Development and Implementation of Climate Resilient Water Safety Plan Faridpur Pourashava as Flood Prone and Barguna Pourashava as costal Area

Baseline Report

(2015)

Department of Public Health Engineering

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Executive Summary

Climate change is expected to exacerbate the environmental determinants of health. It will impact on a wide range of infectious diseases and are likely to be increased. Most of these threats are directly related with the water, sanitation and hygiene which have a very significant impact on health. In Bangladesh the identified problem of water resources due to the impact of climate change and its variability are too little water, too much water, wrong type of water and wrong timing of water including deterioration of water quality. Such problem of water resources will impact the large scale water supply system which usually covered a large population in the urban area. Therefore, the vulnerability of the population as well as the water supply system will be increased. The WHO and DFID have been providing technical and financial support to the Department of Public Health Engineering to develop and implement climate resilient water safety plan to reduce the vulnerabilities of large scale water supply system as a preventive measure.

The situation was assessed by conducting a baseline survey with an overall objective to determine the knowledge, attitude and practice (KAP) about the safe water among the supply system’s users including the baseline status of Barguna and Faridpur water supply systems. The specific objectives were determination of the user's understanding about climate change and its impacts, perception about the water safety and health, water related disease, practice of consuming safe water, water quality considering microbiological and chemical parameter and the user's satisfaction about the supply water. The methodology of the survey was consisting of qualitative and quantitative information collection through questioner survey, observation and water quality testing. The methodology of the system assessment was observation consisting of information collection through sanitary inspection and various records.

The Barguna Pourashava water supply section was established in 1973 located in coastal area. The total holdings in the Pourashava were around 6105 of which 62% were the users of the Pourashava water supply system. The Barguna Pourashava piped water supply system was based on both the ground and surface water. During the assessment the surface water treatment plan was found non-operational due to its high operation cost. A total of 13 productions well had been pumping the water directly into the piped network and as the system has no overhead tank. The supply water has light yellowish brown colour which created an aesthetic problem among the water users. The reason was unknown. The fecal contamination rate of the supply water was very high. The *E. Coli* analysis of supply water indicated that 11% have intermediate risk, 37% have high risk and 52% have very high risk considering the health.

The temperature and rainfall have been changing over the past three decades in Barguna district. The historical temperature data analysis of last 40 years indicated that the yearly mean maximum and minimum temperature has increased 1.13°C and 0.56°C respectively at the end of 2015 than the base year 1973 when the yearly average maximum and minimum temperature was 30.1°C and 22.3°C. These revealed that the weather has been becoming hotter. The projected mean maximum temperature in the area in 2030 will be 31.71°C which was 1.61°C higher than the base year. The analysis of yearly total rainfall data indicated that there was no significant change in annual rainfall over the last 30 years of period but the seasonal patterns have been changing over the decades. The community, water supply staffs and professionals of the Barguna Pourashava identified bad fecal sludge management, river bank erosion, salinity and agro chemicals as key environmental hazards while increased temperature, erratic heavy rainfall, increased storms, tidal surge and flooding as climatic hazards.

A total of 97% of the respondents of the Barguna Pourashava knew about the different outcomes of climate change of which 50% of the respondents mentioned for increased temperature and erratic rainfall. Approximately 39% of the respondents of Barguna Pourashava mentioned that they were observing climate change impact on water supply interventions of which 23% of the respondents mentioned that the technologies becoming non-functional during the pre-monsoon frequently. A total of 35% respondents of the Pourashava could define safe water correctly. 96% respondents were dependent on the privately owned hand tube well for drinking water then the Pourashava running water. Majority percentage of the water supply users of the (98%) Pourashava collected drinking water by *Kolshi*. 97% of the users cleaned the water collection container every time during collection of water and 99% users transported the filled water container with a cover. A very few percentages of respondents in Barguna Pourashava were practicing the storage of drinking water in a container covered with a lid and kept in raised and ventilated place. It was found from the survey that an average of 13 episodes of water related disease in a week had been occurring among the respondents. The frequency of occurring such water born/washed/related diseases was higher among the age group <5 years then the other age group. 44% respondents believed that the diseases were occurring due to drinking water contamination and the main reason was the quality of Pourashava supply water.

The Faridpur Pourashava water supply system was established in 1969. The total holdings in the Pourashava were around 15695 of which 50% holdings were using the Pourashava supply water. The water supply system was based on the ground water. There were 11 production tube wells, installed at shallow depth, feeding two water treatment plants located in different location of the Pourashava. In the treatment plants, the pumped water was processed through different physical and chemical treatment units. The treated water lifted to an overhead tank. The water was then distributed through piped network to the users. The water of the production wells (raw) has high concentration of the arsenic, iron and *E. Coli.* The water samples from household's storage indicated very high risk to intermediate risk from the health point of view.

The historical temperature data analysis of last 60 years indicated that the yearly mean maximum and minimum temperature has increased 1.3°C and 0.60°C respectively at the end of 2015 than the base year 1954 when the yearly average maximum and minimum temperature was 29.8°C and 20.9°C in Faridpur district. These revealed that the weather has been becoming hotter. The projected mean maximum temperature in the area in 2030 will be 31.41°C which was 1.61°C higher than the base year. The yearly total rainfall data of indicated that it has been decreasing since last 30 years and its amount is below the national yearly total rainfall of 2472 mm with having a maximum amount of monthly total rainfall 822 mm The annual pattern of rainfall after every 10 years since 1983 indicating that the seasonal rainfall pattern has been changing over the decades. The community, water supply staffs and professionals of the Pourashava identified poor faecal sludge management, river bank erosion, low lying area and high use of ago chemicals as key environmental hazards, while increased temperature, erratic heavy rainfall, increased storms, and flooding as key climatic hazards.

A total of 84% of the respondents of Faridpur Pourashava knew about different outcomes of climate change of which 50% of the respondents mentioned about increase of temperature and erratic rainfall. Approximately 22% of the respondents complained that they were not getting adequate amount of water as before. A total of 53% of the Pourashava dwellers of Faridpur Pourashava could define safe water correctly. 60% of respondents have identified the supply water as safe water considering the water born or related disease and a total of 38% of the respondents identified the hand tube well water (with platform) was safe over the supply system’s water. Half of the users (47.5%) collected drinking water by *Kolshi*. 88% of the users cleaned the water collection container every time during collection of water. 72% users transported the filled water container with a cover. Avery few percentage of respondents of had been practicing the standard practice of storage of drinking water as drinking water. It was found from the survey that on an average 19 episode of water related disease had been occurring every week among the respondents. Survey also illustrated that prevalence of diarrhoeal incidences among the family members in both the Pourashava was higher in the recent years (2013-2015) then previous years (<2013). The probability and frequency of occurring water born/washed/related diseases among the age group >12 years were higher then the other age group. A total of 51% of the respondents believed that the diseases were due to drinking of contaminated water and main reason was the poor quality of water in the supply system.

The higher number respondents in both the Pourashava spent BDT 501-2,000 per year for treatment of such diseases. The survey illustrated the background situation of the supply system, its usage and the management. The information gathered through the survey will significantly contribute for the development of the climate resilient water safety plans both hardware, software and management context.

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CHAPTER 1: Introduction

1.1 Background

The impact of climate change, variability and climate extreme events are visible in every sector in Bangladesh with a variable degree considering the geography. The country has already been experiencing too little water in dry season, too much water during monsoon,[1] wrong time type of water and wrong type time of water. The change in distribution pattern of water resources seriously impacting the livelihood of the people, which encompasses agricultural productivity to drinking water supply and personal hygiene. In addition climate extreme events like flood, drought, and sea level rise, storm, tidal surges etc. has been making the situation worse. Safe drinking water consumption is the pre-requisite for maintaining sound health. The magnitude of the impact of climate variability and change on the safe water supply system differs with respect to the geography, technology type, environmental setting and people's health vulnerabilities (like water washed/born/related diseases). The WHO and DFID have been providing technical and financial support to the Department of Public Health Engineering to develop and implement climate resilient water safety plan to reduce the vulnerabilities of water supply system as a preventive measure.. Two Pourashava water supply system were selected considering the geography namely Faridpur Pourashava of Faridpur district (as flood prone area), Barguna Pourashava of Barguna district (as coastal area) for the development and implementation of the climate resilient water safety plan. Therefore, a baseline survey was designed and implemented for collecting the background information of the water supply system and the people's knowledge, attitude and practice on safe water use for the development of the climate resilient water safety plan.

Water safety plans (WSPs) is a systematic comprehensive risk assessment and subsequent management approach to ensure safety of drinking water from catchments to point of consumption that proactively identifies sources of hazards and level of risks that affects adequacy and quality of the water supply service delivery systems. In recent decades the climate change and its variability has been posing a substantial threat to the safe water supply system considering the physical, chemical and biological hazards which has been deteriorating the functionality, accessibility, availability and quality of the supply system. The climate resilient water safety plan is an approach that systematically includes climate

[1] *Climate Change Cell, Component 4B of Comprehensive Disaster Management Programme CDMP @ June 2006*

variability, extreme weather events as key issues for consideration during development of water safety plan. Some examples are higher temperatures, combined with changes in the frequency and magnitude of heavy rains, increased the incidence of diseases such as malaria and dengue fever; erratic rainfall caused flash flooding which deteriorated the biological quality of water and hence increased the diarrhoeal incidences; draw down of water table increased the non-functionality of the ground water based technologies thus reduced the accessibility. The Fig. 1.1 illustrates the probable climatic and environmental hazards drivers on different steps of water supply system which could be useful during the development of the climate resilient water safety plan in coastal and flood prone area water supply system.

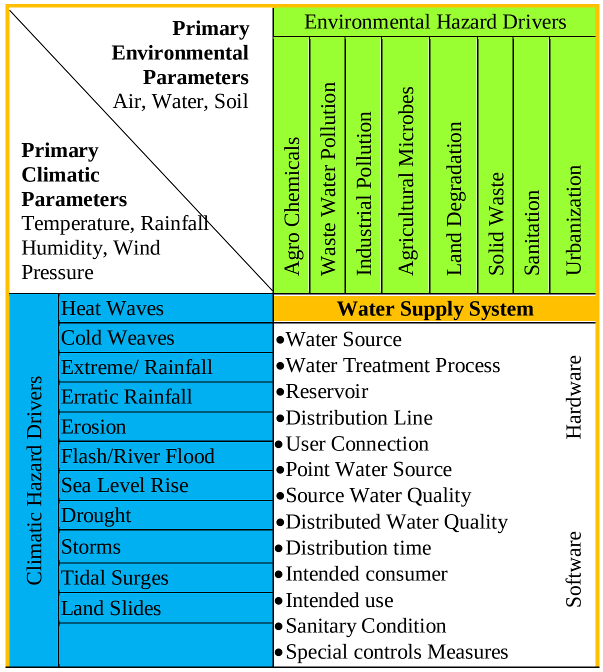


Fig. 1.1: Climatic and environmental hazard drivers

1.2 Outline of the Report

The baseline survey report consist of six chapters namely introduction, geography, climate and environmental setting of coastal and flood prone area, survey design, system assessment and findings of KAP survey. The first chapter (introduction) describes the climate resilient water safety plan, environmental and climatic hazard drivers. The chapter also provides an overall idea how the environmental and climatic hazards will impact on different components of the piped water supply system considering the geographic setting. The second chapter illustrates the climatic and environmental setting of the Barguna district located in the coastal area. The third chapter reflects the climatic and environmental setting of the Faridpur district located in the flood prone area. The fourth chapter (survey design) illustrates the objectives, methods, sample size and limitations of the survey. The fifth chapter (system assessment) provides information about the present condition of the supply system considering source, source water quality intended use and users, consumers, piped network details, sanitary condition, risk score etc. of Faridpur and Barguna Pourashava water supply system. The sixth chapter (findings of KAP) illustrates user's perception about the climate change and its impact on the water supply system, understanding about safe water, user's current practice of water collection, transportation, storage, consumption and health.

CHAPTER 2: Geographic Setting & Meteorology of Barguna

2.1 Geography

The Barguna district is located on the southern part of Bangladesh and is situated in between the Patuakhali and Khulna district. It is a flat land area full of rivers and estuarine creeks, having regular low and high tides. It is situated over the Ganges tidal flood plain and the land type is medium to high. The notable rivers in Barguna district include khakdon and the Baleshwar. The Bay of Bengal is positioned in the southern boundary of this district. The district is highly susceptible to storms and tidal flooding. It is consisting of flat land area with full of rivers and estuarine creeks, having regular low and high tides. The total area of the district is around 1,831.31 km^2 of which 399.74 km^2 is riverine and 97.18 km^2 is under forest. The total area of the Barguna Pourashava is about 15.57 sq. km[1] and the population density is around 2069/km^2. The total slum area is about 2.5 acre comprising around 180 numbers[2] of households.

2.2 Climate Condition of Barguna

2.2.1 Temperature

The regression analysis of past 40 years[3] temperature data of Patuakhali weather station approximately 45 km *away* from the Barguna Pourashava illustrated that the yearly *average maximum and minimum temperature has increased 1.16 °C (r^2 = 0.55) and 0.56 °C respectively at the end of 2015 (Fig.1). These revealed that the weather has been becoming hotter.* The projected mean maximum temperature in the area in 2030 will be 31.71°C which was 1.61°C higher than the base year (1973). The projected temperature up to 2080 in Barguna area is presented in Table 1.

Table: *The temperature variability analysis of Barguna since 1973 and projection to 2080*

Year	Maximum Temperature (°C)		Minimum Temperature (°C)	
	Annual Mean	Increment	Annual Mean	Increment
1973	30.10	Base Year	22.30	Base Year
2016	31.26	1.16	22.86	0.56
2030	31.71	1.61	22.86	0.56

[1] *https://en.wikipedia.org/wiki/Barguna_District*
[2] *District Statistics (2011): Barguna*
[3] *Date Source Climate http://www.barcapps.gov.bd/dbs/index.php*

Year	Maximum Temperature (°C)		Minimum Temperature (°C)	
	Annual Mean	Increment	Annual Mean	Increment
2050	32.35	2.25	22.87	0.57
2080	33.31	3.21	22.89	0.59

Monthly maximum mean temperature was plotted for every 10 years since 1973 and presented in Fig. 2.1. The figure indicated that as the years are passing the area of high temperature in the graph has been increasing over the mean maximum temperature of the respective year indicating that the number of hot days has been increasing since 1973. *Such increase of temperature and the hot spells will significantly contribute to the pathogenic activities as well as the temperature related diseases. The pathogens will get more favourable surface and subsurface environment to propagate.* As a result there is a high risk of pathogenic contamination of the supply water when there exists a considerable number of leakages in the pipeline, storage tanks if not cleaned properly frequently and chlorinated regularly, sluice valve chamber even in the households tanks or storage if not properly cleaned and hygiene is not maintained.

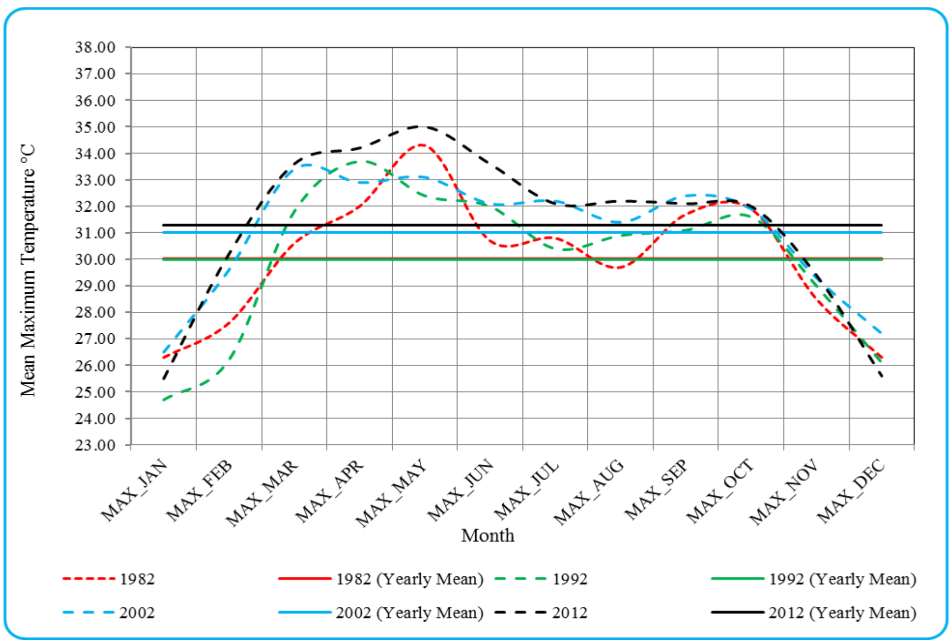


Fig. 2.1: The mean maximum temperature scenario of Barguna district considering last three decades

2.2.2 Rainfall

There was no significant change observed between the national (2472 mm) and Patuakhali (2486 mm) total annual rainfall in last 30 years (1982 to 2013). The decadal average of annual total rainfall trends and the seasonal patterns in different times of the year are presented in the Fig. 2.2 and Fig. 2.3. The Fig. 2.2 illustrated that since 1975 the trend of decadal average of annual rainfall in Barguna was sinusoidal in nature. That is in one decade the decadal average of annual rainfall is below the line of last 30 years average and the consecutive decadal average of total annual rainfall was above the last 30 years average

rainfall. Fig. 2.3 indicated that there was no significant change in the decadal average of monthly total rainfall in winter, pre monsoon and post monsoon in different decades. *But the annual average rainfall in different decades indicated that the number of wetter days has been increasing over the time*. Fig. 4 also illustrated that as the time is passing since 1975 the yearly trend of monthly total rainfall curve's tip has been coming sharp indicating *more rainfall in small time.*

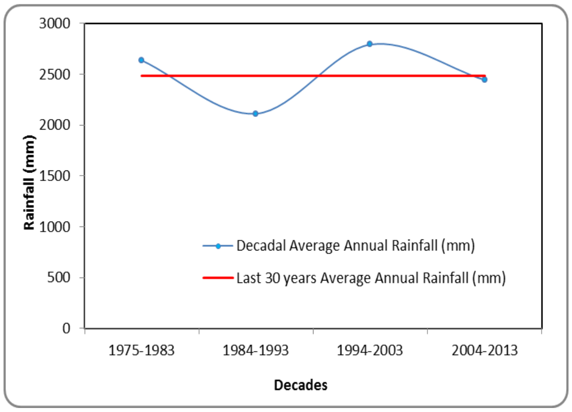


Fig. 2.3: The rainfall trend of Barguna

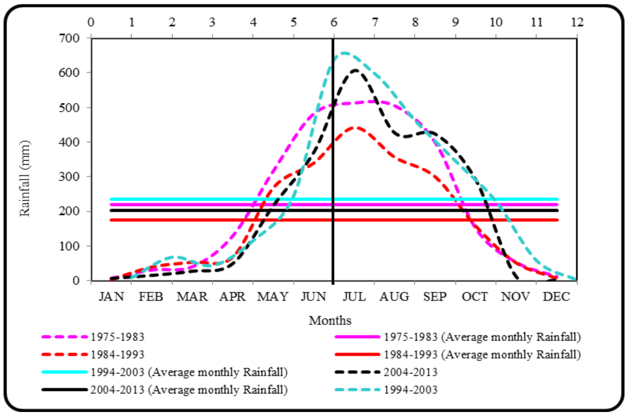


Fig. 2.3: The rainfall trend of Barguna

2.2.3 Storms

The Barguna district of Bangladesh is susceptible to cyclones and storm surges and subjected to severe damages frequently. The historic dataset (1877-2003) of land falling storm track in Bangladesh[1] developed applying the Global Tropical Cyclone Climatic Atlas (GTCCA) revealed that *thirty-five depressions, storms and cyclones hit directly Barguna district during the last 130 years* (Fig. 2.4). Along this Barguna was also affected by hard hit severe cyclones during 1935, 1965, 1970 and the most recent cyclone in SIDR in 2007. The extent of damage caused by the last catastrophic cyclone SIDR, which swept through Bangladesh coast on 15 November 2007, was about $450 million. The entire Patuakhali, Barguna and Jhalokati districts were hit hard by the storm surge over 5 meters (16ft). In Barguna district, 1335 people were died (44.5% of total casualties), 1119.89 sq. km area was annihilated (61.15% of total area), 60-70% of crop was lost and 95,412 houses were fully and partially damaged (36.89 % of total).

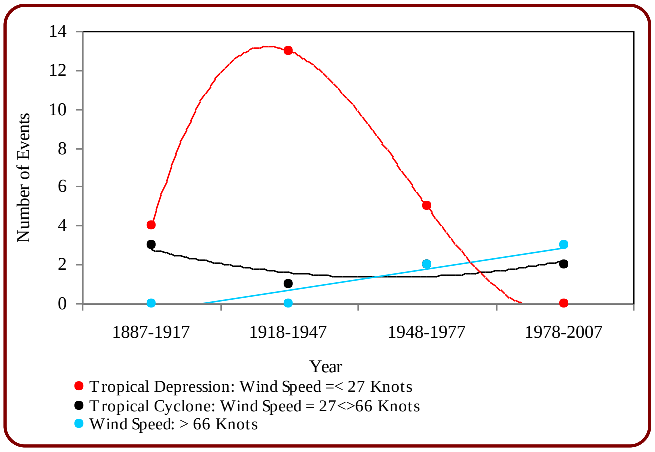


Fig. 2.4: The historic trends of different types of extreme weather events

[1] *Umma Tamima (December 2009): Population Evacuation Need Assessment in Cyclone Affected Barguna District, Journal of Bangladesh Institute of Planners ISSN 2075-9363, Vol. 2, pp. 145-157 Bangladesh Institute of Planners*

2.2.4 Tidal Surge and Flooding

The Barguna district is susceptible to tidal surges and flooding with a variable degree considering the distance from the ocean and the elevation (Fig. 2.5). The elevation of the Barguna Pourashava is around 1m and it is 34.84 km distant from the coast. *The surge level at different points of river Haringhata, Bishkali and Burirshawr and at the confluences of the three rivers during sever cyclonic storm SIDR was compared with the previous cyclone in the district during 1970 and 2007.*[1] *The results showed that storm surge level and surge induced coastal flooding reached from the outfall of Baleshwar River up to 50 km upstream at Morrelganj with high surge level. Analysis also revealed that except two upazila in Barguna district, the rest of the three upazila were submerged by storm surge due to the overtopping of embankment.* It is important to note that the height of the embankment is 5m along the three upazila

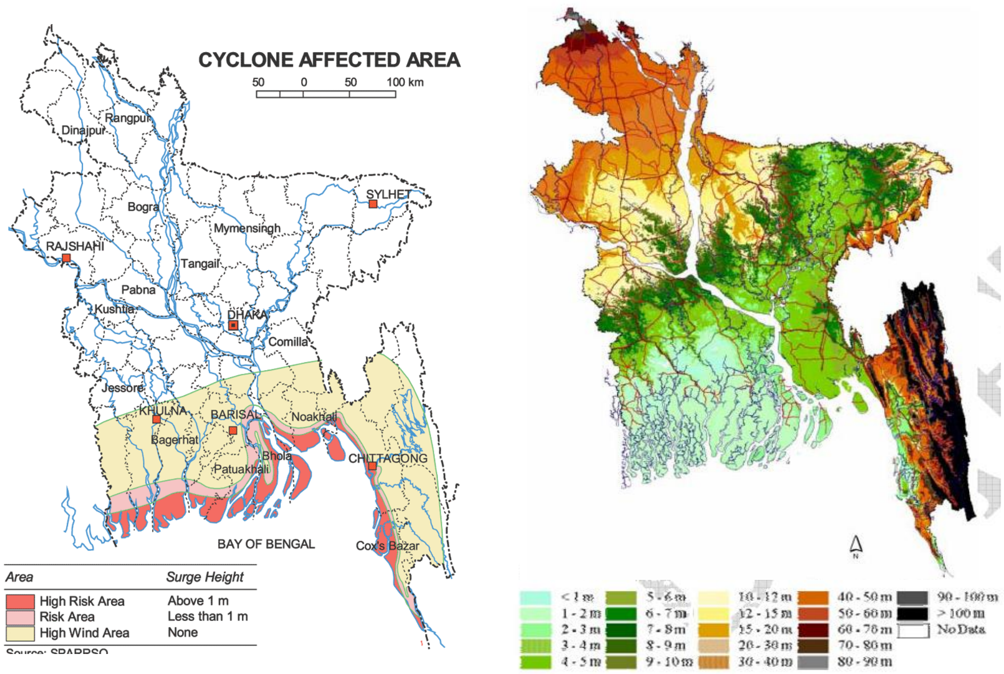


Fig. 2.5: Tidal surge map left (SPARSO) and elevation (Tight) map of Bangladesh

namely Patharghata, Amtali, Barguna Sadar and the Pourashava at a variable degree depending upon the elevation and the surge height which varied form from 1 meter to 9.15 m. It needs to be noted that in general the high tide during summer rises up to 1.3 meter above the general ground level.[2] Embankments and Polders do not provide the enough heights to prevent overtopping of cyclone storm surge. Embankment was built to protect the high tide water of 6 feet but not tidal surge of 20 or 30 feet. That is why the embankment failed during SIDR and the whole area was inundated.

[1] *Umma Tamima (December 2009: Population Evacuation Need Assessment in Cyclone Affected Barguna District, Journal of Bangladesh Institute of Planners Vol. 2, pp. 145-157, ISSN 2075-9363*

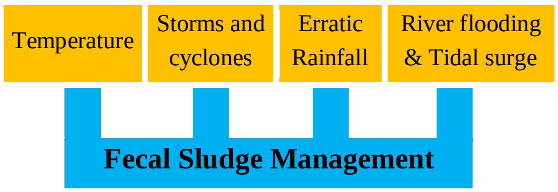
[2] *S. A. HAQUE (2006): Salinity problems and crop production in coastal regions of Bangladesh, Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh, Pak. J. Bot., 38(5): 1359-1365*

2.3 Environmental Setting of Barguna

Almost one fourth (40%) of the total population of the country live in the coastal areas of Bangladesh, where majority of the population will be affected by coastal floods/tidal surges, river-bank erosion, salinity, tropical cyclones etc. with the rise of sea-level up to one meter. The country could lose up to 15% of its land area under the sea water and around 30 million people living in the coastal areas Salinity intrusion from the Bay of Bengal already penetrates 100 kilometres inside the country during the dry season and the Climate Change in its gradual process is likely to deteriorate the existing scenario to a great extent. A 7% increase of area of brackish water will force 7.5 million people to be exposed to high salinity of 5 ppt in 2050. In general half of the peoples of the country lived the flood area.

2.3.1 Fecal Sludge Management

The significance of fecal sludge management in Municipal area is important because its improper management and disposal will create unhealthy environment in the municipal area for the dwellers, contaminate the surface water as well as the ground water, increases mosquitoes and files. Research suggests that improved excreta management could reduce the diarrhoeal morbidity by 36%.1 Another study showed that sewerage systems typically reduces the diarrhoeal incidence by about 30% or perhaps as much as 60% when starting sanitation conditions are very poor.[2] In Bangladesh 61% of the population has access to improved sanitation facilities Besides, 25% and over 15% of the population are using shared latrines and unimproved sanitation facilities (largely open pit latrines) respectively. In Barguna Sadar upazila 24.80% population has access to improved latrine has and 72.8% has unimproved latrine and 2.40% of the peoples have no toilet,.[3] The pit latrine was the dominating sanitation technology in the Pourashava area followed by septic tank. Most of the dwellers who has septic tank emptied the septic tank when it is filled and disposed off the excreta into the nearby drain or surface water bodies, ditch or buried in the ground. The excess excreta of the filled ring/pit latrine was generally disposed off by the dwellers into the municipality drainage system or nearby surface water body or low lying area for avoiding cost of construction of a new system. This will lead to the deterioration of the water quality of the water supply system. There was numerous evidence that the climatic parameters namely temperature, erratic rainfall, storms and cyclones, river flooding and tidal surges have a significant impact on these type of fecal sludge management e.g., tidal surges and the river flooding will increase the risk of mixing of the excreta/fecal matters with the surface water, sea level rise will increase the probability of river flooding, inundation and water stagnation and erratic rainfall will add increased potential to such events. The increased frequency of storms and cyclones will increase the



[1] *Carr, Richard (2001). Excreta-related infections and the role of sanitation in the control of transmission, Water Quality: Guidelines, Standards and Health. World Health Organization (WHO)*

[2] *Norman, G., Pedley, S., and Takkouche, T. (2010); Effects of sewerage on diarrhoea and enteric infections: a systematic review and meta-analysis. Lancet Infect Dis 2010; 10: 536–44*

[3] *JMP 2015*

probability of tidal surges and destruct the infrastructure of sanitation and the water supply system as a result the probability fecal contamination of the water supply system increases.

2.3.2 Riverbank Erosion

River bank erosion and river morphology in Bangladesh is highly dynamic in nature. *Char's* are found in most of the major rivers of the country which are highly unstable. It moves with the flow and are extremely sensitive to changes in the river morphology. Losses by river erosion happen slowly and gradually and it makes peoples livelihood miserable. In many cases such people migrates to an urban area for better livelihood, work and create slums. The slum dwellers increase the water demand and sanitation facilities in the urban area. The natural shape of Bangladesh coastal and marine areas are generally controlled by tides, wave actions, strong winds and sea level variations which are dynamic in nature. Over the last two centuries, huge changes have taken place due to continuous land erosion and accretion along the coastline. Erosion is also a problem in inland coastal rivers in Barisal, Patuakhali, Bhola, Barguna, Jhalakathi and Pirojpur districts of the Barisal division, resulting in hundreds of family homeless and shelter less. In Barguna district the *Payra* river erosion took (Fig. 2.6) a serious turn at Amtoli upazila adjacent to Barguna Pourashava rendering more than hundreds of acre crop land damaged. The *Payra* River continued erosion threatening fresh areas of new area (15 villages) at Amtoli upazila.

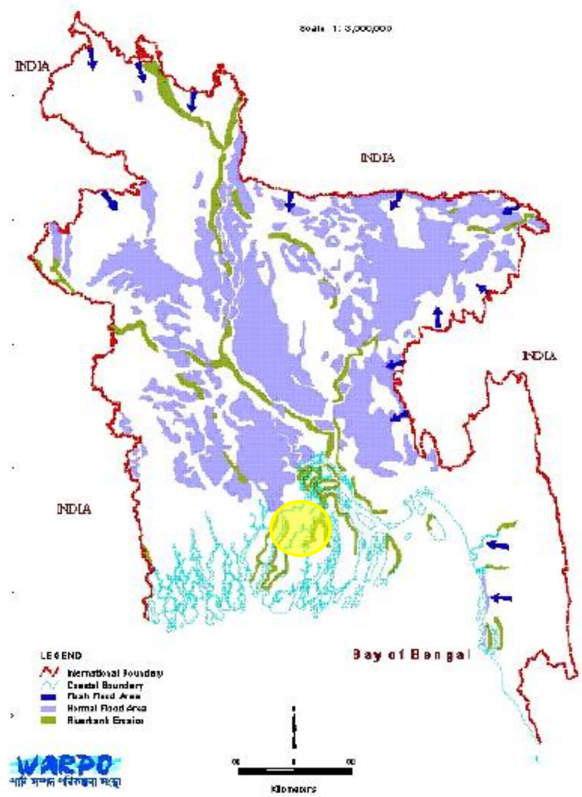


Fig. 2.6: The riverbank erosion area of Bangladesh

2.3.3 Water Salinity

Salinity is one of the major environmental problems in the coastal area. It is expected to be exacerbated by the climate change and sea level rise in the future. The coastal area of the Ganges delta in Bangladesh is characterized by tides and salinity from the Bay of Bengal. Salinity intrusion due to a reduction of fresh water flow from upstream, salinization of groundwater and fluctuation of soil salinity are the major concern of the coastal area of the country. The higher salinity levels have adverse impacts on agriculture, aquaculture, and domestic and industrial water use and so. The present temporal and spatial variation of salinity is likely to deteriorate further as a consequence of the external drivers of change. The average salinity level of Barguna Sadar surface water is 1<>5 ppt and soil is 4<>15 ppt. The Barguna Pourashava

water supply system used the groundwater as the source water and extracts the water form the secondary aquifer approximately 1000ft bellow the ground level. Hence there is less possibility of Contamination of deep ground water by the saline water but the shallow aquifer has higher possibility of the saline water contamination. The salinity of the shallow ground water increases in the dry seasons. There is a possibility of the contamination through the leakages in the pipeline of the supply system. In addition in the Pourashava area the poor and ultra poor people who have no connection used the river and pond water which is vulnerable to the salinity. The recent study showed that from100 salinity observation wells that have been constructed to a depth of 200ft, salinity concentration at 10ft interval have been measured twice in a year during high and low tide. From these data, underground salinity concentration maps have been prepared. From these maps, it is revealed that salinity front is advancing towards North at a depth 110ft as shown in Fig. 2.7.

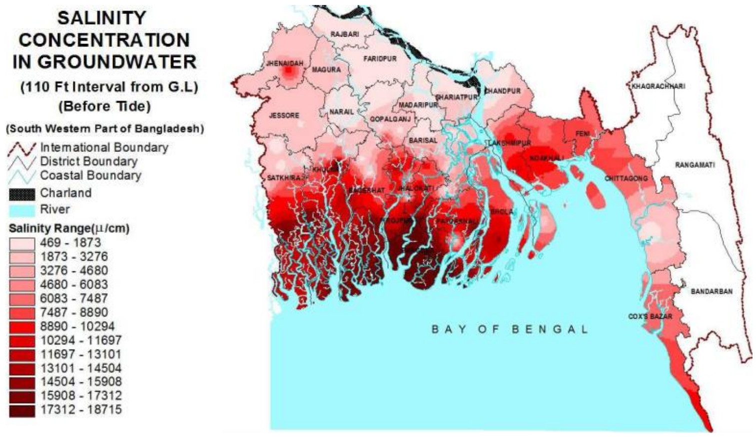


Fig. 2.7: Underground salinity front at depth at a depth 33.85m

2.3.4 Agrochemicals

Continuous use of agrochemicals against agricultural pest and disease vectors poses serious threats on both human health and environment.[1] Agrochemicals exposure periods and levels, types of agrochemicals used, and various environmental conditions of the different areas are factors for acute and chronic poisoning on human health and environment. The primary recipient of agrochemicals is soil of crop field but water bodies adjacent to the crop field is the ultimate recipient of agrochemicals residues. Climate change is likely to increase human exposures to agricultural contaminants. The magnitude of the increases will be highly dependent on the contaminant type. Climate change will also affect the fate and transport of pathogens and chemical contaminants in agricultural systems.[2] Increases in temperature and changes in moisture content are likely to reduce the persistence of chemicals and pathogens, whereas changes in hydrologic characteristics are likely to increase the potential for contaminants to be transported to water supplies. It needs to be noted that all the agrochemical chemicals have different characteristics and their breakdown depends on the soil pH, dissolved organic matter, metal ions, and temperature. The penetration through soil to groundwater occurs when chemical fertilizers and pesticides associate with soil pore water, which is directly related to the chemical property of water solubility and soil organic carbon content.

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[1] *S.K. Biswas*,S. Rahman, S.M.A. Kobir, T. Ferdous and N.A. Banu: (2014): A Review on Impact of Agrochemicals on Human Health and Environment: Bangladesh Perspective. Plant Environment Development 3(2):31-35, ©Department of Botany, University of Rajshahi, Dept. of Biotechnology and Genetic Engineering, Islamic*

[2] *Alistair B.A. et. al. (April, 2009): Impacts of Climate Change on Indirect Human Exposure to Pathogens and Chemicals from Agriculture, Environmental Health Perspectives, Vol 117, 4*

A study of pesticide residues[1] illustrated that in some selected ponds of Bangladesh showed the residue level of Malathion was 0.0241 to 0.463 ppm, carbofuran was 0.0302 to 0.0629 ppm and cypermethrin (pyrethroid) was 0.0141 to 0.09 ppm, diazinon was 0.033 to 0.079 ppm, chlorpyriphosin Meherpurregion was 0.010 to 0.471 ppm. Among carbamate pesticides, carbofuran was identified from two samples ranged from 0.0143 to 0.0387 ppm.

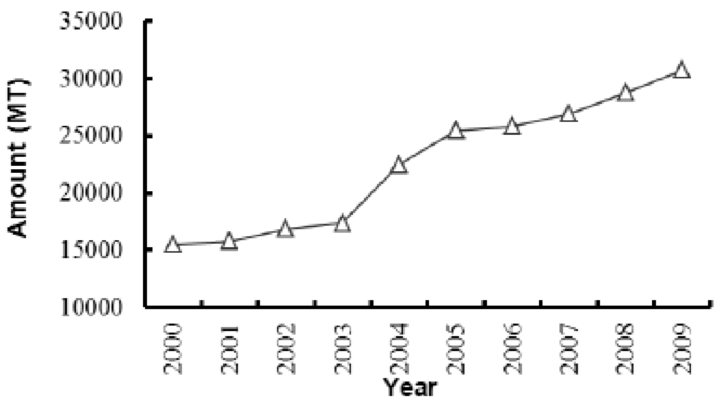


Fig. 2.8: Annual trend of use of pesticides and urea in Bangladesh

The yearly use of different pesticides and urea in Bangladesh are presented in Fig. 2.8. The Fig. 2.8 indicated that use has been increasing with respect to time. *Increasing the intensity of crop production using chemical fertilizers and pesticides will effects the surface water and shallow ground water during aquifer recharge as there is thin/no aquitartd in between the layers. Fertilizers such as urea, triple super phosphate, different types pesticides used by farmers in the vicinity of the Pourashava for agricultural production therefore, increasing the probability of the agrochemical contamination of the shallow ground water.* It needs to be noted that the supply system used that deep ground water as the source water therefore, probability of contamination is less but there is greater possibility of contamination through the leakages in the piped network. In addition the water stagnation in different location and increase of temperature will also enhance the photo-oxidation of the pesticides leading to a number of disintegrated products which have longer period of residence time (half life) in the environment and more harmful to human health.

[1] *Md. Abu Sayeed et. al: (2015): Chemical and Pesticides uses Status in the Chalan beel, Bangladesh and Present Status of Fish Biodiversity, American Journal of Experimental Agriculture, 6(5): 267-289, , Article no.AJEA.2015.086 ISSN: 2231-0606*

2.4 Community Perceived Climate Change Vulnerabilities in Coastal Area

The Barguna Pourashava water supply system's users were asked whether they have heard about climate change. A total of 97% of the households in Barguna Pourashava mentioned that they have heard about the climate change. Their observation and understanding about different issues/impacts of the climate change is presented in Fig.2.9. The figure indicated that more than 50% of the water users have been observing increase of temperature and excessive rainfall in the area. The respondents also expressed concern increased storms in Barguna. The respondents were further asked how the identified climate change issues have been affecting their water supply intervention. Approximately 39% mentioned that they were observing that the climate change has been impacting the WASH interventions and 61% of the respondents mentioned that they were not observing any impact of climate change in the water supply. Details are presented in Table 2.2.

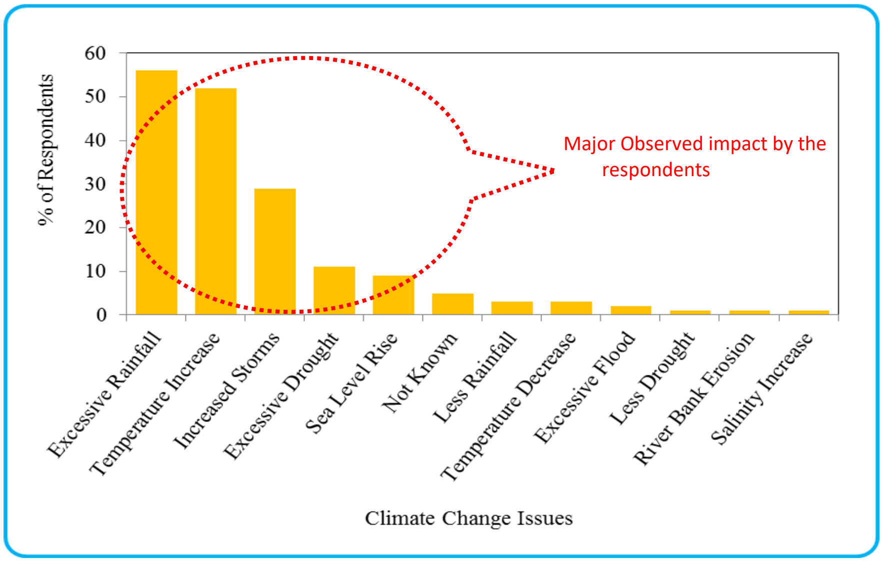


Fig. 2.9: The major climate change issues observed by the respondents in Barguna Pourashava

Table 2.1*: Barguna Pourashava Respondent's perception about the impact of climate change on water supply*

No	Observed Impacts	% of respondent
1	Technologies becoming non-functional frequently	19
2	Getting water is small quantity	11
3	Technologies becoming non-functional frequently + Colleting water from long distance + water quality becoming bad + getting small quantity of water	9
4	Not impacting	61

Among the respondents who mentioned that the climate change has been impacting the water supply were further asked when they had been observing the impact in a year. The result indicated that 23% of the respondents had been observing that the technology had been becoming non-functional during the pre-monsoon in Barguna Pourashava. The details are presented in Table 2.3.

Table 2.2: Barguna Pourashava respondent's perception about the impact of climate change on water supply considering different seasons

No	Seasons	Months	Impact of climate change on water supply (% of respondents)			
			Technologies became non-functional frequently	Colleting water from long distance	Getting water is small quantity	Quality of water becoming bad
1	Winter	DJF	1 (2)	0.5 (1)		
2	Pre-Monsoon	MAM	23 (41)		9 (16)	
3	Monsoon	JJAS	1 (2)	2 (3)	2 (3)	0.5 (1)
4	Post-Monsoon	ON				

The V&A assessment report[1,2] illustrated that water quality is the primary concern among the coastal rural community. Many households in this region have been using pond or river water, not only for cooking and washing but also for drinking. The key problem of the water quality was associated with the salinity of the shallow ground water. The poor quality of tube well water forced at least 50% of the people to collect water form canal/river/pond for drinking and other household uses. Salinity problem of drinking water is acute and most of the time it became extremely bad when the level of iron concentration is high. Because of salinity in the water, there were a significant number of patients having skin diseases. Diarrhoea and dysentery were the most common reasons for hospital visits in different seasons among the coastal population.

The situation of the Barguna Pourashava water supply system was different then the rural area. Pourashava dweller's reliance on the water quality of the supply system's water was less and a very few people drink the supply water due to the presence of the slight yellowish color of the supplied water. It creates a negative impression among the users for using it as drinking water. Presumably, they collect water from the tube wells. But the tube well water tastes saline and therefore collects water from ponds and *Kals*. In recent years they are facing water scarcity due to unavailability of sweet surface water and shallow ground water especially in dry seasons when all the production wells of the supply system start pumping together.

2.5 Hazard Matrix of Barguna Pourashava

The climatic hazard drivers and its subsequent impact on environmental hazard drivers have combined or individual impact on different step of water supply system from source to consumption. The potential biological, physical and chemical hazards and related hazardous events arose from climatic hazard[3] and its subsequent impact the on the environmental hazards are discussed in the previous sub sections in

[1] *Environmental Health Unit, WHO (November 2015): Vulnerability and Adaptation to Climate Change in Coastal and Drought Prone Areas of Bangladesh: Health and WASH*
[2] *Environmental Health Unit, WHO (June 2014): Final Report: Assessment of Vulnerability Reduction to Climate Change in Bangladesh*
[3] *Baseline survey report (2015)*

details. The climatic and environmental hazards[1] associated with the operation and maintenance of the pipeline water supply system were identified by the Pourashava, Department of Public Health Engineering professionals and water workers by direct visual observation, sanitary inspection, secondary document review, expatriate opinion and the baseline report. The developed hazard matrix is presented in Table 2.4.

Table 2.3: *Matrix of climatic and environmental hazard and its subsequent impact on water supply system*

(Reference number are used in different Table)	Environmental **Hazard Drivers**			
Climatic Hazard **Drivers**	**E1** Bad Fecal Sludge Management	**E2** River Bank Erosion	**E3** Water Salinity	**E4** Agro Chemicals
C1 Increased temperature	**Ref: C1E1** Increase of temperature will impact on the fecal sludge and that will likely to increase the threat of fecal contamination then the normal Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C1E2**	**Ref: C1E3**	**Ref: C1E4**
C2 Erratic heavy rainfall	**Ref: C2E1** Erratic heavy rainfall will enhance the movement of the fecal sludge to different location and have significant impact on Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C2E2** The erratic heavy rainfall will enhance the river bank erosion and that will destroy the piped network Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C2E3**	**Ref: C2E4** Erratic and heavy rainfall will increase the probability of spread of agrochemical in the vicinity of the low lying area Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection
C3 Increased storms	**Ref: C3E1**	**Ref: C3E2** Increased storms will enhance the river bank erosion and as the Pourashava water supply system was not extended in that area therefore risk is low Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C3E3**	**Ref: C3E4**

[1] *Fecal Sludge Management paper for Barguna*

(Reference number are used in different Table)	Environmental **Hazard Drivers**							
	E1 Bad Fecal Sludge Management		**E2** River Bank Erosion		**E3** Water Salinity		**E4** Agro Chemicals	
C4 Tidal surge and flooding	**Ref: C4E1**		**Ref: C4E2**		**Ref: C4E3**		**Ref: C4E4**	
	Flooding and tidal surge will likely to enhance the movement of the fecal sludge to different location in the area inundate the user connection sluice valve etc.		Flooding and tidal surge will enhance the river bank erosion and it will impact the Pourashava peripheral water supply network.		As the Pourashava water supply system current has no surface water based production therefore the risk is very low		Agricultural activities were observed in the urban periphery flooding and tidal surge will transport the different agrochemical in the vicinity and could enter through the leakages in the pipeline	
	Water Source	Underground reservoir	Water Source	Underground reservoir	Water Source	Underground reservoir	Water Source	Underground reservoir
	PTW (Pump & Pump House)	Overhauled tank	PTW (Pump & Pump House)	Overhauled tank	PTW (Pump & Pump House)	Overhauled tank	PTW (Pump & Pump House)	Overhauled tank
	Water Treatment Plant	Distribution line	Water Treatment Plant	Distribution line	Water Treatment Plant	Distribution line	Water Treatment Plant	Distribution line
	House/Commercial connection		House/Commercial connection		House/Commercial connection		House/Commercial connection	

NB: Red shading indicated for possible increased risk due to climate and environmental hazards

CHAPTER 3: Geographic Setting & Meteorology of Faridpur

3.1 Geography

The Faridpur Pourashava is located by the side of the mighty river Padma and bounded to the north and east. Most of its land is low lying. The district is confined by Madaripur district to the east, Golpalganj to the south and Rajbari, Narial and Magura to the west and Manikganj, Dhaka and Munshiganj district across the river. Small rivers namely *Old Kumar*, *Arial Kahn*, *Goarai*, *Chandana*, *Bhubanshwar* and *Modhumoti* have been flowing over the district. The soils are highly fertile as the district lied in the flood plain of river *Padma*. Faridpur is said to be river bank erosion and flood prone district. The area of the districts is around 2073 km^2 and the total area of the municipality is around 22.65 km^2. The total holdings in the Pourashava area are around 15,695 and the population density is around 5370/km^2. The total slum area inside the Pourashava is about 41 acres consisting of 2050 number of household.[1]

3.2 Climate Condition of Faridpur

3.2.1 Temperature

The regression analysis of last 60 years[2] temperature data of Faridpur weather station illustrated that the yearly maximum and minimum mean temperature has increased 1.14 °C and 0.86 °C respectively at the end of 2015. These illustrated that the summer and winter days have been becoming hotter. The *projected mean maximum temperature in 2030 will be 31.41°C which was 1.43°C higher than the base year temperature.* The calculation was made by considering the 1961's temperature data as the base year temperature data. The projected temperature up to 2080 in Faridpur area is presented in Table 3.1.

Table 3.1: The temperature variability analysis of Faridpur since 1961 and projection to 2080

Year	Maximum Temperature (°C)		Minimum Temperature (°C)	
	Annual Mean	Increment	Annual Mean	Increment
1961	29.98	Base Year	20.66	Base Year
2016	31.12	1.14	21.52	0.86
2030	31.41	1.43	21.73	1.08
2050	31.82	1.84	22.05	1.39
2080	32.43	2.45	22.51	1.86

[1] *District Statistics (2011): Faridpur*

[2] *Date Source Climate http://www.barcapps.gov.bd/dbs/index.php*

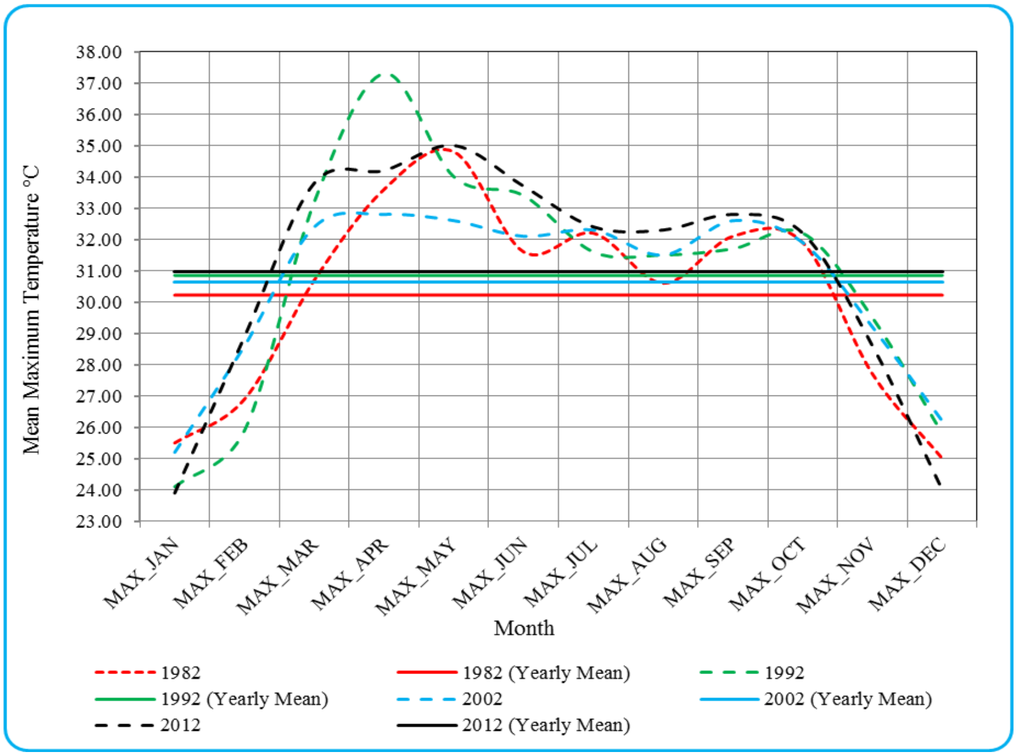


Fig. 3.1: The mean maximum temperature scenario of Faridpur district considering last three decades

Monthly maximum mean temperature was plotted for every 10 years since 1982 and presented in Fig. 3.1. It revealed that as the years are passing the trend lines of *mean monthly average temperature are becoming flattened over the yearly mean temperature of the respective year indicating that the number of hot days has been increasing with respect to time. The increase of hot spells will create an environment where the pathogens will get a favourable condition to propagate increasingly in the surface and subsurface environment.* There is high risk of pathogenic contamination of the supply water when there exists a considerable number of leakages in the pipeline, storage tanks if not cleaned properly and chlorinated regularly, sluice valve chamber even in the households tanks or storage if not properly cleaned and maintained.

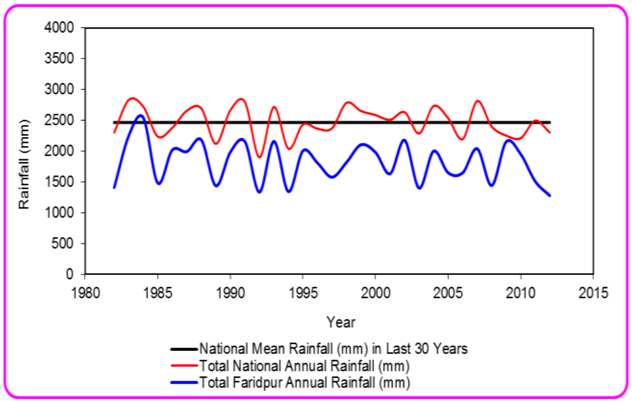
3.2.2 Rainfall

The total annual rainfall of Faridpur district was significantly lower than the national annual rainfall in last 30 years (1982) and also in recent years (2013). There are no significant changes in the national annual rainfall comparing to the year 1982 and 2013 but in Faridpur the annual rainfall has increased since 1982. The details are presented in Table 3.2 and Fig. 3.2. *The seasonal rainfall pattern has been changing because in 80s the higher rainfall occurred in the month of August-September which was shifted to May-June in 2013. As Faridpur is low lying and situated beside the Ganges flood plain which was vulnerable to river flooding therefore, timing of occurrence of floods may change, with implications for*

the seasonality of the hydrological cycle.[1] *In addition increased precipitation in upstream of Ganges basins may increase the magnitude, depth and spatial extent of floods due to siltration small runoff cannels and small rivers.*

Table 3.2: The rainfall variation in Faridpur since past thirty years

Year/Particulars	Annual Rainfall (mm)			
	National	Faridpur	Difference	Comparison
1982	2303	1410	893	Lower
2013	2300	1639	661	Lower
Changes in Past 30 Years	-3	229		
Status	No significant difference	Increased		



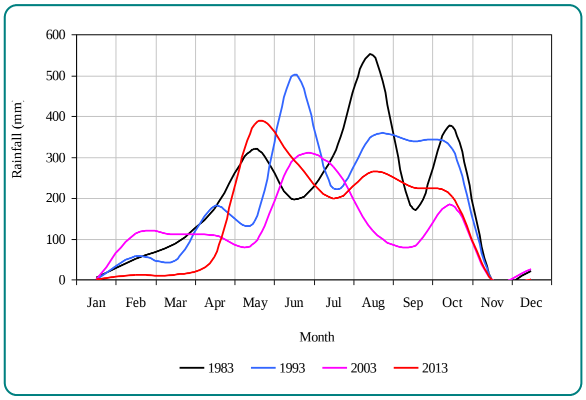


Fig. 3.2: The national and Faridpur annual rainfall status (left) and seasonal pattern of rainfall after every 10 years since 1983 (right)

3.2.3 Storm

The severe local convective storms (SLCs) are classified depending on the magnitude of wind speed.[23] *If the storms have the wind/gust speed velocity is above 42 m/s are defined as tornadoes, while wind and gust speed is in between 11 m/s to 42 ms−1 are called as 'nor'westers (local name: kalbaishakhi)*. A group of researchers collected information on SLCs from 1975 to 2005. Yearly and monthly distribution with location (district) specific average number is presented in Fig. 3.3. The frequency of nor'westers usually reaches the maximum in April, while a few occur in May, and the minimum in March. Nor'westers and tornadoes are more frequent in the afternoon. Nor'westers may occur in late February due to early withdrawal of winter from the country. The occasional occurrence of nor'westers in early June sometimes observed. The severe nor'westers is generally associated with tornadoes and the tornado

[1] *MOEF (Ministry of Environment and Forest, G.o.t.P.s.R.o.B., National Adaptation Programme of Action. Final Report. 2005, UNFCCC*
[2] *http://www.cimms.ou.edu/~doswell/Monograph/Overview.html?_ga=1.191146990.57415955.1456547119hailfallbuoyancy*
[3] *Yamane et. Al., (2010): Severe local convective storms in Bangladesh: Part 1. Climatology, ELSEVIER, Atmospheric Research, 95 pp. 400-406*

forms within the nor'wester and moves along the direction of the squall of the mother storm. *The research also found that in April and May on an average monthly 5-10 storms occurred per month*. Such storms will increase the probability of infrastructural damage, deposition of dusts and dirt in the treatment unit as well as in the open sluice valve chamber which ultimately deteriorate the water quality and availability. *Some devastating tornadoes were happened in Faridpur in 10th April 1974, 1st April 1977*

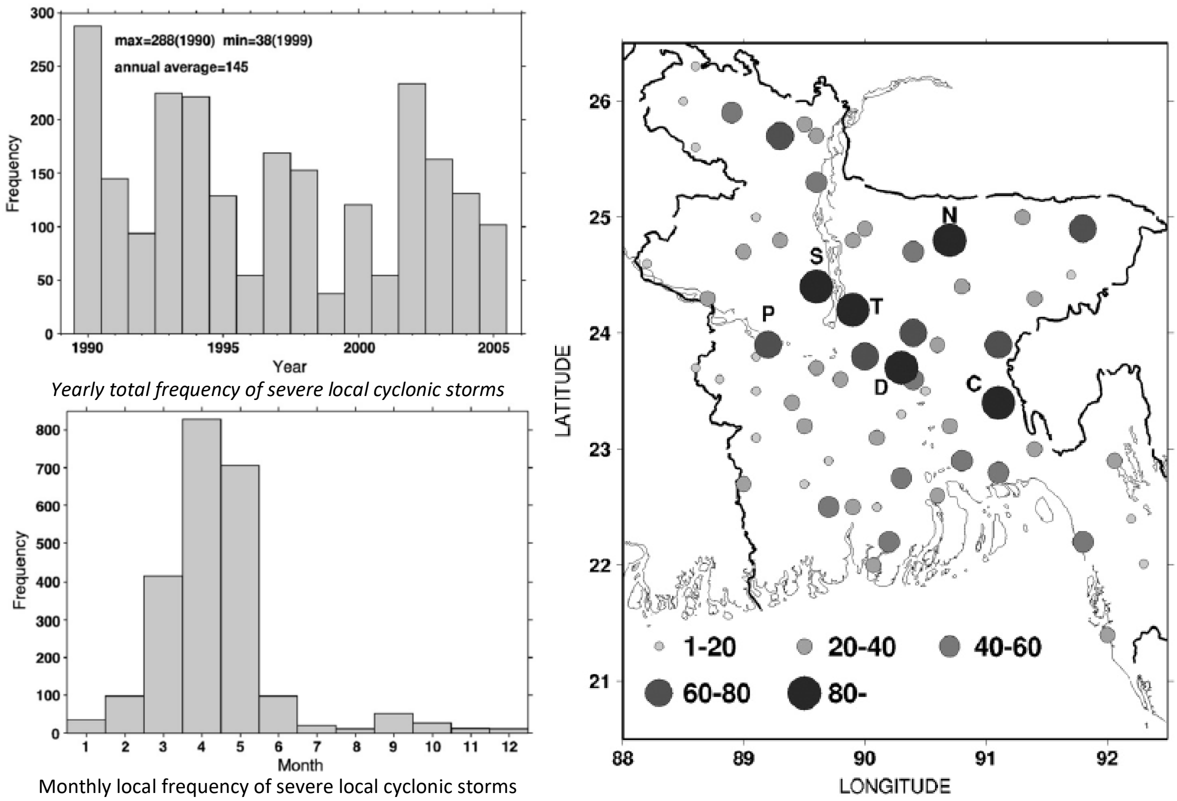


Fig. 3.3: Geographical distribution of severe local convective storms in Bangladesh (1990-2005)

3.2.4 Flooding

The combined flow of the Jamuna and Ganges rivers made the Faridpur district as flood susceptible.[1] The district is composed of five upazila and most of the upazilas of the district are affected by floods of which, more severely Faridpur Sadar where the municipality is located. *Every year during the peak flow season (July, August and September) the river overflows their banks which turn the inhabitants to move temporarily in the vicinity of the Pourashava. Such movement disrupts the livelihood of the shifted people and increases the economic load. The flood water also enters into the Pourashava area through the tributaries, distributaries, cannels and khals and inundated the low lying area of the Pourashava. The*

[1] *National encyclopaedia of Bangladesh*

situation ultimately creates water logging problem in the low lying area in different wards of the Pourashava. It becomes worse if the erratic monsoon rainfall occurs during that period. Under such circumstances the water supply system becomes unable to provide safe water to its user in terms of quality and quantity. There is a high portability of the damaging the peripheral pipeline network, sluice valve chamber, intrusion of contaminated flood water into the pipeline through the existing leakages, deterioration of biological (Fecal contamination), physical quality (suspended particulate matter), chemical quality (agrochemicals) of water to a variable degree. It also increases the in-accessibility of the consumer to the sources ultimately increases the safe water unavailability.

Table 3.3: Inundated area of Faridpur in different major floods

No	Flood Year	Area Inundated (% km^2)
1	1988	99%
2	1998	50%
3	2004	25%

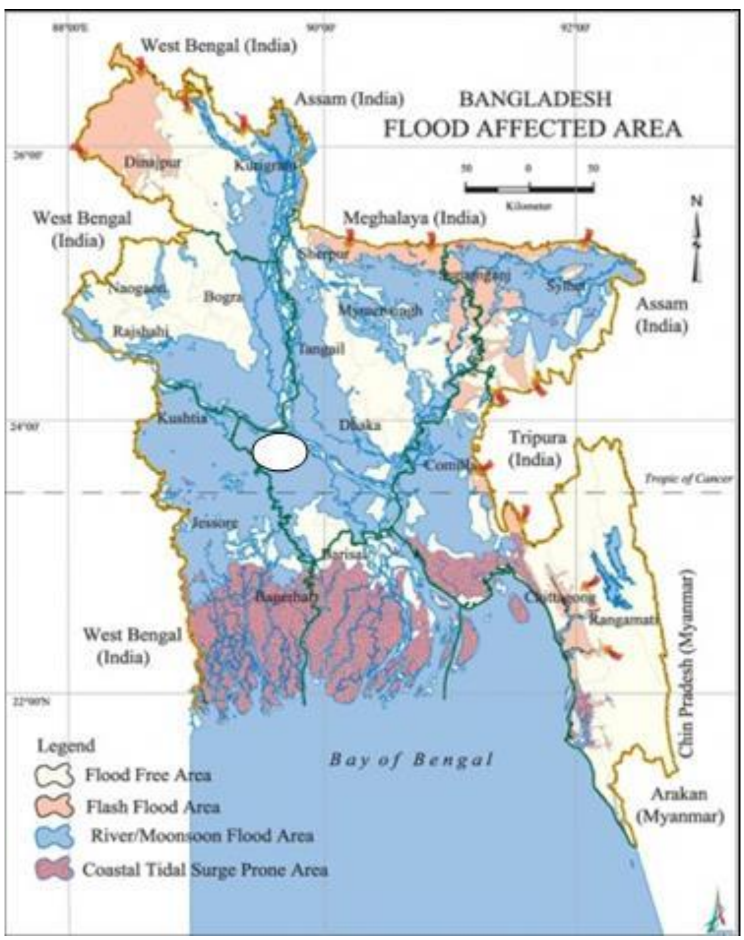


Fig. 3.4: Flood prone area of Bangladesh

3.3 Environmental Setting of Faridpur

3.3.1 Fecal Sludge

The recent estimate revealed [1] *that only 26% of the fecal sludge of the Faridpur Municipality is safely managed.* The situation analysis of Faridpur Pourashava identified some key problems associated with fecal sludge management in the town and these were unsafe containment of sludge at source, lack of capacity in collection & transportation, contrasting characteristics of service and unsafe disposal of sludge. *A total of 94% of residents including the low income group in the Pourashava have access to toilets facilities among which 42% has single pit latrines and 32% have septic tank.* According to the municipality estimates a quarter of all septic tanks have no soak pit and the effluent and some fecal sludge was discharged directly to open drains. Both the pit and septic tanks have limited storage capacity and hence required frequent emptying and the households by passed the containment by connecting their toilets directly to a storm drain or surface water body. Some households do not do anything and when the latrine is filled up it simply overflow into the surrounding environment. *The Pourashava pit emptying services are only used by 55% of individuals and 81% of institutions and the services are estimated to serve less than 30% of cases where containment should be emptied has the capacity of serving only 30% of the dwellers.*[2]

The municipality's conservancy department along with two low income sweeper groups has the responsibility of emptying the pit and it is substantially below the mark of requirement of what is necessary for an effective city- wide system. The municipality conservancy department whose primary task to maintain the environmental cleanliness of the town with trained workforce with limited equipment and it has no formal procedures for providing such services. The pit emptying services are insufficient as it used substandard equipment, is highly centralized, costly, heavily subsidized and mostly serves influential groups of the town. It is slow, expensive, focused on institutions rather than individual household residents, struggles to meet demand and is almost 25% subsidized. There was limited transport equipment and with no incentive to safely dispose therefore, the workers typically apply the principle of the fastest disposal route composed of leaving containments and their surroundings, directly disposed to the storm water drainage system, disposed of to the open drains, waste lands and in surface waters. The workers in most of the case use a bucket and a rope for the job. A water quality test of the storms water drainage sites (close to where the septic tanks were freely emptied into the drain) found fecal coliform level 2.5 times higher than the safety disposal (2,540 number/100ml: safe limit of 1000 number/100ml). Levels of Biochemical Oxygen Demand (BOD) were also extremely high: at 380 mg/l compared to the standard of 40 mg/l.

[1] *L. Stevens, R. Islam, A. Morcrette, N. de la Brosse & A. al Mamun (UK): (2015)Water, sanitation and hygiene services beyond 2015: improving access and sustainability, Faecal sludge management in Faridpur, Bangladesh: scaling up through service level agreements, briefing paper 2248, 38th WEDC International Conference, Loughborough University, UK*

[2] *Practical Action (2014) Situational Report on Faecal Sludge Management in Faridpur Municipality*

The over all scenario of the *fecal sludge management and practice in Faridpur Pourashava as well as the adjacent area increased the susceptibility of fecal contaminations of the surface water as well as the shallow ground water. Also plenty of ring slab latrines in the Pourashava area have been adding potential to the shallow ground water for enhanced fecal contamination. The increase of the temperature and erratic rainfall will exacerbate the situation by creating a more favourable environment such fecal pathogens to grow more rapidly.* As the Pourashava pipeline network including the sluice valve chambers are not well maintained considering the leakages therefore, there is a large susceptibility of the supply water to be contaminated with fecal coliform. *The baseline E. Coli testing of the pipeline water at different location of different wards of the Pourashava indicated that 10% of sample have fecal contamination > 100 cfu, 33% have >11 <99 cfu and 33% > 1 < 10 cfu have intermediate level of fecal contamination. The water samples of the production well have also high level fecal contamination.*

3.3.2 River Bank Erosion

The enhanced snow melts from the Himalayan due to increase in temperature will force more water to flow through the Ganges, Meghna, Brahmaputra river systems and their river networks. This will create additional flooding extending over the central flood plain of Bangladesh. Again the additional flow will bring with it sediments which will make the shallow riverbed even shallower. This will result in a lower capacity of riverbed to flow out water rapidly thus increasing the probability of enhanced flooding and erosion of riverbanks (Fig. 3.5). Riverbank erosion is a serious problem in Bangladesh. The process is largely controlled by river dynamics. The disruption in the life of many local communities is almost a continuous process due to riverbank erosion and the changing course of the river.

Fig. 3.5: River bank erosion area of Bangladesh

The Faridpur Sadar, Char Bhadrasan and Sadarpur upazila of Faridpur district have the problem of severe river bank erosion. It was revealed from the previous statistics that a large number of populations of the Faridpur Sadar upazila were shifted from the river side to the Pourashava area due to river bank erosion permanently. In addition, every year during monsoon the river bank resident usually shifts to the Pourashava area due to erosion and river flooding. The shifted of population in the Pourashava

usually increased the water demand and most of the time people were engaged in unauthorized connection which increases the vulnerability of the piped network as well as quality of the water. A typical river bank scenario is presented in Table 3.4.

Table 3.4: River bank erosion scenario of *Padma* in 2004 along different upazila Faridpur districts[1]

Upazila	Total Land (ha)	Eroded Infrastructures				
		Settlement (ha)	District Road (m)	Upazila Road (m)	Rural Road (m)	Embankment (m)
Faridpur Sadar	200	57		1175	370	
Char Bhadrasan	78	17	320			
Total	281	75	320	1175	370	

2.3.3 Topography

Approximately 50% of the country lies within the 6-7 m elevation level and about 68% of the country is vulnerable to flood of which 25% to 30% of the area is inundated during normal flood. The elevation of Faridpur district lies within this range. It made the district highly susceptible towards normal floods, water logging and river bank erosion. The elevation map of Bangladesh is presented in Fig. 3.6.

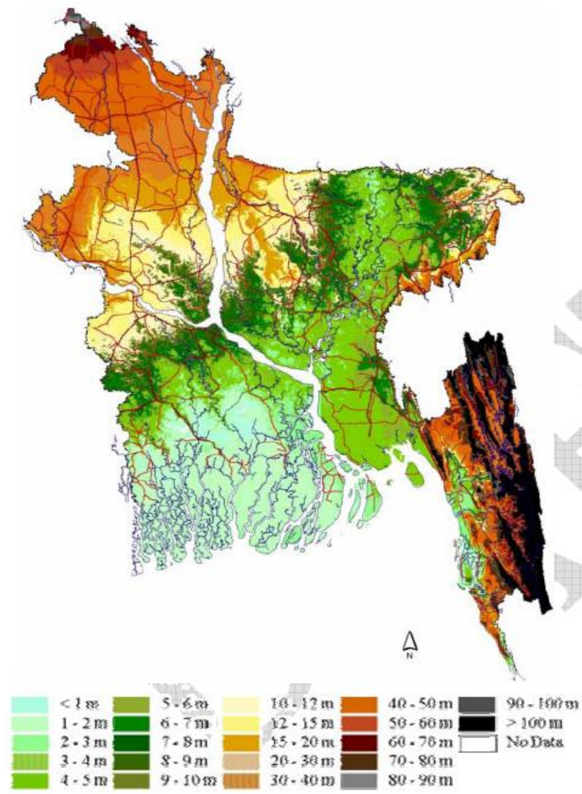


Fig. 3.6: Elevation map of Bangladesh

2.3.4 Ground Water Arsenic Contamination

Faridpur district is one of the worst arsenic contaminated districts of Bangladesh. The shallow aquifer of Faridpur is heavily contaminated with arsenic and the contamination has no specific pattern[2] *Arsenic concentrations are mainly confined to the approximately upper 100 m of the aquifer.* The district of consists of five upazila with having a variable rate of tube well contamination. The National Arsenic

[1] *Bangladesh National Disaster Management Plan 2010-2015Source, CEGIS, 2005*
[2] *Productive Employment Project (PEP) RD-5 (June 2003): Bench Mark Report, Arsenic Mitigation Program, Bangladesh Rural Development Board (BRDB)*

Mitigation Information Centre (NAMIC)[1] in 2001-2004 showed that the overall *arsenic contamination of tube well in Faridpur was 45%.* The Bangladesh National Drinking Water quality survey[2] illustrated that the level of tube well contamination in Faridpur was 33% in 2009. The NAMIC also showed that the level of arsenic contamination of tube well in the Faridpur Sadar upazila was 26%. In 2003 the *Productive Employment Project (PEP) of Bangladesh Rural Development Board (BRDB) showed that 23% of the tubes well in the municipal area were contaminated with arsenic.* The rate level of tube well contamination of arsenic is presented in Fig. 3.7.[3] *The baseline survey of Faridpur Pourashava also found that all the production of the municipal water supply system has the arsenic concentration over three times higher than the Bangladesh standard of 0.05 mg/l.*

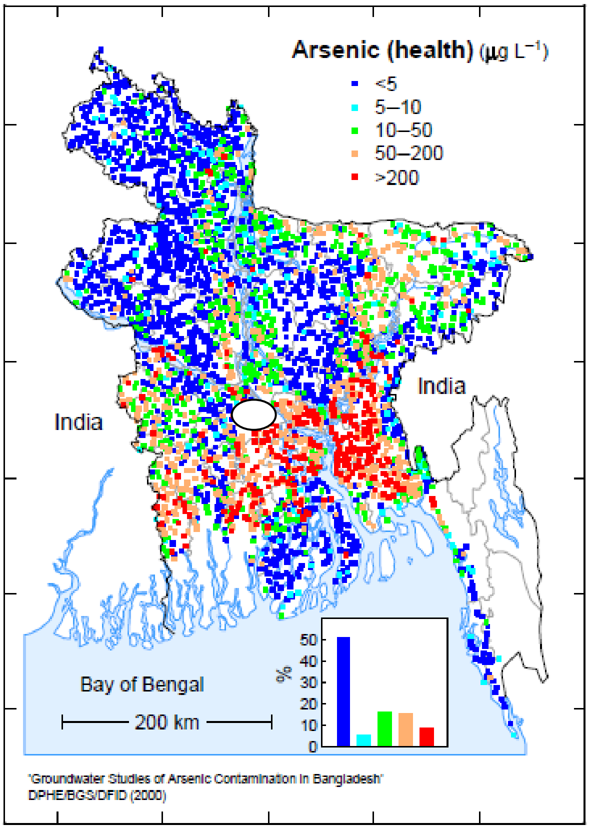


Fig. 3.7: Arsenic contamination map of Bangladesh

3.3.5 Agro Chemicals

Continuous use of agrochemicals against agricultural pest and disease vectors poses serious threats upon both human health and environment.[4] Agrochemicals exposure periods and levels, types of agrochemicals used, and various environmental conditions of the different areas are factors for acute and chronic poisoning on human health and environment. The primary recipient of agrochemicals is soil of crop field but water bodies adjacent to the crop field is the ultimate recipient of for agrochemicals residues. Climate change is likely to increase human exposures to agricultural contaminants. The magnitude of the increases will be highly dependent on the contaminant type. Climate change will also affect the fate and transport of pathogens and chemical contaminants in agricultural systems.[5] Increases in temperature and changes in moisture content are likely to reduce the persistence of chemicals and pathogens, whereas changes in hydrologic characteristics are likely to increase the potential for contaminants to be transported to water supplies. It needs to be noted

[1] *The distribution of arsenic in ground water of Bangladesh, Courtesy BAMWSP, 2004*

[2] *Multiple Indicator Cluster Survey (MICS) (2009): Bangladesh National Drinking Water Quality Survey, Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government Peoples Republic of Bangladesh*

[3] *BGS Map Location: http://www.bgs.ac.uk/research/groundwater/health/arsenic/Bangladesh/mapsnhs.html*

[4] *S.K. Biswas*,S. Rahman, S.M.A. Kobir, T. Ferdous and N.A. Banu: (2014): A Review on Impact of Agrochemicals on Human Health and Environment: Bangladesh Perspective. Plant Environment Development 3(2):31-35, ©Department of Botany, University of Rajshahi, Dept. of Biotechnology and Genetic Engineering, Islamic*

[5] *Alistair B.A. et. al. (April, 2009): Impacts of Climate Change on Indirect Human Exposure to Pathogens and Chemicals from Agriculture, Environmental Health Perspectives, Vol 117, 4*

that all the agrochemical chemicals have different characteristics and their breakdown depends on the soil pH, dissolved organic matter, metal ions, and temperature. The penetration through soil to groundwater occurs when chemical fertilizers and pesticides associate with soil pore water, which is directly related to the chemical property of water solubility and soil organic carbon content.

A study of pesticide residues[1] illustrated that in some selected ponds of Bangladesh showed the residue level of Malathion was 0.0241 to 0.463 ppm, carbofuran was 0.0302 to 0.0629 ppm and cypermethrin (pyrethroid) was 0.0141 to 0.09 ppm, diazinon was 0.033 to 0.079 ppm, chlorpyriphosin Meherpurregion was 0.010 to 0.471 ppm. Among carbamate pesticides, carbofuran was identified from two samples ranged from 0.0143 to 0.0387 ppm.

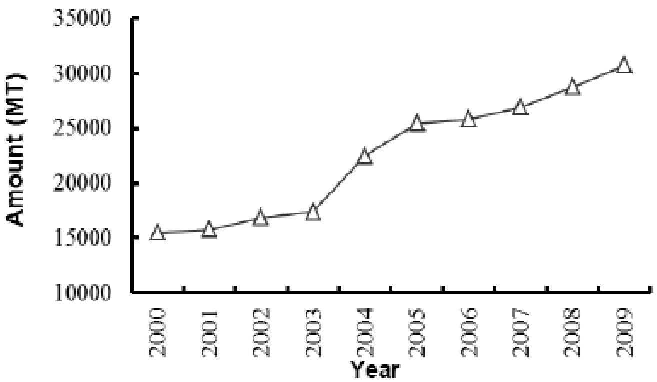


Fig. 3.8: Annual trend of use of pesticides and urea in Bangladesh

The yearly use of different pesticides and urea in Bangladesh are presented in Fig. 3.8. The Fig. 3.8 indicated that use has been increasing with respect to time. *Increasing the intensity of crop production using chemical fertilizers may affect the ground water in the area as the sub surface silty clay layer which is vulnerable to leaching of contaminants in the shallow aquifer from the surface water during aquifer recharge.[2,3] Fertilizers such as urea, triple super phosphate, different types pesticides used by farmers in the vicinity of the Pourashava for agricultural production therefore, increasing the probability of the agrochemical contamination of the shallow ground water*. It needs to be noted that the supply system used that shallow ground water as the source water. The agrochemical might also contaminate the supply water though the leakages especially in the low lying area. In addition the water stagnation and increase of temperature will also enhance the photo-oxidation of the pesticides leading to a number of disintegrated products which have longer period of residence time (half life) in the environment and more harmful to human health.

[1] *Md. Abu Sayeed et. al: (2015): Chemical and Pesticides uses Status in the Chalan beel, Bangladesh and Present Status of Fish Biodiversity, American Journal of Experimental Agriculture, 6(5): 267-289, , Article no.AJEA.2015.086 ISSN: 2231-0606*

[2] *https://books.google.com.bd/books?id=GXuCMXN4JecC&pg=PA148&lpg=PA148&dq=Faridpur+Shallow+aquifer&source=bl&ots=Yga9Gf7yhB&sig=Dx4_juyZ_dhW03oupEWi2ug2kjY&hl=en&sa=X&redir_esc=y#v=onepage&q=Faridpur%20Shallow%20aquifer&f=false*

[3] *Anwar Zahid and Syed Reaz Uddin Ahmed: Groundwater Resources Development in Bangladesh: Contribution to Irrigation for Food Security and Constraints to Sustainability, Ground Water Hydrology Division, Bangladesh Water Development Board, Dhaka, Bangladesh*

3.4 Community Perceived Climate Change Vulnerabilities on Water Supply

Increased temperature, excessive rainfall less rainfall in the respective seasons, increased storms, river flooding, flash flooding, rain fed flood, river bank erosion are the major climate vulnerabilities and have been impacting the livelihood and health among the inhabitants of Faridpur as identified by the baseline survey respondents (Fig. 3.9). These climatic variables have been impacting the environmental determinants of health namely fecal sludge, agrochemicals, solid wastes, municipal garbage. The climatic and environmental variables have been exacerbating the water supply and sanitation interventions by increasing the non-functionality, inaccessibility, unavailability and bad quality of water. The intense rainfall events during the wet season causing increased turbidity of the water (suspended solid content) and enabling higher concentrations of pathogens to be transported through the sub-surface.[1] The vulnerability of shallow groundwater within the wet seasons is due to the high permeability of lateritic soils and high groundwater levels which enables pathogens (and other suspended contaminants) to enter into shallow groundwater directly from the base of latrines and other conduits, and travel up to 1 km within the shallow, subsurface whilst still virulent.[2] In addition Faridpur is highly susceptible to the ground water arsenic contamination mostly in the shallow aquifer.

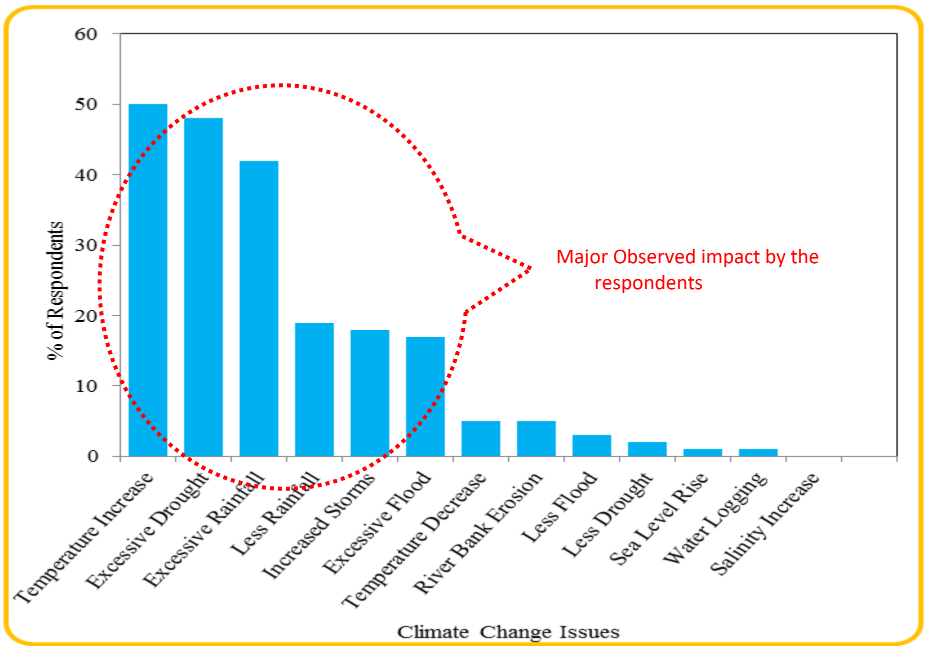


Fig. 3.9: The major climate change issues observed by the respondents in Faridpur Pourashava

A total of 84% of the respondents of the baseline survey mentioned that had been observing impact of climate change in the water supply system. Among the respondents who mentioned that the climate

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[1] *Hunter 2003; Taylor et al. 2009, Pritchard et al. 2008*
[2] *Taylor et al. 2009, Pritchard et al. 2008*

change has been impacting the water supply were further asked when they had been observing the impact in a year. The result indicated that 43% of the respondents in Faridpur Pourashava had been getting small quantity of water in the pre-monsoon period. The details are presented in Table 3.5.

Table 3.5: Faridpur Pourashava respondent's perception about the impact of climate change

No	Seasons	Months	Impact of climate change on water supply (% of respondents)			
			Technologies became non-functional frequently	Colleting water from long distance	Getting water is small quantity	Quality of water becoming bad
1	Winter	DJF	2 (5)	0.5 (1)	2 (7)	0.5 (2)
2	Pre-Monsoon	MAM	8 (31)	32 (130)	43 (172)	26 (104)
3	Monsoon	JJAS	4 (15)	2 (9)	10 (38)	6 (23)
4	Post-Monsoon	ON	0.5 (1)			1 (3)

3.5 Hazard Matrix of Faridpur Pourashava

The hazards associated with the operation & maintenance, environment and climate variability were identified by the water professionals and workers of the Department of Public Health Engineering and Pourashava, direct visual observation, sanitary inspection, secondary document review, expatriate opinion, the KAP survey and climatic data of Faridpur weather station. *The identified environmental hazards in relation to water supply were fecal sludge, river bank erosion, agrochemical, water logging (low lying area) and high arsenic pollution of the ground water. The identified climatic hazards in relation to the water supply system were increase of temperature, erratic heavy rainfall, increased storms and flooding.*[1] The impact of climatic hazard drivers on environmental hazard drivers and their individual impacts on different steps of water supply system from source to consumption are presented in Table 3.6 which illustrates the potential biological, physical and chemical impacts.

Table 3.6: Matrix of climatic and environmental hazard and its subsequent impact on water supply system

<table>
<tr><td colspan="2" rowspan="2">(Reference number are used in different Table)</td><td colspan="4">Environmental Hazard Drivers</td></tr>
<tr><td>E1
Bad Fecal Sludge Management</td><td>E2
River Bank Erosion</td><td>E3
Low Lying Area</td><td>E4
Ago Chemicals</td></tr>
<tr><td rowspan="2">Climatic Hazard Drivers</td><td rowspan="2">C1
Increased temperature</td><td>Ref: C1E1</td><td>Ref: C1E2</td><td>Ref: C1E3</td><td>Ref: C1E4</td></tr>
<tr><td>Increase of temperature will impact on the fecal sludge (which was bad in the municipality) and that will likely to increase the threat of fecal contamination then the normal
Water Source | Underground reservoir
PTW (Pump & Pump House) | Overhauled tank
Water Treatment Plant | Distribution line
House/Commercial connection</td><td></td><td></td><td></td></tr>
</table>

[1] *Baseline survey report (2015):*

(Reference number are used in different Table)	**E1** Bad Fecal Sludge Management	**E2** River Bank Erosion	E3 Low Lying Area	E4 Ago Chemicals
	Environmental Hazard Drivers			
C2 Erratic Heavy rainfall	**Ref: C2E1** Erratic heavy rainfall will enhance the movement of the fecal sludge to different location especially in the low lying area and have significant impact on Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C2E2** The erratic heavy rainfall will enhance the river bank erosion enhance the Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C2E3** Erratic heavy rainfall will inundate the low lying area will create inundation of the HH connection, reservoir Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C2E4** Erratic and heavy rainfall will increase the probability of spread of agrochemical in the vicinity of the low lying area Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection
C3 Increased storms	**Ref: C3E1**	**Ref: C3E2** Increased storms will enhance the river bank erosion and as the Pourashava water supply system was not extended in that area therefore risk is low Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C3E3**	**Ref: C3E4**
C4 Flooding	**Ref: C4E1** Flooding is likely to enhance the movement of the fecal sludge to different location especially in the low lying area and inundate the user connection sluice valve etc. Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C4E2** Flooding will enhance the river back erosion no significant impact because the water supply system was extended to that area of the Pourashava	**Ref: C4E3** Flooding will inundate the low lying area and will inundate the household water outlet by Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection	**Ref: C4E4** Agricultural activities were observed in the urban periphery flooding will transport the different agrochemical in the vicinity and could enter through the leakages in the pipeline Water Source; Underground reservoir; PTW (Pump & Pump House); Overhauled tank; Water Treatment Plant; Distribution line; House/Commercial connection

NB: Red shading indicated for possible increased risk due to climate and environmental hazards


CHAPTER 4: KAP Survey Design

4.1 Objectives

The overall objective of the survey is to determine the knowledge, attitude and practice about the safe water use among the water supply system users and the baseline status of the water supply system of Faridpur Pourashava (as flood prone area) and Barguna Pourashava (as coastal area). The specific objectives are:

1. To determine the proportion of water users who have knowledge about the safe water
2. To determine the proportion of water users who have knowledge about climate change and its impacts
3. To determine the proportion of water users who have perception about the water safety and health
4. To determine the proportion of people who has been facing water related disease
5. To determine the practice of consuming safe water among the water users
6. To assess the water quality considering microbiological and chemical parameter
7. To determine the user's satisfaction about the supply water

4.2 Methodology

The methodology of the system assessment was observation consisting of information collection through sanitary inspection and various records. The methodology of the KAP survey was consisting of qualitative and quantitative information collection through questioner, observation and water quality testing.

4.3 Sample Size and Survey Tools

The Faridpur Pourashava water supply system has around 7600 users and the Barguna Pourashava have 3800 users. *A total 5% of samples were selected from each of the Pourashava. The user list was collected from each of the Pourashava and every 20th user was selected which were proportionally distributed in each ward. The sample size of Barguna Pourashava was 190 and Faridpur Pourashava was 380.* The survey questioner is presented in Annex 1. The DPHE and Pourashava water workers conducted the survey.

A total of three water samples were collected from each of the ward for microbiological (FC) quality analysis. The water samples were collected from the nearest water users of the distribution line in any ward, middle and the farthest. A few household's samples were checked for arsenic. *The source water was checked for FC, arsenic, iron, manganese occasionally nitrate. Millipore microbiological field testing kits was used for E. Coli testing,* DR 2800 HACH spectrophotometer was used for determination of manganese, iron, and nitrate and Wegtech Digital Arsenator was used for arsenic determination. The water quality testing was conducted by the skilled professionals. The sampling pattern of Faridpur Pourashava is presented in Fig. 4.1. The Barguna sampling was done following the same pattern.

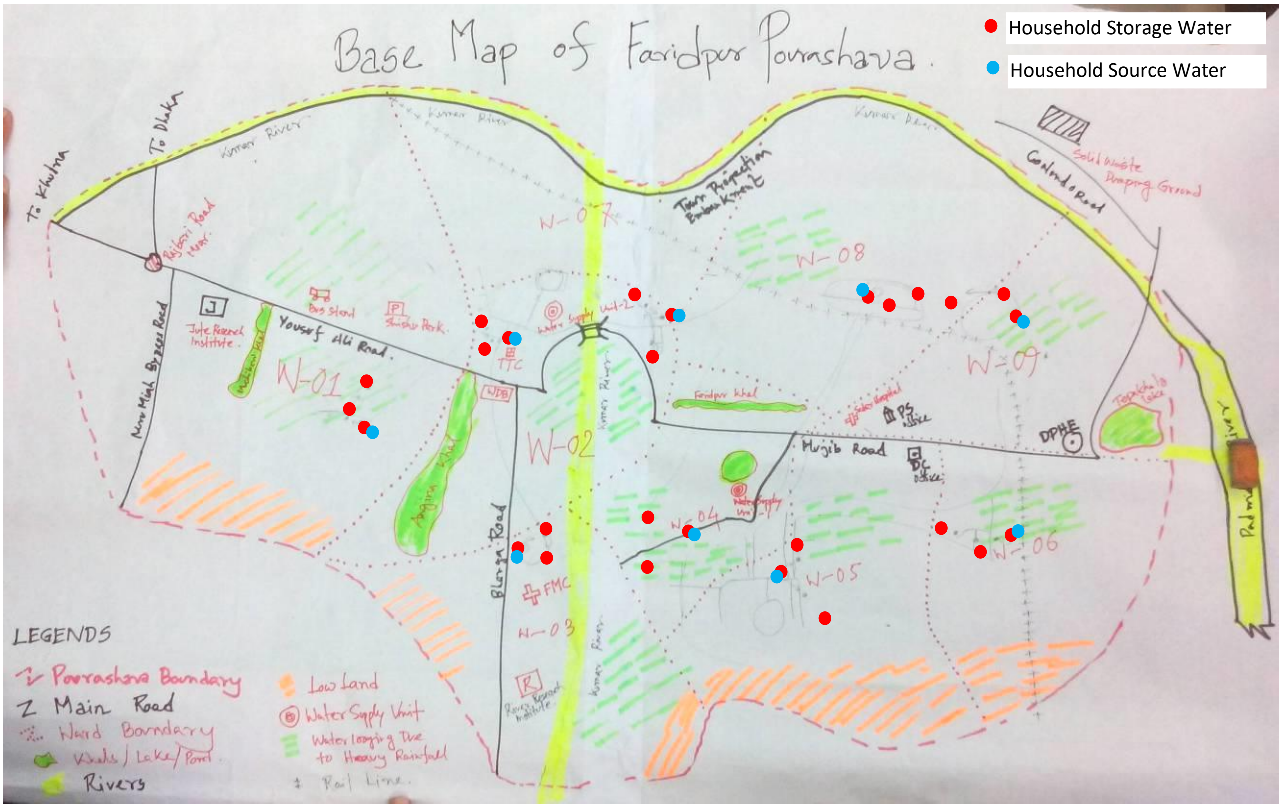


Fig. 4.1: Sampling pattern in Faridpur for E. Coli analysis

4.4 Limitations

Limited numbers of samples were considered for the baseline survey considering the time frame, resources availability and moderately skilled manpower used for the questioner survey.

CHAPTER 5:KAP Survey Findings

5.1 Socio Economic Distribution of Samples

The average family size of the water users of the Barguna and Faridpur Pourashava was 5. The male female ratio in Barguna and Faridpur was 2:2 and 4:3 respectively. 61% and 70% of the family do not have any children less than 5 years in Barguna and Faridpur Pourashava respectively. The distribution of occupation and housing pattern is presented in Table 5.1 and Table 5.2. The Table 6.1 indicated that the major occupation was business followed by service in both of the Pourashava. Table 5.2 indicated that the dominating housing pattern was earthen house in Barguna and the tin shade with wall one storied house in Faridpur Pourashava.

Table 5.1: Distribution of occupation

Occupation	Pourashava (% of respondents)		Grand Total
	Barguna	Faridpur	
Business	58.0	43.5	47.9
Service	27.3	34.3	32.1
Agriculture	2.8	0.8	1.4
Day Labour	1.1		0.3
Driver		0.5	0.3
Rickshaw Puller		0.3	0.2
Others	10.8	20.8	16.1
Grand Total	100.0	100.0	100.0

Table 5.2: Distribution of housing pattern

Type of Houses	District (% of respondents)		Grand Total
	Barguna	Faridpur	
RCC Roof + One Storied	10.2	22.3	18.6
Multi-storeyed Building	19.9	25.0	23.4
One storied + Tin Shade Building	17.6	19.8	19.1
Bamboo Made Home		0.5	0.3
Tin Shade + Wall + One Storied	21.0	32.0	28.6
Earthen House	29.0		8.9
Mixed	1.2	0.3	1.5
Others	1.1	0.3	0.5
Grand Total	100.0	100.0	100.0

The average monthly income considering the housing pattern and occupation was higher among the respondents of Faridpur Pourashava dwellers than the Barguna. Table 5.3 and 5.4 reflected the distribution of average monthly income (BDT) considering type of service and housing structure in Barguna and Faridpur Pourashava Piped supply system's users respectively.


Table 5.3: Distribution of average monthly income (BDT) considering type of service and housing structure of Barguna Pourashava Piped supply system's users

Housing vs Occupation matrix considering average income (BDT)		Housing Patten (% of respondents)						
		Multi-storeyed Building	RCC Roof + One Storied	One storied + Tin Shade Building	Tin Shade + Wall + One Storied	Earthen House	Mixed	Others
Occupation (% of HH)	Service	35,300	20,750	31,429	25,000	19,000	20,000	10,000
	Business	51,095	31,000	18,211	24,130	20,552		
	Agriculture	15,000		10,000	20,000	18,000		
	Day Labour					5,000		
	Others	51,667	25,000	16,000	10,500	45,000		3,000

Table 5.4: Distribution of average monthly income (BDT) considering type of service and housing structure of Faridpur Pourashava Piped supply system's users

Housing vs Occupation matrix considering average income (BDT)		Housing Patten (% of respondents)				
		Multi-storeyed Building	RCC Roof + One Storied	One storied + Tin Shade Building	Bamboo Made Home	Tin Shade + Wall + One Storied
Occupation (% of HH)	Not Mentioned	40,000				
	Service	32,778	28,125	16,750		23,143
	Business	37,895	27,583	22,500	8,000	19,619
	Agriculture	40,000				
	Rickshaw Puller	6,000				
	Driver			15,000		
	Others	6,800	6,000	11,500	8,000	8,000

5.2 User Satisfaction on Supply Water

A total of 79% and 45% of the respondents were satisfied and *21% and 55% were unsatisfied with Pourashava water supply of Barguna and Faridpur respectively. A total of 91% users of the water supply system paid their monthly tariff regularly.* 8% and 6% of the water user paid the monthly tariff irregularly in Barguna and Faridpur Pourashava respectively. *The ward wise distribution of the user satisfaction indicated that in Faridpur Pourashava out of nine wards the respondents of 6 wards have un-satisfaction level more than 50% increasing upto 84%. In Barguna Pourashava the un-satisfaction level was more than 40% existed in two wards.* The ward wise distribution of user satisfaction is presented in Table 5.5.

Table 5.5: Ward wise distribution of user satisfaction among the Pourashava water supply users

Ward	Barguna (% of respondents)		Faridpur (% of respondents)	
	Satisfied	Not Satisfied	Satisfied	Not Satisfied
Ward 1	96	4	82	18
Ward 2	100		86	14
Ward 3	78	22	30	70
Ward 4	78	22	23	77

Ward	Barguna (% of respondents)		Faridpur (% of respondents)	
	Satisfied	Not Satisfied	Satisfied	Not Satisfied
Ward 5	59	41	62	38
Ward 6	100		16	84
Ward 7	86	14	44	56
Ward 8	60	40	41	59
Ward 9	88	12	24	76
Average	79	21	45	55

The overall scenario of the tariff recovery and the user satisfaction of the Barguna and Faridpur Pourashava are presented in Table 5.6. *The Table 4.6 indicated that 19% and 50% users of Barguna and Faridpur Pourashava water supply system respectively paid tariff without having satisfaction.* A few percent of users paid their bill irregularly or did not pay the bills. *Analysis also indicated that 90% and 77% users of the Barguna and Faridpur Pourashava water supply system respectively knew about the complaint system.*

Table 5.6: Matrix of tariff and user satisfaction about water supply in Barguna and Faridpur Pourashava

Satisfaction vs Payment Status		Barguna (% of respondents)			Faridpur (% of respondents)		
		Satisfied	Not Satisfied	Grand Total	Satisfied	Not Satisfied	Grand Total
Tariff Payment (% of HH)	Regularly Paid	73	19	91	40	50	91
	Irregularly Paid	6	2	8	3	3	6
	Not paying		1	1	1	1	1
	No Information				2	1	3
	Grand Total	79	21	100	46	55	100

5.3 Perception about Safe Water among Users

The respondents were asked to define the safe water. The most desirable answer was "The water which does not create any disease if consumed is the safe water" The question was asked to observe the perception/knowledge among the Pourashava water users. *The analysis result indicated that the*

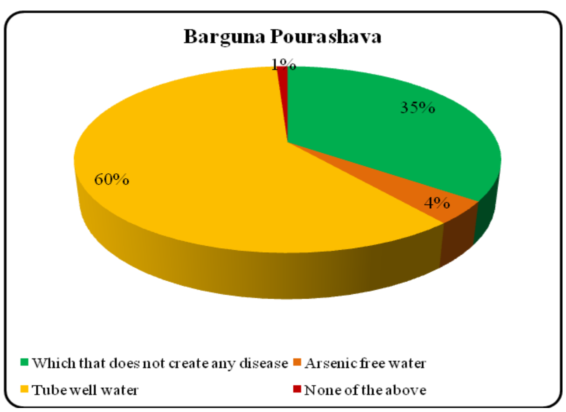


Fig. 5.2: Perception of safe water among the Pourashava dwellers of Barguna Pourashava

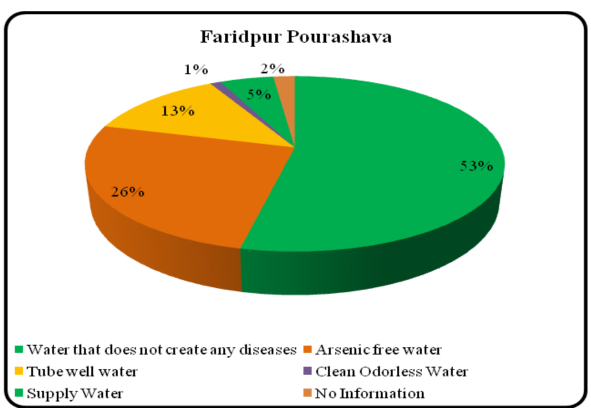


Fig. 5.1: Perception of safe water among the Pourashava dwellers of Faridpur Pourashava

respondents have different perceptions of safe water. 35% and 53% of the Pourashava dwellers in Barguna and Faridpur Pourashava respectively defined safe water definition correctly. The details are presented in Fig. 5.1 and Fig. 5.2.

In Barguna Pourashava 96% of the respondents have identified the tube well water (which has platform) as safe water considering the water born or related disease over the supply system's water. It indicated that the respondents were not using the supply water as the drinking water. The details are presented in Table 5.7.

Table 5.7: Knowledge and practice matrix about safe water among the Barguna Pourashava water users

Knowledge and Practice Matrix on Safe Water		Practice (% of respondents collecting water from)			
		Supply water	Tube well without platform	Tube well with platform	Grand Total
Knowledge (% of respondents)	Water that does not create any disease	1		34	35
	Arsenic free water	1		3	4
	Tube well water		1	59	60
	Fail to define	1			1
	Grand Total	3	1	96	100

In Faridpur 60% of the respondents have identified that the supply water as safe water considering the water born or related disease over the supply system's water. A total of 38% of the respondents identified the tube well water (with platform) was safe over the supply system's water. The details are presented in Table 5.8.

Table 5.8: Knowledge and practice matrix about safe water among the Faridpur Pourashava water users

Knowledge and Practice Matrix on Safe Water		Practice (% of respondents collecting water from)				
		Supply water	Tube well without platform	Tube well with platform	Other source	Grand Total
Knowledge (% of respondents)	Water that does not create any disease	33	1	20		54
	Arsenic free water	18		7	1	26
	Tube well water	3		10		13
	Clean and odorless water	1				1
	Supply Water	4		1		5
	Fail to define	1				1
	Grand Total	60	1	38	1	100

*A total of 4% and 29% of respondents of Barguna and Faridpur Pourashava respectively mentioned that the source***,** from where they have been collecting water was unsafe due to many reasons which are presented in Table 5.9. These respondents have been drinking the water by performing purification before consumption in a number of ways as presented in Table 5.10. *More than 50% of the respondents used the pond water for cooking purposes in Barguna and 71% in Faridpur Pourashava.* Details are presented in


Table 5.11. *Almost 100% respondents of the Pourashava Piped water system of Barguna and Faridpur mentioned that have to use safe water for drinking and cooking purposes and for that they have some responsibilities.*

Table 5.9: Distribution of reasons for un-safety of water

Reasons for un-safety	Pourashava	
	Barguna (out of 4% of respondents)	Faridpur (out of 29% of respondents)
Pipe water is polluted		21
Water is Turbid		19
Water have bad smell	14	24
Water having small insects		13
Water have iron	86	18
No information		5
Grand total	100	100

Table 5.10: Different types of treatment method used for unsafe water by the respondents

Treatment method	Pourashava	
	Barguna (out of 4% of respondents)	Faridpur (out of 29% of respondents)
Drink without treatment	43	4
Drink after boiling	14	24
Drink after filtration	14	56
Drink after filtration by Alum	14	4
Drink after using water purification tablet	14	1
Others	0	1
No information	0	11
Grand Total	100	100

Table 5.11: Distribution of water sources used for cooking purposes

Water Source	Pourashava (% of respondents)	
	Barguna	Faridpur
Other source (Pond Water)	54	
Supply Water	15	71
Rain Water	30	4
TW with Platform	1	12
TW without Platform	1	2
Dug Well	0	3
No Information	0	9


5.4 Connection Type and Cleanliness of Water Source

In Barguna Pourashava 85% and in Faridpur Pourashava 61% of the respondents were connected to the Piped water supply system through a water reservoir in house. Among these ground water reservoir and surface water reservoir was dominated in the Barguna (46%) and Faridpur (37%) Pourashava respectively. The remaining users were connected in different ways namely directly to the kitchen, directly to the bathroom, stand post with platform inside home, stand post without platform inside home. The distribution of the type of connection at household is presented in Table 5.12. *In both the Pourashava 14% of connection was made through the drain/ditch to the household respectively.* Another observation was made to see whether the water reservoir (underground and surface) of the respondents were clean or not. *The result indicated that 98% and 77% of the reservoirs were clean in Barguna and Faridpur Pourashava respectively who have water reservoir.*

Table 5.12: Distribution of type of connection at household

No	Type of Household Connection	% of respondents	
		Barguna Pourashava	Faridpur Pourashava
1	To underground reservoir	30	37
2	To overhead tank	2	5
3	Through pump to underground reservoir to overhead tank	7	15
4	To surface reservoir though stand post	46	4
	Total household connected through reservoir	85	61
5	Directly to the kitchen	1	10
6	Directly to the bathroom	9	6
7	Stand post with platform inside home	0	4
8	Stand post without platform inside home	1	15
	Total household connected without reservoir	11	35
9	Others	4	4
		100	100

The frequency of cleaning is presented in Table 5.13 and the pattern of cleaning is presented in Table 5.14. *In Barguna Pourashava highest percentage of respondents (38%) cleaned the ground and surface water reservoirs only with water. In Faridpur Pourashava highest percentage of respondents (52%) cleaned the ground and surface water reservoirs with bleaching powder/chemical reagents and water*.

Table 5.13: Distribution of frequency of cleaning of the underground and surface water reservoirs

No	Cleaning pattern	% of respondents	
		Barguna Pourashava	Faridpur Pourashava
1	Every Month	58	3
2	Quarterly	32	26
3	Half Yearly	8	34
4	Yearly	2	23
5	Biannual		1


No	Cleaning pattern	% of respondents	
		Barguna Pourashava	Faridpur Pourashava
6	Irregular		7
7	Never Cleaned		6
	Grand Total	100	100

Table 5.14: Distribution of pattern of cleaning of the underground and surface water reservoirs

No	Cleaned by	Pourashava (% of respondents)	
		Barguna	Faridpur
1	Brushing and water	38	10
2	Soap/detergent and water	23	25
3	Bleaching powder/chemical reagents and water	32	52
4	Only water	6	7
5	Other Method	1	6
	Grand Total	100	100

Among the water users 100% and 86% of the respondent's overhead tanks were found clean in Barguna and Faridpur Pourashava respectively. A total of 65% and 35% of the respondents cleaned their overhead tank every month in Barguna and half yearly Faridpur Pourashava respectively. Details are presented in Table 5.15 and the distribution of pattern of cleaning is presented in Table 5.16.

Table 5.15: Distribution of frequency of cleaning of the overhead tank

No	Cleaning pattern	Pourashava (% of respondents)	
		Barguna	Faridpur
1	Every Month	67	25
2	Quarterly	22	18
3	Half Yearly	5	35
4	Yearly	2	17
5	Biannual	0	1
6	Irregular	0	3
7	No Information	5	1
	Grand Total	100	100

Table 5.16: The distribution mechanism of cleaning of the overhead tank

No	Cleaned by	Pourashava (% of respondents)	
		Barguna	Faridpur
1	Brushing and water	28	11
2	Soap/detergent and water	18	24
3	Bleaching powder/chemical reagents and water	50	57
4	Only water	3	8
	Grand Total	100	100

5.5 Collection of Safe Water

Majority percentage of respondents in Barguna (98%) and half of the respondents in Faridpur (47.5%) Pourashava collected their drinking water by Kolshi. The details are presented in Table 5.17. The table indicated that a good percentage of the water supply users of Faridpur Pourashava used mixed containers for collecting water comprising *Kolshi*, bucket, jug and glass). 97% of the supply water users of Barguna Pourashava cleaned the water collection container every time during collection followed by 3% occasional cleaning during collection of water respectively. *88% of the supply water users of Faridpur Pourashava cleaned the water collection container every time during collection followed by 8% occasional cleaning during collection of water and 5% thought that it was not necessary for cleaning of water collection container before collection.* The details of cleaning mechanism, reagents and water used are presented in Table 5.18. The table indicated that *65.9% of the water users rigorously cleaned the collection container to the bottom by brass/hand with using source water which was collected in Barguna Pourashava. The table also indicated that 57.1% of the water users cleaned the collection container with stirring by using source water which was collected in Faridpur Pourashava*.

Table 5.17: The distribution of water collection container

No	Water collected by	Pourashava (% of respondents)	
		Barguna	Faridpur
1	Kolshi	98.3	47.5
2	Bucket	1.1	5.3
3	Jug		26.5
4	Glass		3.0
5	Mixed (Kolshi + Bucket + Jug + Glass)	0.6	15.5
6	Unknown		2.5
	Grand Total	100	100

Table 5.18: The distribution of collection container cleaning mechanism, reagents and water used

How the water container was cleaned?	What reagent was used during cleaning?	Which water was used for cleaning?	Pourashava % of HH	
			Barguna	Faridpur
Rigorous cleaning to the bottom of the container by brass/hand	**Only water**	**Cleaned with water from the same source from where water is collected**	**65.9**	13.6
		Cleaned with water at home by other water	0.6	0.9
	Subtotal only water		66.5	14.5
	Powdered soap or detergent	Cleaned with water from the same source from where water is collected	4.7	13.3
		Cleaned with water at home by other water	0.6	0.9
	Subtotal powdered soap or detergent		5.3	14.2
	Ash	Cleaned with water from the same source from where water is collected	2.4	
	Subtotal ash		2.4	
	Other	Cleaned with water from the same source from where water is collected		2.9
	Sub total other			2.9
Sub total rigorous cleaning to the bottom of the container by brass/hand			74.1	31.6

How the water container was cleaned?	What reagent was used during cleaning?	Which water was used for cleaning?	Pourashava % of HH	
			Barguna	Faridpur
Stirring with water	**Only water**	**Cleaned with water from the same source from where water is collected**	22.9	**57.1**
		Cleaned with water at home by other water		1.2
	Subtotal only water		22.9	58.3
	Powdered soap or detergent	Cleaned with water from the same source from where water is collected	2.4	6.7
		Cleaned with water at home by other water		0.3
	Subtotal powdered soap or detergent		2.4	7.0
	Ash	Cleaned with water from the same source from where water is collected	0.6	0.9
	Subtotal ash		0.6	0.9
	Other	Cleaned with water from the same source from where water is collected		0.6
		Cleaned with water at home by other water		0.3
	Sub total other			0.9
Subtotal stirring with water			25.9	67.0
Other	Only water	Cleaned with water from the same source from where water is collected		0.9
	Subtotal only water			0.9
	Powdered soap or detergent	Cleaned with water from the same source from where water is collected		0.6
	Subtotal powdered soap or detergent			0.6
Sub total other				1.4
Grand Total			**100.0**	**100.0**

5.6 Transportation of Water

The analysis result indicated that 99% of the respondents of the Barguna Pourashava water supply system users transported the filled water container with a cover and 72% of the respondents of the Faridpur Pourashava water supply system users transported the filled water container with a cover. A total of 28% of the respondents of the Faridpur Pourashava did not cover the collection container during transport. Among the water users who covered the collection container during transport, 98% and 78% of the respondents of Barguna and Faridpur Pourashava cover the water collection container with unventilated bowel/cover respectively. The details are presented in Table 5.19.

Table 5.19: Distribution of covering of the water collection container during transport

No	Type of cover used during water transportation	% of respondents	
		Barguna	Faridpur
1	Ventilated plastic Cover	1	6
2	Unventilated Bowel/cover	98	78
3	Cloth	1	1
4	Paper/hardboard		2
5	Other		12
6	Unknown	1	2
	Grand Total	100	100

5.7 Storage of Water

The best practice of storage drinking water is it needs to be collected in a container, to be covered with unventilated cover and to be kept in raised place where air and light passes. A very few percentage of respondents had been practicing these. The practice behaviour of water preservation is presented in Table 5.20.

Table 5.20: Practice of water preservation among the respondents

How collected water was preserved?	Was it covered?	With what it was covered?	Where it was kept?	% of respondents	
				Barguna	Faridpur
Do not store water, collect every time when required	Covered	Ventilated plastic Cover	Raised place		1
			Raised place with air and light		1
		Subtotal: Ventilated plastic Cover			1
		Unventilated Bowel/ cover	Raised place	1	2
			Raised place with air and light		9
			Lowered place		1
		Subtotal: Unventilated Bowel/cover		1	12
		Others	Raised place		1
		Subtotal: Others			1
	Subtotal: Covered			1	14
	Uncovered	No information	No information		10
		Subtotal: No information			10
	Subtotal: Uncovered				10
Subtotal Do not store water, collect every time when required				1	24
Plastic jug/bucket	Covered	Ventilated plastic Cover	Raised place		4
		Subtotal: Ventilated plastic Cover			5
		Unventilated Bowel/ cover	Raised place	1	12
			Raised place with air and light		12
			Lowered place		1
			Others		1
		Subtotal: Unventilated Bowel/cover		1	25
		Others	Raised place		1
		Subtotal: Others			2
	Subtotal: Covered			1	32
	Uncovered	No information	No information	1	3
		Subtotal: No information		1	3
	Subtotal: Unccovered			1	3
Subtotal: Plastic jug/bucket				1	35
Earthen *Kolshi*	Covered	Ventilated plastic Cover	Raised place		1
		Subtotal: Ventilated plastic Cover			1
		Unventilated Bowel/ cover	Raised place	3	3
			Raised place with air and light		7


How collected water was preserved?	Was it covered?	With what it was covered?	Where it was kept?	% of respondents	
				Barguna	Faridpur
			Lowered place		1
		Subtotal: Unventilated Bowel/cover		3	10
		Cloth	Raised place	1	
		Subtotal: Cloth		1	
	Subtotal: Earthen Covered			3	12
Subtotal: Earthen *Kolshi*				3	12
Aluminium container	Covered	Ventilated plastic Cover	Raised place	1	
		Subtotal: Ventilated plastic Cover		1	
		Unventilated Bowel/ cover	Raised place	93	6
			Raised place with air and light	1	9
			Lowered place		3
		Subtotal: Unventilated Bowel/cover		93	18
		Paper/Hard Board	Raised place		1
		Subtotal: Paper/Hard Board			1
		Others	Raised place		1
			Raised place with air and light		1
		Subtotal: Others			2
	Subtotal: Covered			94	20
	Uncovered	No information	No information		1
		Subtotal: No information			1
	Subtotal: Uncovered				1
Subtotal: Aluminium container				94	21
Glass container	Covered	Unventilated Bowel/ cover	Raised place		1
		Subtotal: Unventilated Bowel/cover			1
	Subtotal: Covered				2
Subtotal: Glass container					2
Others	Covered	Unventilated Bowel/ cover	Raised place	1	
			Raised place with air and light		3
		Subtotal: Unventilated Bowel/cover		1	3
	Subtotal: Covered			1	3
Subtotal: Others				1	3
Combination of the mentioned above	Covered	Unventilated Bowel/ cover	Raised place	1	
			Raised place with air and light		4
		Subtotal: Unventilated Bowel/cover		1	4
	Subtotal: Covered			1	4
Subtotal: Combination of the mentioned above				1	4
Grand Total: All				100	100


5.8 Safe Water and Health Status

The respondents were asked about kinds of water related diseases they had been facing in last 7 days and for last nine months (since January 2015). *The analysis results indicated that that on an average every week 13 and 19 episodes of water related disease had been occurring among the respondents of Barguna and Faridpur Pourashava respectively. The details are presented in Table 5.21. Table 5.22 represents the distribution of diseases considering the age group and frequency. The Table illustrated that the frequency of occurring water born/washed/related diseases was higher in Barguna Pourashava quarterly among the age group <5 years then the other age group. The Table also indicated that the frequency of occurring water born/washed/related diseases quarterly among the age group >12 years male and female was higher in Faridpur Pourashava then the other age group.*

Table 5.21: Distribution of diseases among the respondents in different times

No	Diseases	Last seven days (no of respondents)			Last nine months (no of respondents)		
		Barguna	Faridpur	Grand Total	Barguna	Faridpur	Grand Total
1	Diarrhea	4	12	16	26	11	37
2	Dysentery	7	6	13	25	4	29
3	Typhoid				1		1
4	Jaundice				1		1
5	Skin Disease	1		1	50	4	54
6	Worms	1		1	55		55
7	Cholera		1	1	1		1
9	Other related disease				1	1	2
	Total	13	19	32	160	20	180

Table 5.22: Distribution of diseases considering age group and frequency of disease

Different Aged Group	Frequency of different water born/washed/related disease	% of respondents	
		Barguna	Faridpur
Child < 5 years	Monthly	3	1
	Quarterly	6	3
	Half yearly	2	3
	Yearly	1	3
Subtotal: Child < 5 years		12	10
Child 5-12 years	Monthly	1	
	Quarterly	3	4
	Half yearly	1	4
	Yearly	1	3
Subtotal: Child 5-12 years		6	11
>12 years male	Monthly	1	1

Different Aged Group	Frequency of different water born/washed/related disease	% of respondents	
		Barguna	Faridpur
	Quarterly	3	3
	Half yearly	1	5
	Yearly	1	5
Subtotal: >12 years male		6	14
>12 years female	Monthly	1	
	Quarterly	2	2
	Half yearly	1	5
	Yearly	2	11
Subtotal: >12 years female		6	18
Not attacked by any disease		70	47
Grand Total		100	100

The respondents who were attacked by water born/washed/related diseases expended on an average BDT 4,237 and BDT 3,291per year for treatment. The higher number respondents (Barguna 21 and Faridpur 129) expensed BDT 501-2,000 per years for such diseases followed by BDT 2001 -5,000 (Barguna 18, Faridpur 75). Questions was asked to the respondents when they or one of their family member last attacked by diarrhoea to the best of their memories. *The results indicated that higher percentage of the respondents or their family members in both the Pourashava were attacked by diarrhoea in the recent years (2013-2015) then past previous years (<2013).* The details are presented in Fig. 5.3

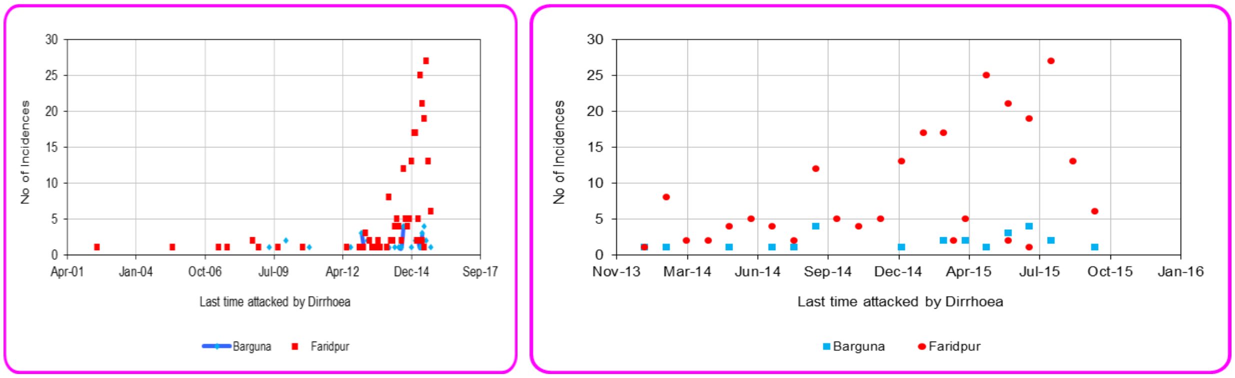


Fig. 5.3: Frequency of diarrhoeal incidence last time among the respondents

The respondents were asked if they belief/presume that the reasons for such health deterioration was because of the contamination of the drinking water followed specifically due to the Pourashava supplied water. *The analysis result indicated that 83% and 52% of the respondents of Barguna and Faridpur Pourashava respectively belied that the diarrhoeal diseases were due to drinking water contamination. Among these respondents 44% and 51% mentioned that the main reason was the Pourashava supply*

system's water. Result also indicated that a good parentage of respondents in Faridpur Pourashava still do not believed that the prevalence of such diseases were not due to contamination of drinking water. *A total of 13% and 29% respondents of Barguna and Faridpur Pourashava did not know about the reasons of such diseases.* The details are presented in Table 5.23.

Table 5.23: Perception about the reasons of health deterioration among the respondents

Do you think that the mentioned diseases are created due to drinking water contamination?	Do you think that the main reason of mentioned diseases is the Pourashava water supply system?	% of respondents	
		Barguna	Faridpur
Diseases are created due to drinking water contamination	The main reason is the Pourashava water supply system	44	51
	The main reason is not the Pourashava water supply system	39	1
Subtotal: Diseases are created due to drinking water contamination		83	52
Diseases are note created due to drinking water contamination	The main reason is the Pourashava water supply system	1	
	The main reason is not the Pourashava water supply system	2	18
Subtotal: Diseases are not created due to drinking water contamination		3	18
I do not know the reason of such diseases	The main reason is the Pourashava water supply system	2	
	The main reason is not the Pourashava water supply system		1
	I do not know if the main reason is the Pourashava water supply system	13	29
Subtotal: I do not know the reason of such diseases		14	30
Grand Total		100	100

CHAPTER 6: System Assessment

In the following sub section each of the Pourashava Piped water supply system is described by considering water source, quality of source water, treatment process, existing water supply system, reservoir, distribution line, distribution time, type of water supply connection, intended consumer, intended use, quality of the distributed water, sanitary condition of the source special controls etc.

6.1 Description of Water Supply System

6.1.1 Barguna Pourashava Piped Water Supply Systems

The Barguna Pourashava water supply section was established in 1973 (Fig. 5). A total 17 employees have been working under the supervision of an Executive Officer in the water section. *The total holdings in the Pourashava were around 6105 of which 62% (3782 (208 was closed)) were the user of the water supply system.* The users were spreading over 9 wards of the Pourashava. The remaining holdings have been using deep tube well (around 556) as the water source. The rate of tariff collection was 75.76%.

Fig. 6.1: Photograph of production well A: Ground water based, B: Surface water based with treatment plant (C)

The Pourashava Piped water supply system has 13 productions well comprising 12 ground water based and a surface water based systems. The only surface water based system is closed due to high electrical charges for its operation and maintenance. Among the ground water based pump house 9 was found functional, 1 was under construction and 2 was non-functional. There was not overhead tank and the water was directly decanted into the Piped form the pump houses. The total length of the pipe network was 76.34 km. The background information of the system is presented in Table 6.1 and the process is presented in Fig. 6.2.

Table 6.1: System description of the Barguna Pourashava Piped water supply system

Step	Description	Status
Source of Water	Current source	Ground water and Surface water
	Total No of production well (PW)	13
	Working condition of PW at present	Active = 4; Inactive = 1, Non-functional = 2, Under construction 6
	Average depth	936ft
	Abstraction process	Turbine pump = 0


Step	Description		Status
			Submersible pump = 11
Source Water Quality (ground water)	Parameter	Water Quality Target for drinking water in Bangladesh	Pump 1 / Pump 2 / Pump 3 / Pump 4
	Arsenic	< 0.05 mg/l	Water quality testing was done at field. Details of findings are presented in section 3.2.1 and Table 3.3. The instrument used: HACH DR 2800 spectrophotometer (water quality testing lab, Wegtech digital arsenator and Millipore fecal coliform testing kit
	Manganese	< 0.40 mg/l	
	Iron	< 1.00 mg/l	
	Fecal Coliform	0 CFU/100 ml	
Water Treatment Process	Water is supplied without any treatment or chlorination		No treatment system exists
Water Supply System (existing)	The groundwater is abstracted from production wells. The produced water is directly inserted in to the pipe network		Operational
Reservoir	Reservoir type		Total no: x; Usable no: x; Capacity: x
Distribution Line	Length of distribution line :76.34 Km	Size (Dia)	100 to 200 mm
		Total Sluice Valve	250 nos Active
		Sluice valve	250 nos
		Total wash out	60 nos
		Active wash out	60 nos
Distribution time	Average distribution time in a day		5.5 hours / day
Water supply connection	Total Number of connection: 3915	Residential connection	3,781 nos
		Commercial connection	118 nos
		Street Water Stand post	16 nos
Intended consumer	Residential user		Dwellers of Barguna Pourashava
	Commercial user		Consumer of hotel & restaurant, people working at office and institutions etc.
Intended use	Household and personal activities		The distributed water is used for drinking, cooking, personal hygiene and household washing purposes
Distributed Water Quality	Standard: Health Based Target of government (HBT – WSF 2011). Parameter / Unit / Target (standard) Fecal coliform / CFU /100 ml / 0 Total coliform / CFU /100 ml / 0 Arsenic / mg/l / < 0.05 Manganese / mg/l / < 0.40 Iron / mg/l / < 1.00		HH-1 / HH-2 / HH-3 A total of 27 household's storage water samples (3 from each ward) were tested for the parameters mentioned below. Details are provided in Section 3.2.1, Table 3.4
	Aesthetic requirements	Colour	Yellowish
		Taste	Good
		Odour	Odourless
Sanitary Inspection Score	Reference to the Sanitary Inspection 2015, conducted by DPHE district Office, under the CC resilient WSP implementation program, the risk scores of different steps of water supply are:	Steps	Risk Score
		Production Well	High
		Pump House	Medium
		Overhead Tank	Medium
		Distribution line	High

Step	Description	Status
Any special controls required?		No controlling process existed

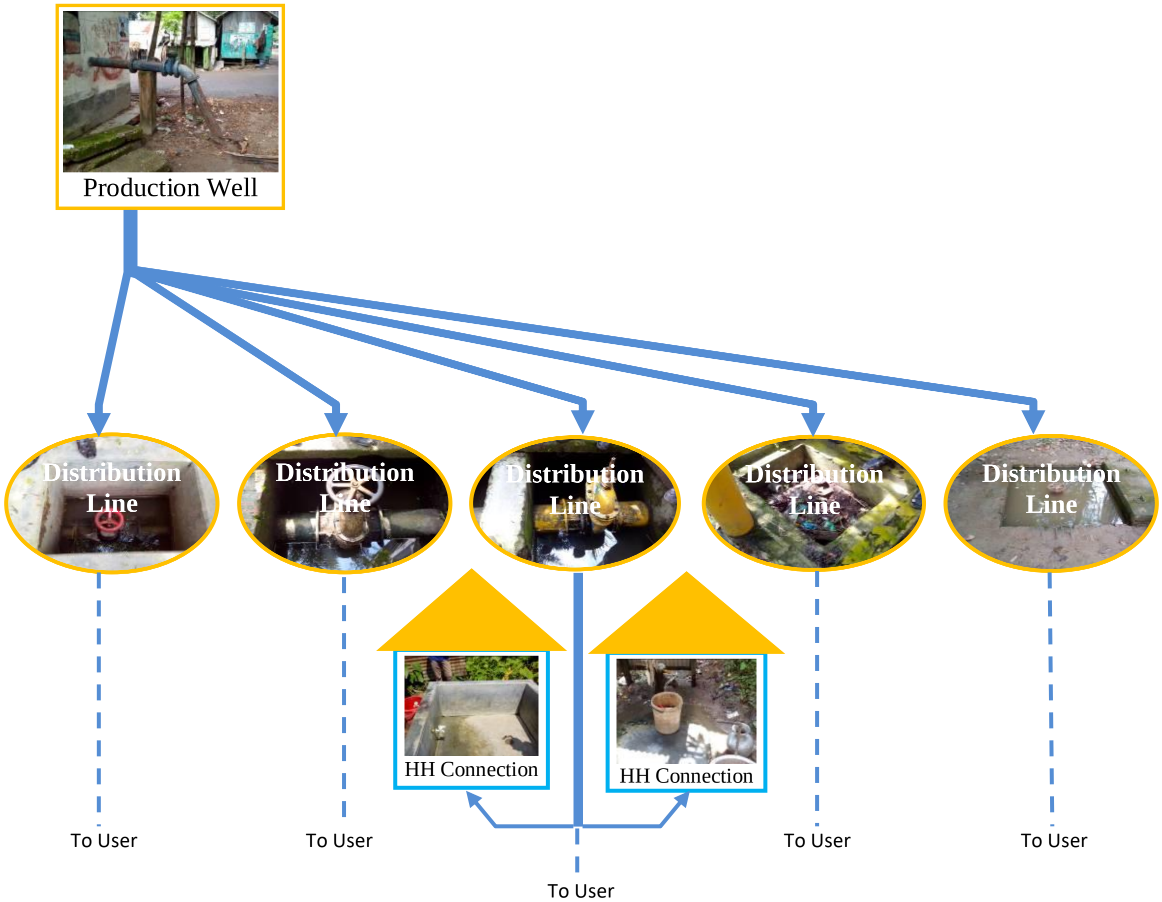


Fig. 6.2: Process flow diagram of the Barguna Pourashava Piped water supply system

6.1.2 Faridpur Pourashava Piped Water Supply Systems

The Faridpur Pourashava water supply section was established in 1969 (Fig. 5.3). A total 31 employees have been working under the supervision of an Executive Officer in the water section. *The total holdings in the Pourashava are around 15695 of which 50% (8522) holdings have been using the water supply system.* The users were spreading over 9 wards of the Pourashava and the remaining holdings has been using shallow well and occasionally dug well and rain water for collection of drinking water. The rate of tariff collection was 80 %.

The Faridpur Pourashava Piped water supply system was based on the ground water. A total of 11 production tube wells were installed at shallow depth had been pumping the ground water into two water treatment plants. In the treatment plants the pumped water was processed through different physical, chemical and biological treatment unit. The treated water was lifted to an overhead tank. The water was then distributed through Piped to the users in different wards of the Pourashava. The total length of the Piped was 129. The detail of background information of the system is presented in Table 6.2 and the process is presented in Fig. 6.4.

Fig. 6.3: Photograph of treatment plant A: aeration chamber, B: chlorine dosing, C: Overhead tank

Table 6.2: General system description of the Faridpur Pourashava Piped water supply system

Step	Description		Status
Source of Water	Current source		Ground water
	Total No of production well (PW)		14 nos.
	Working condition of the production well (PW) at present		Active = 9; Inactive = 5, Under construction = 3
	Average depth		368 ft
	Abstraction process		Turbine pump = 1 Submersible pump = 8
Source Water Quality (ground water)	Parameter	Water Quality Target for drinking water in Bangladesh	Pump1 | Pump2 | Pump3 | Pump4 | Pump5 | Pump6 | Pump7 | Pump8 | Pump9
	Arsenic	< 0.05 mg/l	Water quality testing was done at field. Details of findings are presented in section 3.2.2 Table 3.5. The instrument used: HACH DR 2800 spectrophotometer (water quality testing lab, Wegtech digital arsenator and Millipore fecal coliform testing kit
	Manganese	< 0. 40 mg/l	
	Iron	< 1.00 mg/l	
	Nitrate	< 10.00 mg/l	
	Total Coliform	0 CFU/100 ml	
	Fecal Coliform	0 CFU/100 ml	
Water Treatment Process	Iron Removal Plant		2 Nos
Water Supply System (existing)	The groundwater is abstracted from 9 production wells and transferred into two iron removal plant located in two area (Jhil Tuli and Goal Chamot) followed by chlorination and reserved into the underground reservoir. The reservoir water is then lifted into an overhead tank and from their distributed to the user through piped		Operational

Step	Description			Status		
	network.					
Reservoir	Underground reservoirs and overhead tank existed	Reservoir type		Total no	Usable no	Capacity
		Underground reservoir		1	1	150,000
		Overhead Tank (OHT)		2	2	150,000
Distribution Line	Length of distribution line129 Km	Size (Diameter)		3” to 12”		
		Total Sluice Valve		187		
		Active sluice valve		60		
		Total wash out		36		
		Active wash out		0		
Distribution time	Average distribution time per day			5.5 hours / day		
Water supply connection	Total Connection: 8522 Nos	Residential connection		7425 Nos		
		Commercial connection		1097 Nos		
		Street Water Stand post		50 nos		
Intended consumer	Residential user			Citizens of Faridpur Pourashava		
	Commercial user			Consumers of hotel & restaurant, people working at office, hospitals and institutions etc.		
Intended use	Household and personal activities			The distributed water is used for drinking, cooking, household washing, bathing and personal hygiene purposes.		
Distributed Water Quality	Standard: Health Based Target of government (HBT – WSF 2011).			HH-1	HH-2	HH-3
	Parameter	Unit	Target (standard)	A total of 27 household’s storage water samples (3 from each ward) were tested for the parameters mentioned below. Details are provided in Section 3.2.2, Table 3.6 and 3.7		
	Fecal coliform	CFU /100 ml	0			
	Total coliform	CFU /100 ml	0			
	Arsenic	mg/l	0.05			
	Iron	mg/l	1.00			
	Manganese	mg/l	0.40			
	Nitrate	mg/l	10			
	Aesthetic requirements		Colour	Clear		
			Taste	Good		
			Odour	Odourless		
Sanitary Inspection Score	Reference to the Sanitary Inspection 2015, conducted by DPHE district Office, under the CC resilient WSP implementation program, the risk scores of different steps of water supply system are shown below.	Steps		Risk Score		
		Production Well		High		
		Pump House		Medium		
		Overhead Tank		Medium		
		Distribution line		High		
Any special controls required?				Treatment and chlorination process for the water supply system.		

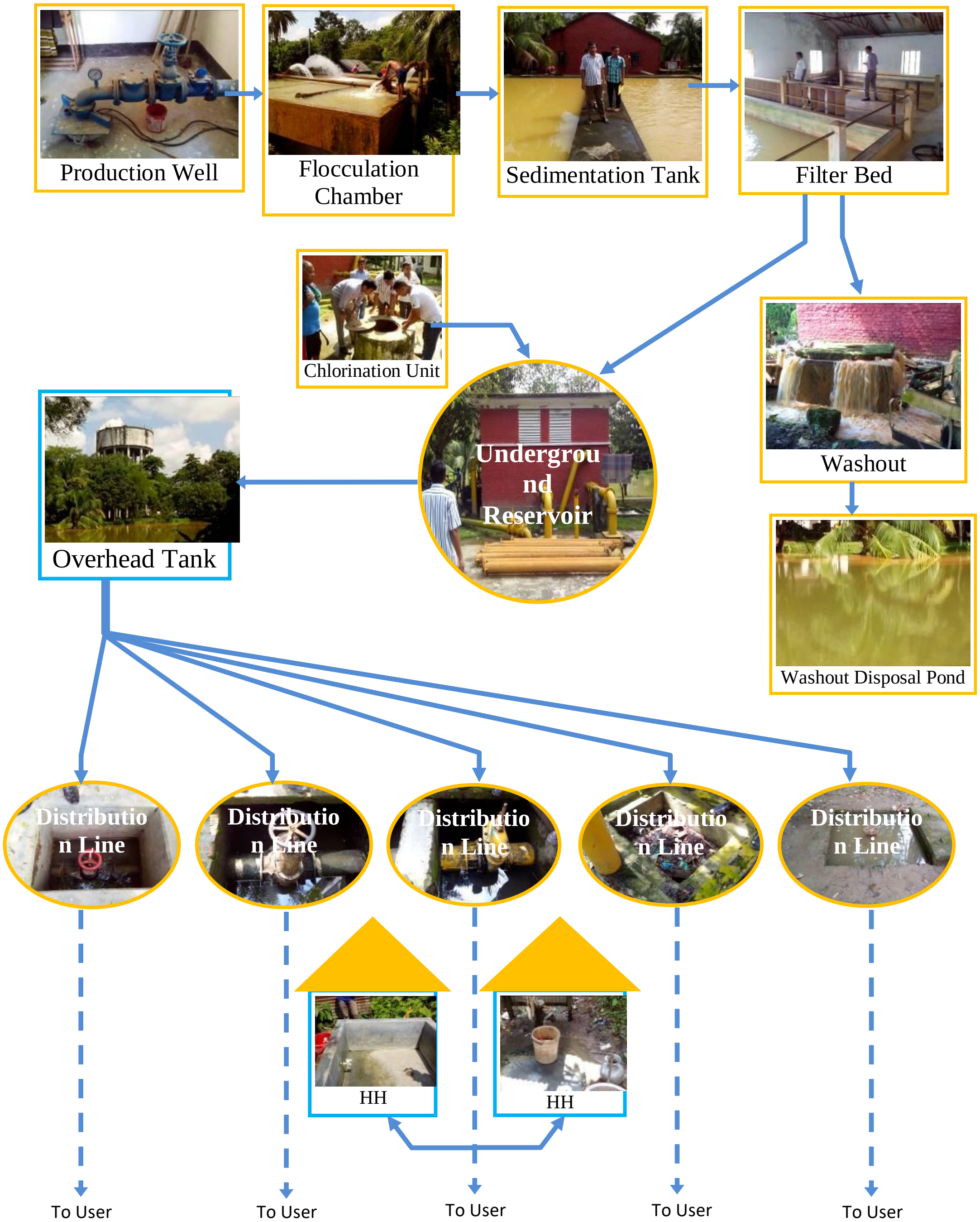


Fig. 6.4: Process flow diagram of the Faridpur Pourashava Piped water supply system


6.2 Chemical and Biological Hazards

Water samples were collected form the household's storage, source from each of the ward of Barguna Pourashava and tested for arsenic, iron, manganese, nitrate and fecal coliform. Some physical parameters were also tested namely pH, turbidity, total dissolved solids, conductivity etc. In the following sub section the details are presented. HACH DR 2800 spectrophotometer (water quality testing lab) was used for testing of iron, manganese and nitrate, Wegtech digital arsenator was used for arsenic testing, Millipore fecal coliform testing kit was used for fecal and other coliform testing and the physical parameters were tested by HACH potable instruments. All the testing was conducted in the field.

5.2.1 Barguna Pourashava

Only one ground water based production well's water was examined for some concerned chemical, biological and physical parameters as presented in Table 6.3 for an initial assessment of the water quality of the source water. *The light brown yellowish colour created an aesthetic problem among the water users and the fecal contamination was too high.* Three household's storage samples were collected randomly from each of the 9 wards of the Pourashava for microbiological analysis and the total samples collected samples were 17. The analysis results were categorized by considering the *E. Coli* concentration per 100 ml; namely 0 for low risk, 1-10 medium risk, 11-99 high risk and above 100 is very high risk (Table 6.4). *The analysis result indicated that 11% have intermediate risk, 37% have high risk and 52% have very high risk of considering the health.*

Table 6.3: Water quality analysis result of production wells of Barguna Pourashava water supply system

No	Particulars	Unit	Results
1	Location		Tulatoli Pump House
2	Source Type		Deep Tube Well
3	Catchment Area/Depth	ft	940
4	Color		Light Yellowish Brown
5	Odor		Smell of Rotten Egg
6	pH		8.16
7	ORP	mV	-155.8
8	Conductivity	µs/cm	1158
9	Salinity	mg/l	
10	LOD	mg/l	2.83
11	Turbidity	NTU	1.1
12	As	mg/l	0
13	Fe	mg/l	0.05
14	Mn	mg/l	0.4
15	Nitrate	mg/l	8.5
16	E. Coli	/100ml	TNTC
17	Other Coli form	/100ml	TNTC
18	Total Coli form	/100ml	TNTC

TNTC: To numerous to count) in the source water

Table 6.4: Microbiological analysis of the household's storage water samples of Barguna Pourashava

Ward No	Microbial Risk (% of household's storage water sample)			
	Intermediate	High	Very High	Grand Total
Ward 1	33 (1)	67 (2)		100 (3)
Ward 2	33 (1)		67 (2)	100 (3)
Ward 3		33 (1)	67 (2)	100 (3)
Ward 4			100 (3)	100 (3)
Ward 5	33 (1)		67 (2)	100 (3)
Ward 6		67 (2)	33 (1)	100 (3)
Ward 7		67 (2)	33 (1)	100 (3)
Ward 8		33 (1)	67 (2)	100 (3)
Ward 9		67 (2)	33 (1)	100 (3)
Grand Total	11 (3)	37 (10)	52 (14)	100 (27)

( ) indicated number of sample

5.2.2 Faridpur Pourashava

The analysis results of water samples collected from nine production well of the Faridpur Pourashava water supply system is presented in Table 6.5. *The result indicated for high concentration of the arsenic, iron and E. Coli in the production well's water.* A total of nine samples, one from each ward were collected form the entry point of the supply water to the user's house were analysed for *E. Coli* which represented the quality of the Piped water. The analysis results are presented in Table 6.6**.** *The result indicated that the supply line water in two wards has low risk of microbiological contamination considering the health and the remaining have variable degrees of risk.* The Table 6.7 represents the analysis result of *E. Coli* of the household's storage water sample. *The result indicated that 48%, 44% and 7% have very high risk, high risk and intermediate risk from the health point of view.*

Table 6.5: Water quality analysis result of the production tube wells of Faridpur

No	Particulars	Unit	Goal Chamot 1	Goal Chamot 2	Goal Chamot 3	Goal Chamot 4	Jhiltuli 1	Jhiltuli 2	Jhiltuli 3	Jhiltuli 4	Jhiltuli 5
1	Location		In front gate	Salim's house	Bishorgon Ghat	Bus stand	Road side	Moshiur's house	Anis's house	Behind filter house	Mizan's house
2	Source Type		STW	STW	STW	STW	STW	STW	STW	STW	STW
3	Depth		380	300	290	300	290	290	295	290	300
4	Color		Reddish	Reddish	Reddish	Reddish	Light Reddish	Light Reddish	Light Reddish	Light Reddish	Light Reddish
5	Odor		Fishy Smell	Fishy Smell	Fishy Smell	Fishy Smell	Fishy Smell	Fishy Smell	Fishy Smell	Fishy Smell	Fishy Smell
6	pH		7.50	7.09	7.42	7.18	7.24	7.44	7.34	7.26	7.16
7	ORP	mV	150.1	155.4	148.4	168.7	53.9	102.3	20.6	58.8	22.4
8	Conductivity	µs/cm	1462	1693	1040	1091	1035	1019	852	894	440
9	Salinity	mg/l									
10	LOD	mg/l	6.99	7.28	6.85	7.47	4.24	4.77	3.07	4.74	7.56
11	Turbidity	NTU	57.6	64.3	82.4	136.0	69.6	67.0	81.5	69.2	58.8
12	As	mg/l	170	235	225	135					

No	Particulars	Unit	Goal Chamot 1	Goal Chamot 2	Goal Chamot 3	Goal Chamot 4	Jhiltuli 1	Jhiltuli 2	Jhiltuli 3	Jhiltuli 4	Jhiltuli 5
13	Fe	mg/l	6.8	8.9	14.6	11.6	6.3	4.1	3.2	2.6	2.45
14	Mn	mg/l	0.4	0.3	0.3	0.9	0	0	0.3	0.3	0.4
15	Nitrate	mg/l	0	0	0	0	0	0	0	0	0
16	E. Coli	/100ml	30	25	31	TNTC	36	112	12	54	53
17	Other Coli form	/100ml	280	37	192	TNTC	80	204	35	43	47
18	Total Coli form	/100ml	310	62	223	TNTC	116	316	47	97	100

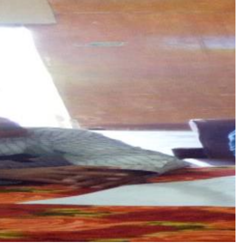
Table 6.6: Microbiological analysis of the household's source water samples of Faridpur Pourashava

Ward No	Microbial Risk (HH's source water sample)				
	Low	Intermediate	High	Very High	Grand Total
Ward 1		1			
Ward 2			1		1
Ward 3		1			1
Ward 4		1			1
Ward 5	1				1
Ward 6	1				1
Ward 7			1		1
Ward 8				1	1
Ward 9			1		1
Grand Total	2	3	3	1	9

Table 6.7: Microbiological analysis of the household's storage water samples of Faridpur Pourashava

Ward No	Source	Microbial Risk (HH's storage water sample)				
		Low	Intermediate	High	Very High	Grand Total
Ward 1	Intermediate			100 (3)		100 (3)
Ward 2	High		33 (1)	67 (2)		100 (3)
Ward 3	Intermediate			33 (1)	67 (2)	100 (3)
Ward 4	Intermediate			67 (2)	33 (1)	100 (3)
Ward 5	Low			67 (2)	33 (1)	100 (3)
Ward 6	Low		33 (1)		67 (2)	100 (3)
Ward 7	High				100 (3)	100 (3)
Ward 8	Very High				100 (3)	100 (3)
Ward 9	High			67 (2)	33 (1)	100 (3)
Grand Total			7 (2)	44 (12)	48 (13)	100 (27)

(_) indicated number

Annex 1: Survey Questionnaire

Water Safety Plan: Baseline Survey Questioner KAP Survey (Use Connection)

G1: Name of the Respondent [ ] **G5:Date of Survey** [ ]

G2: Name of the head of the family [ ] **G6: Time of survey** [ ]

G3: Respondent/Head of Family Mobile No. [ ] G7:Ward No [ ]

G4: Relation with Family Head **G8:**Holding No [ ]

Self 1 Husband/Wife 2 Son 3 Daughter 4 Others¨ 5 **G9:** Customer No [ ]

G10: Number of Family Member [ ] G101: Male [ ] G102: Female [ ] G103: Child <5 year [ ] G104: 5 to 12 year Child [ ]

G11 Principle occupation of the family Head: Service 1 Business 2 Agric ulture 3 Riksha Puller 4 Day Labour 5 Driver 6 Other 7

G12 Monthly Income of Head of the Family [ ]

G13 Type of House

One storied Building with RCC roof 1 Multi-storied Building 2 Slum House 3

Semi Pucka + Tin roof top One storied House 4 House Manufactured by Bamboo 5 Earthen House 6

Tin Roof + Wall+ One Storied House 7 Others 8 [ ]

G14: Do you pay your water bill? Pay regularly 1 Pay irregularly 2 Do not pay any bill 3

G15: Are you satisfied with the supply water? Satisfied 1 Not satisfied 2

G16: If you are not satisfied then do you know about the complain system of the Pourashava Yes 1 No 2

PART A⇨ Safe water

SW1: What is safe drinking Water

The water which will not create any diseases after drinking is safe water 1 Arsenic Free water 2

Tube well water 3 Clean odourless water 4

Supply water 5 I do not know what is safe water 6

If none of the above, please note what the user is mentioning? 7 [ ]

SW2: What is the source of drinking water?

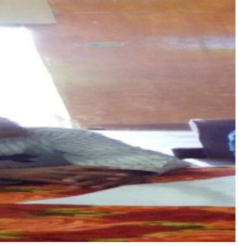
Supply Water 1 Water from Stand post in the Street 2 Water from PSF 3 Pond Water 4

Rainwater 5 Water from tube well with out platform 6 Water from tube well with platform 7 River water 8

Dug well water 9 Water from reverse osmosis 10 AIRP water 11 Filtered water 12

Other source 13 [ ]

SW3: Do you think that the water you are using is safe for drinking? Yes 1 No 2



SW4: KSW3 is "YES" then why it is unsafe?

Pipe water is contaminated	1	Water is turbid	2	Water have bad smell	3	Water has small earthworm	4
Water has iron	5	Water has salty taste	6	Water has arsenic	7	others	8

SW5: KSW3 is "No" then how you purify your water?

Drink without any treatment	1	Drink after boiling	2	Drink by filtering	3	Purify by using 'fitkiri"	4
Drink after using water purification table.	5	Others	6				

SW6: Which source of water you used for cooking activities

Supply water	1	Stand post near the road side	2	Dug-Ring Well	3	Rain water	4
Tube well with Platform	5	Tube well without platform	6	Other water source	7		

SW7: Do you think that we need to use safe water for drinking and cooking? Yes 1 No 2

SW8: Do you think that you have some responsibilities for keeping drinking and cooking water safe? Yes 1 No 2

PART B⇨ Climate Change

CC1: Do you hear about climate change? Yes 1 No 2

CC2: What type of change you are observing due to climate change? (Type of impact observed)

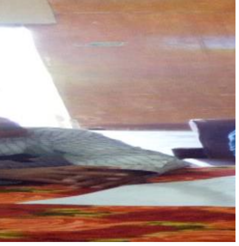
Temperature Increase	1	Excessive Rainfall	2	Excessive Drought	3	Less drought	4
Temperature Decrease	5	Less Rainfall	6	Heavy Flooding	7	Less Flooding	8
Increased Salinity	9	Sea Level Rise	10	Increase of storm	11	Water Logging	12
River Bank Erosion	13	Others	14				

CC3: What are the impacts of climate change on your drinking water?

Technologies are becoming non-functional frequently	1	Need to collect waster from long distance	2	Getting water in less amount	3	Quality of water becoming bad	4	No Impact	5

When the event no 1 to 4 has been happening

Month	**Season**				
December, January, February	**CC31** Winter	1	2	3	4
March, April, May	**CC32** Pre-Monsoon	1	2	3	4
June, July, August, September	**CC33** Monsoon	1	2	3	4
October, November	**CC34** Post Monsoon	1	2	3	4



PART C: Water Source

S1: What type of water connection you have at your house? (Observation)

Connected through underground reservoir	1	Connected through overhead tank in roof	2	Connected through pump to underground reservoir and overhead tank	3	Connected directly to the Kitchen	4
Connected directly to the Bathroom	5	Connected through stand post inside the home without platform	6	Connected through stand post inside the home with platform	7	Connected through stand post to surface reservoir	8
Other type	9						

S12 Is your house connection is crossing over drain, ditch and cannel (Observation)? Yes 1 No 2

S2 Is the surface and underground reservoir looked cleaned (Observation) Yes 1 No 2

S21 How many times your clean your surface and underground reservoir?

Every Month 1 Quarterly 2 Half yearly 3 Yearly 4 Biennial 5 Irregular 6 Never cleaned 7

S22 How you clean the reservoir?

Brushing with only water	1	Powdered soap and water	2	Bleaching powder / chemical ingredients and water	3	Only water	4	Other process	5

S3 Is the overhead tank cleaned (Observation)? Yes 1 N 2

S31 How many times you clean your overhead tank?

Every Month 1 Quarterly 2 Half yearly 3 Annual 4 Biannual 5 Irregular 6 Never cleaned 6

S32 How you clean your overhead tank?

Brushing with only water	1	Powdered soap and water	2	Bleaching powder / chemical ingredients and water	3	Only water	4	Other process	5

PART D: Water Collection

C1: You do you collect water from source by Picher 1 Bucket 2 Jug 3 Glass 4 Bottle 5

C2: Do you clean your the water collection container before collection? Yes, every time of collection 1 Yes, occasionally during collection 2 It is not necessary to clean every time of collection 3

C22: How do you clean your water collection container Cleaned to the bottom of the container, rubbing with hand and brush 1 Stirring with water 2 Others 3

C23: What type of material you use to clean the water collection container Only water 1 Powdered soap and detergent 2 Ash 3 Others 4

C24: Which water you use for cleaning the collection container? Water of that source from where the water will be collected 1 Cleaned from house by other water 2

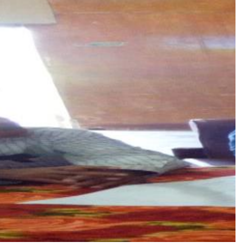
PART D: Water Transportation

T1: During collection of water do you cover the collection container? Yes 1 No 2

T2: T1 Question's answer is "Yes" then what is used to cover the container Plastic cover with hole 1 Bowl/cover (No hole) 2 Cloth 3 Paper/ Hardboard 4 Others 5

PART E: Water Storage

P1: How do you preserve your drinking water (Observation)?



No preservation collect directly from tap when required	1	Plastic Jag-Bucket	2	Earthen pot	3	Aluminium Pot	4
Glass pot	5	Other					

P2: Is the preservation container kept covered? (Observation)? Yes 1 No 2

P21: If answer of Ques. P2 is "Yes" then what is used to cover it	Plastic cover with hole	1	Bowl/cover (No hole)	2	Cloth	3	Paper/ Hardboard	4	Others	5
P22: Where the preservation container is placed in the house	Raised Place	1	Placed at raised place where air and light passes	2	Lower Place	3	Raised place where air and light do not passes	4	Others	5

PART F: Heath

How many times your family member attacked by the following water born/related diseases in last seven days?

H11 Diarrhoea		**H12** Dysentery		**H13** Typhoid		**H14** Jaundice	
H15 Skin Diseases		**H16** Worms		**H17** Arsenicosis		**H18** Cholera	
H19 Other water related/washed diseases							

Hoe many of your family member was attacked by the following water/related/bon/washed diseases since January 2015

H21 Diarrhoea		H22 Dysentery		H23 Typhoid		H24 Jaundice	
H25 Skin Diseases		H26 Worms		H27 Arsenicosis		H28 Cholera	
H29 Other water related/washed diseases							

H3: Who is affected by the above mentioned diseases frequently	< 5 years child	1	5-12 years child	2	Male greater 12 years of ager	3	Male greater 12 years of Female	4
H4 Frequency of incidence of above mentioned diseases among the family members	Monthly	1	Quarterly	2	Half yearly	3	Annually	4

H5: Do you think that the incidences of the mentioned diseases are due to the contamination of drinking water? Yes 1 No 2

H6: Do you think that the reason behind the incidence of the mentioned diseases is the contamination of Pourashava water supply system? Yes 1 No 2

H7: How much money you spent for the mentioned diseases per year

H8: Please mention the time when at lease one person in your family who was affected by diarrhoea last time