However, some sorts of credit facilities have been found at the less affected areas of Shyamnagar, Dacope and Koyra.

The Department of Forest, under the Ministry of Environment and Forest has undertaken a project titled "The Coastal Greenbelt Project" for the period 1995-96 to 2001-2002. The project will cover 12 coastal districts of Bangladesh such as Barisal, Jhalkati, Patuakhali, Borguna, Bhola, Bagerhat, Pirojpur, Lakshmipur, Noakhali, Feni, Chittagong, and Cox's Bazar. The main objectives of the project are to prevent loss of life and damage to property by cyclone, storms, and associated tidal surges; protect and improve the coastal environment through increased vegetative cover in the project areas; help poverty alleviation of the local rural population by generating supplementary income opportunities by augmenting tree cover in the coastal region; contribute to the government objectives for increasing the country's forest resources; help increase the stability of the coastal embankments; help establish cottage industries based on forest products to be grown in plantation; find multiple uses for land along the roadsides railways, feeder roads, and embankments, rather than keeping the land fallow; enrich homesteads of the coastal region with trees that produce timber, fuel-wood, and fruits; and impart training to youth and elderly regarding raising nurseries and growing trees, and create awareness among people with regard to forest management that leads to income generation, and self-reliance (SoE, 2001).

5.1.2.1 Policy, Guidelines and Advocacy

Lack of clear reconstruction policy from the government and a delay to formulate technical guidelines was seen as one of the key challenge by many agencies by the Shelter Working Group. The shelter-working group was formed by the implementing member agencies as important platform to share information and also to establish a technical sub-working group where it identifies hazard resilient construction options. This group proved to be useful for some of the member agencies that undertook core shelter response. Another sub-working group was established within the shelter-working group, to look into the housing need of around 30% of the affected population who are landless and to provide shelter and settlement planning options (Kabir, 2009). Due to the lack of any donor funding and less interests among the working group members to be

engaged on policy issues, this group dissolved after few months. Despite of this, some agencies found their way to provide shelter for the landless families by working with the local government.

5.1.2.2 Leadership and Coordination

During the cyclone Sidr recovery, an interim government was running the country. This resulted into lack of distinct leadership and affected the reconstruction and recovery coordination. This is evident in the deadlock of the Indian government funded housing scheme, as the families, who were selected to receive Shelter Assistance from the Government of India are still without a house. Even after cyclone Aila in May 2009, the lack of strategic leadership resulted in less donor's interest and less fund mobilization. On the other hand, the Shelter Working Group established after cyclone Sidr is still proactive for ensuring a continuation for a coordinated recovery and reconstruction process by its member agencies. Therefore, strategic leadership is needed and coordination among various ministries, district and local administration and NGOs are important to cope with crisis resulting from natural calamities (Kabir, 2009).

5.1.2.3 Transparency and Accountability

From the survey it has been seen that most of the local people claim that a significant amount of relief do not reach to them due to the corruption. Usually it is found very common in Bangladesh. In order to solve this problem transparency in each and every administration sector is must. People in these sectors should obey government rules and regulation with honesty, loyalty and responsibility. Higher administration should form a review team to the affected area to evaluate that either the distribution process is working effectively or not.

5.2 Intervention

The intervention strategy must be emphasized to recover the shelter, pre-living condition and the restoration of damages, losses and resources.

To implement this intervention, following activities need to be carried out:

1. Identification of Safe Land for Landless
2. All materials should be durable and reusable
3. An integrated shelter planning
4. Core Shelter Model within Time Limitations

The Recovery Interventions highlighted two different processes:

a) Core Shelter Programming:

It is important to consider salinity during selection of housing materials, as salinity is one of the persistent risk factors for strong houses in the area. This intervention will generate a lot more livelihood opportunities for jobless people in the disaster affected areas.

b) Model Shelter Construction:

The construction of ‘Model Shelters’ can be an effective solution when a large portion of the target community is able and is in the process of rebuilding their own shelters. In the construction of the model shelter, skilled and unskilled members of the community that will be involved in the construction of future houses are invited to learn new construction techniques that improve the structural strength and disaster resistance of the houses they construct.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Climate change has significant impact on people of Bangladesh living in coastal area. It has changed the life style and destroyed the livelihood options. Floods are getting more common, storms are hitting frequently with more intensity and salinity is increasing day by day with loss crop productivity. The food production is under pressure and habitats of plants and animals are threatened.

The effects of a natural disaster or a combination of more than one natural disaster have direct loss of life, and causes serious damage to assets or physical properties. The impacts of disasters vary with their type and magnitude. The consequences of these natural hazards and the resulting environmental degradation pose a serious threat to the economic development of the country. Hence, it requires considerable resources and efforts for disaster management which is a combination of mitigation, recovery and preparedness. Therefore, the situation calls for an effective disaster warning and dissemination system. It also critically depends on institutional strength and response by the different agencies that usually take measures to mitigate and eventually overcome the losses.

The study on frequent natural calamities revealed many vital aspects of the disaster problem which should have been considered and they can be put forwarded by the development practitioners, government and other stakeholders. The results of the study indicate that the climate factors of Satkhira are sensitive to diarrhea, skin disease and malnutrition as each of these diseases was found to have positive correlation with at least one of the climate variables mentioned in the study. Moreover, skin disease and malnutrition are more or less highly correlated with all three climate variables (rainfall, temperature and salinity).

Natural disasters cannot be prevented, but the damage can be mitigated with adequate planning and adaptation. Proper pre-disaster preparedness programs should be further enhanced to empower the community on the matter and where door-to-door awareness

campaigns can enhance the capacity building activities of communities. A mechanism should be applied to repair and maintain cyclone shelters regularly, so that during the disasters people can use them in a right way.

6.2 Recommendation

The case study finds that the people living in coastal area of Bangladesh are highly vulnarable to frequent natural disaster, and so mitigation measure must be introduced to reduce the impact and save people from suffering. It is true that the occurance of the disasters cannot be stopped but proper management will help to minimize the loss. Therefore, following recommendations are made:

1. Timely alert for the natural disaster must be improved so that all people can prepare themselves before the natural disaster strike. Many lives and movable belongings can be saved if people are alerted in due time. They can go to safer place as soon as possible and the fisherman fishing in the sea will get enough time to return and stay safe.

2. People must reserve some food and medicine for the hard time. During the time of disasters people suffer for food mostly. If they can reserve some dry food for that time, it will help them to fight the sufferings.

3. Many people loose their houses and become shelterless during the natural hazards. So,building houses using ferrocement can protect the houses even after the disaster. Building houses with ferrocement can be cost effective and the Government should assist them to get loan for contructing houses.

4. Number of deep tubewell must be increased so that it will not contaminate with the salty sea water. The people will get fresh water even after the disaster.

5. Number of cyclone shelters must be increased and the facilities in the cyclone shelter must be improved. Sanitation facilities should be upgraded to the standard level. Location of cyclone shelter should not be far away and easily accessible.

6. People must have easy access medical facilities during the disaster period. People often become sick after the disaster and they need mecical treatment badly. If they get eoungh medical attention it will reduce their sufferings.

7. People become financially broke. So government can arrange interest free long term bank loan which will help them to become self relient.

8. The literacy rate must be increased so that they can switch to other option for livelihood. Without the light of knowledge their suffering will never end.

REFERENCES

Ahmed, A.U., (2006). Bangladesh Climate Change Impacts and Vulnerability: A Synthesis. Dhaka : Climate Change Cell, Bangladesh Department of Environment.

Ahmed, A.U., Siddiqi, N.A., & Choudhuri, R.A., (1999). Vulnerability of Forest Ecosystems of Bangladesh to Climate Change. In: Vulnerability and Adaptation to Climate Change for Bangladesh.

Agarwala et al., (2005).Intergovernmental Panel for Climate Change (IPCC) Third Assessment Report. Report cited by Government of Bangladesh, Water Resources Planning Organization, Ministry of Water resources, Bangladesh; National Adaptation Program of Action, Dhaka.

Agrawala, S, Ota, T, Ahmed, A. U, Smith, J, and Aalst, M. V., 2003. Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans, OECD.

Buet, (2008). Field Investigation on the Impact of Cyclone SIDR in the Coastal Region of Bangladesh.

BCAS, 2010. Gender and Climate Change Issues in the South Central and South West Coastal Regions of Bangladesh.

BBS, (2001). "Information on Khulna and Satkhira District", Community Series, Bangladesh Bureau of Statistics, Dhaka, Bangladesh.

Barua, P., Chowdhury, M. S.N., (2010). Climate Change and Its Risk Reduction by Mangrove Ecosystem of Bangladesh. Bangladesh Res. Pub. J. 4(3): 218-225.

DoE, (2009). Impact Assessment of Climate Change and Sea Level Rise on Monsoon Flooding, Climate Change Cell; Department of Environment.

DMB, (2010). National Plan for Disaster Management 2010-2015; Disaster Management Bureau, Disaster Management & Relief Division.

Adger, N., Aggarwal, P., Agrawala, S., Alcamo, J., Allali, A., Anisimov, O., Arnell, N., Boko, M., Canziani, O., Carter, T., Casassa, G., Confalonieri, U., Cruz, R.V., de Alba Alcaraz, E., Easterling, W., Field, C., Fischlin, A., Fitzharris, B.B., García, C.G., Hanson, C., Harasawa, H., Hennessy, K., Huq, S., Jones, R., Bogataj, L.K., Karoly, D., Klein, R., Kundzewicz, Z., Lal, M., Lasco, R., Love, G., Lu, X., Magrín, G., Mata, J.L., McLean, R., Menne, B., Midgley, G., Mimura, N., Mirza, M.O., Moreno, J., Mortsch, L., Niang-Diop, I., Nicholls, R., Nováky, B., Nurse, L., Nyong, A., Oppenheimer, M., Palutikof, J., Parry, M., Patwardhan, A., Lankao, P.R., Rosenzweig, C., Schneider, S., Semenov, S., Smith, J., Stone, J., van Ypersele, J., Vaughan, D., Vogel, C., Wilbanks, T., Wong, P.P., Wu, S., & Yohe, G. (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Intergovernmental Panel on Climate Change: Summary for Policymakers. IPCC Secretariat : Geneva, Switzerland.

Alley, R.B., Berntsen, T., Bindoff, N.L., Chen, Z., Chidthaisong, A., Friedlingstein, P., Gregory, J., Hegerl, G., Heimann, M., Hewitson, B., Hoskins, B.J., Joos, F., Jouzel, J., Kattsov, V., Lohmann, U., Manning, M., Matsuno, T., Molina, M., Nicholls, N., Overpeck, J., Qin, D., Raga, G., Ramaswamy, V., Ren, J., Rusticucci, M., Solomon, S., Somerville, R., Stocker, T.F., Stott, P.A., Stouffer, R.J., Whetton, P., Wood, R.A., Arblaster, D.W.J., Brasseur, G., Christensen, J.H., Denman, K.L., Fahey, D.W., Forster, P., Jansen, E., Jones, P.D., Knutti, R., Le Treut, H., Lemke, P., Meehl, G., Mote, P., Randall, D., Stone, D.A., Trenberth, K.E., Willebrand, J., & Zwiers, F., (2007). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policymakers. IPCC Secretariat : Geneva, Switzerland.

Chowdhury, A.,(2002). Disasters: Issues and Responses. In: Bangladesh Environment: Facing the 21st Century. (2nd ed.) Ed. Gain, P. Dhaka : Society for Environment and Human Development (SHED).

Choudhury, J.K., & Faisal, A.M. (2005). Nursery and Planting Techniques of Wetland Plants. Ed. Nishat, A. Dhaka : IUCN-The World Conservation Union Bangladesh Country Office.

Christian Aid, 2006. The climate of poverty: facts, fear and hope. Eds. Cunningham, M., & Jacques, A. London : Christian Aid.

Christian Aid, 2007. Adapting to inevitable changes in the climate. Climate Change: Policy and Approach. (A Global Advocacy Briefing). London : Christian Aid. 8.

Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton., (2007). Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

McGranahan, G., Balk, D., & Anderson, B., (2006). Low coastal zone settlements, Tiempo. 59. 23-26.

Mirza, M.M.Q., (2002). Global warming and changes in the probability of occurrence of floods in Bangladesh and implications; Global Environmental Change.

Bashar, M. A., (2011). Climate Change: Coastal ecosystem too vulnerable to sea level rise, retrieved on 05 April, 2012 from http://www.thedailystar.net/newDesign/news-details.php?nid=176381.

Tanner, T.M., (2005). Responding to Climate Change ,International Workshop on Community Level Adaptation to Climate Change. Organized by: Bangladesh Centre for Advanced Studies, IIED, CIDA, IUCN & The Ring. Pan Pacific Sonargaon Hotel, Dhaka, 16th – 18th January, 2005.

Tanner T.M., Hassan, A., Islam, K. M. N., Conway, D., Mechler R., Ahmed, A.U., and Alam, M., (2007). ORCHID: Piloting Climate Risk Screening in DFID Bangladesh, Detailed Research Report (Draft). Institute of Development Studies, University of Sussex, UK.

Chowdhury, A., (2002). Disasters: Issues and Responses. In: Bangladesh Environment: Facing the 21st Century (2nd ed.) Ed. Gain, P. Dhaka : Society for Environment and Human Development (SHED).

Nicholls, R.J., Hoozemans, F.M.J., Marchand, M., (1999). Increasing flood risk and wetland losses due to global sea-level rise: regional and global analyses, Global Environmental Change 9, pp.S69-S87.

Islam, M.R. (Ed.), (2005). Coastal Zone, An Information Source (in Bangla), Integrated Coastal Zone Management Project Development Office (ICZM-PDO), Water Resources Planning Organization (WARPO), Dhaka, p. 161.

DHV-WARPO, (2000). Gorai River Restoration Project: Draft Feasibility Report (Main Volume), DHV Consortium and Water Resources Planning Organization (WARPO), Dhaka.

SoE, (2001). Report: Natural Disasters, BANGLADESH: STATE OF THE ENVIRONMENT 2001

Halcrow-WARPO, (2001). National Water Management Plan Project, Draft Development Strategy, Vol 11, Annex-O:Regional Environmental Profile, Halcrow and Partners, and Water Resources Planning Organization (WARPO), Dhaka, pp. 57-74

Shushilan, (2011). A Follow Up Rapid Food Security Assessment in Satkhira in the Context of August 2011 Flood and Water Logging (Shushilan report 2011, December).

Kabir, R., (2009). Post-Cyclone Sidr Family Shelter Construction in Bangladesh Documentation of Plans and Processes

Kumar U., Baten , M. A., Masud, A. A., Osman ,K. S., M. Mizanur Rahman ,M.M., (2010). Cyclone Aila: One Year on "Natural Disaster to Human Sufferings"

Appendix 1

Questionnaires' for sample Survey

Name:

Gender:

1. What is your occupation?

a. Farmer b. Fisherman

c. Service holder d. Businessman e. Others […….]

2. What is your age?

a. < 20 b. 21-30

c. 31-40 d. 40+

3. What is your educational level?

a. Primary b. SSC level

c. HSC level or more d. Can't sign his name

4. What is your income range?

a. Below 5000 b. 5001- 8000

c. 8001-12000 d. 12000+

5. What is no. of family members?

a. 2 b. 3-5

c. 5+

6. What are the major natural disasters in this area?

a. Flood b. Cyclone

c. Tidal wave d. Others […….]

7. What was the time of the last disaster?

a. > 1 year b. 1-2 years

c. 2-5 years d. 5-10 years

8. How many disaster hit this place in a single year?

a. One b. Two

c. Three d. More than three

9. What was the most devastating disaster?

a. Flood b. Cyclone

c. Tidal wave d. Others […….]

10. In which time of year most disaster took place?

a. October-December b. January-March

c. April-June d. July-September

11. How you get the alert before the disaster

a. Via radio b. Via television

c. Via local announcement d. Others [……]

12. What is the topographic condition after the disaster?

a. Land becomes Saline b. Erosion c. Others […….]

13. What is the impact on aquatic life?

a. Fishes die b. Salinity increase

c. Food web destroys d. Others […….]

14. What is the impact on forestation?

a. Loss of trees b. Loss of species

c. Loss of green cover d. Others […….]

15. What is the impact on ground water?

a. Salinity increase b. Turbidity increase

c. Arsenic contamination d. No impact

16. Which diseases attack more during natural disaster?

a. Diarrhoea b. Cholera

c. Flu d. Others […….]

17. What is the loss of life?

a. 0- 7 b. 8-20 c. 21-45

d. 46-60 e. 60+

18. What was your personal loss?

a. Loss of houses b. Loss of livestock

c. Loss of crops d. Other assets […….]

19. What was the amount of your financial loss?

a. <5000 b. 5001-15000

c. 15001-25000 d. 25000+

20. In which sector you suffer most during disaster?

a. Food b. Treatment

c. Shelter d. Others […….]

21. How far is the nearest cyclone center?

a. 0-1 km b. 2-5 km

c. 5-10 km d. More than 10 km

22. What is the capacity in that cyclone center?

a. 100-200 b. 201-400

c. 401-600 d. More than 600

23. What is the condition of the cyclone center?

a. Well elevated. b. Strong

c. Weak d. Others […….]

24. Do you get the relief during disaster?

a. Yes b. No

25. What is the main source of relief?

a. Government b. Military

c. Local NGOs d. Others […….]

26. Is there any Emergency medical facility available after the disaster?

a. Yes b. No

27. How much time is needed to mitigate the effect of disaster?

a. Less than 6 month's b. 6-12 months. C. More than one year.

28. Do you think the villagers are aware about these frequent disasters?

a. Yes b. No

29. What sort of assistance do you require after the disaster?

a. Financial b. Logistic

c. Food c. Food support.

Comment (If any):

Appendix 2

Checklists of FGD

1. Identify the most vulnerable groups and the causes of their being the most vulnerable.

2. Context wise climate change related disasters and externalities variability and vulnerability of women and men- Before Disaster, During Disaster and After Disaster , Livelihood, Food, Clothing, Shelter, Safe Water, Health, Sanitation, Social Security, Land, Trees, Agriculture, Fisheries Resources and Livestock.

3. Describe the climate change related vulnerabilities.

4. Roles of NGOs vs. Government.

5. Initiative before disaster.

6. Impact on fisheries and livestock.

7. Topographic condition before and after the disaster.

8. Changes of livelihood pattern due to the disaster.

9. Aid after disaster.

10. Sources and types of relief.

Appendix 3

Key issues for interview

1. What kind of individual and collective actions can play a significant role in enhancing community in adaptation to climate change by women and men?

2. How do different adaptation measures impact on affected people?

3. Who is more vulnerable- men or women? If women, why are they vulnerable?

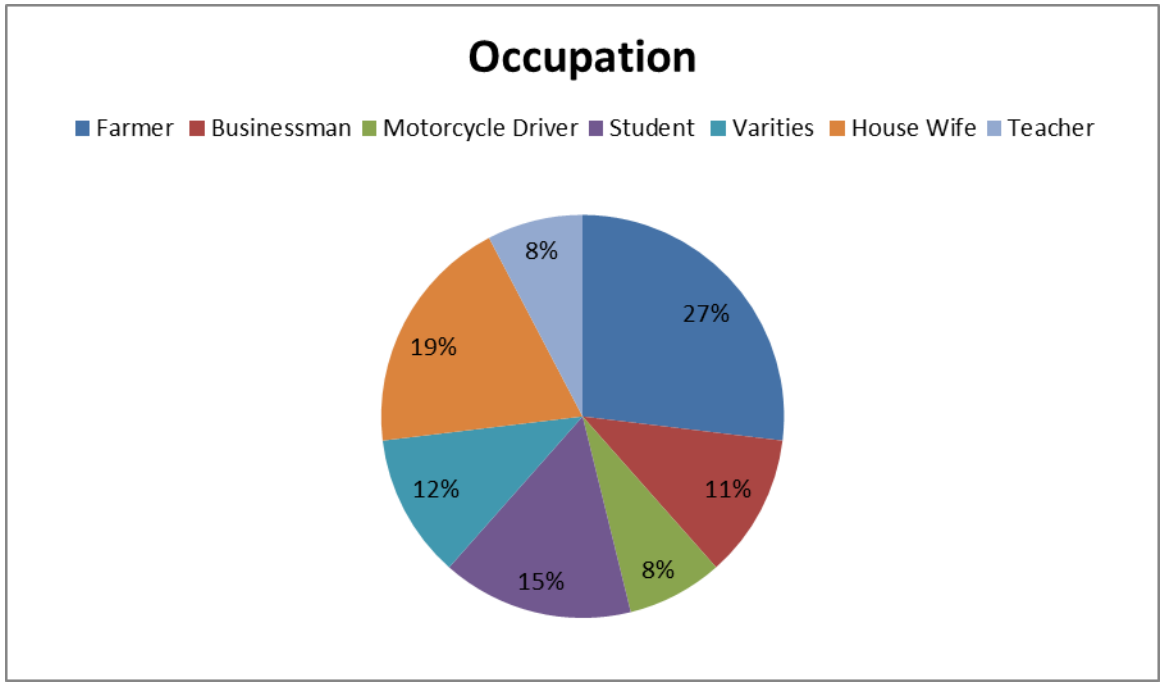
4. What kinds of measurement and mechanisms have been developed to assist different types of vulnerable groups in adapting to climate change?

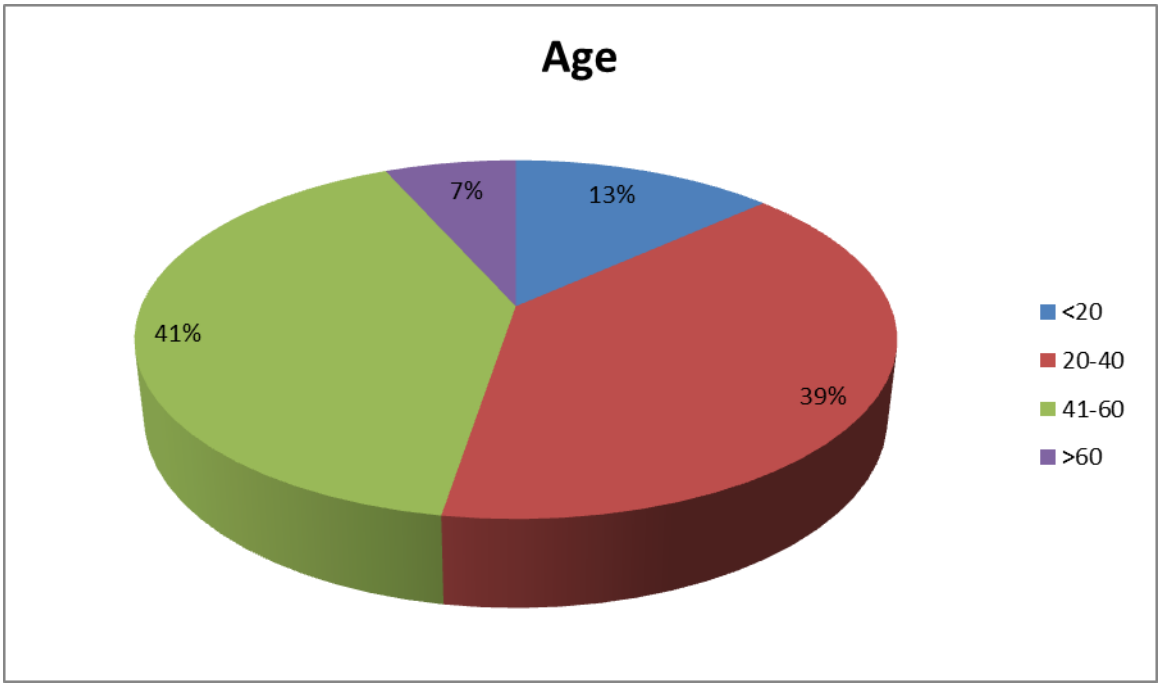
5. What kinds of adaptation measurement have they developed for themselves?

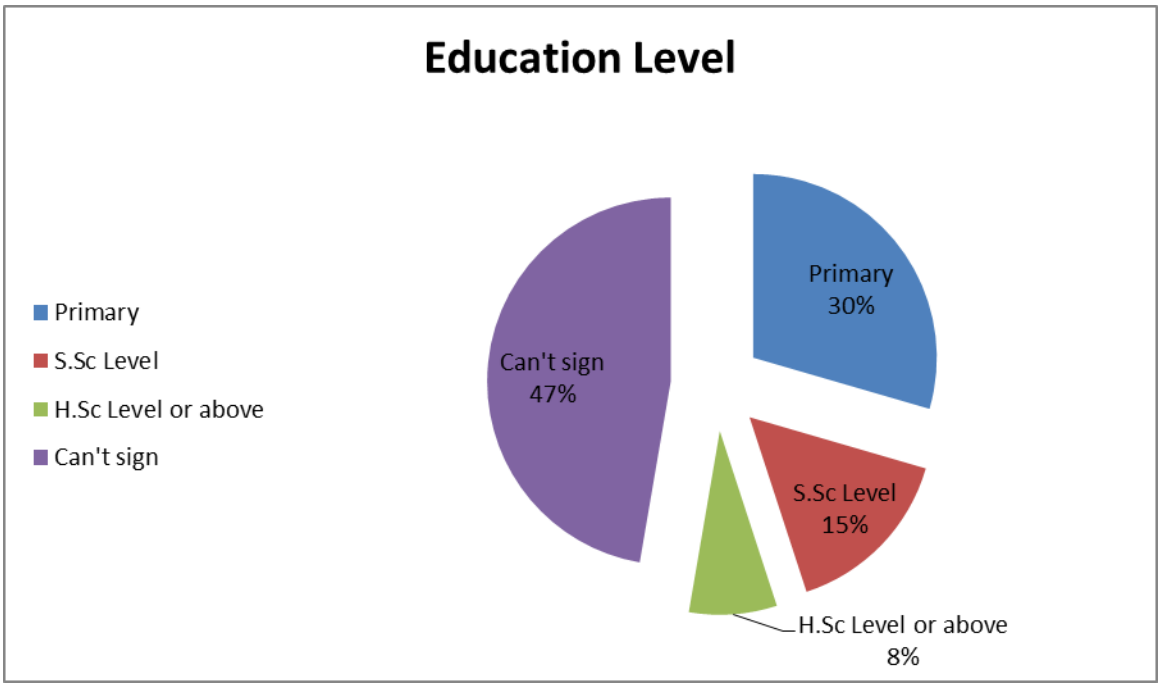
6. What do you think why and how Satkhira is more vulnerable than any other areas?

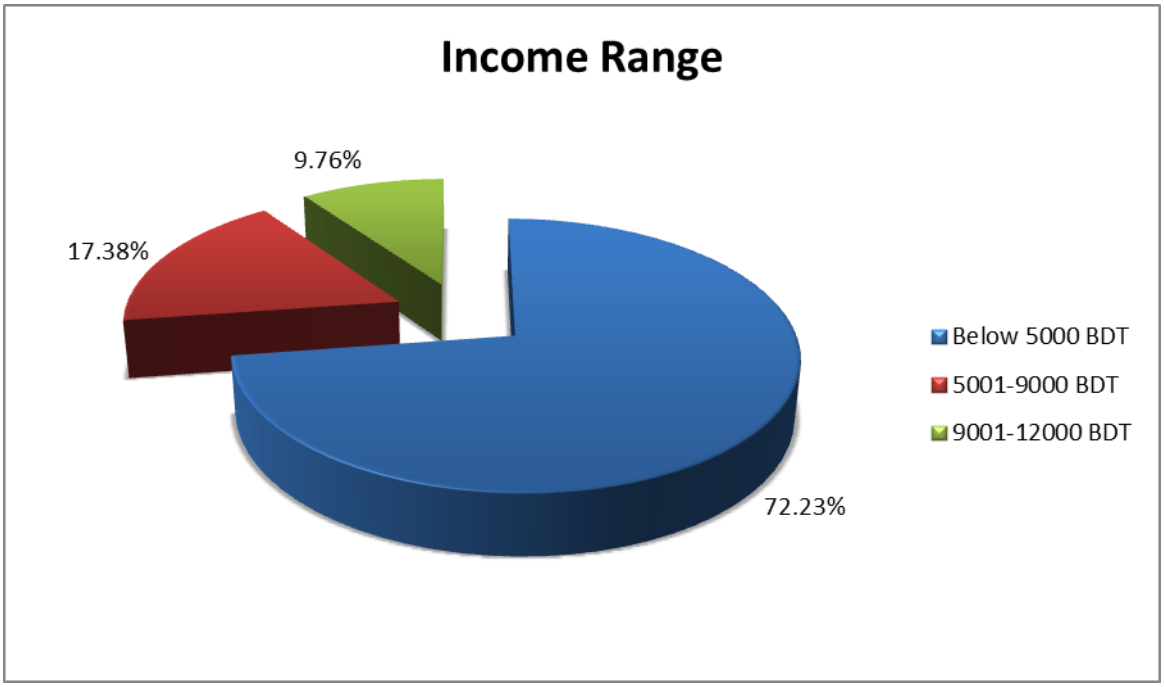
Appendix 4

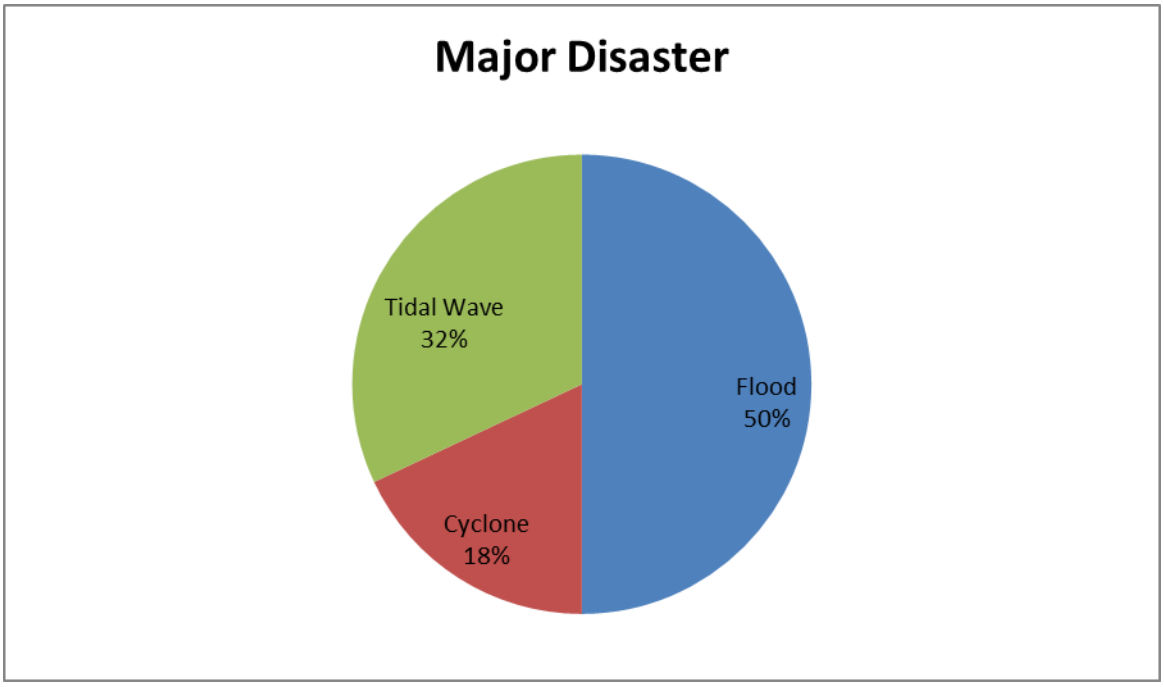
Findings from sample survey

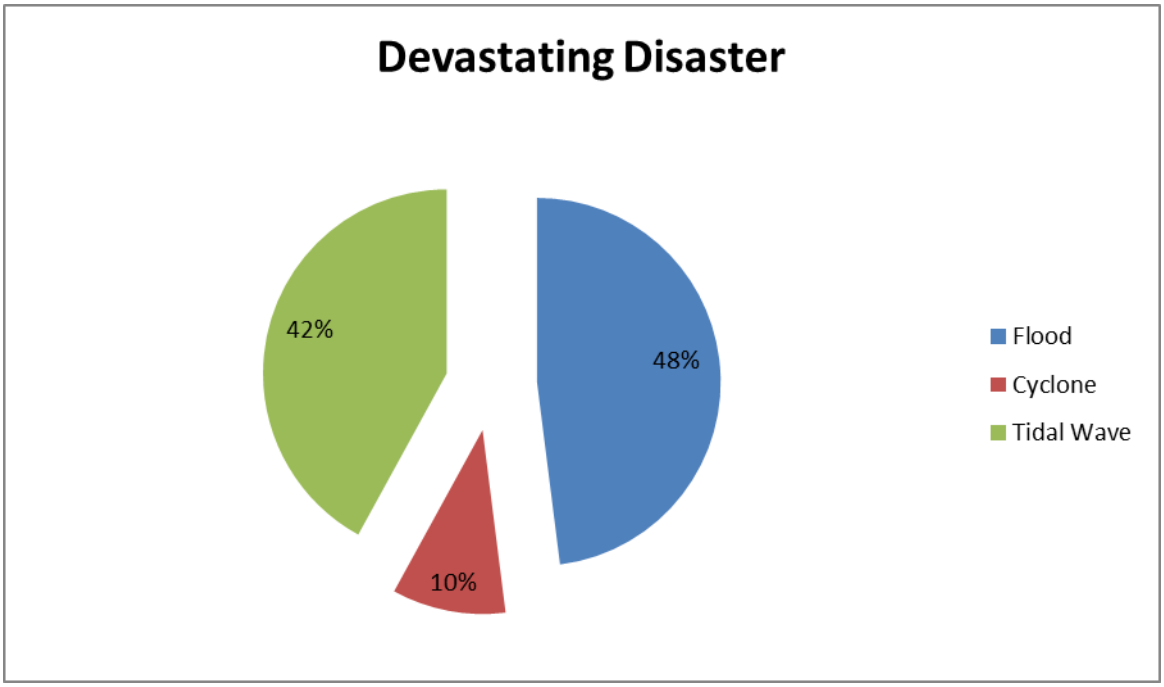


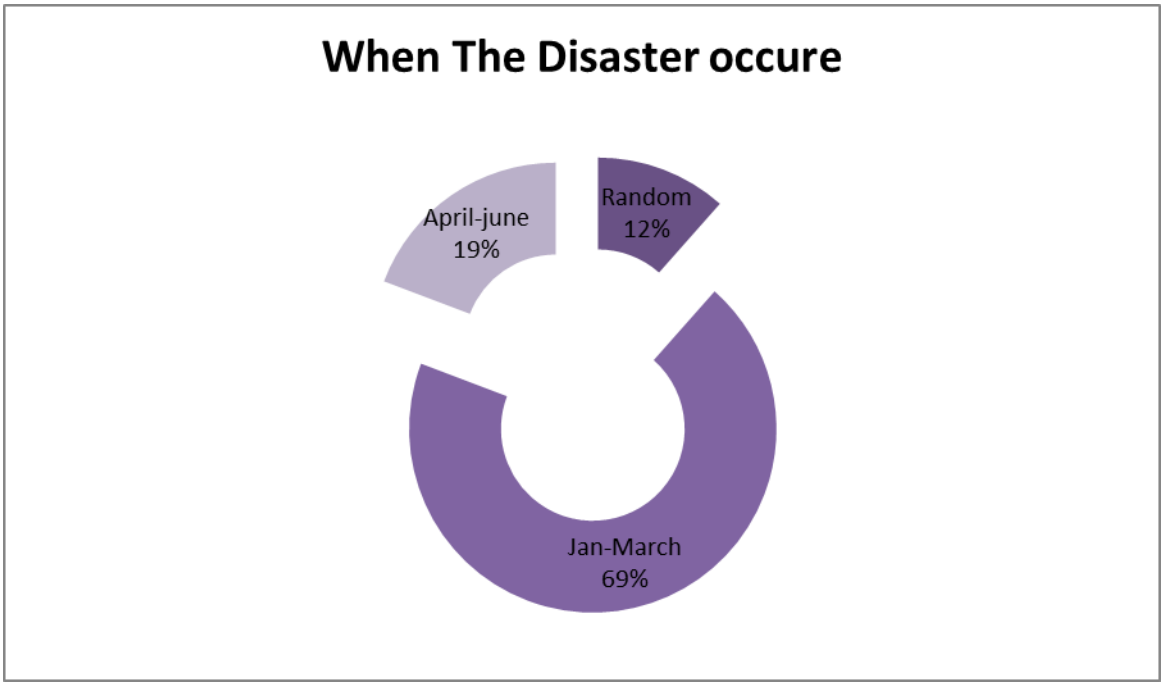

Age
7%
13%
41%
39%
<20
20-40
41-60
>60

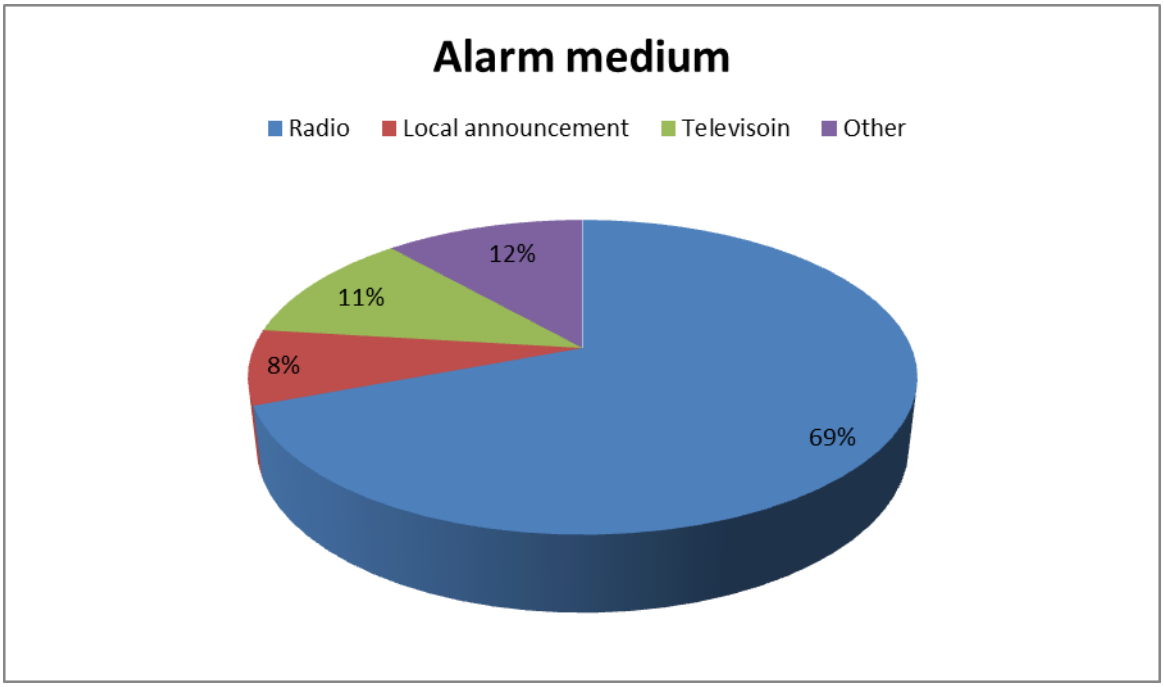

Education Level
Primary
S.Sc Level
H.Sc Level or above
Can't sign
Primary
30%
Can't sign
47%
S.Sc Level
15%
H.Sc Level or above
8%

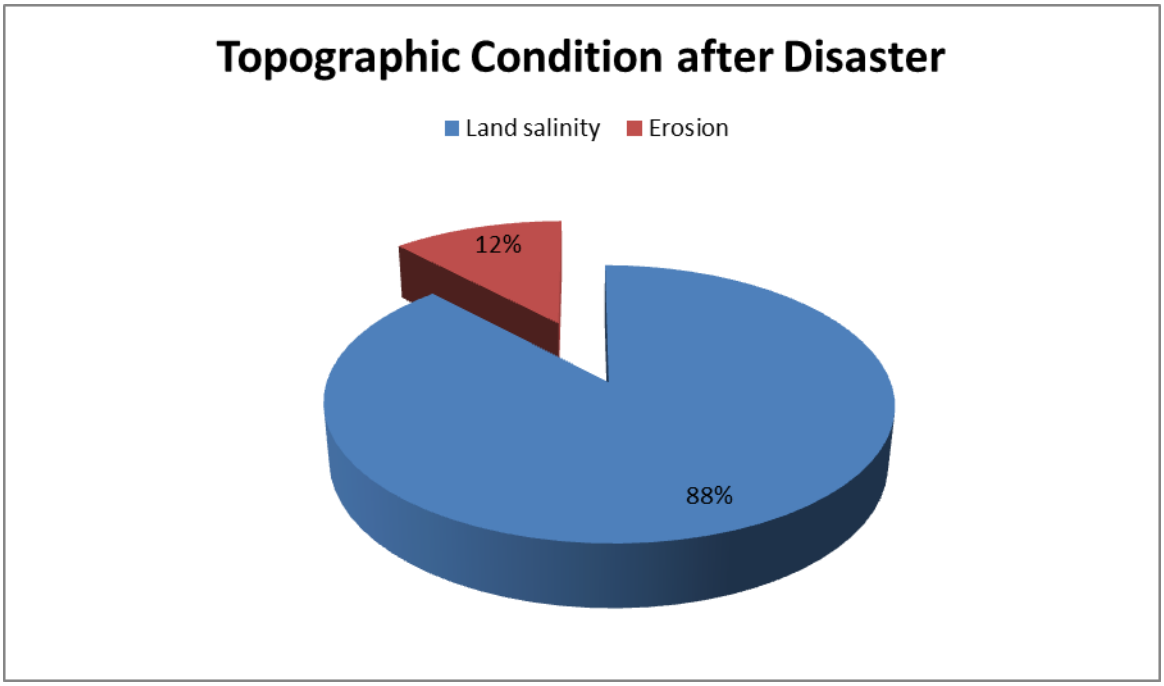

Income Range
9.76%
17.38%
72.23%
Below 5000 BDT
5001-9000 BDT
9001-12000 BDT

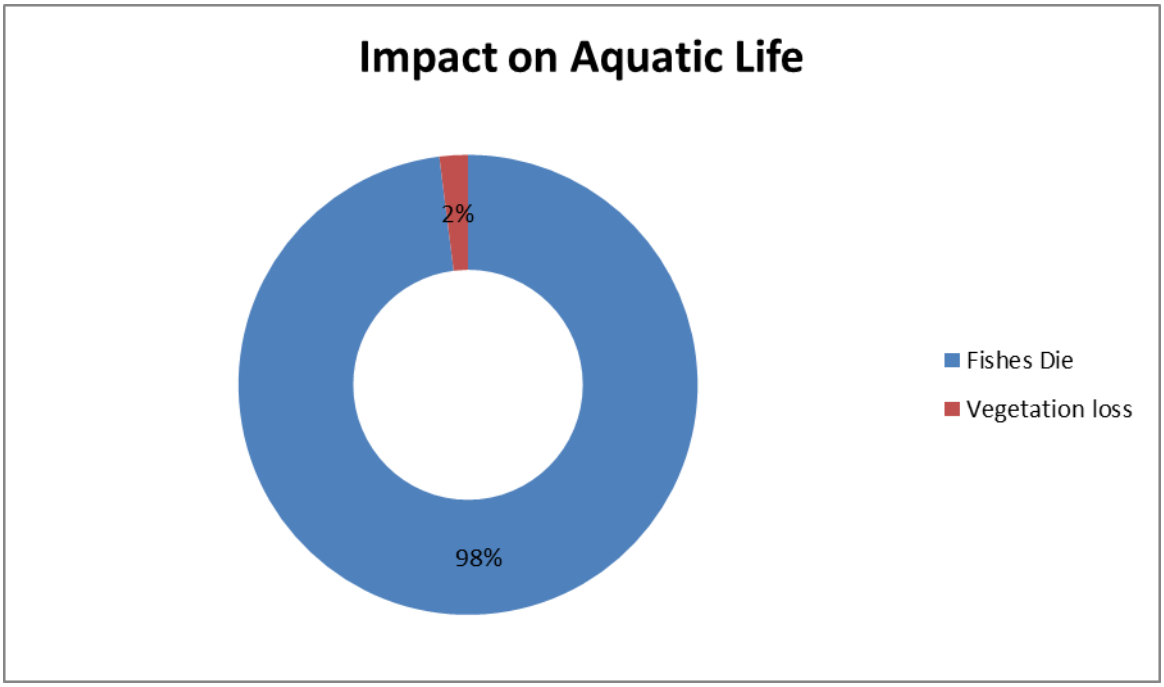

Major Disaster
Tidal Wave
32%
Flood
50%
Cyclone
18%

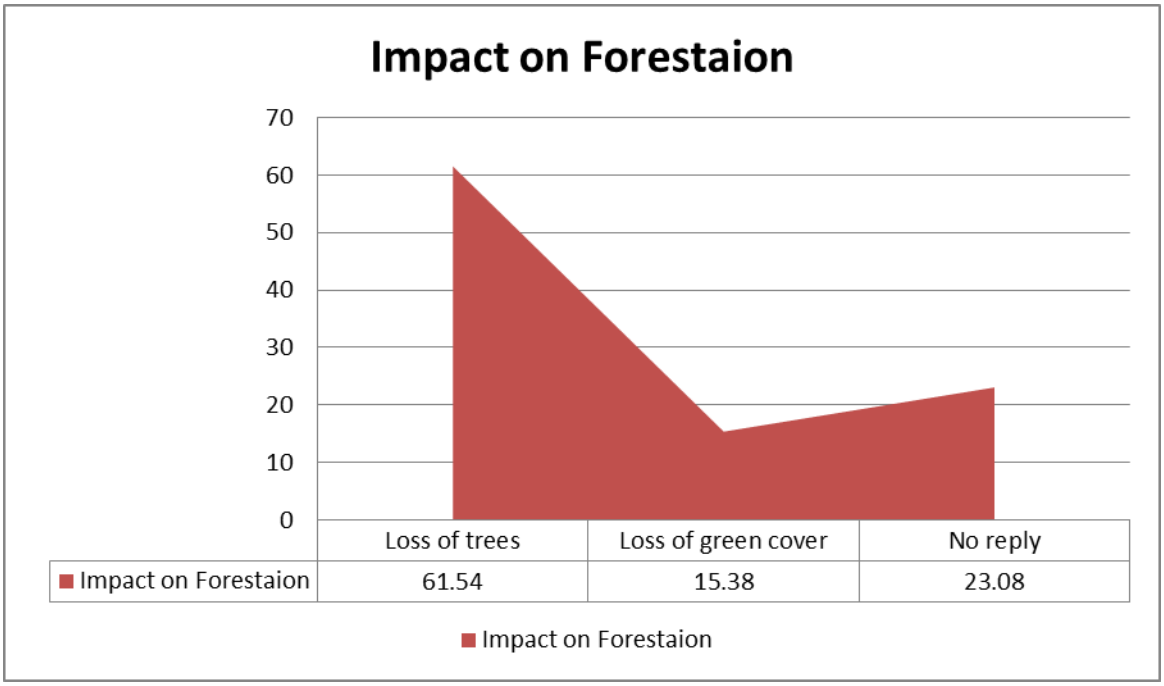

Devastating Disaster
42%
48%
10%
Flood
Cyclone
Tidal Wave

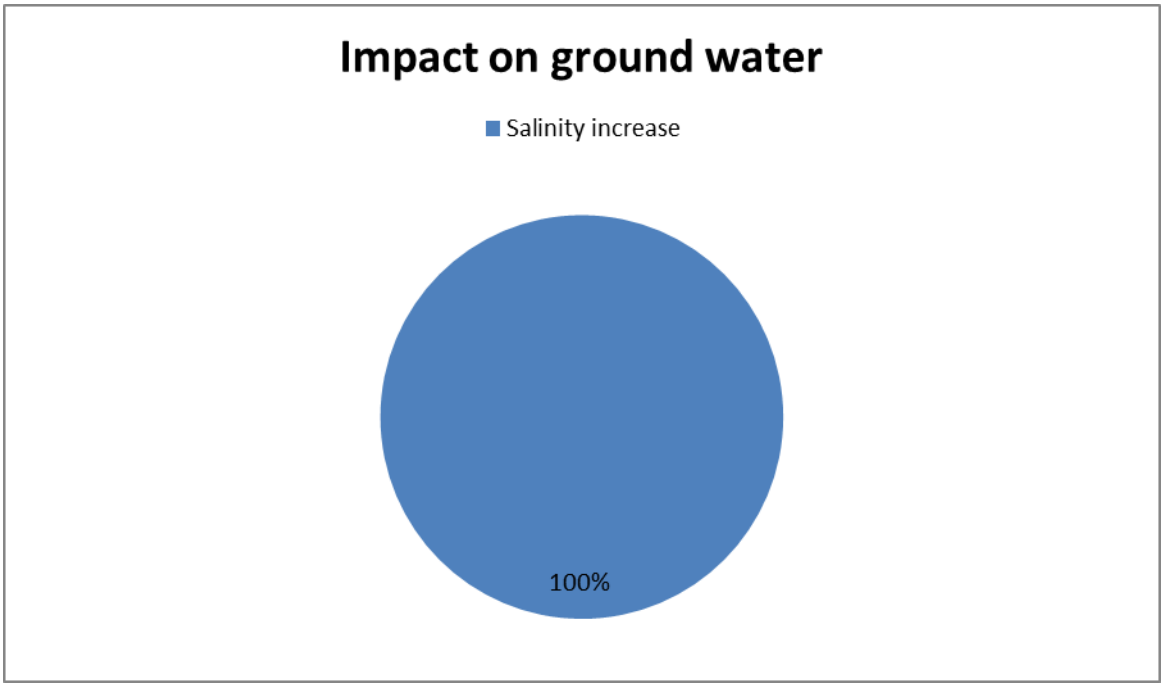

When The Disaster occure
April-june
19%
Random
12%
Jan-March
69%

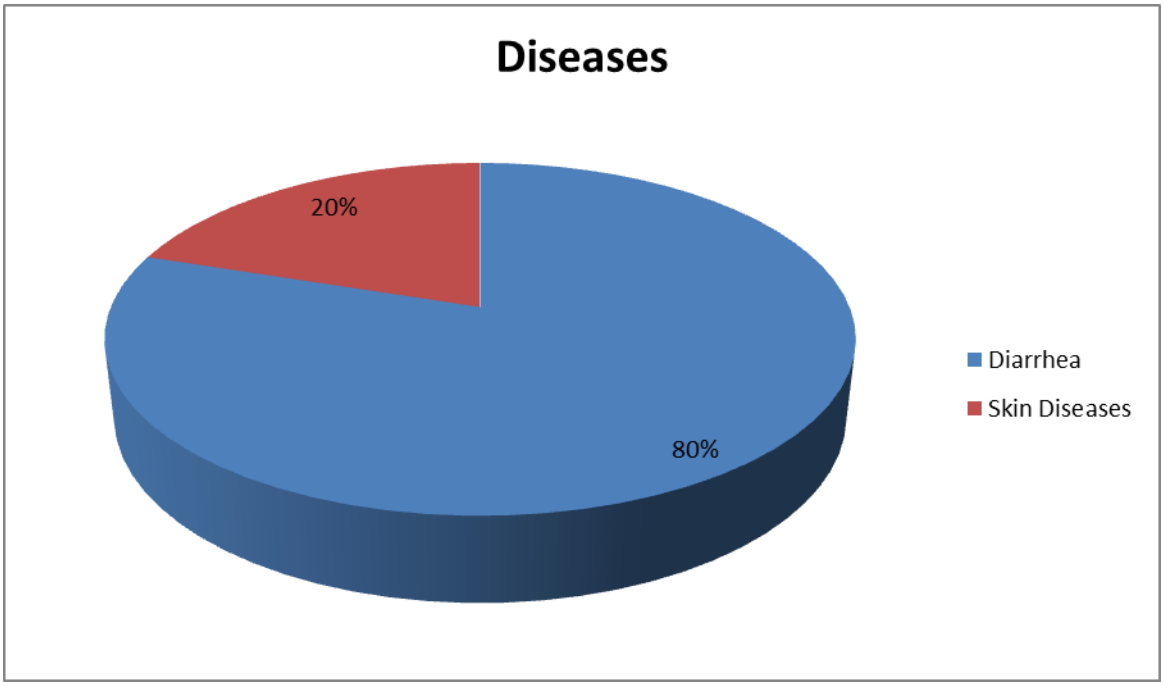

Alarm medium
Radio
Local announcement
Televisoin
Other
12%
11%
8%
69%

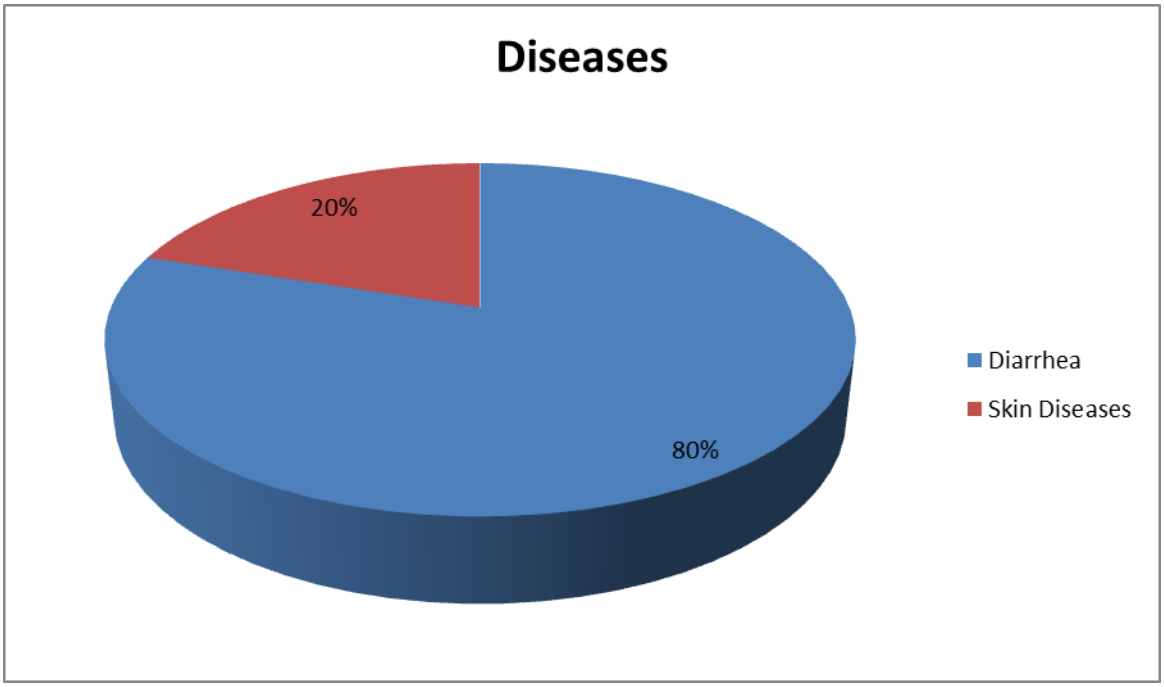

Topographic Condition after Disaster
Land salinity
Erosion
12%
88%

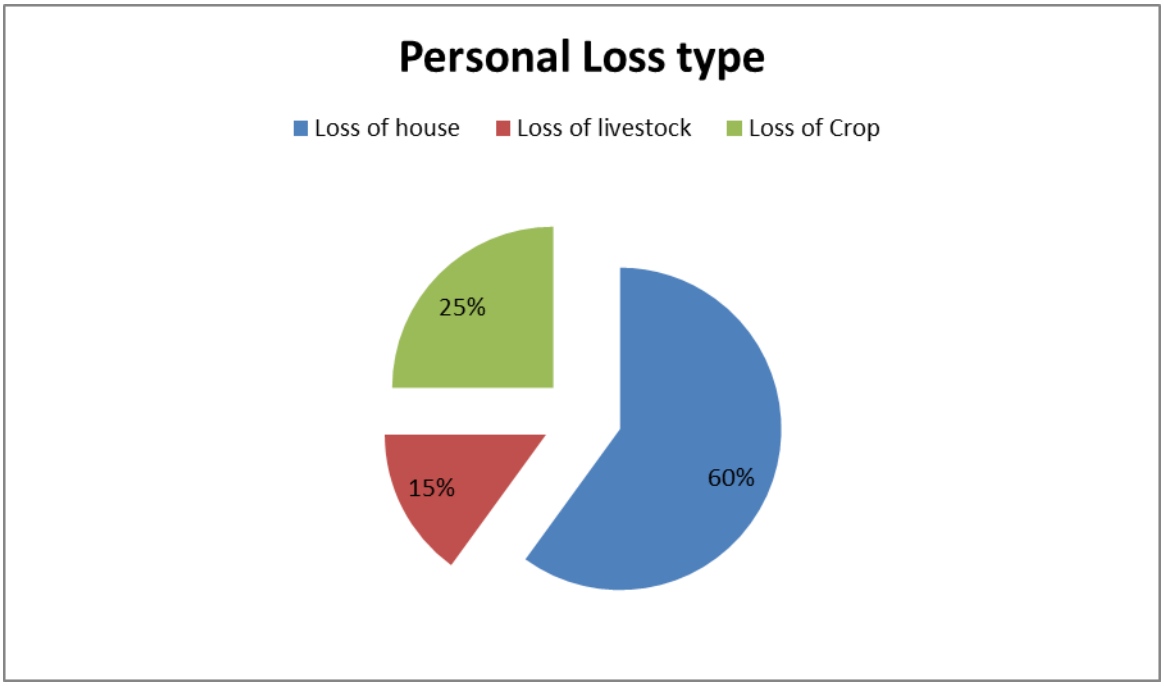

Impact on Aquatic Life
2%
98%
Fishes Die
Vegetation loss

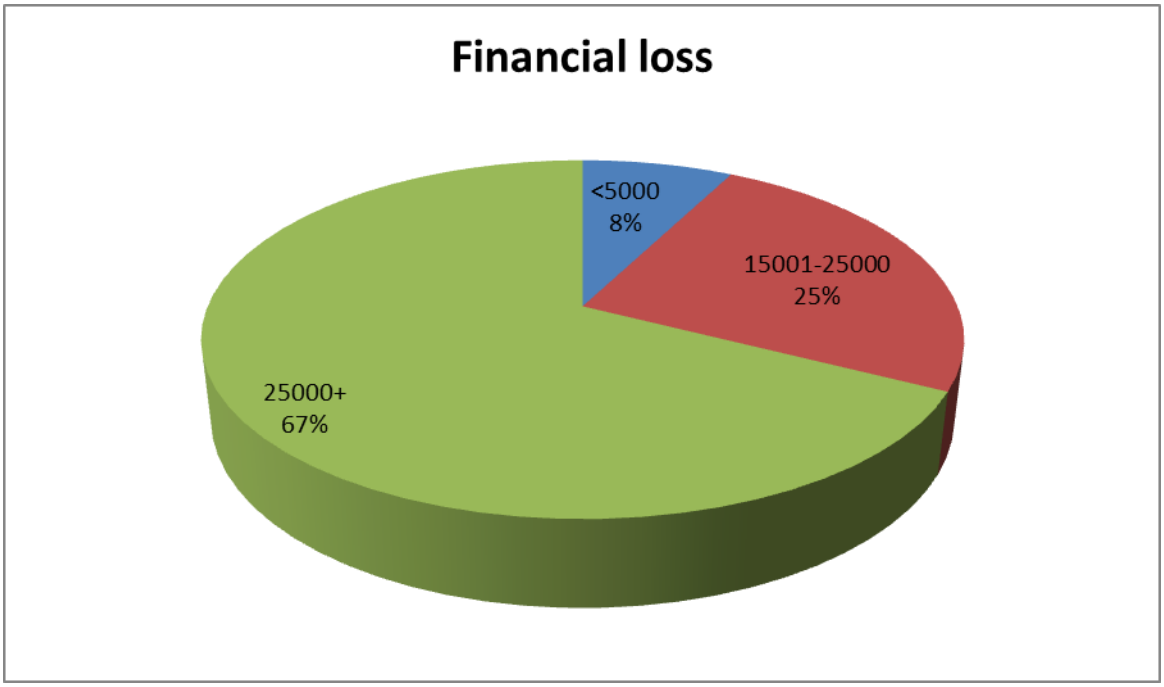

Impact on Forestaion
70
60
50
40
30
20
10
0
Loss of trees
Loss of green cover
No reply
Impact on Forestaion
61.54
15.38
23.08
Impact on Forestaion

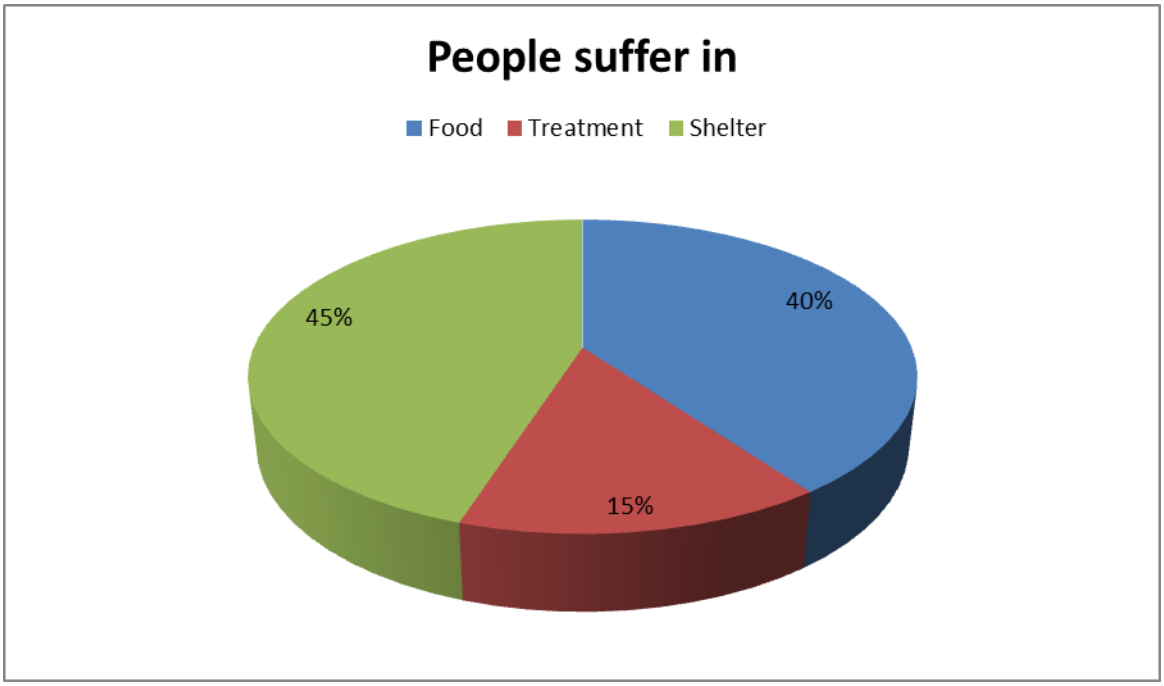

Impact on ground water
Salinity increase
100%

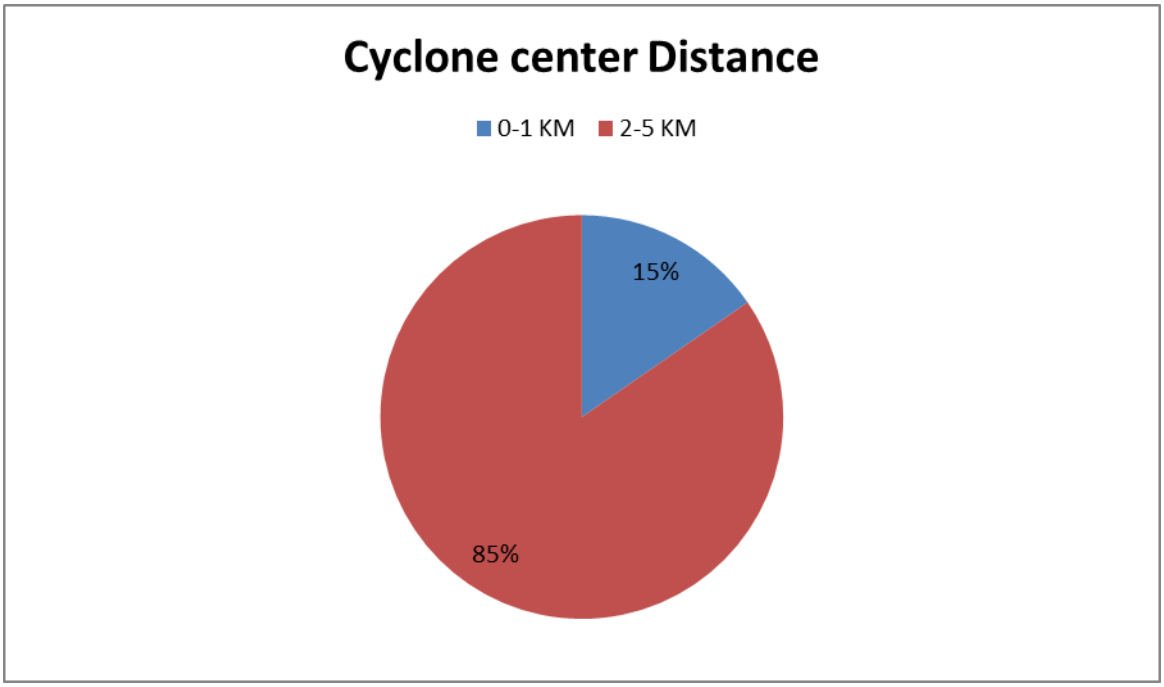

Diseases
20%
80%
Diarrhea
Skin Diseases

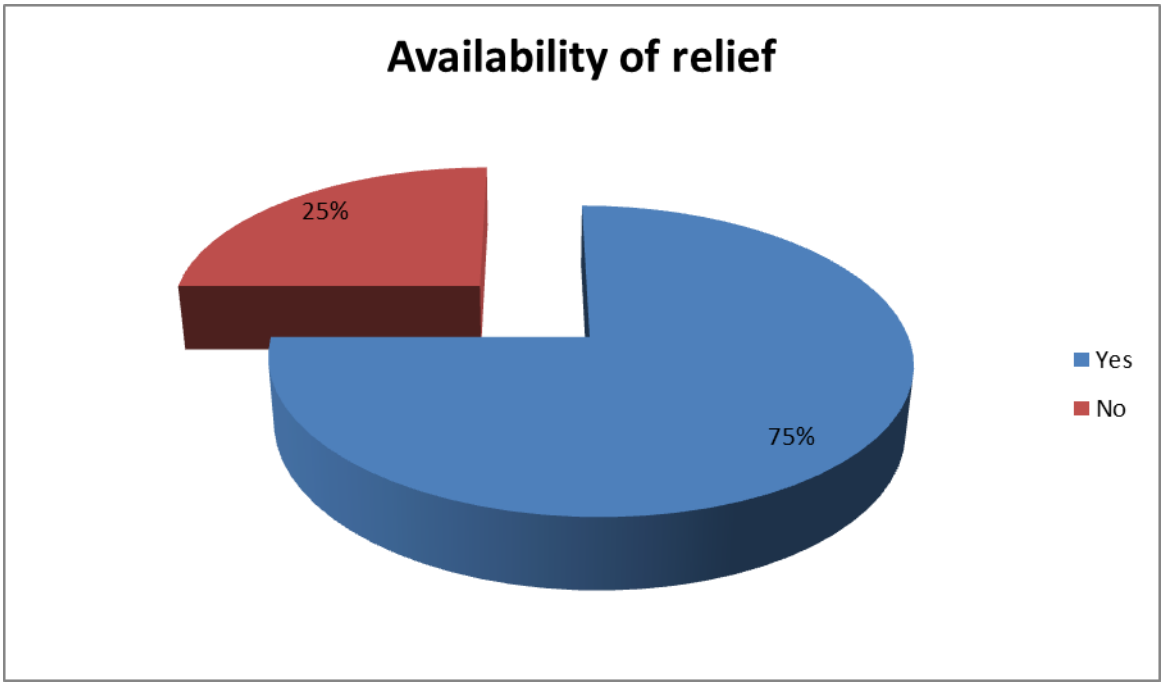

Diseases
20%
80%
Diarrhea
Skin Diseases

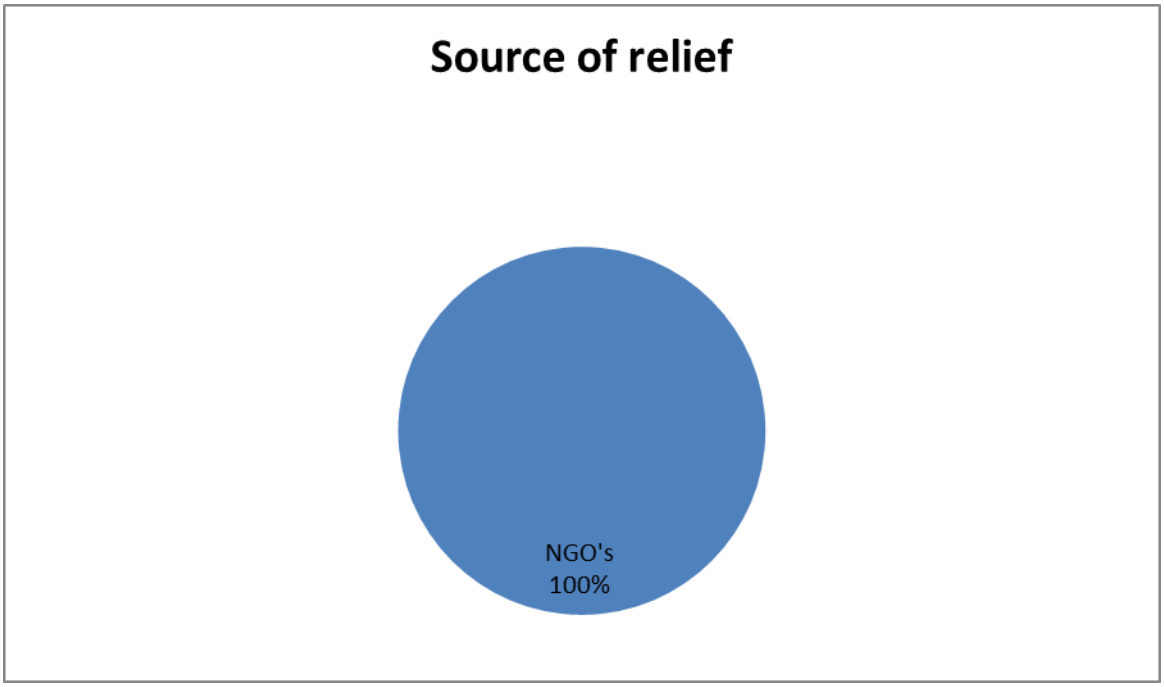

Personal Loss type
Loss of house
Loss of livestock
Loss of Crop
25%
15%
60%

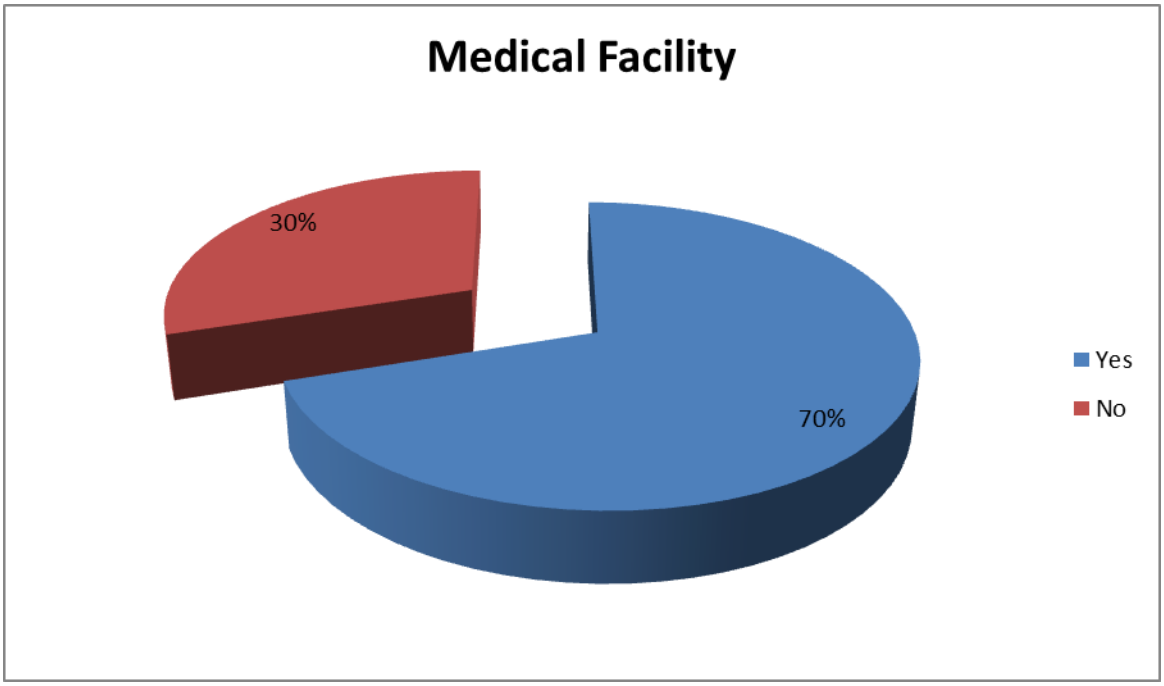

Financial loss
<5000
8%
15001-25000
25%
25000+
67%

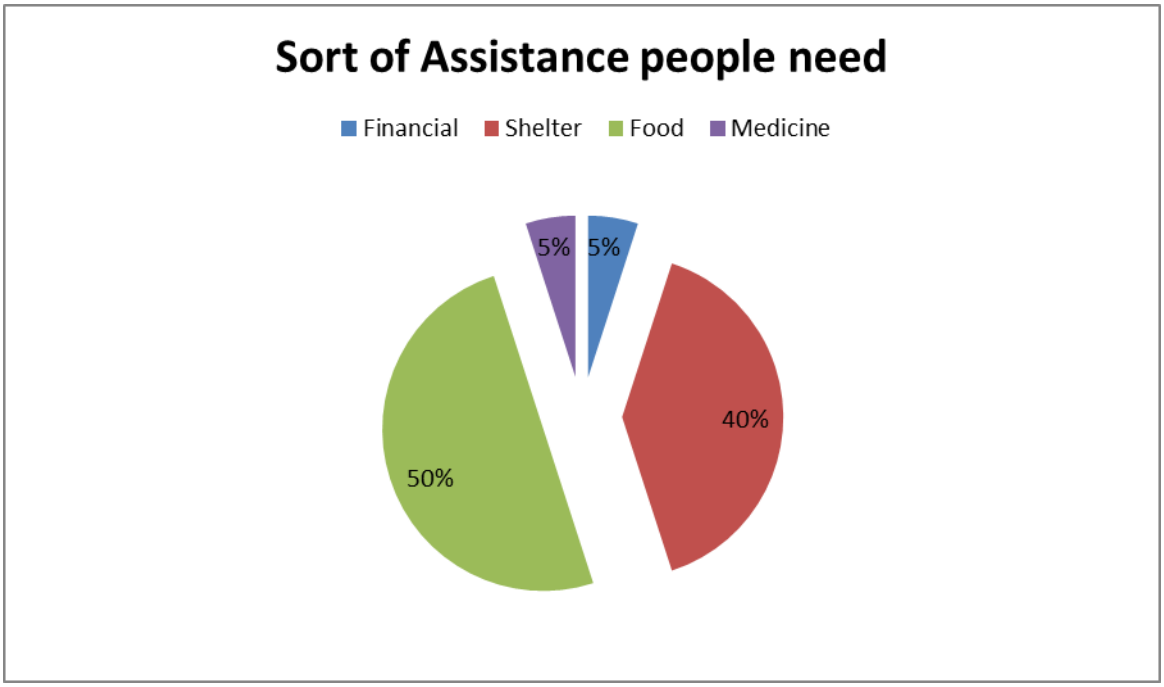

People suffer in
Food
Treatment
Shelter
40%
15%
45%


Cyclone center Distance
0-1 KM
2-5 KM
15%
85%


Availability of relief
25%
75%
Yes
No


Source of relief
NGO's
100%


Medical Facility
30%
70%
Yes
No


Sort of Assistance people need
Financial
Shelter
Food
Medicine
5%
5%
40%
50%