LOCAL PEOPLE'S ACCESS TO SAFE DRINKING WATER: A STUDY AT BAGERHAT

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Abstract

The coastal areas of Bangladesh, with near flat topography and location at the tip of "funnel shaped" Bay of Bengal, are susceptible to salinity intrusion and are also frequently visited by natural calamities like floods-cyclones-tsunamis which is making the drinking water sources in those regions unsuitable for the use of the people inhabiting there. Bagerhat is one of such coastal areas of Bangladesh where high salinity in drinking water is a widespread and catastrophic problem that adversely affects people's lives also.The goal of the study is to explore the drinking water sources at Bagerhat and assess local people's adjustment to it. For this study different techniques like interviewing local people with close and open ended questionniare , observation methods etc. have been used. People in the district are using contaminated water from ponds for drinking and household work as most of the Pond Sand Filters (PSF) in government reserve ponds have become inoperative. Besides, private ponds contain saline water as they are being used for shrimp and prawn cultivation.The institution and NGO based projects are inadequate to help these situations. There is also huge lackings in equipments , training, funding , planning and co-ordiantion among different institutions. But one thing can be a great solution of this situation which is to create a mass movement for harvesting and storing rainwater at family, society and UP level through utilizing big rooftops of different types of schools, mosques, madrasas, and other institutions. Government and non-government initiatives are necessary to make it work. Besides, awareness build-up programs among mass people is needed to better off the situation.

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Chapter 1

Introduction

1.1 General background

Research comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications. It is used to establish or confirm facts, reaffirm the results of previous work, solve new or existing problems, support theorems, or develop new theories. A research project may also be an expansion on past work in the field. To test the validity of instruments, procedures, or experiments, research may replicate elements of prior projects or the project as a whole. The primary purposes of basic research which is opposed to research are

documentation, discovery, interpretation, or the research and development of methods and systems for the advancement of human knowledge. Approaches to research depend on epistemologies, which vary considerably both within and between humanities and sciences.

For acquiring knowledge through practical observation there is no other way without observing different physical and socio-economic conditions of various region of a country.Geographers use spatial analysis to define a particular region that process is based on practical analysis rather than descriptive method. Usually as a student of Geography and Environment we get a yearly tour trip somewhere around in Bangladesh. We try to learn many important aspects through it.

Therefore, we are the students of 2017-18 Honors second year students went to Mongla, Bagerhat district. The trip that was conducted consisted of interview sessions, observation sessions and recreational events in and around the study area.

Although the time span of the trip was limited to few days, Observations, regarding the adjustments and adaptations of the inhabitants and the geography of the study area were noted throughout the trip. The focus of the research report would be on the general drinking water sources and the adjustments strategies of the local people inhabiting there.

1.2 Objectives of study

The main objective of our field trip was to

- Explore drinking sources at Bagerhat
- Assess local people's adjustment with safe drinking water

The objectives of the study are mentioned below:

- **Explore drinking water sources**: The purpose of this was to identify the drinking water sources of the local people and how they collect, mange, store and utilize it.

- **Assess local people's adjustment with safe drinking water:** The objective of this was to find out how the local people at different levels of the society are adjusting to the situation of the scarcity of safe drinking water due to salinity intrusion in that area.

1.3 Justification

To find out how the local people are managing their drinking water in such situation and adjusting with it, it is important to do some sort of research to get the answers and help their basic need. Physical, human and socio-economic analysis is a way of knowing about the relationship among man and environment. We completed an observation on the adaptation and adjustment pattern in Chilabazar and Kanainagar. This are the rural areas of Mongla, under Bagerhat district. These study areas are chosen considering the fact where people are facing massive difficulties for high salinity in drinking water and that adversely affecting people's lives. Besides, these areas are also vulnerable to natural calamities which is adding more to the existing problem. So this is a perfect area to complete our objectives considering a four day tour field trip.

1.4 Research Methodology:

The study is based on a day long field trip in Mongla Upazila, Bagerhat District. The whole process was conducted in the following way:

Extensive uses of primary and secondary materials are used to achieve the desired

objectives. Secondary data is to be used to understand the background of the study area, maps, images and other relevant information have been collected from BBS census reports, journal articles, books, newspapers and from various internet sources.

Observation: Observational research (or field research) is a type of correlational research in which a researcher observes ongoing behavior. There are a variety of types of observational research, each of which has both strengths and weaknesses. These types are organized below by the extent to which an experimenter intrudes upon or controls the environment. Observational research is particularly prevalent in the social sciences and in marketing. It is a social research technique that involves the direct observation of phenomena in their natural setting. We tried to observe everything around us to find out the facts which are responsible for their living condition.

Sample Surveys: A sample survey is a study that obtains data from a subset of a

population, in order to estimate population attributes. We made questionnaire to survey the people of Chilabazar and Kanainagar.

Personal/Household Interviews: A personal interview survey, also called as a face-to-face survey, is a survey method that is utilized when a specific target population is involved. The purpose of conducting a personal interview survey is to explore the responses of the people to gather more and deeper information. Personal interview surveys are used to probe the answers of the respondents and at the same time, to observe the behavior of the respondents, either individually or as a group. The personal interview method is preferred by researchers for a couple of advantages. But before choosing this method for your own survey, you also have to read about the disadvantages of conducting personal interview surveys.

Questionnaire: A questionnaire is a research instrument consisting of a series of questions (or other types of prompts) for the purpose of gathering information from respondents. Questionnaires are often designed for statistical analysis of the responses; this is not always the case. Questionnaires have advantages over some other types of surveys in that they are cheap, do not require as much effort from the questioner as verbal or telephone surveys, and often have standardized answers that make it simple to compile data. However, such standardized answers may frustrate users. Questionnaires are also sharply limited by the fact that respondents must be able to read the questions and respond to them. We made two type of questionnaire, one is for household and other is for focused group discussion

Focus Group Discussion: A Focus Group Discussion (or FGD) is a qualitative research method in the social sciences, with a particular emphasis and application in the developmental program evaluation sphere. FGDs are a predetermined semi-structured interview led by a skilled moderator. The moderator asks broad questions to elicit responses and generate discussion among the participants. The moderator's goal is to generate the maximum amount of discussion and opinions within a given time period. We divided into some parts and conducted discussion. The local fishermen of the areas took part in it as they share a close relationship with our topic of interest of this research.

1.4.1 Selection of the area:

The area was selected by our honorable course teacher Professor Dr. Humayun Kabir. We completed an observation on the adaptation and adjustment pattern in Chilabazar and Kanainagar. This are the rural areas of Mongla, under Bagerhat district. These study areas are chosen considering the fact where people are facing massive difficulties for high salinity in drinking water and that adversely affecting people's lives. Besides, these areas are also vulnerable to natural calamities which is adding more to the existing problem.

Fig 1.1: The Upazila map of Mongla

1.4.2 Data collection:

We were supplied two copies of questionnaire form by our course teacher. Some gathered information according to the household questionnaire and also conducted focused group discussion about many facts. Then we were divided into several groups then we started to collect data of different issues. Some of them are as follows:

Physical features:

-Physical Features/ landform

-Man Made Features

Living conditions:

-Types of Family

-Settlement Pattern

-Sources of Drinking Water

-Sanitation

-Electricity Connection

Adjustments and Adaptations:

-Perception

-Migration

-Health issues

-Preventive measures

1.4.3 Observation of features:

After completing the data collection we preserved the form to submit to our honorable course teacher. Then all the questionnaires were gathered to submit to our teacher. Then he formed a group to analyze these data into table format. Then we were supplied the data by one of the members of that group.

1.5 Limitations of the Research:

A number of problems were there to be faced. Some of them are as follows:

Short period of Observation: The overall period of observation was very short, summing up to a total of three hours only. Hence thorough investigation into the study area was not possible.

Overgeneralization: This report is being prepared on the basis of findings from a total of four interviews of the dwellers in the study area. As proper data analysis from all the researchers was not possible to accumulate, the study suffers from a lack of diversity among perspectives.

Biased Responses: The respondents are often found biased to the issues which we are investigating.

Area Coverage by the Researcher: It was not possible for every researcher to cover the whole of the study area which occupies a large area.

Insufficiency of secondary data: The number of prior research conducted is less. As a second year student, we had limited knowledge about how to collect data interviewing respondents.

From my point of view these limitations hampered the trip to some extent.

Chapter Two

Literature Review

2.1 Water Resources of Bangladesh:

Most of Bangladesh is located within the floodplains of three great rivers: the Ganges, Brahmaputra and Meghna (GBM), and their tributaries, such as the Teesta, Dharla, Dudh kumar, Surma and Kushiyara. The three major river systems drain into the Bay of Bengal through Bangladesh:

- The Brahmaputra river enters Bangladesh from the north and flows south for 270 km to join the Ganges river at Aricha, about 70 km west of Dhaka in central Bangladesh.
- The Ganges river flows east-southeast for 212 km from the Indian border to its confluence with the Brahmaputra, then as the Padma river for about a further 100 km to its confluence with the Meghna river at Chandpur.
- The Meghna river flows southwest, draining eastern Bangladesh and the hills of Assam, Tripura and Meghalaya of India to join the Padma river at Chandpur. The Meghna then flows south for 160 km and discharges into the Bay of Bengal.

The combined discharge of the three main rivers is among the highest in the world. Peak discharges are 100 000 m3/s in the Brahmaputra, 75 000 m3/s in the Ganges, 20 000 m3/s in the upper Meghna and 160 000 m3/s in the lower Meghna.

There are 230 rivers criss-crossing the country, most of which are either tributaries or distributaries to the GBM river systems. The total length of the rivers is approximately 24 000 km and the total GBM catchment area is about 1.75 million km2, out of which only 7 percent lies within Bangladesh. There are 57 transboundary rivers, of which 54 are shared with India and the remaining three originate in Myanmar.

On average, 1 121.6 km3 of water crosses the borders of Bangladesh annually, of which 85 percent between June and October. Around 48 percent (537.2 km3) is contributed by the Brahmaputra, 47 percent (525.0 km3) by the Ganges, 4 percent (48.4 km3) by the Meghna/Barak and nearly 1 percent (11 km3) by other minor rivers to Chittagong in the southeast.

Because of the great disparity between the monsoon floods and the low flow during the dry season, the manageable surface water resources are considered to be 80 percent of the dependable flow in March. Surface water resources are used extensively for dry season irrigation, mainly Boro rice using low-lift pumps (LLPs) and traditional devices.

The availability of groundwater resources in Bangladesh is determined by the properties of the groundwater storage reservoir and the volume of annual recharge. Key factors that determine groundwater availability include the capacity of the country's aquifers to store water, and the characteristics that govern economic withdrawal of groundwater for irrigation, domestic and industrial needs. The source of recharge is rainfall, flooding, and stream flow in rivers. The quaternary alluvium of Bangladesh comprises a huge aquifer with reasonably good transmission and storage properties. Heavy rainfall and inundation during the monsoon substantially recharge aquifers annually.

A regional groundwater recharge assessment took place in 1987 by Master Plan Organization (MPO) under the National Water Plan (NWP) of the Ministry of Water Resources. Subsequently, MPO updated the groundwater resources assessment during the NWP Phase–II in 1991 and the average annual available groundwater recharge for the country was estimated as 21 km3 (Table 2.1)

Table 2.1: Regional estimates of annual groundwater recharge (National Water Plan) (Source: MPO, 1987 and 1991)

Region	Area (million ha)	Usable recharge (million m^3)		Available recharge (million m^3)	
		NWP-I	NWP-II	NWP-I	NWP-II
Northwest – NW	3.016	13 400	12 100	9 480	9 786
Northeast – NE	3.569	17 800	23 100	9 615	9 594
Southeast – SE	3.007	9 000	9 800	1 538	1 498
South Central – SC	1.426	3 600	3 500	1 801	1 249
Southwest – SW	2.562	3 900	5 600	1 980	1 961
Total	**13.580**	**47 700**	**54 100**	**24 414**	**21 088**

The internal renewable water resources are an estimated 105 km3/year (Table 3). The overlap is considered negligible, this includes 84 km3 of surface water produced internally as stream flows from rainfall and about 21 km3 of groundwater resources produced within the country. Part of the groundwater comes from the infiltration of surface water with an external origin. Since annual cross-border river flows and entering groundwater are estimated to be 1 121.6 km3, the total renewable water resources are therefore estimated to be 1 226.6 km3.

Table 2.2: Water resources

Renewable freshwater resources			
Precipitation (long-term average)	-	2 320	mm/yr
	-	334 000	million m^3/yr
Internal renewable water resources (long-term average)	-	105 000	million m^3/yr
Total actual renewable water resources	-	1 226 600	million m^3/yr
Dependency ratio	-	91.4	%
Total actual renewable water resources per inhabitant	2009	8 343	m^3/yr
Total dam capacity	2013	6 477	million m^3

2.2 Water Usage in Bangladesh:

Domestic water demand is the basic human need. Water is used in different sectors where 50% demand is met from ground water and 50% from surface water (WARPO, 2004a). The per capita consumption varies from 100 to 350 l/c per day depending on the economic status (WARPO, 2004a). The projected gross domestic demand of water supply by 2025 for SMAs, other towns and rural areas are 167 l/c per day, 136 l/c per day and 112 l/c per day respectively (WARPO, 2004b). Mostly river water is used for irrigation in certain regions as well as for processing. Groundwater is used where surface water is not accessible. The estimated evaporative demand of agriculture is 28,483 Mm3 for the year of 2025 (WARPO, 2004b).

In 2008, the total water withdrawal was an estimated 35.87 km3, of which 31.50 km3 (88 percent) was for agriculture, 3.60 km3 (10 percent) for municipalities and 0.77 km3 (2 percent) for industries (Table 2.2 and Figure 1).

Table 2.3: Water use in Bangladesh

Water withdrawal			
Total water withdrawal	2008	35 870	million m^3/yr
- irrigation + livestock	2008	31 500	million m^3/yr
- municipalities	2008	3 600	million m^3/yr
- industry	2008	770	million m^3/yr
• per inhabitant	2008	247	m^3/yr
Surface water and groundwater withdrawal	2008	35 870	million m^3/yr
• as % of total actual renewable water resources	2008	2.9	%
Non-conventional sources of water			
Produced wastewater		-	million m^3/yr
Treated wastewater		-	million m^3/yr
Reused treated wastewater		-	million m^3/yr
Desalinated water produced		-	million m^3/yr
Reused agricultural drainage water		-	million m^3/yr

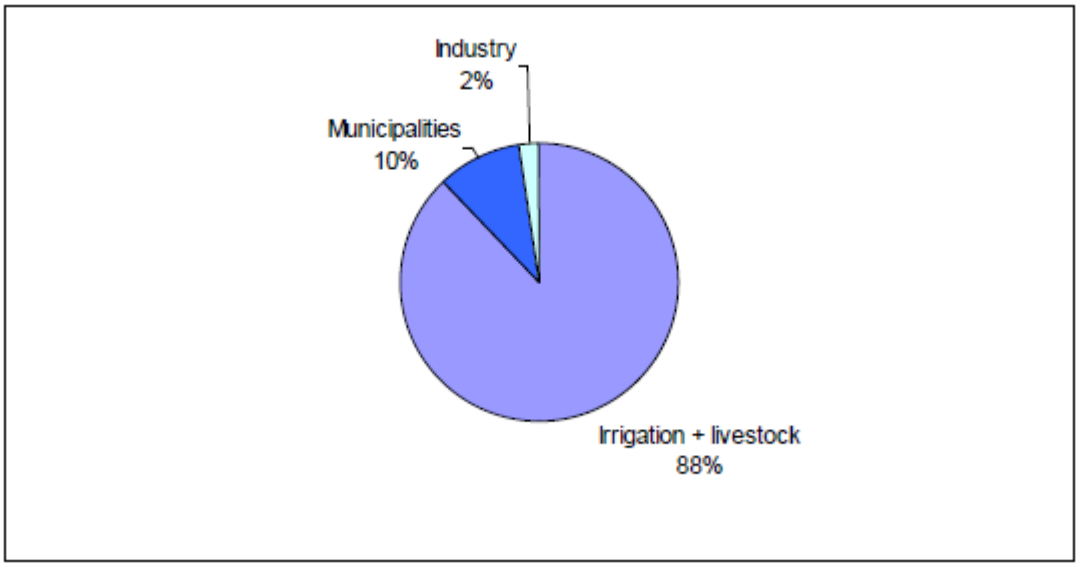

Fig 2.1: Water withdrawal by sector

Approximately 28.48 km3, or 79 percent of the total water withdrawal, comes from groundwater and 7.39 km3, or 21 percent, from surface water (Figure 2).

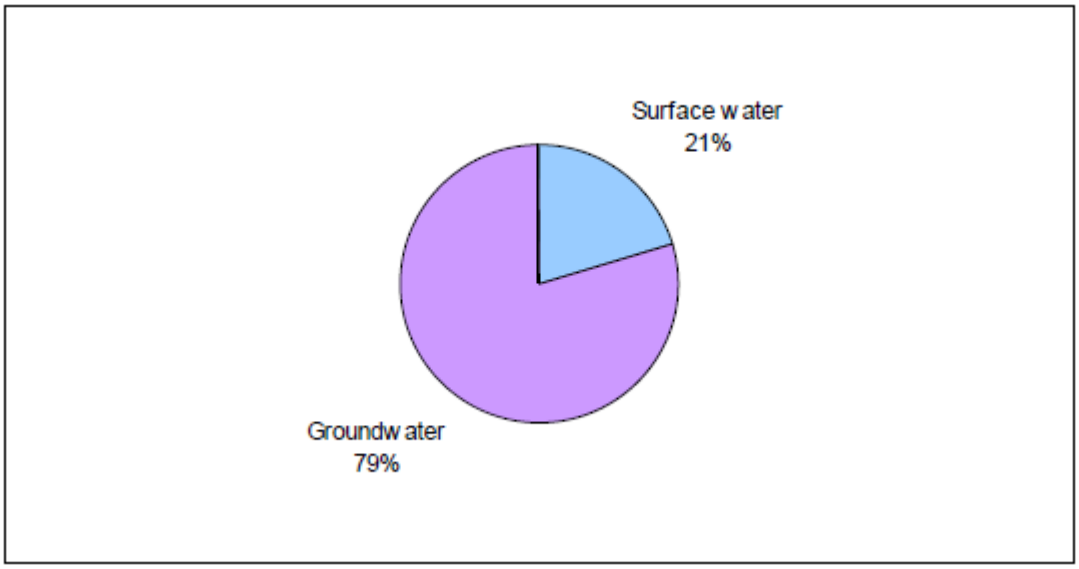

Fig 2.2: Water withdrawal by source

2.3 Safe Coverage of Drinking Water Supply

Safe or improved drinking water source is defined as one that, by nature of its construction or through active intervention, is protected from outside contamination, in particular from contamination with fecal matter.

The national water supply coverage in Bangladesh with improved water is 80% with about 38 million new people who gain access to water supply from 1990.

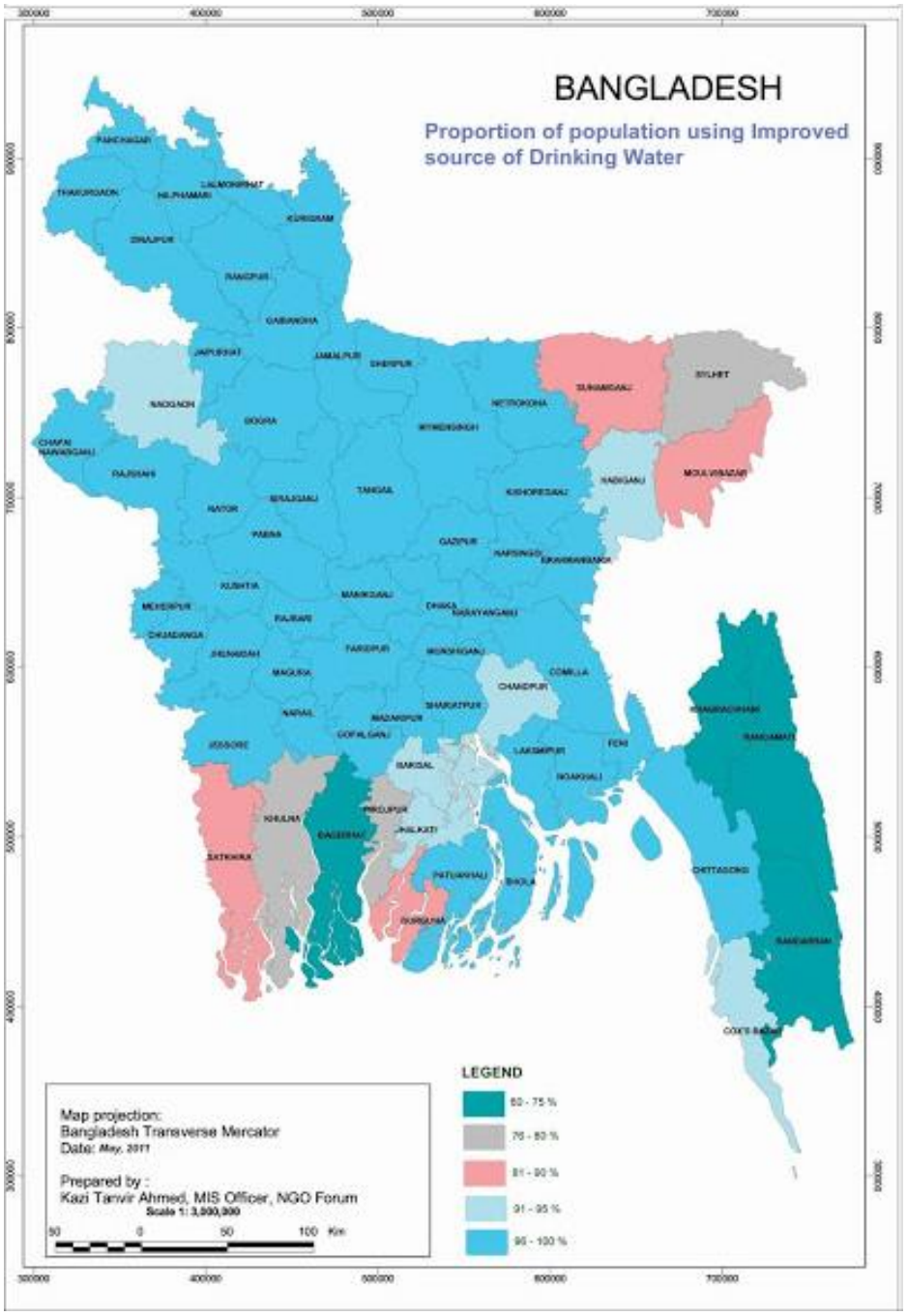

Fig 2.3: National Drinking Water Supply Coverage

The percentage of population using improved sources of water is 97.8% which is similar to the 97.6% found in 2006. In urban areas, the rate is 99.5%, which is marginally higher than the 97.4% found in rural areas.

At the division level, the percentage of improved water source ranges from 91.6 in Sylhet to 99.6% in Dhaka. At the district level, it ranged from 66.5 in Rangamati to 100% in Gazipur. (BBS, 2009)

Most of the households have tubewell connections. On an average 87% households have connection to tap water and 4% households use tube-well as main source of drinking water. The rest of the households use other sources of water such as bottled water, pond sand filter, rainwater, spring or well.

People are highly dependent on tube well water with more than 75% households using this source. Tap water is used in 25% of the households. Use of other sources of water is mainly observed in Lakshmipur, Noakhali, Chittagong and Cox's Bazar districts of the coastal zone. In the Sundarbans 25-50% households have tubewell water, 5-25% households have tap water and 25-75% households use other sources.

2.4 Drinking Water Crisis:

Since the dawn of the earth, water has played the most essential role to form and sustain life on the earth. When the most spectacular creature on the universe, human being drink water to live, that water must has to be safe and affordable for every human use. Although access to safe and affordable drinking water is one of the fundamental human rights and a foundation for the socio-economic development of any country, however up to 1.8 billion people worldwide rely on water from 'unimproved' sources or 'improved' sources that are fecally contaminated (Bain et al., 2014 and Onda et al., 2012). Fecal contamination is also considered to be the main threat to public health (WHO-UNICEF, 2010). The situation is more worsened in the developing countries where majority of the populations are still lack of safe drinking water and more than half of the populations have no access to potable water (UNDP, 1992).

Bangladesh, a developing country had achieved a great success ensuring safe drinking water to rural people through providing shallow tube-wells by the year 1990 (Ahmed and Rahman, 2000).But the idea of using shallow tube-wells has been disrupted due to severe arsenic contamination in shallow aquifer and then shallow tube-wells are replaced by installing deep tubewells that contains low arsenic (Karim and Safiuddin, 2003). WHO (2008) reported that nearly one fourth of the population has no access to safe drinking water in Bangladesh, particularly in the coastal districts. The development of a dependable water supply system to use groundwater like tubewell, is limited in the coastal area because of the unavailability of freshwater aquifers at suitable depths. Both shallow and deep tubewells are not useful due to high salinity in the groundwater rather than arsenic contamination (Kamruzzaman and Ahmed, 2006). About 15 million people are already forced to drink saline water and 30 million people are unable to collect potable drinking water due to a lack of available safe water sources (Hoque, 2009). The southwestern coastal region (Khulna, Satkhira and Bagerhat district) has been identified as the most climate induced, hazard-prone, hard-to-reach area of Bangladesh (Ghosh et al., 2015) which is facing extreme difficulties in accessing safe drinking water (Quazi, 2006). The ground water of these areas is unsuitable for human consumption due to high salinity (WHO, 2004), where in places neither ground nor surface water is saline-free (Rahman et al., 1997). Hence, preservation of rainwater in natural or man-made ponds and collection of rainwater is the only source of drinking water in these areas (Alam et al., 2011). The proportion of rain-fed pond water and other alternative options for drinking purposes used in these three southwestern coastal districts varies from 23.1 to 34.1%, while the national average is 3% (BBS-UNICEF, 1999). In these areas, the alternative water supply options are household-based rainwater harvesting systems (RWHSs), community-based rainwater harvesting systems (CRWHSs), community-based pond sand filters (PSFs) and rain-fed pond water. Although PSF and RWH are seem as sustainable water supplier in these special hydrogeological regions, several difficulties have limited the use of water supply technologies. As the majority of coastal peoples are poor, their low income level limits the desire to pay for drinking water though they badly need safe drinking water (Harun and Kabir, 2012).

Consequently, coastal people are choosing to consume cost free direct rain-fed pond water which has potential public health risks such as cholera and other diarrheal diseases. It has been estimated that more than 4,500 children died every day from pathogens that cause diarrhea and other diseases (WHO-UNICEF, 2005).

Water poverty due to salinity and recent salty sand dumping in the locality, arsenic, lack of availability of sweet water sources, un-affordability of buying water, etc. have turned into an emerging crises in our study area since, couple of years back. Till now, no study was conducted to find out the recent water poverty situation with root causes and its broader gender-based impacts on the human life, livelihood as well as the economy

2.5 Vulnerabilities to Natural Hazards:

Bangladesh is affected with hazards of different types such as flood (river flood and flash flood), drought, cyclone, storm surge, erosion, salinity intrusion, earthquake etc.

The coastal morphology influences the propagation of storm surges. Inundation due to flooding and storm surge differs based on the land elevation and surface form. In the last 200 years more than 70 cyclones have hit the coast damaging life and properties. Erosion is visible only in the estuaries where new land is also formed due to the accretion process. Regarding rainfall availability, there are some areas that have very little rainfall termed as 'Rainfall stressed areas". This low amount of rainfall along with salinity intrusion will reduce the freshwater flow endangering the sustenance of ecosystem. Salinity ingress is another major problem for the coastal zone which leads to change in biodiversity, agricultural practices, forest species change etc and most

importantly contaminating the drinking water.

Floods: Bangladesh is one of the most flood prone countries in the world. Due to its location in the deltaic floodplains of Himalayan rivers, heavy monsoon rainfall associated with a low floodplain gradient, congested drainage channels and tidal flow and storm surges in coastal area causes severe floods in Bangladesh. Flood is a concurrent phenomenon in Bangladesh.

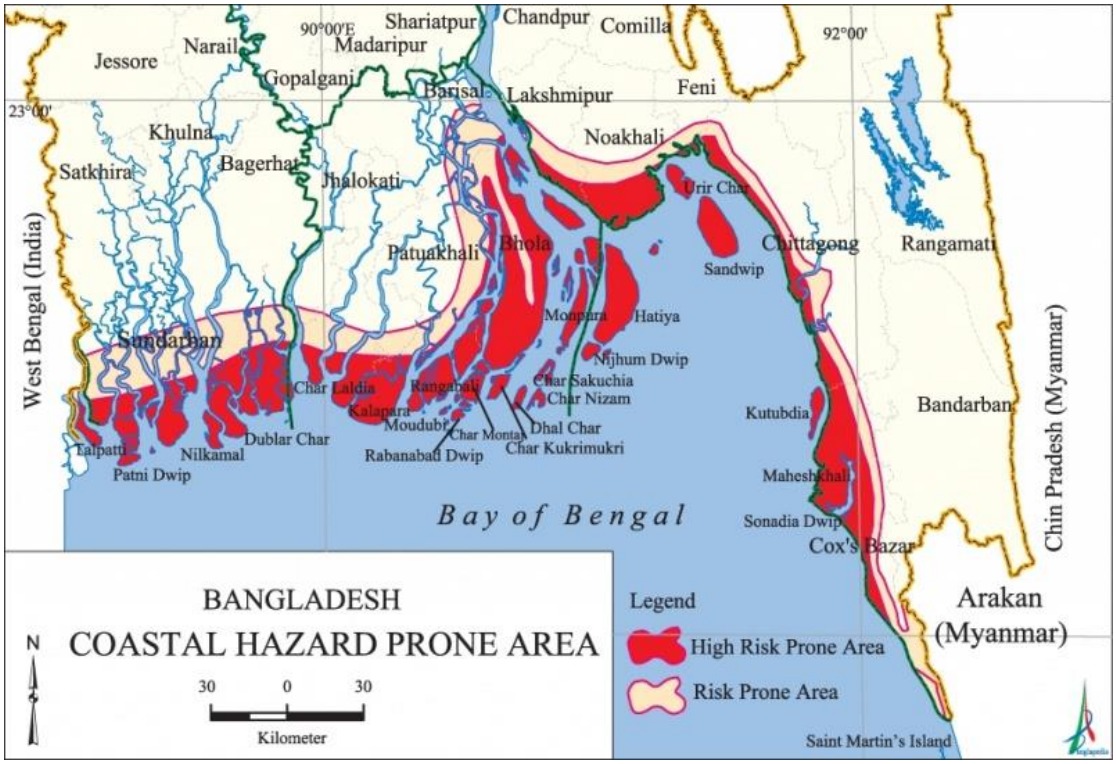

Fig 2.4: Coastal Hazard Prone Areas of Bangladesh

Bangladesh has experienced severe floods in 1954, 1955, 1961, 1962, 1968, 1969, 1970, 1971, 1974, 1984, 1987, 1988,1998, 2004 and 2007. During the last 50 years, at least 6 serious floods occurred, affecting 35-75% of the land area. The devastating floods in 1987, 1988 and 1998 inundated more than 60% of the country. In the coastal zone 9 out of the 19 districts are under flood risk coverage of more than 50% in which the most vulnerable are Barisal, Chandpur, Gopalganj, Jhalokati, Narail, Pirojpur and Shariatpur districts.

Riverbank Erosion: Riverbank erosion is one of the major natural disasters of Bangladesh. The hazard vulnerability assessment of erosion in the ECZ has taken into consideration both riverbank erosion and shoreline erosion affected areas. The erosion process in the right bank of Padma River, Ganges River and the lower Meghna River and also the erosion along the coastline specially the Chars (small islands) has been considered. Currently, there are 9 districts that are erosion prone with Bhola, Chandpur and Shariatpur districts having more than 10% of erosion prone areas.

Cyclone and Storm Surge: Among the countries affected by tropical cyclones, Bangladesh is one of the worst sufferers because of the huge number of deaths. For example during the cyclone of 1970 and 1991, the number of people who died is 5 lakh and 1 lakh 39 thousand respectively. Cyclone Sidr one of the strongest cyclones in the Bay of Bengal made landfall in Bangladesh on November 15, 2007. The storm caused large-scale evacuations and 3,200 deaths. The total estimated amount of damage and loss is BDT 115,600 million (US$ 1,675 million). In the coastal zone, half of the area is threatened with cyclonic storm surge. Around 45% area and 4% area are threatened by storm surge of more than 1 metre and less than 1 metre height respectively. There are 13 districts which are vulnerable to storm surge of more than 1 metre namely Bagerhat, Barguna, Barisal, Bhola, Chittagong, Cox's Bazar, Feni, Jhalokathi, Khulna, Lakshmipur, Noakhali, Patuakhali, and Pirojpur districts.

Again, for a storm surge of less than 1 metre, the districts at risk are Bagerhat, Barisal, Khulna, Lakshmipur and Pirojpur.

2.6 Salinity Intrusion:

The movement of saline water into a freshwater aquifer or surface reservoir is known as saltwater intrusion and if the source of this saline water is sea water, then this process is known as seawater intrusion. The magnitude of salinity intrusion in coastal areas depends on sensible balance between freshwater flow and saltwater from the sea. The interface between freshwater and saline water is influenced by geology, hydrogeology, ground water heads and groundwater well pumping rates. But fresh water is important issue to counterbalance salinity intrusion at the upstream water intake. To quantify that required fresh water, indeed detailed understanding of the physical phenomena (tidal motion, wind mixing etc, river flow) is a prerequisite. The coastal zone of Bangladesh comprises of part of the flat Ganga Delta, which is criss-crossed by large tidal rivers discharging into the Bay of Bengal. The estuaries and tidal river systems of coastal zone have been formed by long periodical deltaic accretion which was dominated by the historical morphological changes of Ganga and Brahmaputra. The major estuarine rivers of the southcentral region are interlinked and fed by numerous smaller channels.

The approximate population in the coastal area is 40 million and they are very much vulnerable to the natural disaster along about 720 km coastline. Saline water intrusion is the main problem in the south-western zone. About 60 and 15 percent of arable land (total1.0 mha crop-lands) of southwestern and south- eastern zone respectively are affected by salinity in the dry period. This salinity is caused by cyclone and storm surges, high spring tide inundation and capillary actions. It affects the soil surface and root zones, which decreases the crop production by about 0.13 M.T. in every year. The increase of salinity. The intrusion of saline water from the sea into the inland is hazardous for the environment in many water. Most importantly, saline water contaminates sweet water resources rendering it unusable for drinking. Moreover, salinity damages the fisheries, crops and the Sundarbans. The biodiversity of the Sundarbans is changing due to increased level of salinity. In the base year 14698 sq. km area is exposed to high salinity of 1 ppt under zero sea level rise. Severely affected districts are Bagerhat, Bhola, Chittagong, Cox's Bazar, Jessore, Khulna, Lakshmipur, Narail, Noakhali and Satkhira having more than 15% area under 1 ppt saline zone.

2.7 Salinity Process in Bangladesh:

For the deposition of silt and clay, the spatial distribution and concentrations of salinity in the estuary are important in the delta formation. The intrusion of saline water towards inland determines its suitability for drinking, irrigation and other purposes. During the wet season, vertical variation of salinity may play a role in the seasonal storage of sediment at the outside of the estuary. Because of shallow depth, the Meghna Estuary is generally a well-mixed estuary where the salinity is constant in a vertical water column (BWDB etal, 1998). During the monsoon, Land Reclamation Project (LRP) and Meghna Estuary Survey (MES)measured that an approximately 100 km long zone(Kutubdia-Sandwip) develops in the southeastern part of the estuary where vertical variation occurs where a layer of brackish water moves with the tide in the form of a salt wedge. The general concept is that during the dry season, part of the sediment is brought back into the estuary through a so-called tidal pumping process, and deposited there (BWDBet al, 1998).

In the coastal area of Bangladesh salinity increases during minimum river discharges but never exceeds seawater salinity (34 ppt). Intrusion of saline water during dry season is up to Char Gazaria where salinity is less than 1 ppt. Salinity intrusion can increase either due to a decrease of fresh water flow in the Lower Meghna River during the dry season, or due to further penetration of tide into the river system. Intrusion may be aggravated by upstream withdrawal of water and reducing size of floodplains, or by climate changes like decrease in dry season rainfall and sea level rise. The augmentation of salt water in the surface waters increases the abstraction of groundwater which then becomes vulnerable to a risk that salt water will be drawn into the aquifer.

2.8 Causes of Salinity and Drinking Water Crisis :

Drinking water crisis is the consequence in a large part of the coastal belt. From our study, we found the following causes responsible for salinity and water poverty in our study area in Mongla upazila under Bagerhat district.

- The reduction in upstream freshwater flow from the Ganges, which has dropped off significantly in the Padma (Bangladesh branch of the Ganges River) since India's commission in 1975 of the Farakka Barrage. This has increased salinity levels in river waters near the coast. River water used to push the saline sea water back, but now the rivers lack that power.

- Climate change as a result of global warming makes the sea water rise and makes the salinity of groundwater increase and reach further into the main land.

- Due to the cyclones Sidr in 2007 and Aila in 2009, salinity flooded almost all the sweet water sources of the locality, which is now adding gradually day by day, due to sea level rise and increase of salinity even in the ground water.

- ❏ Frequency and intensity of tidal surges will increase ingression of saline water.
- ❏ Lack of sufficient big ponds in the area for providing drinking water. There are many ponds where peoples are cultivating fish (especially shrimp) through using chemicals and fertilizer, which also makes the water unsuitable for drinking. There is no way to purify it.
- ❏ Since 2015, the Government started dredging of the Ghasiakhali river. Salty sand is dumped on vast areas of land adjoining the river, which make the already existing salinity situation worse and vulnerable groups are hit hardest by this severe adverse effect.
- ❏ Rainwater harvesting needs strong and smooth rooftops, management, technical knowledge and big tanks with technology, which is unknown and inaccessible to extreme poor men and women.
- ❏ In recent years, safe drinking water turned into a commercial product, however access of poor people is limited, due to un-affordability of buying it by men and women.

2.9 Increase in Salinity:

In Bangladesh, salinity intrusion is time varying event and minimum during the monsoon (June-October) by push back of the rivers discharge at the salinity front in estuarine and floodplains. It increases in inland coast from the month of November due to the reduction of fresh water flows and intrude up to 150 km inland in the lower Meghna in the South East and up to 290 km up the Passur River in the south-west of the country.Maximum salinity levels occur during March-April. The increase of salinity intrusion and decrease of arability will be prevailing due to climate change effect and reduction of flood plain. Investigations indicate that one third of the country will be inundated by green-house effect, which may propagate the saline water intrusion all over the country and the total trans-boundary sources of potable water in ground water aquifer will be affected because agriculture is the mainstay livelihood of highly dense population which requires huge ground water abstraction for irrigation purpose.

In this situation management of salinity intrusion is the vital issue for Bangladesh. With the mission of saline waterproofing by structural management like coastal embankment projects,dam, sluices etc and coastal area zoning as nonstructural management to change the land use and other activities can be the vision of sustainable livelihood and environment of Bangladesh. Further study to formulate the optimistic model for proper management by different option scenarios is essentially needed.

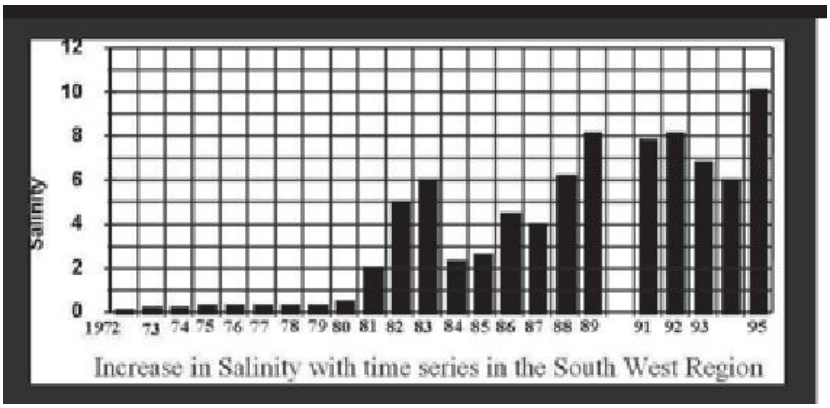

Fig 2.5 : Increase in Salinity with Time Series

2.10 Effects of Salinity:

An extreme scarcity of salinity free water is recorded in the coastal belt of Bangladesh. Water sources such as rivers, ponds, and tube wells are becoming unable to provide sustainable fresh water for people in the coastal community. Many key determinants of human health, such as food availability, fresh water availability, physical safety, and the microbiological environment, are strongly influenced by salinity.

- People have started suffering from various kinds of health problem such as high blood pressure, diarrhea, and cholera. Not only through water but also through consumption of food raised in these highly saline areas, people are getting more saline than they require for optimum health.

- The most vulnerable groups are the pregnant women and the children. Gobeshona is a knowledge sharing platform for climate change research in Bangladesh. It has conducted a Research on "Impact of salinity on women's reproductive Health in Saline prone Bagerhat.," which findings are that saline intrusion in drinking water has multiple impacts including on women's reproductive health. They mentioned a series of critical reproductive disorder like , inability to carry baby to term, pregnancy compromise, birth defects, Leucorrhea, Pelvic Inflammatory Disease (PID), Urinary tract infection(UTI), Abdominal Discomfort, Obesity, Disabled child birth etc, which is really alarming.

- Higher rates of hypertension affecting pregnant women in the southwestern coast of Bangladesh, compared with non-coastal pregnant women, were hypothesized to be caused by salinity contamination. Higher salinity from food grains also might have caused a higher rate of birth defects which is of great concern to the future of Bangladesh.

- Cholera sometimes spreads as an epidemic after a disaster such as flood or cyclone. Lack of drinking water and overconsumption of saline water influence malnutrition, undernutrition, water borne diseases, and food borne diseases and even lead to starvation among coastal people.

- Due to these severe scarcity of safe water, poor men, women and children's are migrating from the area which is already reported by the Guardian in its 1st December, 2015 circulation:

  "Every day, another 2,000 people move to the Bangladeshi capital. It's nothing new – for generations Dhaka has been a magnet for those escaping rural poverty – but now climate change is accelerating the race to the city….the majority of migrants hail from coastal areas that are already experiencing rising sea levels, increased salinity, destructive floods and cyclones.

They were struggling to find fresh water to drink, as rising seas spilled into rivers. ...Ten years back, the area was freshwater –now it is not,"

- Of many families the men spend many months away as migrant labourers or as fishers in the Bay of Bengal, leaving women and children and elderly behind to care for themselves. They have a hard time without fresh water and with the land all turned saline.

- Due to increase in salinity it is expected to induce an overall shift in the World Heritage Sundarbans Mangrove Forest from Sundari (the single most dominant and important species) to Gewa and Guran..

- The biodiversity is also changing. Sweetwater trees are gradually reducing and saline resistance trees (pictures) are growing rapidly, which is not only creating water poverty, but also creating food insecurity and malnutrition in the area. Reduction in fresh water and salinity intrusion along with soil quality depletion slow down plant growth and reduce productivity that put adverse effect on biodiversity and wildlife.

- Salinity affected irrigation water has profound impact on crop production. The most common response of plant towards salinity is reduction in growth. In low to moderate concentration, salinity affects crop production by lowering the soil-water potential and increases concentration of salt at the root zone. Low water potential indicates that plant cannot extract sufficient amount of water from soil and maintain turgor at very low soil-water condition.

- Yield of a crop is directly linked to the quantity of water passed through it by water transpiration. Agriculture production is likely to decrease as saline containing water reduces plant growth through concentrating salt in the root zone of plant and resulting in nutrients imbalance and yield loss. It affects the

soil surface and root zones, which decreases the crop production by about 0.13 M.T. in every year.

- Not only crops and fish have been negatively affected due to the high salt in the coastal belt of Bangladesh. Saline water also has a detrimental effect on livestock production. Survival of livestock is dependent on the field grass, water, and dairy feed. These types of natural resources are connected to saline water. Due to the shortage of fodder crops, livestock has been affected in this coastal region of Bangladesh.

Chapter 3

General Profile of Mongla

3.1 Geographical location:

Mongla is an Upazila of Bagerhat District in the Division of Khulna, Bangladesh. It is located in between 21°49' and 22°33' north latitudes and in between 89°32' and 89°44' east longitudes. It is bounded by rampal upazila on the north, bay of bengal on the south, morrelganj and sarankhola upazilas on the east, dacope upazila on the west. It has a total area of about 1461.22 km². Mongla Thana was formed on 19 September 1976 and it was turned into an upazila on 14 September 1983. It consists of 1 municipality 7 union parishads, 37 mouzas and 77 villages. The 7 unions are Chandpi, Chandpai Range, Chila, Burirdanga, Mithakhali, Sundarban, Suniltala. Its main rivers are Pasur, Mongla, Bhola, Bangra, Chandpai. This upazila is highly disaster prone area among the Bagerhat District. Mongla upazila bears a special significance as it is the second international Sea Port of the Country and the Chandpai range of "Sundarban' Forest area.

Fig 3.1: Map of Mongla Upazila

3.2 Physical Features:

Physical features in geography include bodies of water and landforms, for example,

oceans, mountains, lakes, rivers, plateaus, plains, streams, hills, bays, gulfs, volcanoes,canyons, valleys and peninsulas are all various physical features. Anything that describes the Earth's topography is a physical feature. The term physical features denote naturally made features of a area like landform, lakes, rivers, forests etc.

Though we studied basically the man-environment interaction, some of these physical

features have been studied and they are discussed hereafter.

Fig 3.2: Mongla-Poshur Channel

Mongla is situated on the confluence of the rivers Pasur and Mongla. It is one of the major ports of Bangladesh. It is the second busiest seaport of the Bengal delta. Mongla is located 48 kilometres (30 miles) from the city of Khulna, which is a regional industrial center. The name Mongla originated from Mongla River presently known as Mongla Nulla. Mongla River originated from Pussur and Rampal is situated beside Pussur. It is at the confluence of river Pussur and Mongla Nulla where the present Mongla Port is working.

Fig 3.3: Poshur River

The Pasur River is a river in southwestern Bangladesh and a distributary of the Ganges. It continues the Rupsa River. South of mongla upazila the river flows into the Sundarbans. It is the deepest river in Bangladesh. Large marine ships can easily enter Mongla Sea Port through it.

Fig 3.4: A canal in Kanainogor

3.3 Profile of Respondents:

Table 3.1: Villages of the study area

Village	Respondents
Chila	27
East chila	29
Ghuchchhagram	18
Kanai nagar	21
Keyaboniya	6
South kanaimari	65
West Chilabazar	24

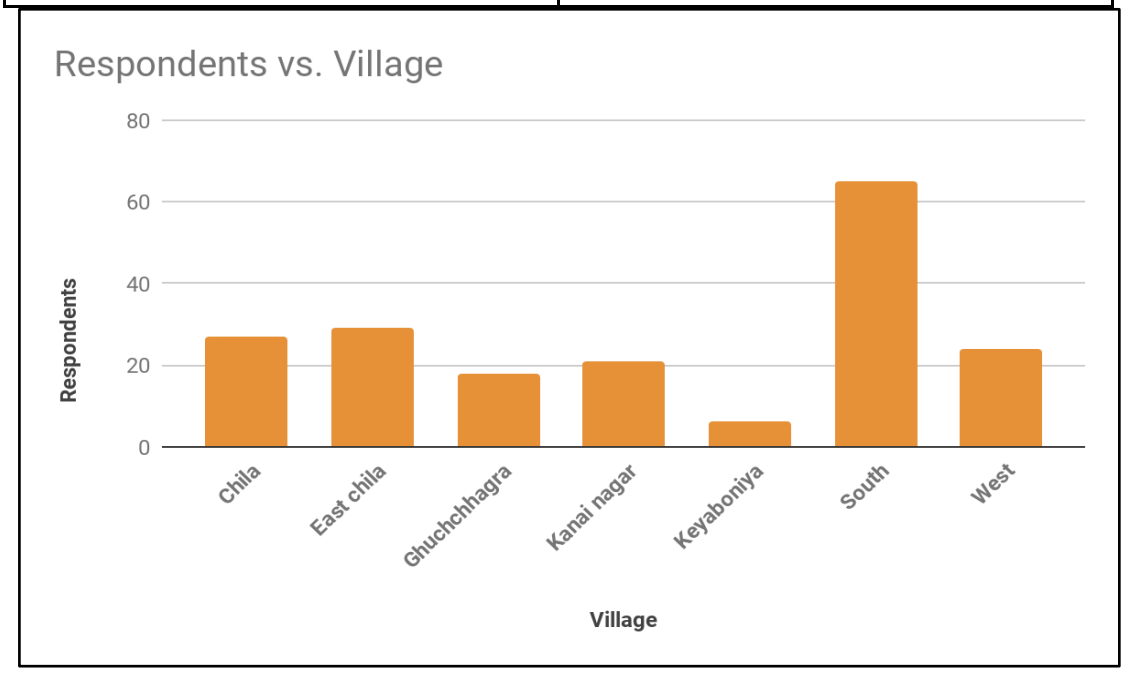

Fig 3.5: Villages of the study area

Table 3.2 : Ages of the respondents of the study area

Age	Frequency

Less than 20	11
20- 40	81
40-60	83
More than 60	15

3.3.1 Types of family:

The types of family show us the development and advancement and also express the psychology to form such families. We gathered information about 186 families in the study area or we can say in what type of family they live in and the table is given as follows:

Table 3.3: Frequency and percentage of family types in study area

Type of family	Frequency	Percentage (%)
Nuclear	151	81.18
Joint	34	18.28
Extended	1	0.54

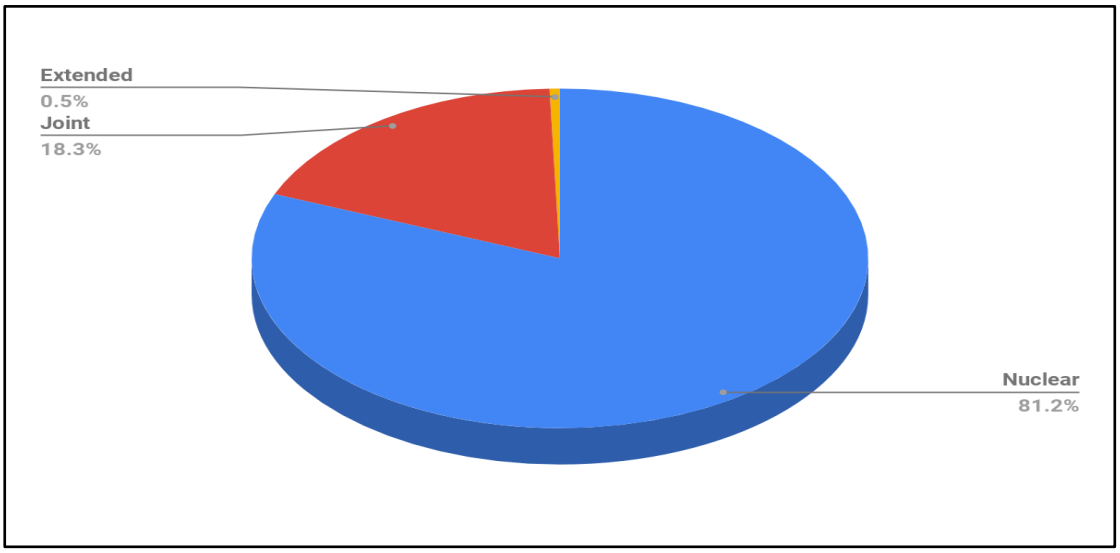

Fig 3.6: Types of family in the study area

3.3.2. Demography:

According to last population Census 2011 the upazila has a total population 1, 36,588, Male 71,492, female 65,096 in 32383 HH, (Muslim 102298, Hindu 29426, Christian 4837, Buddhist 21 and others 6) and population density is 1018 per Sq Km.

We also studied the population condition of our study area and find out the following results:

Table 3.4: Gender of the local residents of study area

Gender	Frequency	Percentage (%)
Male	131	58.48
Female	93	41.52

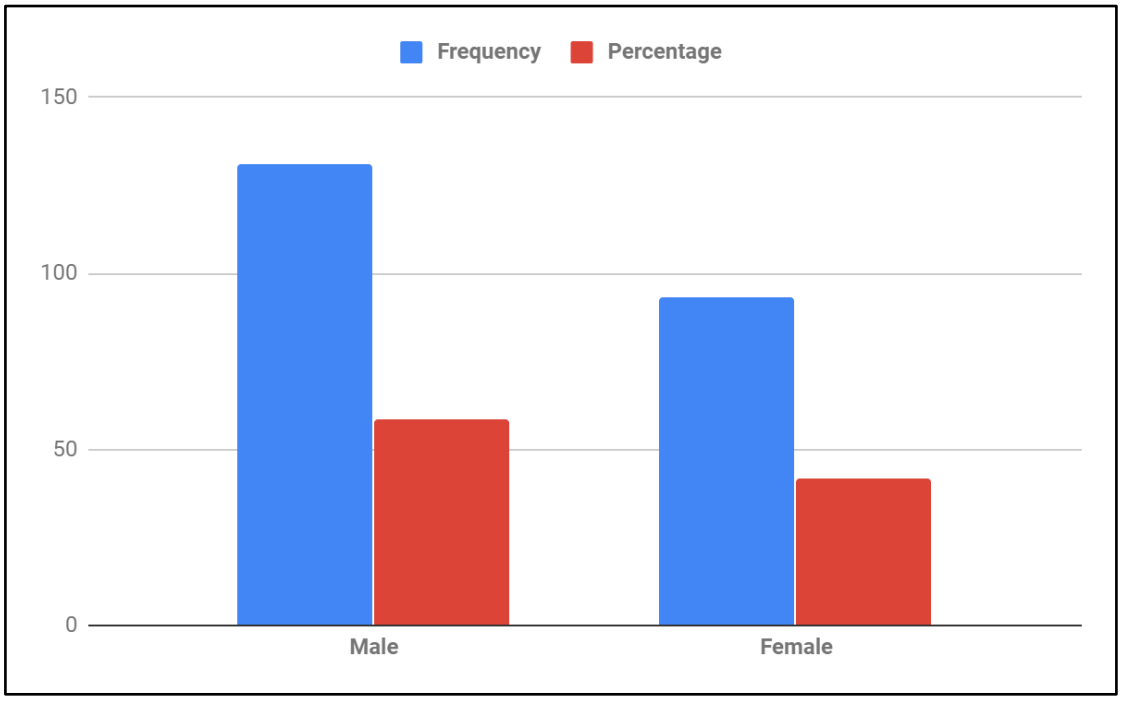

Fig 3.7: Gender of the local residents of study area

Moreover, of the 186 families that we have interviewed in that area, we found the following results about the marital status of the local residents there:

Table 3.5: Marital status of the local residents of the study area

Marital status	Frequency	Percentage (%)
Married	187	66.08
Unmarried	69	24.38
Widow	25	8.83
Divorced	1	0.35
Separated	1	0.35

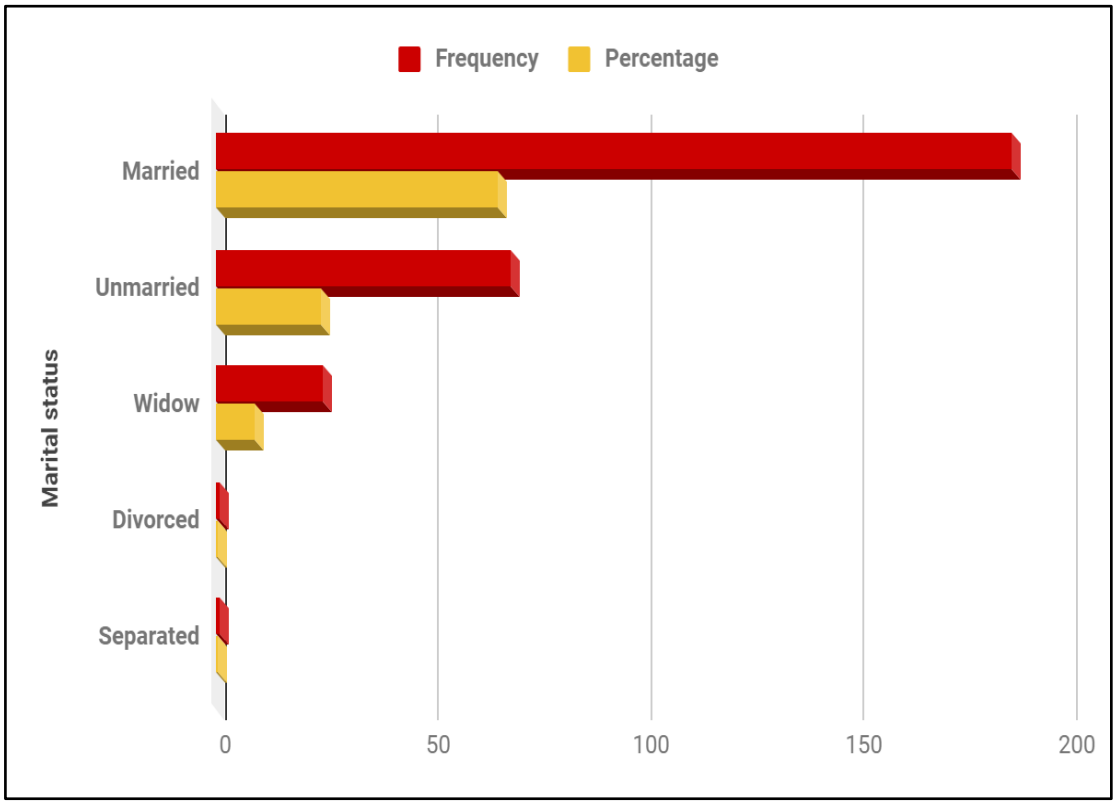

Fig 3.8: Marital status of the local residents of the study area

3.4: Literacy Rate:

Average literacy rate 56.1%; male 59.5%, female 52.1%.. From our research we have found that because of poor livelihood, most of the parents cannot afford the expenses of schooling the children. Because of their poor economic status they are not aware much and do not have the urge to sending children in school.

Fig 3.9: A school in Kanainogor

Table 3.6: Literacy rate of the local residents of the study area

Education level	Frequency	Percentage (%)
Illiterate	60	23.35
Primary	81	31.52
JSC	48	18.68
SSC	39	15.18
HSC	9	3.5
Honors	11	4.28
Masters	2	0.78
Other	7	2.72

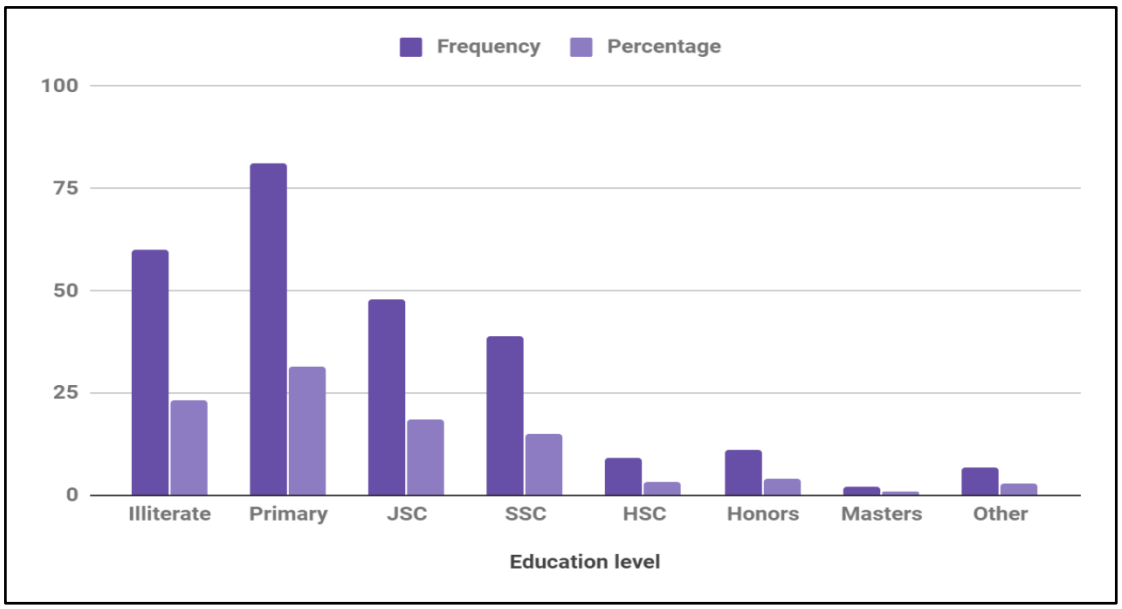

Fig 3.10: Literacy rate of the local residents of the study area

3.5 Living Conditions:

3.5.1 Settlement patterns:

A settlement pattern means the shape of a settlement. The structures of settlements are usually influenced by the surrounding landscape. Being a disaster and flood prone area, most of the settlements are tin-shed houses with high muddy base in the area.

Fig 3.11: Settlement patterns of the study area

3.5.2 Access to electricity:

All the wards and unions of the upazila are under rural electrification net-work. However 31.17% of the dwelling households have access to electricity.

However, from our study in the all 187 houses in that area we found the following electricity status according to respondents :

Table 3.7: Electricity connection in the study area according to respondents

Status	Frequency
Have Electricity	131
No electricity	57

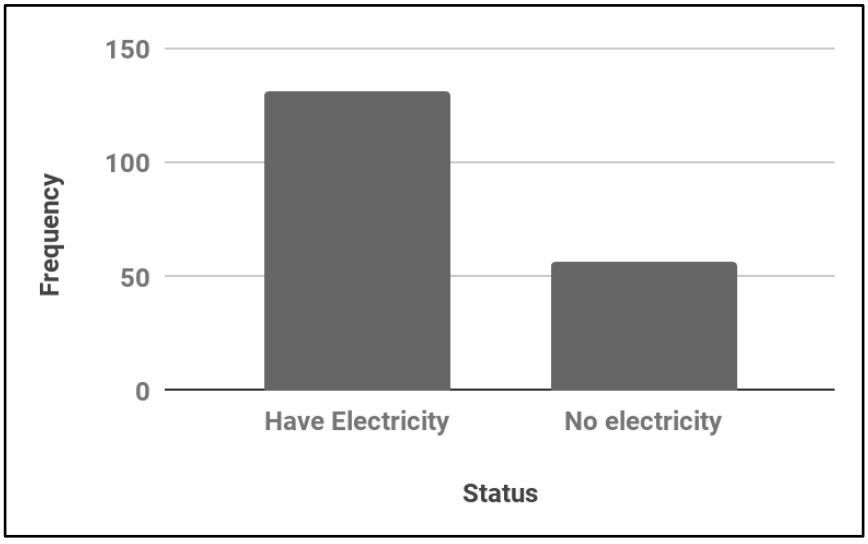

Fig 3.12: Electricity status in the study area

3.5.3 Sources of Drinking Water:

According to the Census 2011, 4.4% households have tube wells water source facilities 6.6% HH used tap water (running water) and 88.9% HH used others sources. We studied the overall living conditions of the respondents and find out one of the most important health related issues which is sources of drinking water.

Table 3.8: Source of drinking water of study area

Source of Drinking Water	Frequency
Tubewell	00
PSF	10
Rainwater	164
Pond Water	123
Outside the community	28
Others	13

Fig 3.13: A pond in the study area

3.5.4 Sanitation condition:

From the responses in the study area about using sanitary latrines we got to know that more than 50% people are not using healthy ones which is due to their poor financial status and lack of awareness. Thus they are at risk of getting affected by many fatal diseases.

Table 3.9: Sanitation condition in the study area

Condition of Toilet	Frequency	Percentage
Hygienic	96	50.79
Unhygienic	80	42.33
None	13	6.88

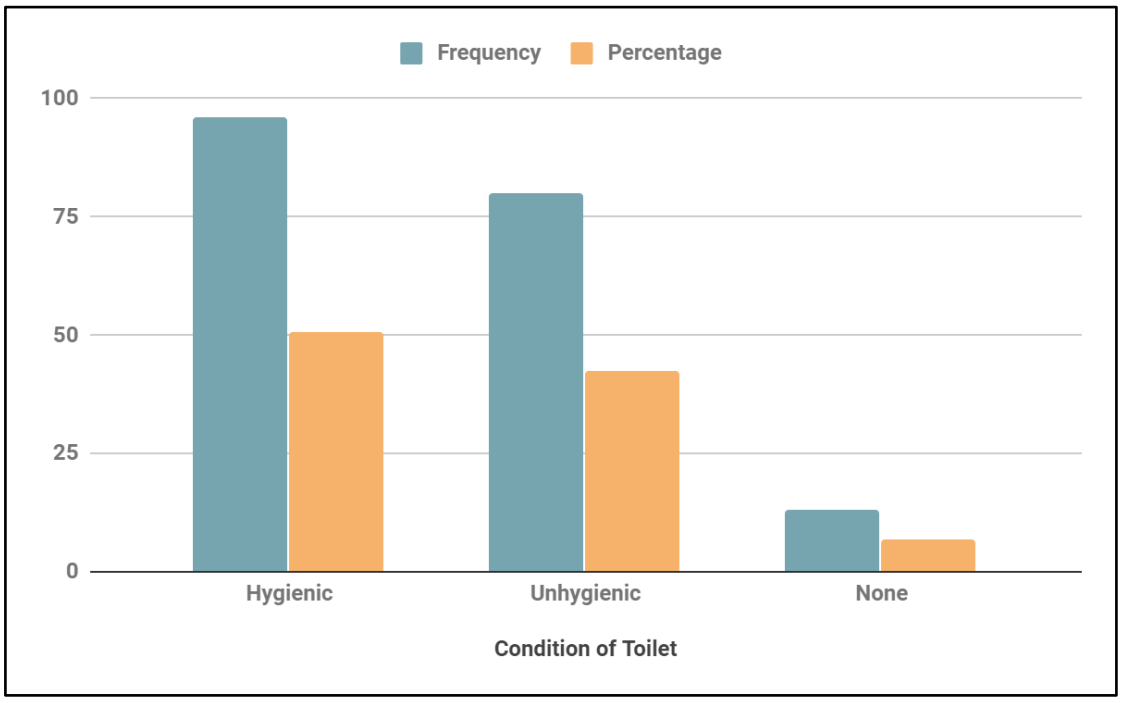

Fig 3.14: Sanitation condition of the study area

3.6: Agriculture and livestock:

According to the Bangladesh Bureau of Statistics (BBS) District Statistics 2011, about 21.41% of people in Mongla upazila are involved in agricultural production. . Rice is the main crop, coconut; betel nut and sugarcane are nearly extinct crops. Main fruits are mango, blackberry, lemon palm and papaya. Officials and locals said crop production and acreage fell drastically due to increased salinity after the cyclone Aila in 2009. As a result, rice production in the area fell and so did cropping intensity.

Due to salinity of the water and soils farmers have chosen to shift from agricultural production to shrimp farming due to salinization. Moreover, fisheries sector (shrimp, prawn and white fish) of the study area is highly vulnerable due to the problems of salinity, virus attack, cyclone etc. It was found from the field observation, questionnaire survey that most of the land area of study area is now practiced by the shrimp gher (small area inundated by saline water for shrimp cultivation) farming. There is no available grazing land for livestock farming.

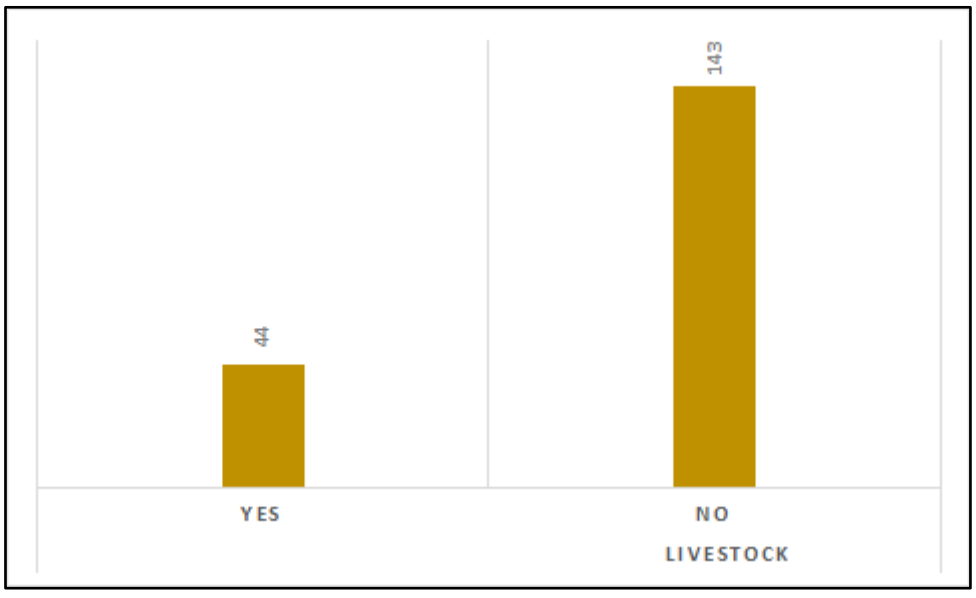

Fig 3.15: People who rear livestock

Fig 3.16: Golpata plants in the study area

Fig 3.17: Vegetation of the study area

Fig 3.18: A shrimp gher in the study area

3.7: Economic conditions:

Like other rural areas of this district about 60-70% per cent (approx.) people are living below poverty line. According to CRA report, 2009, the livelihood groups and their corresponding activities of Mongla upazila are very much diversified. The major livelihood activities include farming, fish culture, agro-labor, fishing service, business, van/rickshaw (mechanized van) pulling, cart pulling, date/palm climber), carpenter(wood), masonry, pottery, boat plying, blacksmith, barber, handicraft, imam, port labor, and honey collection from Sundarban.

Table 3.10: Sources of income of the local residents of the study area

Source of income	**Number**
Agriculture	4
Business	32
Fishing and shrimp cultivation	72
Job	10
Labor	25
others	40

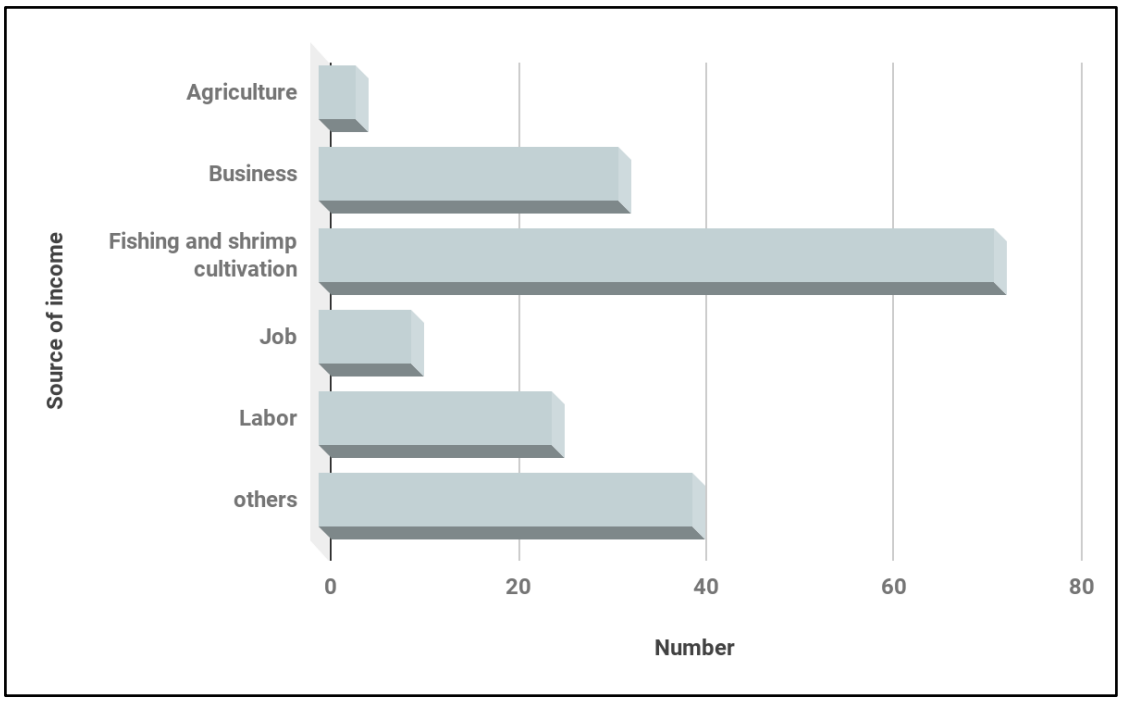

Fig 3.19: Source of income of the local residents of the study area

- Average total income 13864.64088 tk
- Average total expenditure 11602.74725 tk

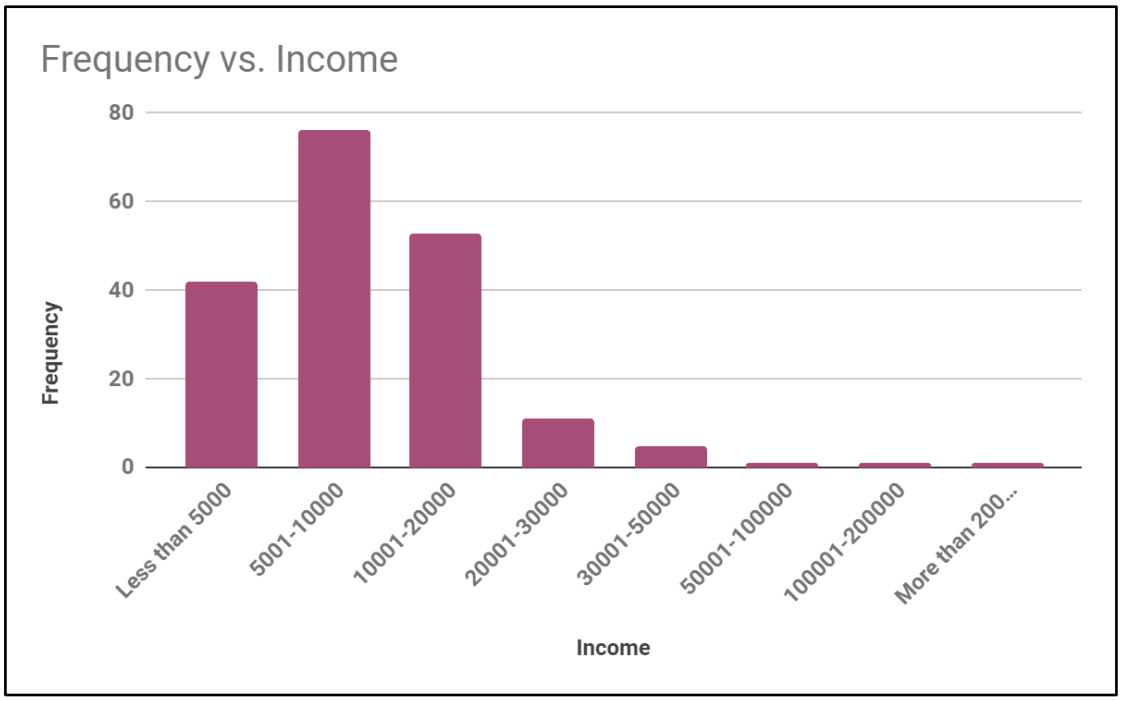

Fig 3.20: Incomes of the respondents of the study area

Table 3.11: Incomes of the respondents

Income	Frequency
Less than 5000	42
5001-10000	76
10001-20000	53
20001-30000	11
30001-50000	5
50001-100000	1
100001-200000	1
More than 200000	1

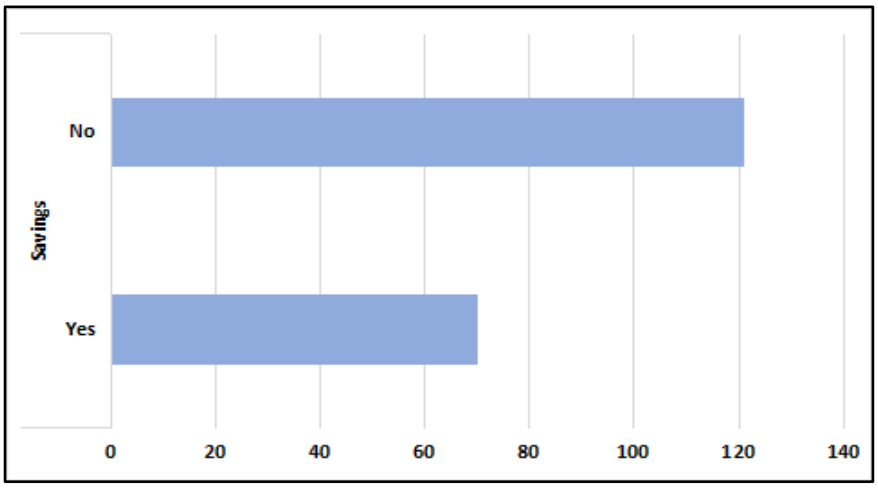

Fig 3.21: Frequency of savings of the respondents

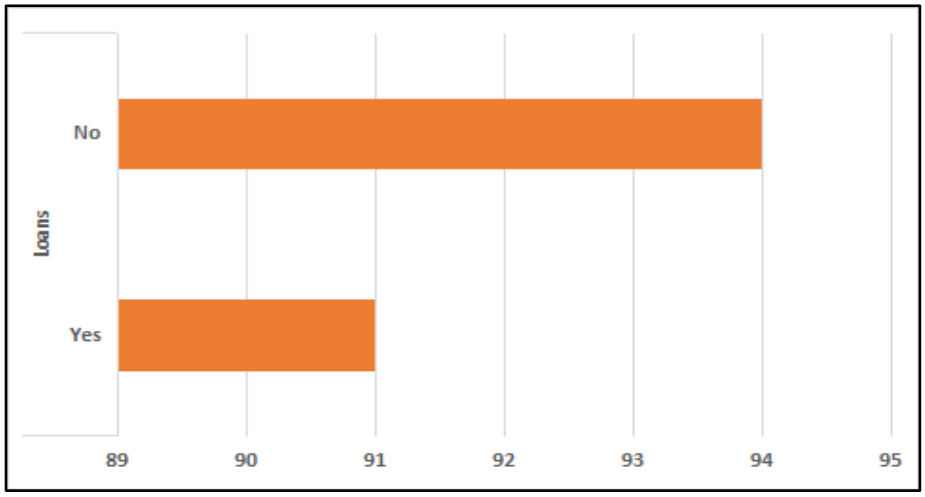

Fig 3.22: Frequency of loans of the respondents

Fig 3.23: Local market of the study area

Fig 3.24: Local boatmen's boats at ferry ghat

Chapter 4

Drinking Water Condition in the Study Area

4.1 Water Supply Scenario:

In the 187 studied households, there is an average drinking water demand of 315.7153846 litres per day. RWH and pond are the major drinking water supply sources in the study area. About 80 % of the populations rely on these sources. Other sources like tubewell, household filter, river water etc. are also used in a very little number of households.

Table 4.1: Source of drinking water of study area

Source of Drinking Water	Frequency
Tubewell	00
PSF	10
Rainwater	164
Pond Water	123
Outside the community	28
Others	13

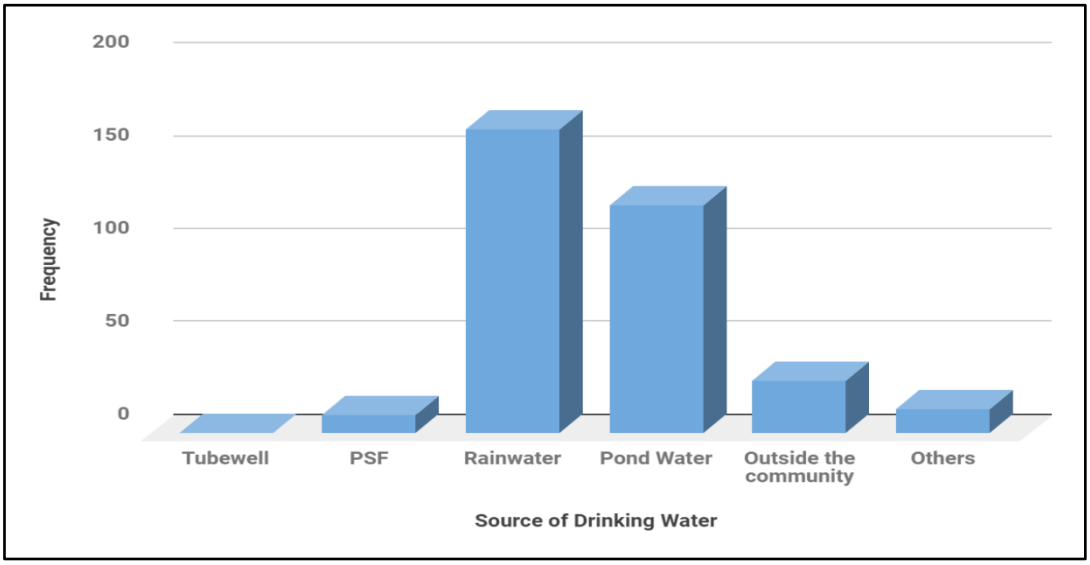

Fig 4.1: Sources of drinking water

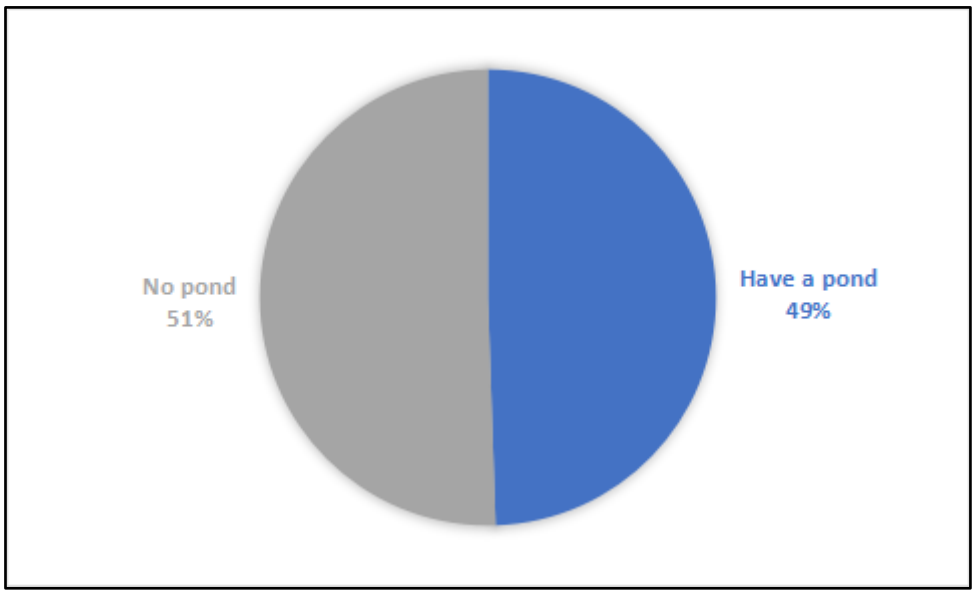

Fig 4.2: Respondents who have pond in study area

Fig 4.3: A pond in the study area

4.2 Collection of Drinking Water:

Table 4.2: Collector of drinking water of study area

Collector of Water	Frequency
Self	72
Husband/Wife	108
Son/Daughter	45
Others	17

Due to overall difficulties of existing water supply technologies, people are forced to drink direct rain fed pond water from their nearby sources. If pond water users want to fetch water from a functional PSF instead of consuming direct pond water, more than 80% of them have to travel more than 1 km and spend more than 1 hour. Because of these greater hardships to collect water from PSFs, people are inclined to drink direct pond water, particularly women and girls who are generally responsible for water collection and don't have the adequate knowledge about potential health risks of consuming direct pond water.

Fig 4.4: A woman's fetching water from the PSF

Table 4.3: Distance from the source of drinking water of study area

Distance from the source	Frequency
Neighbour's house	11
0 - 1 Km	88
1 -2 Km	39
>2 Km	45

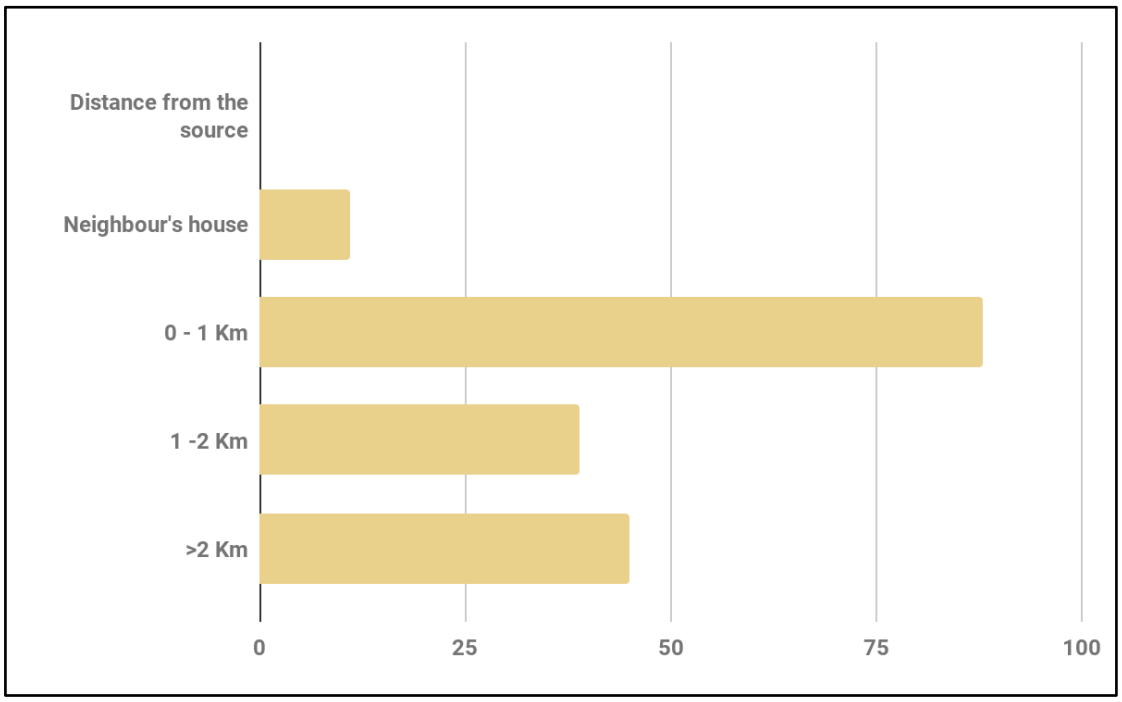

Fig 4.5: Distance from the drinking water sources

4.3 Concerning Issues of Safe Water Supply:

RWH appears to be one of the most promising alternatives to supply safe drinking water in the area. But high establishment cost restricts the use of RWH. It is also hindered by seasonal variation; and health risk due to lack of proper storage and treatment facilities. Most of the RWH's users do not have large storage tank to store water for dry season (November to March) so they have to depend on PSF or pond in dry season. As RWH systems in the study area are mostly household based.

On the other hand, distance and time required difficulties are greatly seen among PSF's users. PSFs in the study area have been installed randomly. More than half of the PSF's users must have to spend more than one hour and walk several distance to collect water, moreover, low flow rate of PSF and substantial queuing time are additional burden. This scattered water suppliers are frequently damaged due to natural disaster, lack of regular cleaning and proper maintenance; and becoming dysfunctional within a short time after installation.

4.4 Water Quality Analysis:

From our visit in the study area, we collected five samples of water from different sources and analysed those samples in our laboratory. The results are as follows:

Although the pH content is found tolerable in those samples, the chloride content of the samples varies from 131350 to 1508 ppm which is far more than the standard amount 250 ppm because of the presence of high salinity in waters. Same for the amount of TDS which standard limit is 500 mg/L as given by WHO (2003).

Table 4.4: Water sample analysis collected from the study area

Sample	pH	EC (µS)/m)	TDS (ppm)	Chloride Content (ppm)	Source
1	7.5	0.94	675	2396.3	River water
2	7.9	1.31	945	3106.3	Pond water
3	7.8	0.93	673	1686.3	Fish cultivation water
4	7.9	0.72	519	1508.8	Reserve Pond water
5	7.7	4.55	712	131350	Shrimp cultivation pond water

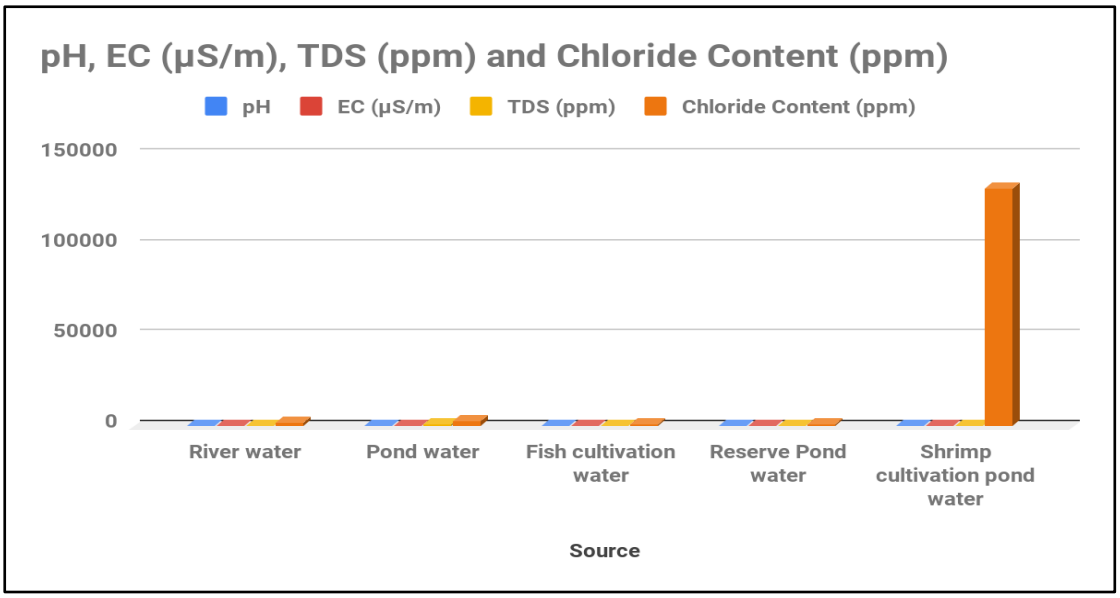

Fig 4.6: Water sample analysis collected from the study area

4.5 Impact on Health:

People in the study area suffer from various health-related problems caused by saline or impure water. According to the Food and Agriculture Organization's recommendation, consumption of salt should be limited within 5g/day, but people in the study area take up to 16g of salt just by drinking the water (Daily Star 2013). As a consequence, various skin and intestinal diseases, dysentery, fever, and diarrhea become a regular part of life for the people in the area. Women in the study area suffer from a gynecological disorder caused by carrying big jars of water on their hip when fetching drinking water from a long distance.

Table 4.5: Water-borne diseases in study area

Water-borne diseases	Frequency
Diarrhea	130
Dysentery	124
Jaundice	24
Cholera	22
Others	6
None	7

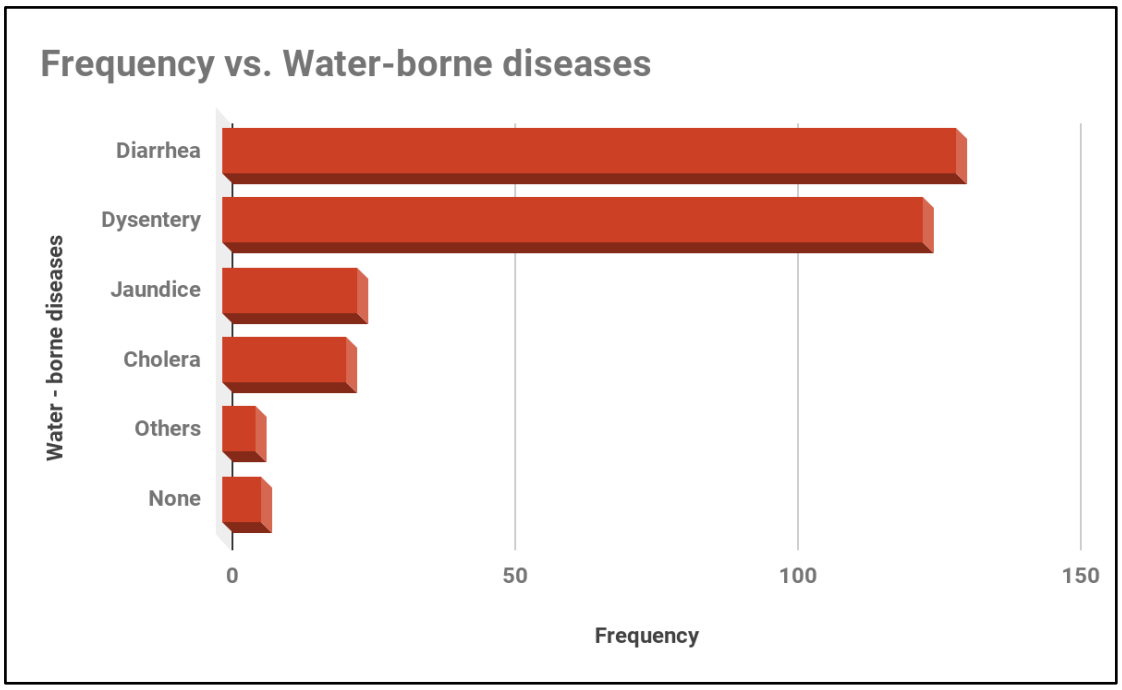

Fig 4.7: Water-borne diseases in study area

Most of the people in the study area are totally unaware of the hygiene and safety of drinking water, moreover, they think that safe water is nothing but salt free water. Evaluating among the users of different sources, pond's users are more suspected to water-borne diseases rather than the users of PSF and RWH.

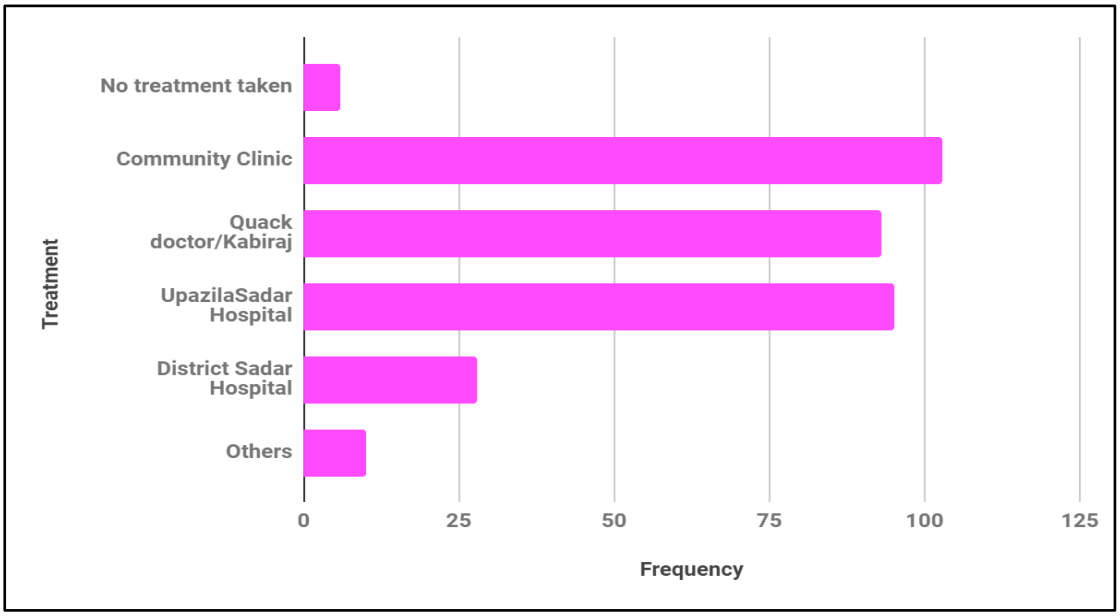

Fig 4.8: Condition of treatment of diseases of respondent in study area

Fig 4.9: An impure water source in the study area

Fig 4.10: Stored drinking water in a container

Chapter 5

Community Perception, Adaptation and Adjustments

5.1 Community Perceptions:

The coastal area of Bangladesh is composed of different geomorphological regions with dissimilar hydrology, climate, and soils (Islam 2004). The area experiences all types of hazards including cyclones, tidal surges, floods, droughts, salinity intrusion, waterlogging, and land subsidence (Abedin et al. 2012). With increasing climate variability, Dankelman et al. (2008) note that salinization of drinking water sources is becoming a major problem. Ahmed (2008) argues that sea level rise further aggravates salinity ingress along coastal rivers. Salinity has increased the vulnerability of the people to the decreasing availability of potable water over the last few decades in the study area.

Considering all the issues, the respondents were asked about the most prevalent hazards that directly related to reliable available drinking water in their locality. The findings reveal that nearly all respondents perceive salinity to be the most prevalent hazard that causes a lack of safe drinking water in these areas. Apart from salinity, more than half of the respondents mentioned natural hazards are also responsible for enhancing drinking water scarcity in this region.

The respondents were further asked about the natural and human causes of these hazards and the drinking water scarcity experienced in this region. The respondents pointed out that the increase in salinity intrusion is the main natural cause that limits potable drinking water. In addition, many of the respondents stated that extensive shrimp cultivation is a human activity that compromises drinking water availability.

The respondents were also asked to give their opinion about the water quality that they use for drinking purposes. And the responses were as follows:

Table 5.1: People's opinion regarding purity of drinking water of study area

Opinion	**Frequency**
Very pure	29
Partially pure	128
Somewhat drinkable	24
Impure	12

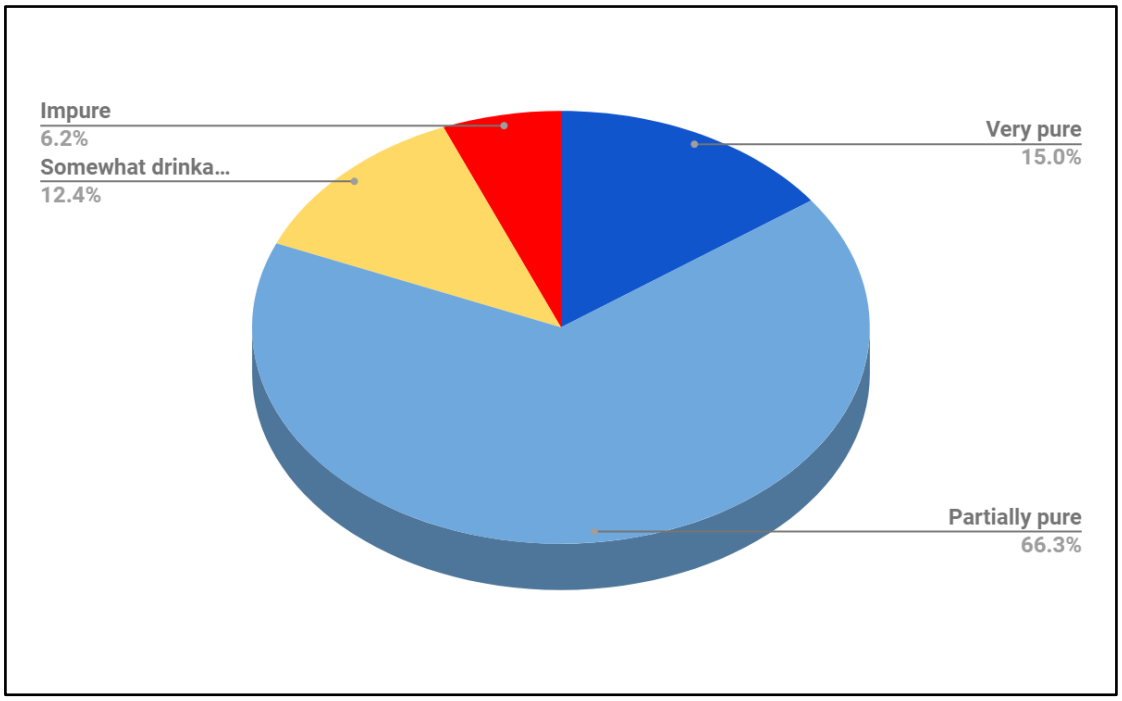

Fig 5.1: People's opinion regarding purity of drinking water

The have also talked about their perceptions on the increase of salinity in the local water sources, the difficulties that they face while collecting drinking water for their families and also about how this condition is changing their ways of leading lives to cope with the existing problem of safe drinking water crisis in the area.

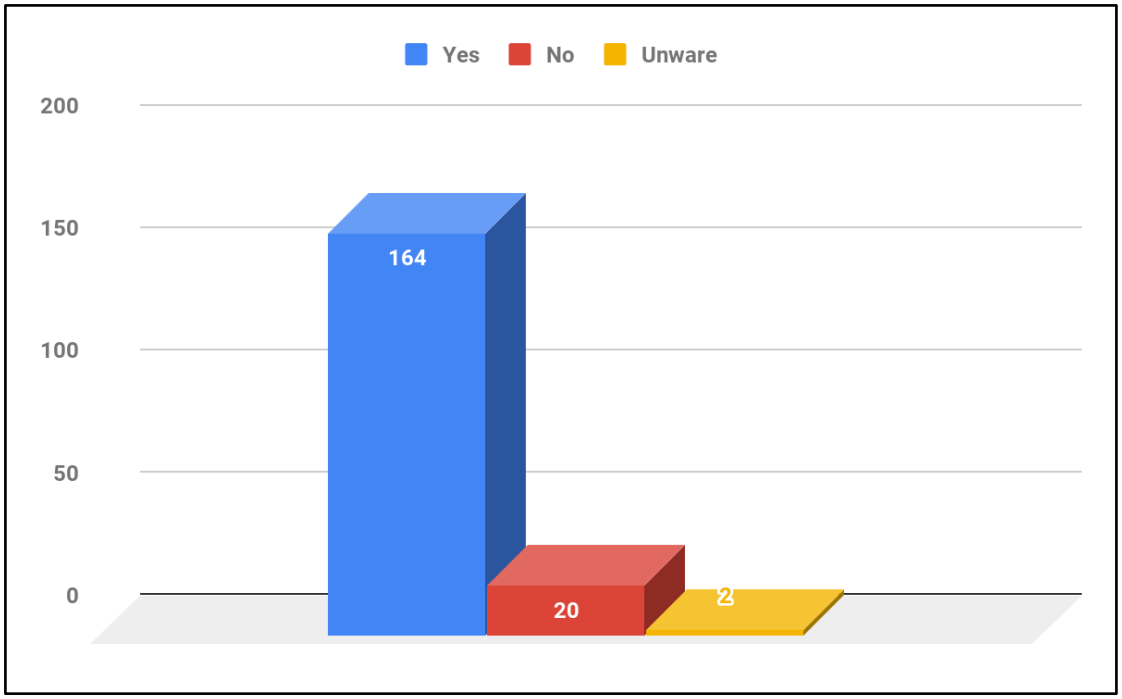

Fig 5.2: People's opinion regarding increasing salinity in water of study area

Table 5.2: People's perception about facing problems during collecting drinking water

Problems during collection	
Yes	**No**
145	44

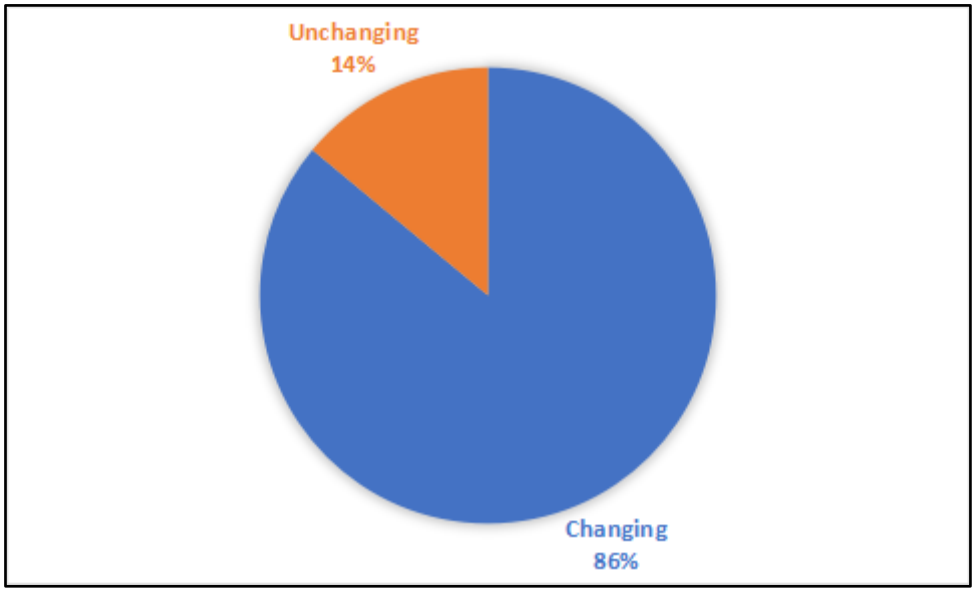

Fig 5.3: People's perception about changing phenomena

5.2 Adaptations and Adjustments:

Adapting to or coping with water scarcity means to live in harmony with the environmental conditions specific to and dictated by limited available water resources (Pereira et al. 2009). Adaptation is a two way process, which initially requires the recognition of changes and then responding to change through adaptation (Habiba et al. 2012). To reduce the safe drinking water scarcity problem, different stakeholders adopted various approaches.

The specific adaptation and coping actions of individuals, local communities, and institutions (local governments, NGOs, and private sector) are all important because together they can potentially reduce the safe water scarcity in a locality. This section introduces adaptation and coping measures adopted at the individual and community levels in the area as well as those supported by various organizations based outside local communities.

5.2.1 Individual and Community Level:

The existing adaptation and coping measures are followed by individuals as well as communities to combat drinking water scarcity.

At the individual level, depending on socioeconomic conditions, a respondent employs measures that are manageable for a single household, whereas at the community level, members of a community share responsibilities and draw benefits from the measures they adopt collectively.

For example, small units of ponds with sand filters and rainwater harvesting systems are considered as the most suitable safe drinking water options used by individual households. On the other hand, large ponds with sand filters and large rainwater harvesting systems are used in communities and are now the only major sources of safe drinking water maintained at the community level. Very few people have the ability to buy purified water from water treatment plants or shops; as the majority of residents live under the poverty line.

5.2.2 Institutional Level:

Institutions play a leading role in supplying drinking water in the whole country. Various local and international NGOs such as Sushilan, Uttaran, ActionAid, Caritas, Concern Worldwide, UNICEF (United Nations Children's Fund), USAID (United States Agency for International Development), and government organizations such as DPHE (Department of Public Health) and CDMP (Comprehensive Disaster Management Program) are involved in supplying drinking water in coastal Bangladesh. Among them, UNICEF and DPHE carried out the introduction of pond sand filters (PSF) along the coastal belt.

The respondents in the study area were asked about the types of adaptation and coping measures supported and implemented by different institutions. Considering the salinity problem, the survey results show that most of the respondents adopted PSFs to get safe drinking water, with the assistance of government organizations (for example DPHE) and non-government organizations (like Sushilan) in cooperation with donor agencies as well as

international NGOs (for example Caritas and UNICEF). In addition, many of the respondents practice rainwater harvesting technology by conserving rainwater during the rainy season and using it for drinking purposes with the help of various NGOs.

Fig 5.4: A project of USAID in the study area

5.2.3 Purification of Drinking Water:

The local people use various types of purification methods to make their stored water suitable for drinking. It is done both in individual and community levels. Where individually people boil or use various types of water purification tablets to purify the water, the community based helps are contributing by providing them with these tools cost free.

From our study in the affected area we found the following results as collected from the respondents:

Table 5.3: Purification Method of drinking water of study area

Purification Method	Frequency
Unpurified	19
Tablet	59
Boiling	54
Fitkiri	148
Others	5

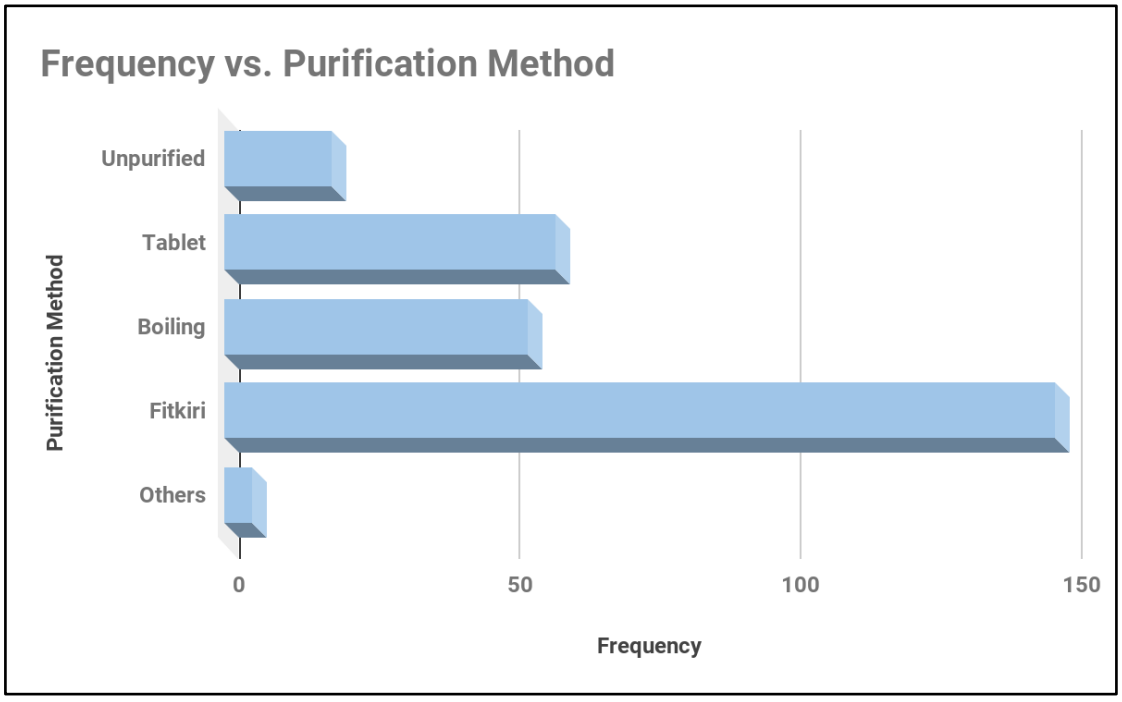

Fig 5.5: Purification Method of drinking water of study area

Table 5.4: Community based purification user in study area

Community Based Purification	Frequency
User	64
Non User	119

5.2.4 Pond Sand Filters (PSF):

Water gets contaminated during flood and water become highly turbid. So Pond sand filter technique is used for treatment of surface water of ponds. It is a type of slow sand filter that removes turbidity from water and yields bacteriologically safe water for domestic use. Pond sand filter is simple low-cost technology, effective in turbidity and bacterial removal and a popular option of potable water supply in the coastal belt areas.

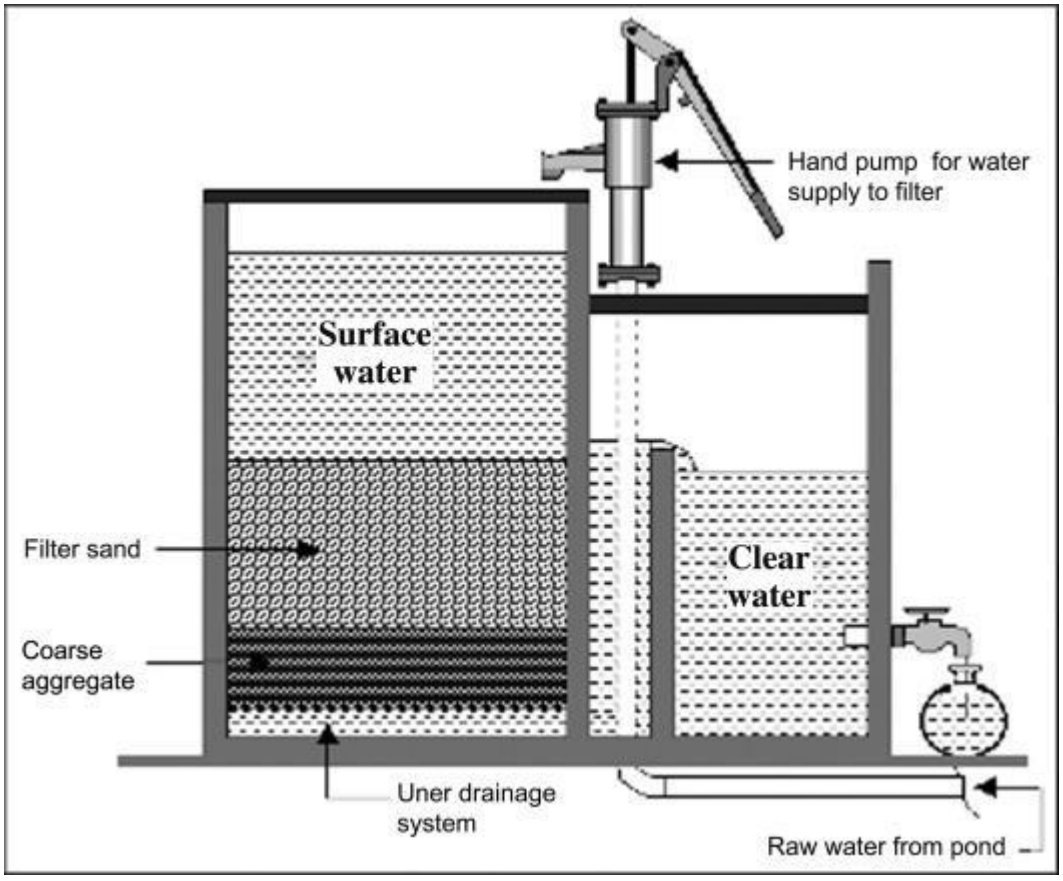

Fig 5.6: Diagram of PSF (DPHE, 2008)

Some basic characteristics of PSF are described below (WaterAid, 2009a):

- The PSF is installed near or on the bank of a pond, which does not dry up in the dry season. The banks of the pond should be raised so that surface run-off cannot enter the pond, if possible, it can be raised over flood level so that the pond water can be used during flood.
- PSF is constructed with locally available materials and trained masons. The water from the pond is pumped by a manually operated hand tube well to feed the filter bed, which is raised from the ground, and the treated water is collected through tap(s).
- On average, the operating period of a PSF between cleaning is usually two months, after which the top layer of the sand bed needs to be cleaned and replaced. Its operation and maintenance are also simple and cheap.

From our study in the area, we have found that about 2.96% of local people use PSF as their drinking water source. Distance and time required difficulties are greatly seen among PSF's users. PSFs in the study area have been installed randomly. More than half of the PSF's users must have to spend more than one hour and walk several distance to collect water, moreover, low flow rate of PSF and substantial queuing time are additional burden.

Again, they have to pay a high amount of money in a monthly basis, ranging from 20-2000 Tk/gallon in different areas, to provide themselves with safe drinking water which is really a difficult task for these people who are already living below the poverty line. As a result, only the people who can afford these costs are able to use the facility and the rest have to depend on pond water or other such sources that is available to them.

This scattered water suppliers are also frequently damaged due to natural disaster, lack of regular cleaning and proper maintenance; and becoming dysfunctional within a short time after installation.

Fig 5.7: A pipeline of PSF at Kanainogor

Fig 5.8: Queue of local's containers to collect water from PSF

5.2.5 Rain Water Harvesting (RWH):

Rainwater harvesting is already a source to obtain drinking in some areas of the country. This technique is expected to become more prominent for the purpose of supplementing other sources. Rain water can be kept safe during flood and can be managed if it is stored in a container or reservoir high from the ground.

Apart from drinking purpose, RWH can be used for domestic use also. It is a simple, affordable, technically feasible and socially acceptable safe drinking water supply option for the difficult geohydrological areas.

The physical, chemical and bacteriological characteristics of harvested rainwater usually represent a suitable and acceptable standard of potable water. Due to ease of collection and storage, acceptable drinking water standards, this option is very useful in the coastal zone especially in the flood prone areas as well as saline areas. This technique is suitable for flood prone areas as ground water sources become unusable during flood.

From our visit in the studied area and according to the responses that we got from the people, we have found the following RWH conditions:

Table 5.5: Users of rain water as drinking water in the study area

Amount of rainwater	Frequency
Less than 1000	117
1000 - 10000	60
More than 10000	8

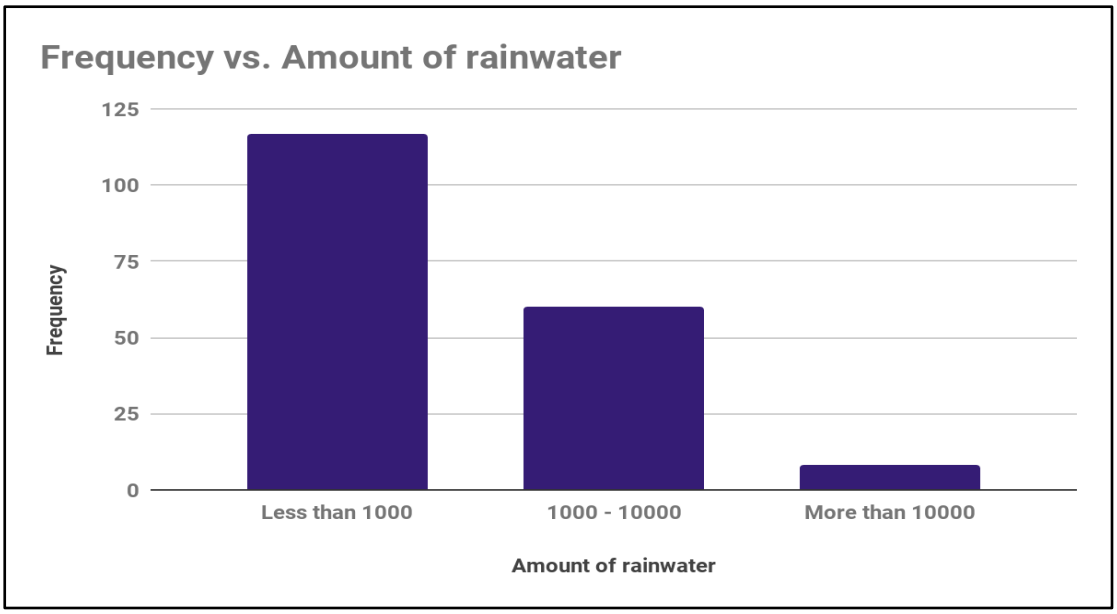

Fig 5.9: Users of rain water as drinking water in the study area

Table 5.6: Rain Water Harvest users in study area

User of rainwater	
Yes	**No**
180	10

Average use of rain water is 1331.066667 Litres. This rain water harvesting is done both in individual and community levels. At the individual level, depending on socioeconomic conditions, a respondent employs measures that are manageable for a single household, whereas at the community level, members of a community share responsibilities and draw benefits from the measures they adopt collectively.

Fig 5.10: An earthern container of rainwater harvest

Chapter 6

Conclusion and Recommendation

6.1 Conclusion:

This field trip was introduced to us to gain basic knowledge of field studies, as explained earlier. But at the end of the day we have acquired some excellent experiences, field research related basics. The findings of the trip are discussed below:

After the nostalgic field trip we have achieved some extra ordinary features on field studies. During data collections we had to interact with different people though the villagers were very hospitable and helpful. Our task was to observe the physical and human elements and collecting data regarding questionnaire. We noticed everything around us, asked questions, noted down the data and made assumptions.

During data collections and observing the physical and human features I came to know that understanding the community's unique perception and assessing their adaptive and proactive capacities is important for creating successful management programs. This study has examined communities' perception of and adopted and expected coping measures for overcoming safe drinking water scarcity problems.

Despite a number of adaptation and coping measures that have been implemented in the study area to upgrade drinking water quality and supply, given the magnitude of the problem, the current level of adaptation and coping measures of the respondents remain inadequate to cope with the future challenges of safe drinking water supply. Most of these measures implemented in the study area are reactive rather than proactive, autonomous rather than well planned when adaptation and coping measures can take many forms and can be adopted at the level of national government, local government, and NGOs.

A combination of structural and non-structural measures can bring smile to the affected people, relieve them from the nightmare of poverty and hunger and can

avoid many environmental and social consequences of scarcity of safe drinking water.

6.2 Recommendations:

Though it is too early to give any comments or recommendations for me as a learner of field research, based on the above description and statistics and from my point of view some useful recommendations are given below.

- Respondents in the study area were asked about their expectations for support from the government or NGOs to reduce their vulnerability to drinking water scarcity. Survey results indicate that most of respondents mentioned installation of or subsidy for rainwater harvesting for every family, whereas a few of them also cited piped water systems as the topmost need for support. Therefore, installation of rainwater harvesting systems at the family level is highly recommended. The government should take proper initiatives in consultation with community members and local NGOs to make the projects sustainable.

- Community-based pond sand filters with proper governmental monitoring and maintenance. Pond sand filters are a simple, easy to use, and effective technique in the southwestern region of Bangladesh, but the innovation needs proper maintenance to run year-round. Community involvement is important to carry out the program successfully in close association with the government.

- Re-excavation of ponds with strict rules for use, as salinity, arsenic and drought prone areas of the country require a program of water conservation. As large dams are difficult to construct due to high cost, re-excavation of a number of small ponds may provide the same benefit as a large reservoir.

- Although a number of government and nongovernment organizations are working at both the local and the national levels, the main problem is a lack of coordination among them. Because there is no integrated approach between adaptation measures of the community, government, and other development organizations, it is difficult to overcome drinking water scarcity.

- The National Water Policy of the Bangladesh government should incorporate methods of coordination and partnership among the development efforts of government, NGOs, and communities in order to insure proper implementation at the grassroots level. This would promote pragmatic actions that facilitate integration by knowing and applying community perception, adaptation measures, and expectations to cope with and solve the safe drinking water scarcity problem.

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