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Revised Baseline Survey Report

On

Identification of the Impact of Climate Variability and Environmental Hazards in Water Supply Systems

Submitted by

PMID
Participatory Management Initiative for Development

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Executive Summary

Climate variability along with environmental characteristics is linked with the physical and chemical quality of water as well as the water availability. Incidences of water related diseases such as diarrhea, cholera, malaria, dengue, dysentery, arsenicosis etc. are increasing significantly in Bangladesh due to the impact of climate change on water supply systems. In addition, climatic and environmental hazards can have impact at different steps of a water supply system, e.g., source/catchment, treatment plant, storage, distribution and household connections of the piped line water supply system.

The WHO-DPHE has been implementing Climate Resilient WSPs to overcome the challenges facing by the Pourashavas in Bangladesh posed by the climate change and environmental hazards in water supply systems to make the water supply systems more resilient. Under this assignment, four Pourashavas (Naogaon Sadar, Cox's Bazaar Sadar, Ullahpara and Birampur) of Bangladesh were selected with an objective to support for ensuring safe water supply through implementation of climate resilient WSPs considering climate and environmental hazards. Participatory Management Initiative for Development (PMID), a consulting firm is conducting this assessment with support from WHO and DPHE.

A baseline survey was conducted under the assignment in Naogaon Sadar, Cox's Bazar Sadar, Ullahpara and Birampur Pourashavas comprising an initial assessment of the water supply system and a KAP survey. The major objectives of the baseline survey were to understand the existing water supply systems, impact of climate change on water supply systems, and the knowledge, attitude and practice (KAP) safe water use among the consumers of the piped water supply systems in the respective Pourashavas.

From the analysis of water supply systems and few climatic parameters of the area of each water supply system it was found that all of the Pourashavas are to some extent facing the problem due to climate change and the problems and challenges vary from region to region. Naogaon and Birmapur Pourashavas which fall under the drought prone areas, dryness, scarcity and quality of water is a big concern among the city dwellers. The challenges of Cox's Bazar Pourashava are different from other Pourashavas. The water quality, specially the salinity of the water is a big concern among the communities of the Cox's Bazar Pourashava. Weather extreme events like cyclone, storm surge and flush flood effects the water supply system heavily in Cox's bazaar Pourashava. The Ullahpara Pourashava falls under the flood prone area and main concern is that, water supply system goes under the flood water and poses high risk of ingress of contaminated water into the pipe network through leakages.

The KAP survey findings indicated that most of the users in the Pourashavas are aware about the characteristics of "safe water" and their responsibilities to keep water safe, there are still significant users who need motivation regarding practicing the appropriate method while water collection, transportation and storage. The respondents in different Pourashavas assumed that water would be less available due to the impact of climate change, especially during the summer period. A few respondents also mentioned that non-functionality will be increased and accessibility will be reduced. Despite some respondents were found aware of climate change impact on water supply, still there is need for improving their knowledge about identifying the climate hazards that can affect water supply and their health condition.

Incidents of diarrhea and dysentery were found more prevalent than the other diseases in Naogaon Pourashava. It was found in Naogaon Pourashava that children below 5 years are the most vulnerable to water-borne diseases. In other Pourashavas it was found that people of all age group were more or less affected. Apart from Naogaon Pourashava, the percentage of respondents in other Pourashavas who could relate water-borne diseases of the water they were using was low. This indicates that motivational program regarding impact of water quality on health would be needed.

A very few percentage of Pourashava dweller's were satisfied with water supply in the different Pourashava. It can be said from the analysis that in none of the Pourashavas over 35% of users were satisfied about their water supply system. From the water quality test results, it was found that As was not posing any threat to water quality in any of the four Pourashavas. Fe concentration was found above acceptable limit in Naogaon, Ullahpara and Birampur Pourashavas. Only in Ullahpara Pourahava Mn in concentration was found above critical limit. Salinity is a threat in Cox's Bazar Pourashava in the coastal zone. The microbial risk was found significant in all the Pourashavas at the water collection points for users, as most of the tested samples showed high concentration of E. Coli in tested water. However, it is expected that based on the findings adequate improvement plans and appropriate motivational programs will be designed and implemented in the Pourashavas to make their their piped water supply systems climate resileint..

Chapter 1: Introduction

1.1 Project Background

The City Corporations and Pourashavas in Bangladesh are located in different climate-vulnerable areas such as coastal, flood-prone, drought-prone and hilly areas. This climate variability along with environmental characteristics is linked with physical and chemical quality of water as well as the water availability. Incidences of water related diseases like diarrhea, cholera, malaria, dengue, dysentery, arsenicosis etc. are increasing significantly in Bangladesh due to the impact of climate change on water supply systems. In addition, different socio-economic factors like population growth, rapid urbanization and industrial activities are also increasing the water demand. As a result, the overall health vulnerability has been increasing gradually which is resulting in higher mortality and morbidity rate.

Climatic and environmental hazards can have impact at different steps of a water supply system, e.g., source/catchment, treatment plant, storage, distribution and household connections of the piped line water supply system. Such hazards can affect the quality of supplied water, reduce availability of fresh water, and can also have negative impact on accessibility to safe water. Climate induced factors like flood, drought and storms increase the threat and risks to water supply systems and thus increasing the risk of water related diseases.

To combat these issues, there is a need to improve the drinking water supply systems through implementation of Water Safety Plan (WSP) recommended by WHO which is a cost-effective and management-oriented preventive approach to ensure drinking water safety. It systematically identifies the climatic and environmental hazards considering the frequency and severity of the risks in relation to the piped water supply system, and suggests the necessary control measures and improvement plans as a preventive measure.

To support Pourashavas in Bangladesh to face with the challenges posed by climate change and environmental hazards in water supply systems, WHO-DPHE has been implementing Climate Resilient WSPs to make the water supply systems more resilient to climatic and environmental hazards. Under this assignment, four Pourashavas (Naogaon sadar, Cox's Bazaar sadar, Ullahpara and Birampur) of Bangladesh were selected with an objective to support these Pourashavas in ensuring the supply of safe water through implementation of WSPs considering climate and environmental hazards. Participatory Management Initiative for Development (PMID), a consulting firm is conducting this assessment in four Pourashavas with support from WHO and DPHE.

1.2 Objectives of the Aassignment

Following are the specific objectives of the assignment:

- Development of "hazards matrix" considering the climate variability and environmental hazards with likelihood and severity at different stages of water supply systems comprising source/catchment, treatment, storage and distribution and user connection located in four Pourashavas under three geographic locations (flood-prone, drought-prone and coastal).
- Evaluation of the existing control measures and identification of new control measure for reducing the risk arising from the identified climatic and environmental hazards in the water supply

systems.

- Development of an improvement plan for reducing the risks arising from the identified climatic and environmental hazards in the water supply systems.
- Development of Water Safety Plan documents for each of the four Pourashavas considering "Climate Resilient: Managing Risks Associated with Climate Variability and Change of WHO 2015 National Guidelines" on Water Safety Framework (WSF) in Bangladesh 2011.

1.3 Objectives of the Baseline Study

One of the major activities under this assignment is conducting a baseline study of water supply systems and consumers' Knowledge, Attitude and Perception survey about water in the Pourashavas. The major objectives of the baseline study are:

- To understand the existing water supply systems in four Pourashavas and impact of climate change on these water supply systems.
- To understand the knowledge level, attitude and practice of the consumers of piped water supply systems in four Pourashavas.

1.4 Report Outline

This "baseline report" contains five chapters which summarize background and the findings from the baseline study carried out in four Pourashavas. Chapter 1 presents the introduction, and highlights project background and study objectives. Chapter 2 presents the methodology used to carry out the baseline study in four Pourashavas. Chapter 3 focuses particularly on water supply systems in four Pourashavas and identified impacts of climate change on the systems. Chapter 4 highlights the knowledge, attitude and perception (KAP) survey findings and analysis of water quality test results. Finally chapter 5 highlights the conclusion and few recommendations based on the study findings.

Chapter 2: Methodology

The methodologies that were followed to carry out the baseline study in Naogaon Sadar, Cox's Bazar Sadar, Ullahpara and Birampur Pourashavas are described below.

2.1 Planning Meeting

A meeting was held at Bogra on June 20, 2016 with representatives from DPHE and Pourashavas. In this meeting, the objectives of the study and activities which were carried out during the course of the study were discussed. The planning for KAP survey, water quality testing and water supply system assessment for the baseline study was also done in the meeting.

2.2 Collection of Climatic Data

Collection of five years data (2011-2015) for temperature, rainfall and humidity was done from Bangladesh Meteorological Department (BMD) in order to analyze short term variation and trend of these parameters. The data was collected from the nearest BMD stations of each Pourashava.

2.3 Collection of Water Supply System Information

The PMID team visited the water supply systems in all four Pourashavas to collect information of different components of the water supply systems. The following information were collected from each water supply system:

- Source of water (groundwater/surface water)
- Number of production tube well
- Treatment plant (if any)
- Number of sluice valves
- Number of wash out valves
- Length of pipe line
- Number of consumers

2.4 Analysis of Impact of Climate on Water Supply System

The collected data of temperature, rainfall and humidity for each Pourashava were analyzed, and based on the results (trend lines) from the analysis, the potential impact of climate change on water supply systems of respective Pourashavas were identified.

2.5 Knowledge, Attitude and Practice (KAP) Survey

A baseline survey was conducted to gather information on perception of consumers of supplied water, and relevant knowledge, attitude and practice. A questionnaire was developed for the KAP survey having eight sections and 39 questions. The sample of the questionnaire used in the survey is attached as Annex-I with this report. The eight sections in the questionnaire are:

- General information
- Safe water use
- Users' perception of climate change
- Information about water connection
- Information about water transportation
- Information about Water Storage/Preservation
- Health Situation
- User Satisfaction

The questionnaire surveys in different Pourashavs were carried out by expert surveyors having prior experience of such tasks. In total, 225 households were surveyed in four Pourashavas. The breakdown of number of households surveyed in each Pourashava is given below:

- Naogaon Sadar Pourashava - 90 households
- Cox's Bazar Sadar Pourashava - 63 households
- Ullahpara Pourashava - 50 households
- Birampur Pourashava - 25 households

The households were selected randomly in each Pourashava. Only households having water connection from Pourashava water supply system or households that use Pourashava piped water supply were considered for the survey. The survey data was entered in excel, and was analyzed for each section which is presented in chapter 4 of this report.

2.6 Water Quality Testing

Five parameters were tested for the samples collected from production tube well and treatment plant, whereas two parameters were tested for samples collected from water collection points for users. For production tube well samples, the tested parameters were Arsenic (As), Iron (Fe), Manganese (Mn), E. Coli and Electrical Conductivity (EC). For samples collected from user points, only E. Coli and Electrical Conductivity were tested. The As, Fe and Mn tests were carried out at the laboratory of Bangladesh University of Engineering and Technology (BUET), and the E. Coli and EC tests were carried out using portable field testing kits. For each ward in a Pourashava, at least three samples from three random water collection points were tested.

While analyzing the water quality results, concentration of As and E. Coli was given priority to assess chemical and microbial risk respectively. If concentration of As was found < 0.05 mg/l, then the chemical risk was assumed to be "low." For E. Coli concentration, the risk classification was done as below:

- If concentration is 0 CFU/100 ml, then "low" microbial risk
- If concentration is 1-9 CFU/100 ml, then "intermediate" microbial risk
- If concentration is 10-99 CFU/100 ml, then "high" microbial risk
- If concentration is > 100 CFU/100 ml, then "very high" microbial risk

Chapter 3: Water Supply System and Impact of Climate Change

Different components of the water supply systems of four Pourashavas and impact of climate change on each of the water supply system in each Pourashava are described in the following sections based on collected information.

3.1 Components of Water Supply Systems and Climate Change Impacts

3.1.1 Naogaon Pourashava Water Supply System

Naogaon is a district in northern Bangladesh which is located in the bank of mini Jamuna river. It is bounded by West Bengal on the north, Natore and Rajshahi districts on the south, Joypurhat and Bogra districts on the east, Nawabganj district and West Bengal on the west The area of the town is about 38.36 km2 (14.81 sq mi) and the population is about 150,025. Here, local people are mostly farmers. This district is also home to a considerable rice processing industries.

It was found that the water supply system of Naogaon Pourashava uses groundwater as source of water. There were eight active production tube wells (Total production tuber well 13; inactive: 5) in the system from which water was found to be supplied to the consumers through pipeline networks. Total number of connections in the Pourashava was 7,316. The depth of the production wells varied from 120' to 140'. The total daily production was approximately 1,200 m^3 during wet season which was reduced to 600-700 m^3 per day in dry season. Water was supplied for 11-13 hours every day to the consumers. There were two inactive treatment plants in the Pourashava. The overhead tanks were also not used. Therefore, water was supplied to consumers through direct pumping into the pipeline without any treatment/disinfection. It was reported by water supply section staff that there were approximately 250 sluice valve chambers and 52 wash out valves in the pipe water supply network. The number of running street water hydrant was 75. The total length of pipe line was approximately 90 km.The flow diagram of the water supply system of Naogaon Pourashava is shown in Figure 1.

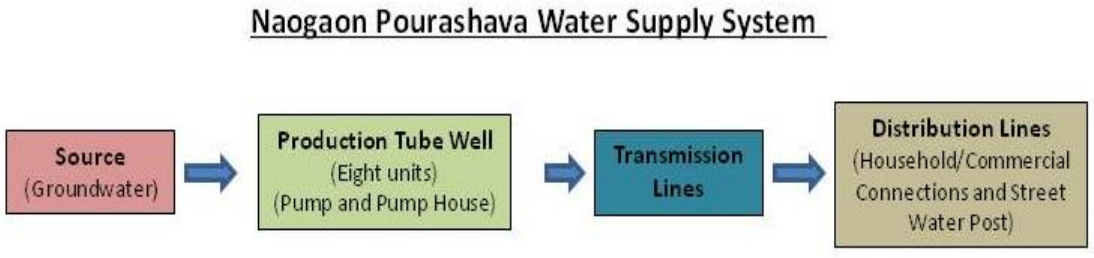
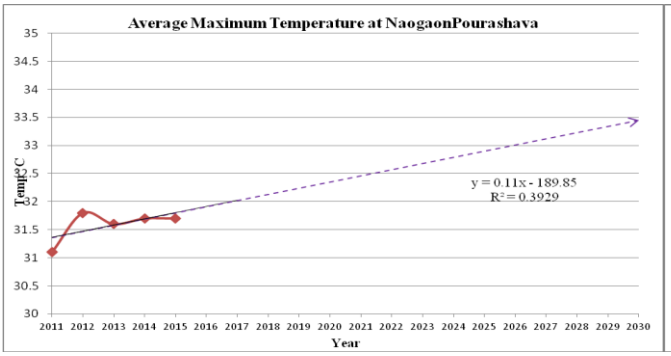


Figure 1: Flow diagram of Naogaon Pourashava Water Supply System

Naogaon Porashava Climate change impact:

In Naogaon Pourashava, analyses of few climatic parameters were carried out to identify the potential impact of such changes on water supply system. All most all participants of the workshops at Naogaon Pourashava mentioned that they had noticed changes in weather pattern; particularly temperature and rainfall. They had noticed dryness of river, irregular pattern of rainfall and lower level of ground water, which was impacting their life in various ways. Participants also mentioned that they couldn't use pipe water for initial few minutes after starting the pump as it carry lead and iron mixed water. End users of pipe water supply system mentioned that most of the time they couldn't use supply water or their drinking purpose, rather they collect it from tube well and sometimes they bought it from shops. Participants of the workshop mentioned that climate changes had significant health and agriculture impact.

Climatic variables such as temperature, rainfall and humidity data for five years (2011-2015) were collected and analyzed to find the mean value and also to draw trend lines for these parameters to identify the probable change in future years. The mean average temperature is 31.6^{0}C in Noagaon. Figure 1a shows the trend line of average maximum temperature; Figure 1b shows the average minimum temperature; Figure 2 shows the trend line for rainfall and Figure 3 shows the trend line for humidity in Naogaon.



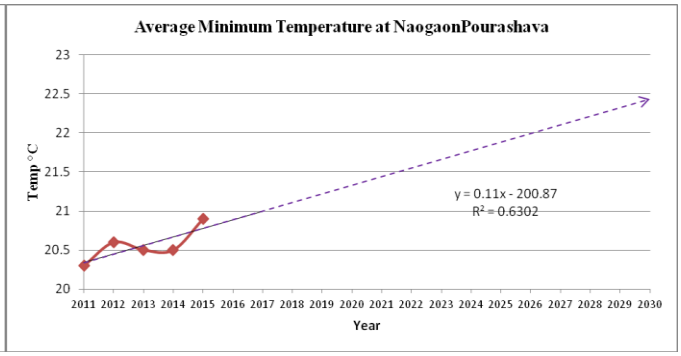


Figure 1a: Trend of Average Maximum Temperature at Naogaon Pourashava Figure 1b: Trend of Average Minimum Temperature at Naogaon Pourashava

Figure 1a shows that the average maximum temperature in Naogaon Pourashava is rising gradually; projected trend also shows that average maximum temperature is increasing at a rate of 0.11^{0}C/yr with a low fit $R^2$0.39. The projection indicates that the temperature will be reach at 33.5^0 C in 2030. Scientific paper in 2010 mentioned that, the temperature of Bangladesh increased gradually during last three decades. An average temperature of last decade (2000-2009) was 0.08^{0}C and 0.07^{0}C higher compared to decade of 1990-1999 and of 1980-1989 respectively.

Figure 1b describes the average minimum temperature in Naogaon. Analysis shows an upward trend of average minimum temperature, similarly the projection for 2030. Projection shows that average minimum temperature in this region will be more than 22^{0}C.

It is to be noted that both increase and decrease of temperature will alter the water quality and quantity and thus health. Temperature has effects on vector borne diseases through a number of pathways. Temperature affects both the distribution and the effectiveness of the vector for pathogen transmission. Workshop participants also highlighted the higher rate of vector borne diseases, diarrhea and dysentery and skin diseases and more severe than before.

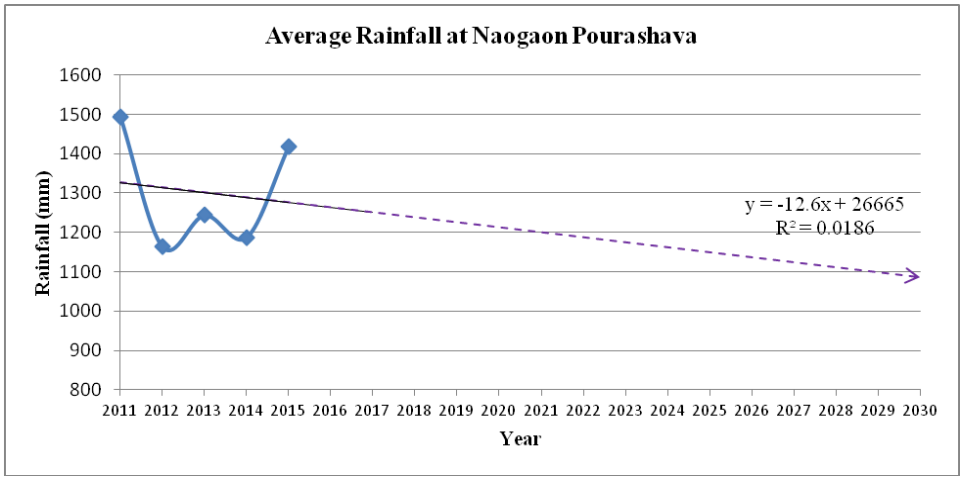


Figure 2: Trend of Average Rainfall at Naogaon Pourashava

Figure 2 shows the total rainfall pattern for the 5 years (2011-2015) and it is irregular in nature. In 2011 the total rainfall was around 1500 mm, and then on, it was decreasing till 2014. In 2015 total rainfall again increases more than 1400 mm. However, the projection of rainfall in Naogaon shows a decreasing trend. The projected total rainfall by the year 2030 would be less than 1100 mm. This indicates that this region is going to be dryer than before which might have impact on water supply system and thus health impacts. Although temperature determines the potential range of the mosquito and the disease organism, rainfall principally governs the availability of breeding sites and the overall population of mosquitoes. Thus, the combination of temperature and rainfall changes modified by many other factors such as land use changes, human population densities, and whether exposed populations have any built-in disease immunity will determine how the patterns of mosquito-borne diseases change.

The study area is one of the most water scarce areas in Bangladesh as the total rainfall is very lower than the other parts of the country. The temperature in the study area is showing a gradual increasing trend whereas the rainfall pattern is decreasing gradually.

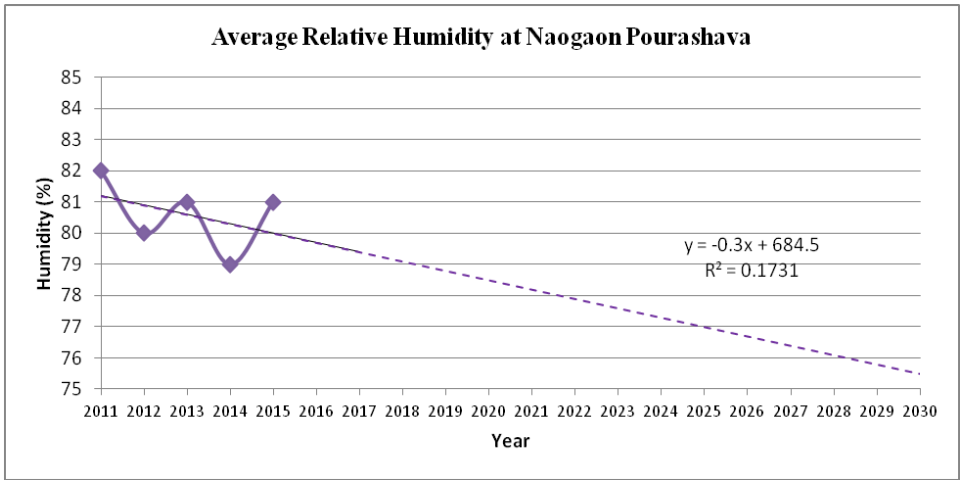


Figure 3: Trend of Average Relative Humidity at Naogaon Pourashava

Figure 3 shows the relative humidity in Naogaon for 2011-2015 and the projection till 2030. The pattern is irregular with ups and downs for last five years though the projection shows a decreasing trend. Humidity has influence on some disease pattern. It has been observed that the annual humidity is one of important indicators of vector borne disease, such as, dengue fever outbreak globally, and the incidence of dengue fever for the people living in humid areas could be 30% higher than people living in areas with less humidity. In this consideration, there is less likely to be dengue in this area though more chances to have respiratory system and water related health hazards.

3.1.2 Cox's Bazar Pourashava Water Supply System

Cox's Bazar is a district in the Chittagong Division of Bangladesh. It is located 150 kilometers south of Chittagong with an area of 2491.86 km². The area of the city of Cox's Bazar is 6.85 km², located at 21°35′0″N 92°01′0″E and bounded by Bakkhali River on the north and East, Bay of Bengal in the West, and Jhilwanj Union in the south. The climate of Cox's bazar is mostly high temperature, heavy rainfall, generally excessive humidity, and distinct seasonal variations. It is further characterized by the location in the coastal area. The annual average temperature in Cox's Bazar remains at about a maximum of 34.8 °C and a minimum of 16.1 °C. The average amount of rainfall remains at 4,285 mm.

The water supply system of Cox's Bazar Pourashava used groundwater as the source water. There were eight active production tube wells (Total production tube well 11; Inactive 3) in the system from which water was supplied to the consumers. Total number of connections in the Pourashava were 996. Groundwater was abstracted from 210' to 455' depth through production wells. Total daily production was approximately 2,400 m^3. Water was supplied for 10-11 hours every day to the consumers. There was no treatment plant and overhead tank existed in the Pourashava pipeline water supply system. Ground water was directly pumped to the pipe network. It was reported by water supply section staff that there were approximately 23 sluice valve chambers among which 3 were active. There was no active wash out

valves found in the pipe water supply network. The total length of pipe line was approximately 60 km. The flow diagram of Cox's Bazar Pourashava water supply system is shown below in Figure 4.

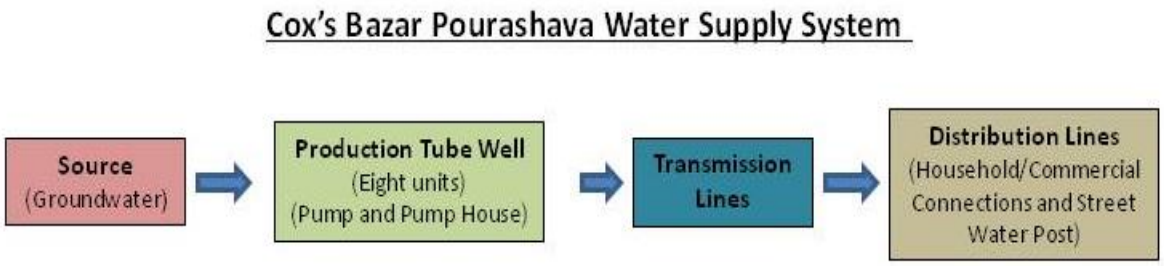


Figure 4: Flow diagram of Cox's Bazar Pourashava Water Supply System

Cox's Bazar Pourashava Climate Change Impact

Analyses of few climatic parameters were carried out to identify the potential impact of such changes on water supply system in Cox's Bazar. The workshop participants at Cox's Bazar Pourashava mentioned that they had observed significant changes in weather pattern; particularly with cyclone and flush flood though some of them mentioned about increased temperature and rainfall. They had noticed more salt in the water than before and the ground water level was going down which was impacting their life in many ways. Shortage of sweet water forcing the residents of the Pourashava to use salty water for their cooking, bathing and sometime drinking too. Participants are experiencing more health impact such as diarrhea, stomach ache and skin diseases than before. End users of piped water couldn't use supply water for their drinking as the taste was salty. Climate change has impacted on health and health system followed by fisheries business due to climate change and it is reported by the participants at the Cox's Bazar workshop.

Climatic variables such as temperature, rainfall and humidity data for five years (2011-2015) were collected and analyzed to find the mean value and also to draw trend lines for these parameters to identify the probable change in future years. The mean average temperature is 31.^{0}C in Cox's Bazar.

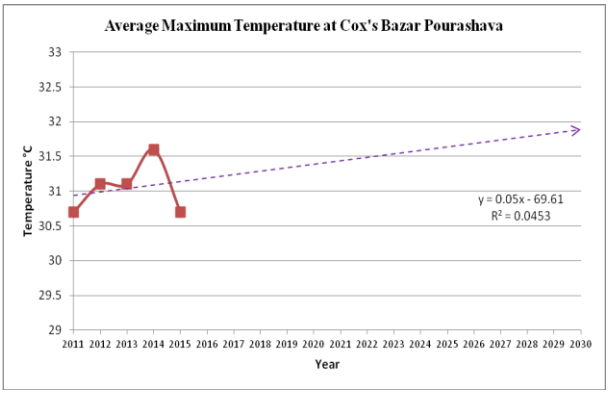


Figure 4a: Trend of Average Maximum Temperature at Cox's Bazar Pourashava

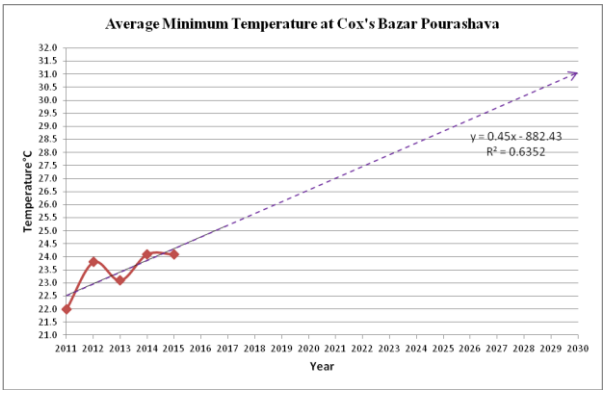


Figure 4b: Trend of Average Minimum Temperature at Cox's Bazar Pourashava

Figure 4a shows the trend line for average maximum temperature, Figure 4b shows the average minimum temperature, Figure 5 shows the trend line of rainfall and Figure 6 shows the trends for humidity in Cox's Bazar.

Figure 4a shows the average maximum temperature in Cox's Bazar Pourashava which is a bit irregular though the projection shows that average maximum temperature is increasing at a rate of 0.05^0C/yr with a low fit $R^2$0.45. If this trend continues, the temperature will be around 32^0C in 2030. Fascinatingly, this projected trend is lower than the temperature of Bangladesh during last three decades.

Figure 4b describes the average minimum temperature in Cox's Bazar. Analysis shows an upward trend of average minimum temperature; similarly, the projection for 2030 shows that average minimum temperature in this region will be more than 31^0C, which is far higher than Naogaon.

The increase or decrease of temperature will hamper the water quality and quantity in many ways and thus health impacts. Workshop participants highlighted the higher rate of stomach ache, diarrheal, dysentery and skin diseases in this region.

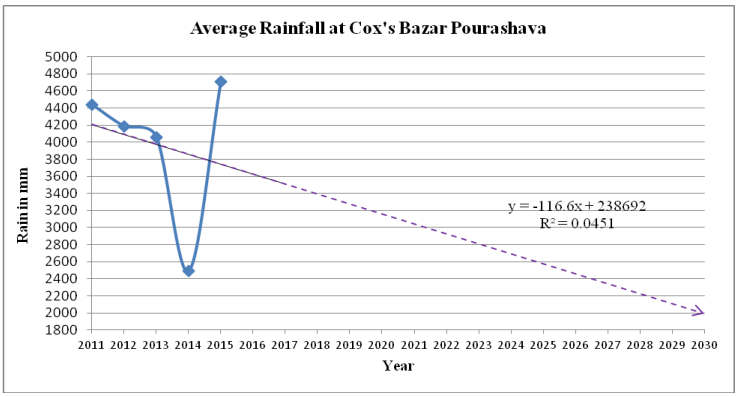


Figure 5: Trend of Average Rainfall at Cox's Bazar Pourashava

Figure 5 shows the total rainfall pattern for the 5 years (2011-2015). In 2011 the total rainfall was around 4400 mm, and then on, it was decreasing till 2014. In 2014, it was significant less rainfall comparing previous years; it was around 2400 mm though there was a sharpen rise in 2015. The rainfall was 4800 mm in 2015. However, the projected pattern of rainfall in Cox's bazar shows a decreasing trend. The projected total rainfall by the year 2030 would be around 2000 mm though it is still higher than average rainfall (1600mm) of Bangladesh. This indicates that this region is going to be dryer than before which might have impact on water supply system and thus health impacts. The combination of temperature and rainfall changes modified by many other factors such as land use changes, human population densities,

and whether exposed populations have any built-in disease immunity will determine how the patterns of some diseases change.

Cox's Bazar is well known for tourism. Both increasing trend of temperature and decreasing trend of rainfall will have impact on water quality, water quantity and thus health of the residents and tourist too.

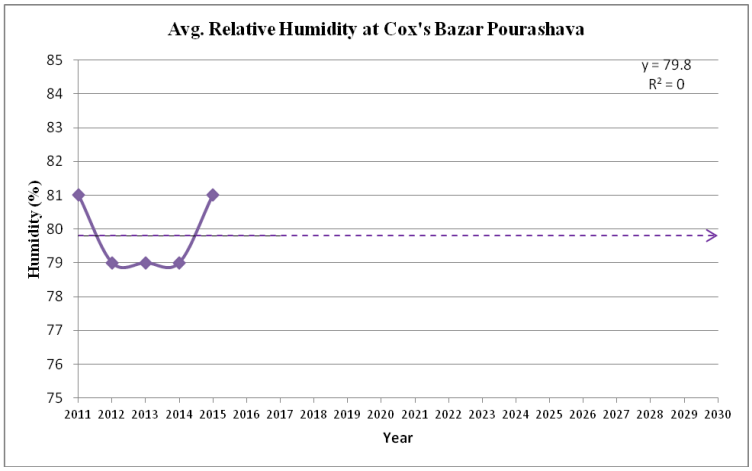


Figure 6: Trend of Average Relative Humidity in Cox's Bazar

Figure 6 shows the relative humidity in Cox's Bazar for 2011-2015 and the projection till 2030. The pattern shows an irregular pattern of relative humidity for last 5 years though the projection shows a steady trend.

3.1.3 Ullahpara Pourashava Water Supply System

Ullahpara is an Upazila of Sirajganj district in the division of Rajshahi, Bangladesh. It is known as the gateway to North Bengal as the intersection of Dhaka-Rangpur and Dhaka-Rajshahi highways at Hatikumrul falls within it. The upazila has an area 414.43 sq km, located in between 24°12' and 24°26' north latitudes and in between 89°24' and 89°38' east longitudes. The annual average temperature reaches a maximum of 34.6 °C, and a minimum of 11.9 °C. The annual rainfall is 1610 mm.

The water supply system of Ullahpara Pourashava under Sirajganj district used groundwater as the source water. There was only one production tube well found functioning in the system. Total number of connections in the Pourashava water supply system was 650. The water abstracted from the production well was subjected to an iron removal plant and the processed water was stored to an underground reservoir from where water was supplied to consumers through pumping. No disinfection method was used before the supply of water to consumers. The flow diagram of the water supply system of Ullahpara Pourashava is shown in Figure 7.

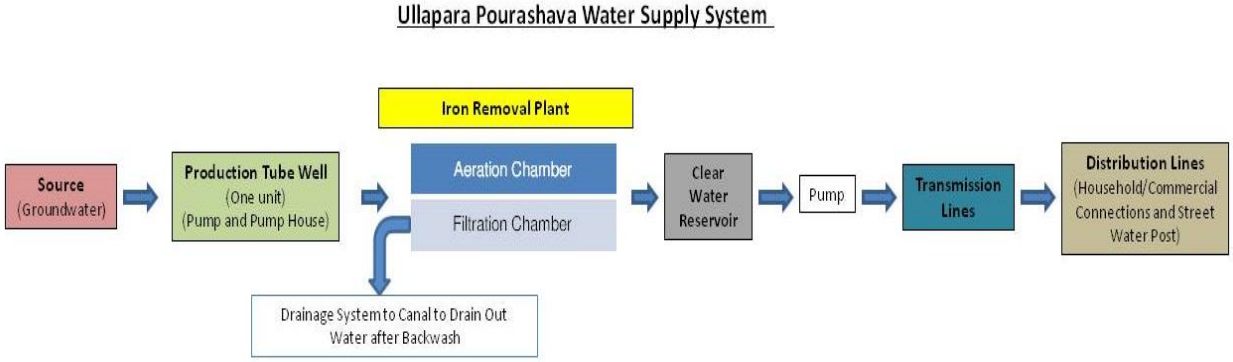
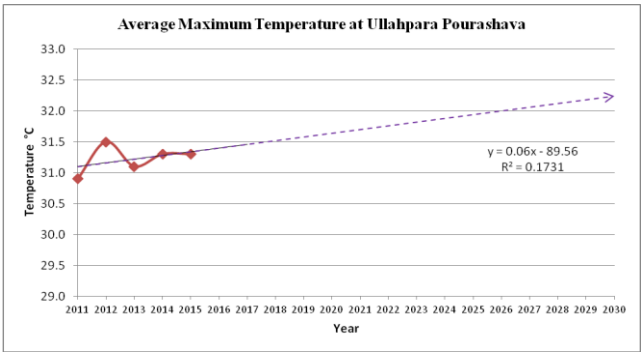


Figure 7: Flow diagram of Ullahpara Pourashava Water Supply System

Ullahpara Pourashava Climate Change Impact

In Ullahpara Pourashava, analyses of few climatic parameters were conducted to identify the potential impact of such changes on water supply system. Climatic variables such as temperature, rainfall and humidity data for 5 years (2011-2015) were collected and analyzed to find the mean value and also to draw trend lines for these parameters to identify the probable change in future years. The mean average temperature is 31.2^{0}C in Ullahpara. Figure 7a shows the trend line for average maximum temperature, Figure 7b shows the average minimum temperature, Figure 8 shows the trend line for rainfall and Figure 9 shows the trend line for humidity in Ullahpara of Sirajganj.



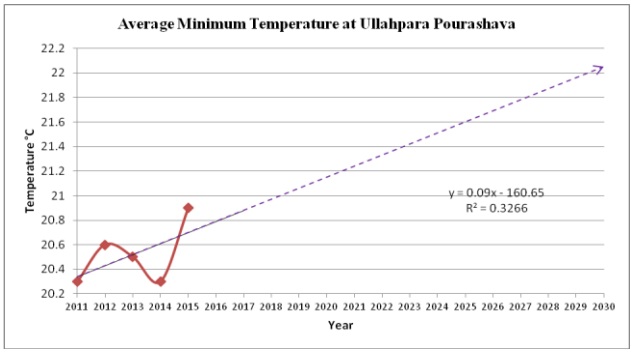


Figure 7a: Trend of Average Maximum Temperature at Ullahpara Pourashava

Figure 7b: Trend of Average Minimum Temperature at Ullahpara Pourashava

Figure 7a shows the temperature in Ullahpara Pourashava, which is rising gradually; projected trend also shows that average maximum temperature is increasing at a rate of 0.06^{0}C/yr. with a low fit $R^2$0.17 . If this trend continues, the temperature will be more than 32^0 C in 2030.

Figure 7b shows average minimum temperature of Ullahpara Pourashava for last five years (2011-2015). Analysis shows an irregular trend of average minimum temperature though there was a significant rise in 2015; similarly, the projection for 2030 showing the increased trend of average minimum temperature in Ullahpara. Projection shows that average minimum temperature in this region will be more than 22^{0}C, which is similar to Naogaon.

It is to be noted that the increase of temperature will alter the water quality and quantity and hence health of the vulnerable population. This is a flood prone area; water supply system often goes under water. Together with changed temperature and flood water logging, Ullahpara become more vulnerable considering health. Diarrheal diseases, skin disease, stomach ache are some major health impacts in the Ullahpara Pourashava. Health system is also vulnerable in Ullahpara due to climatic change.

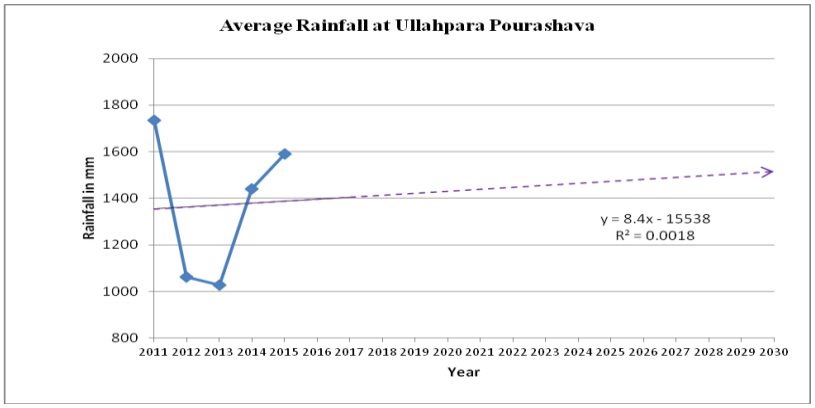


Figure 8: Trend of Total Average Rainfall at Ullahpara Pourashava

Figure 8 shows the total rainfall pattern for the 5 years (2011-2015). There was a significant fall of total rainfall (1000mm) in 2012 and 2013 compare to 2011 (around 1800 mm). However, it was increased in 2014 and 2015 and reaches to 1600 mm. The projected pattern of rainfall in Ullahpara shows a slightly increasing trend. Increasing trend of temperature and rainfall jointly will aggravate more water related diseases such as diarrhea, skin diseases and parasitic infections in this area.

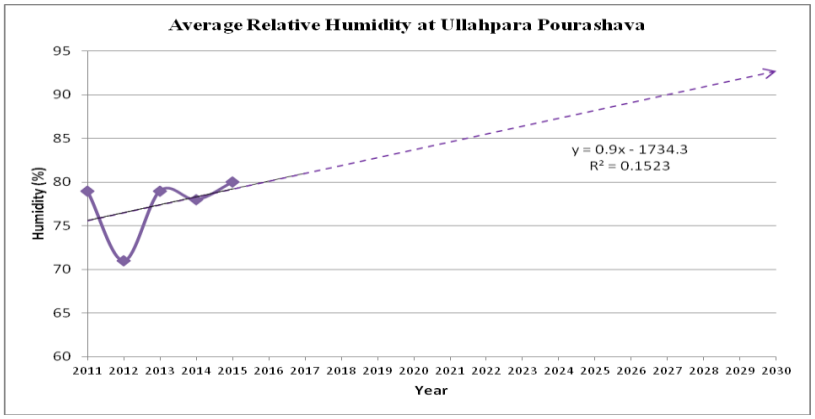


Figure 9: Trend of Average Relative Humidity at Ullahpara Pourashava

Figure 9 shows the relative humidity in Ullahpara for 2011-2015 and also the projection till 2030. The pattern is irregular with ups and downs for last five years though the projection shows an increasing trend. Humidity has an influencing role for growing disease. It has been observed that the annual humidity is one important indicators for some of the vector borne disease such as dengue fever ,and the

incidence of dengue fever for the people living in humid areas could be 30% higher than people living in areas with less humidity.

3.1.4 Birampur Pourashava Water Supply System

Birampur is an Upazila of Dinajpur district in the division of Rangpur, Bangladesh which is located at 25.391479°N 88.992111°E. It has 25,770 households and total area 211.81 km². The average temperature in Birampur is 25.2 °C and highest on average in August, at around 28.9 °C and in January, the average temperature is 17.8 °C. It is the lowest average temperature of the whole year. On the other hand, in a year the average rainfall is 1860 mm; however, in winter, there is much less rainfall than in summer.

The water supply system of Birampur Pourashava under Dinajpur district used groundwater as their source of water. There were two active production tube wells in the system from which water was supplied to the consumers. Total number of connections in the Pourashava was only 191. There was no treatment plant, underground reservoir and overhead tank attached to the water supply system. Ground water was abstracted and directly supplied to the pipeline network without any treatment/disinfection. The flow diagram of the water supply system of Birampur Pourashava is shown below in Figure 10.

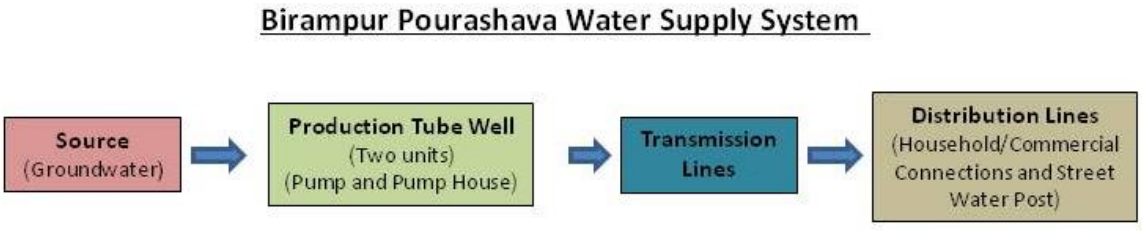
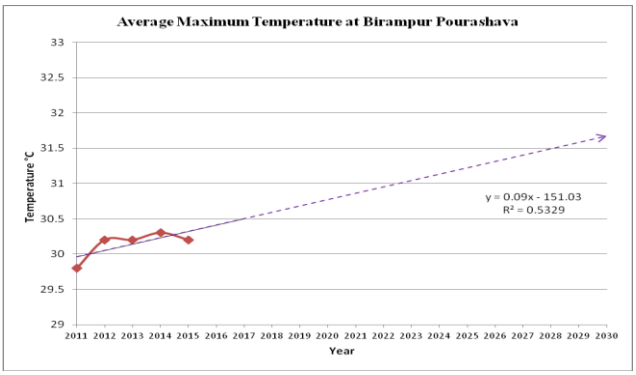


Figure 10: Flow diagram of Birampur Pourashava Water Supply System

Birampur Porashava Climate Change Impact:

In Birampur Pourashava, analyses of few climatic parameters were conducted to identify the potential impact of such changes on water supply system. Climatic variables such as temperature, rainfall and humidity data for five years (2011-2015) were collected and analyzed to find the mean value and also to draw trend lines for these parameters to identify the probable change in future years. The mean average temperature is 30^0C in Birampur. Figure 10a shows the trend line for average maximum temperature, Figure 10b shows the trend line for average minimum temperature, Figure 11 shows the trend line for rainfall and Figure 12 shows the trend line for humidity in Birampur, Dinajpur.



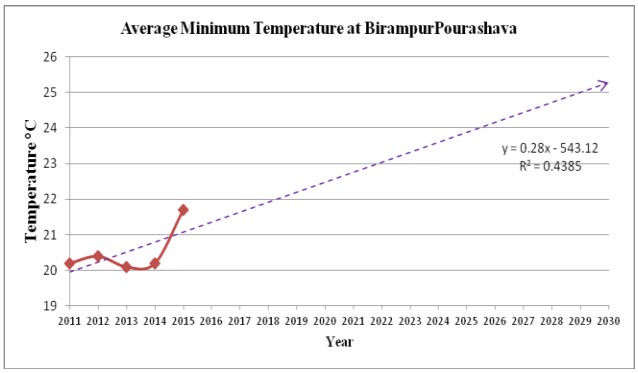


Figure 10a: Trend of Average Maximum Temperature at Birampur Pourashava Figure 10b: Trend of Average Minimum Temperature at Birampur Pourashava

Figure 10a shows the temperature in Birampur Pourashava, which is rising gradually; projected trend also shows that average maximum temperature is increasing at a rate of 0.09^0C/yr. with a low fit R^2 0.53. This trend indicates that by 2030 the temperature will be 31.5^0 C. In contrary, Figure 10b shows average minimum temperature, which varied from 20 to 22^0C during the year 2011 to 2015. However, projection shows increasing trend of average minimum temperature and by 2030, it will be around 25^0C.

It is to be noted that increased temperature will alter the water quality and quantity which will in turn cause health effects of the vulnerable population. Birampur is located in the drought prone area. Ground water level often goes far deeper and pump becomes ineffective. Together with changed temperature and dryness of the area, Birampur become more vulnerable considering health. Water related diseases such as diarrhea, stomach ache, and skin disease are happening more, though malnutrition is causing a big problem in this area.

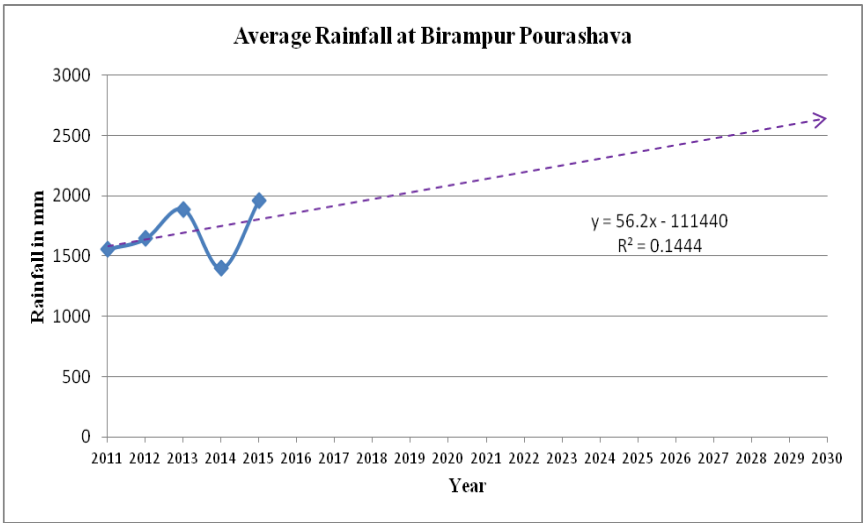


Figure 11: Trend of Average Rainfall at Birampur Pourashava

Figure 11 shows the total rainfall pattern for last five years (2011-2015). Total rainfall varies between 1400 mm to 2000 mm and the future projection shows increasing trend. Projection shows that total rainfall by 2030 would reach more than 2500 mm. Together with increasing trend of temperature and rainfall will aggravate more water related and vector borne diseases such as diarrhea, skin diseases and parasitic infections in this area.

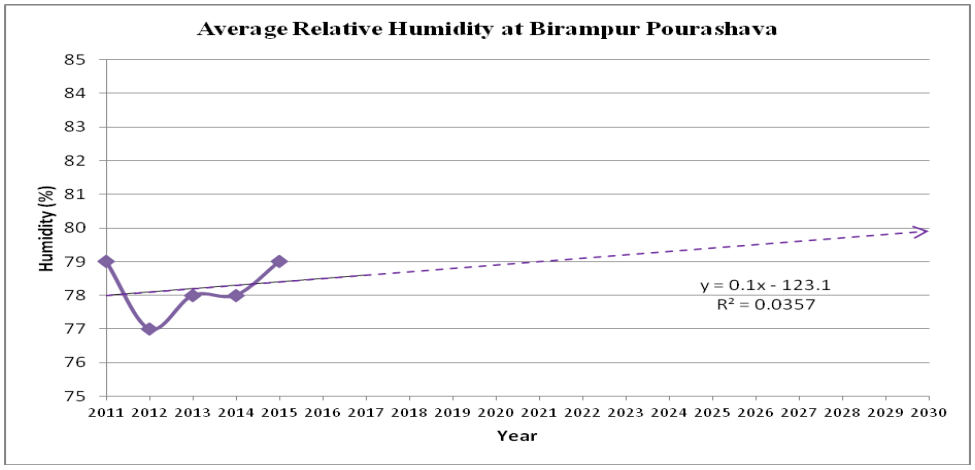


Figure 12: Trend of Average Relative Humidity at Birampur Porashava

Figure 12 shows the relative humidity in Birampur for 2011-2015 and also the projection till 2030. The pattern for last five years shows upward trend though there was a drop in 2012. The projection shows an increasing trend. Humidity has influence on some disease pattern and causation. It has been observed that the annual humidity is also an important indicator for some of the vector borne diseases, such as dengue and malaria.

Chapter 4: KAP Survey Findings and Water Quality Results

4.1 Knowledge, Attitude and Practice (KAP) Survey Results

The baseline survey was conducted to gather information on perception of consumers about supplied water, impact of climate change on water supply and related knowledge, attitude and practice. These included socio-economic status of respondents, safe water use, perception of climate change, water connection, water collection, transportation, storage and preservation, health situation, user satisfaction and water quality status. The numbers of households surveyed in four Pourashavas are given below in Table 1. The findings are provided in the following sub sections.

Table 1: Distribution of surveyed households in different Pourashavas

Sl. No.	Name of Pourashava	Consumer No.	Households Surveyed
1	Naogaon Sadar Pourashava	7,316	90
2	Cox's Bazar Sadar Pourashava	996	63
3	Ullahpara Pourashava	650	50
4	Birampur Pourashava	191	25

4.1.1 General Information

In Naogaon Pourashava, a total of 90 households were surveyed in nine wards. Among the surveyed households, 61% families have five or less number of family members whereas 39% have six to ten family members in their families. In Cox's Bazar Pourashava, a total of 63 households were surveyed in six wards as piped water supply was available in only six out of twelve wards. Among the surveyed households, 12% families have five or less family members, 63% have six to ten family members, and 25% families have more than ten members in their families. In Ullahpara Pourashava, total 50 households were surveyed in five wards as piped water supply was available in only five out of nine wards. Among the surveyed households, 52% families have five or less family members, 44% have six to ten family members, and 4% families have more than ten members.. The distribution of income of surveyed households in Ullahpara showed that monthly income of all surveyed households was below BDT 15,000. In Birampur Pourashava a total 25 households were surveyed in three wards as piped water supply was available in only three of nine wards in the Pourashava. Among the surveyed households, 72% families have five or less family members and 28% have six to ten family members in their families. The distribution of monthly income households in different Pourashavas shown in Table 2 below.

Table 2: Monthly household income distribution of surveyed families in different Pourashavas

Pourashava	Geographic location	Family Income		
		<15,000 BDT	15,000-25,000 BDT	>25,000 BDT
Naogaon Pourashava	Drought Area	54	30	16
Cox's Bazar Pourashava	Coastal Area	47	44	9
Ullahpara Pourashava	Flood Area	100	-	-
Birampur Pourashava	Drought Area	12	36	52

4.1.2 Safe Water Use

The result of respondent's perception/understanding about safe drinking water is presented in Table 2. It can be said from the results that in Naogaon and Birampur Pourashavas, all the respondents think that safe water means the water which does not create any diseases. In Cox's Bazar and Ullahpara Pourashavas, 57% and 88% respondents answered the same respectively. In Cox's Bazar Pourashava, only 9% respondents, and in Ullahpara pourashava, only 12% respondents said that they think supply water is safe. It appears that most of the respondents in all Pourashavas think that water which does not create any disease is safe water, whereas few respondents, especially in Ullahpara and Cox's Bazar Pourashavas think that other characteristics, e.g., odorless, transparent, Arsenic free or supply water is safe water.

The results of respondents response about source that they had been using for drinking water is presented in Table 3. During the survey, it was found that many households use multiple sources of drinking water throughout the year. For example, in Naogaon Pourashava, few families were found using both tube well water and piped water supply for drinking purposes in different periods of the year. They reported that during few months of the year the quality of supply water becomes very poor which makes them choose tube well water for drinking during that period. In Naogaon Pourashava, tube well with platform is the most preferred source of water as 99% respondents use tube well water at least for some part of the year. After that piped water is the second preferred source as 74% respondents use piped water when quality is good. In Cox's Bazar Pourashava, filtered water is the highest preferred option (40%) as quality of piped water and groundwater was not satisfactory to the respondents. In Ullahpara Pourashava, piped water supply is the most preferred option (94%) whereas a few households were found to be using tube well water for drinking purpose. In Birampur Pourashava, a very small portion of the surveyed households (12%) rely on piped water supply as most of them (88%) use tube well water for drinking. It appears from the analysis that piped water use for drinking purpose is high in Naogaon and Ullahpara Pourashavas, but most of the households in Cox's Bazar and Birampur Pourashavas do not rely on piped water.

The respondents were asked whether the water source they had been using for drinking was safe or not, according to their understanding. The results are presented in Table 4. It can be said from the analysis that respondents in Cox's Bazar and Birampur Pourashavas think that there source of water, which is mostly tube well water or filtered water, for drinking is safe. For other two Pourashavas, where piped water supply is used by most of the hosueholds (74% in Naogaon and 94% in Ullahopara), the respondents said that they do not think their drinking water is safe. This also indicates that in all four Pourashavas, piped water supply quality is not considered as "safe" by the respondents; either they were not using it for drinking or people who use it do not think it as a safe source of drinking water.

In Table 5, the answers of the respondents who thought that their drinking water is "unsafe" is summarized. In Naogaon Pourashava where tube well and piped water is mostly used, the respondents said that high Iron content in tube well water and high turbidity in piped water are the main reasons for water being unsafe. In Cox's Bazar Pourashava, high Iron content, polluted piped water and odor in water are the main reasons. In Ullahpara, high Iron content, odor and pollution in piped water supply are the main reasons for unsafe water, according to the respondents. In Birampur Pourashava, all 12 respondents who think their water is unsafe said that high Iron content is the main reason for the poor water quality.

The respondents were asked from where they were collecting the cooking water and the findings are shown in Table 6. Like drinking water source, same household was found using multiple sources during different periods of the year for cooking water. However, except for Birampur Pourashava, use of piped water supply for cooking was high in the Pourashavas. Apart from piped water supply, tube well water was found to be used in high percentage in Naogaon and Birampur Pourashavas.

The respondents were asked about their responsibility to protect their drinking water. The results are shown in Table 7 below. Except for Naogaon Pourashava where only 6% respondents thought that they do not have any responsibility about protecting drinking and cooking water sources, 100% respondents in each of Cox's Bazar, Ullahpara and Birampur Pourashavas responded that they have responsibility to protect the water sources.

Table 3: Perception of "safe water" among the respondents in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondent)					
		Water which does not create disease	Arsenic free water	Clean and odorless water	Supply Water	I do not know what is safe water	None of the above (state)
Naogaon Pourashava	Drought Area	100	-	-	-	-	-
Cox's Bazar Pourashava	Coastal Area	57	22	12	9	-	-
Ullahpara Pourashava	Flood Area	88	-	-	12	-	-
Birampur Pourashava	Drought Area	100	-	-	-	-	-

Table 4: Source of drinking water for the households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of Respondent)											
		Piped water supply	PSF	Pond water	Rain water	Filtered water	Tube well without platform	Tube well with platform	River water	Dug/ring well water	Reverse osmosis water	Arsenic Iron Removal Plant	Other
Naogaon Pourashava	Drought Area	74	1	-	-	13	-	99	-	-	-	-	12
Cox's Bazar Pourashava	Coastal Area	30	-	-	-	40	9	16	2	-	-	-	5
Ullahpara Pourashava	Flood Area	94	-	-	-	-	-	10	-	-	-	-	-
Birampur Pourashava	Drought Area	12	-	-	-	-	-	88	-	-	-	-	-

Table 5: Respondent's perception about the drinking water they had been using in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondent)	
		Yes (Safe)	No (Unsafe)
Naogaon Pourashava	Drought Area	44	56
Cox's Bazar Pourashava	Coastal Area	77	23
Ullahpara Pourashava	Flood Area	43	57
Birampur Pourashava	Drought Area	88	12

Table 6: Reason for drinking water being unsafe in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondent)							
		Pipe water is polluted	Water is turbid	Odor	Small insects in water	Iron	Salinity	Arsenic	Other (state)
Naogaon Pourashava	Drought Area	-	48	1	1	50	-	-	-
Cox's Bazar Pourashava	Coastal Area	20	-	56	-	20	2	-	2
Ullahpara Pourashava	Flood Area	35	29	-	-	46	-	-	-
Birampur Pourashava	Drought Area	-	-	-	-	100	-	-	-

Table 7: Source of cooking water for the households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)					
		Piped water supply	Tube well without platform	Dug/ring well water	Rainwater	Tube well with platform	Other
Naogaon Pourashava	Drought Area	88	-	-	-	98	82
Cox's Bazar Pourashava	Coastal Area	91	-	-	-	7	2
Ullahpara Pourashava	Flood Area	94	-	-	-	6	-
Birampur Pourashava	Drought Area	44	-	-	-	56	-

Table 8: Perception of responsibility of users to protect water used for drinking and cooking in different geographic location

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Have responsibility	Have no responsibility
Naogaon Pourashava	Drought Area	94	6
Cox's Bazar Pourashava	Coastal Area	100	-
Ullahpara Pourashava	Flood Area	100	-
Birampur Pourashava	Drought Area	100	-

Table 9 below summarizes few key findings from this section of the survey. It shows that in Birampur and Naogaon Pourashavas, 100% of the respondents have good knowledge about "safe water," whereas 88% and 57% of respondents in Ullahpara and Cox's Bazar Pourashavas respectively have that knowledge. Therefore, motivation programs for these two Pourashavas will be needed at user level. While answering if the users have any responsibility regarding keeping their water safe, 100% respondents all Pourashavas except Naogaon said that they do have responsibility in this regard, which indicates their good attitude towards water management. It was found from the survey that use of piped water supply for drinking was relatively high in Naogaon and Ullahpara Pourashavas, whereas very low in Cox's Bazar and Birampur Pourashavas which indicate that water supply system needs significant improvement regarding water quality in these two Pourashavas.

Table 9: Knowledge, attitude and practice among the Pourashava water users in different geographic location

Pourashava	Geographic location	Response from Respondents (% of Respondents)				
		Knowledge	Attitude		Practice	
		Respondents know the proper definition of "safe water" (Water which does not create disease)	Respondents who think they have responsibility to keeping water safe		Respondents' family using piped water supply	
			Yes	No	Drinking	Cooking
Naogaon Pourashava	Drought Area	100	94	6	74	88
Cox's Bazar Pourashava	Coastal Area	57	100	-	30	91
Ullahpara Pourashava	Flood Area	88	100	-	94	94
Birampur Pourashava	Drought Area	100	100	-	12	44

4.1.3 Users' Perception of Climate Change

The respondents were asked about their understanding of climate change and what kind of changes in the climate they have been observing. The results are presented in Table 10 and Table 11. The result indicated that 89% of the water users in Naogaon Pourashava, 76% of water users in Cox's Bazar Pourashava, 65% in Ullahpara Pourshava and 76% of respondents in Birampur Pourashava were aware about the climate change. The respondents in coastal area mentioned that they were observing increase of temperature, excessive flood, increase of salinity, water logging and sea level raise; the respondents from drought-prone areas mentioned that they were observing increased temperature, excessive drought and excessive rainfall, and the respondents from flood-prone area mentioned that they were observing increase temperature and water logging problem due to the impact of climate change. All of these changes of climate have significant impact on the water source considering the quality and quantity of water.

The respondents were asked how they think that the climate change has been affecting their drinking water quality and quantity in different seasons of the year. The seasons were divided into summer (March to May), monsoon (June to October) and winter (November to February). The results are summarized in Table 12. The result indicated that most of the respondents in different Pourashavas assumed that water would be less available due to the impact of climate change, especially during the summer period. The water unavailability has also significant impact on the accessibility. But a few respondents mentioned that non-functionality will be increased and accessibility will be reduced. None of the respondent s made any comments on impact of climate change on the water quality.

Table 10: Awareness among the respondents about climate change in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of Respomndents)	
		Have understanding	Have no understanding
Naogaon Pourashava	Drought Area	89	11
Cox's Bazar Pourashava	Coastal Area	76	24
Ullahpara Pourashava	Flood Area	65	35
Birampur Pourashava	Drought Area	76	24

Table 11: Signs of climate change observed by respondents in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of Respondents)											
		Temperature increase	Excessive rainfall	Excessive drought	Temperature decrease	Less rainfall	Excessive flood	Salinity increase	River bank erosion	Water logging	Sea level rise	Increased storms	Others
Naogaon Pourashava	Drought Area	73	90	81	0	1	0	0	0	0	0	0	0
Cox's Bazar Pourashava	Coastal Area	29	0	13	3	6	26	26	0	13	13	0	0
Ullahpara Pourashava	Flood Area	52	16	2	0	2	2	0	0	4	0	2	0
Birampur Pourashava	Drought Area	76	64	64	4	8	0	0	0	0	0	0	0

Table 12: Impact of climate change in different seasons on drinking water in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of Respondents)																	
		Technologies becoming non functional more frequently			Collecting water form long distance			Water supply could not meet the demand			Water quality deterioration			No impact			Others		
		Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter
Naogaon Pourashava	Drought Area	-	-	-	-	-	-	97	-	-	-	-	-	-	-	-	-	-	-
Cox's Bazar Pourashava	Coastal Area	-	2	-	9	-	-	30	-	-	-	-	-	-	-	-	-	-	-
Ullahpara Pourashava	Flood Area	-	-	-	-	-	-	64	-	-	-	-	-	-	-	-	-	-	-
Birampur Pourashava	Drought Area	-	-	-	-	-	-	76	4	4	-	-	-	-	-	-	-	-	-

4.1.4 Information about Water Connection

The respondents were asked about the type of their water connections, cleaning frequency of underground reservoir and overhead tank, and process they follow to clean the reservoirs/tanks. The analysis results are presented in Table 13 to Table 17.The details of type of household connection is presented in Table 13. The table 13 indicated that there were different types of household connection existed in different Pourashavas. In Naogaon Pourashava, maximum number of respondent's (36%) household connection were connected to the pipeline through stand post with platform inside home and directly connected to the over head tank. Majority of the surveyed household's (65%) connection of Cox's Bazar Pourashava was directly connected to the overhead tank whereas in Ullahpara Pourashava, majority of household's connection (68%) was through underground reservoir. More than 90% of the respondent's household connection was through overhead tank in Birampur Pourashava.

One of the most important issues to keep the water safe is the frequency and process of cleaning of the reservoirs because if the reservoir is cleaned properly at a regular interval then the water quality related hazards will be reduced. Table 14 shows the frequency of cleaning underground reservoirs. From the analysis it can be said that users in Naogaon Pourashava do not follow any definite schedule for cleaning their reservoirs which could be dangerous for the water quality. In other three Pourashavas, high percentage of the hosueholds (70% or above) were found cleaning their reservoirs within 6 months.

Table 15 shows how the underground reservoirs were cleaned in the households in the Pourashavas. It appears that except in Naogaon Pourashava, majority of households (above 75%) in other three Pourashavas were using bleaching powder, powdered soap or at least brushes for cleaning their reservoirs. In Naogaon Pourashava, only water was found to be used by all the surveyed households.

Table 16 shows the frequency of cleaning overhead tanks in households. From the analysis it can be said that majority of the users in Naogaon Pourashava do not follow any definite schedule for cleaning their overhead tanks which could be dangerous for the water quality. In other three Pourashavas, high percentage of the households (70% or above) were found cleaning their reservoirs within 6 months.

Table 17 shows how the overhead tanks were cleaned in the households in the Pourashavas. It appears all the households in the Pourashavas were using bleaching powder, powdered soap or at least brushes for cleaning their reservoirs.
Table 18 above summarizes the findings from this section. It appears from the analysis that users in Naogaon Pourashava needs motivation regarding proper cleaning and maintenance of their reservoirs tanks. The users of Birampur Pourashava found to have better knowledge and practice regarding cleaning of their water reservoirs.

Table 13: Type of connection used in the households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)				
		Connected to underground reservoir	Connected directly to over head tank	Connected to stand post without platform inside house	Connected to stand post with platform inside home	Others
Naogaon Pourashava	Drought Area	6	34	10	36	14
Cox's Bazar Pourashava	Coastal Area	30	65	2	-	2
Ullahpara Pourashava	Flood Area	68	28	2	2	-
Birampur Pourashava	Drought Area	-	92	-	8	-

Table 14: Cleaning frequency of underground reservoirs by households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)						
		Every month	Every 3 month	Every 6 month	Every year	Every 2 year	Irregular	Never
Naogaon Pourashava	Drought Area	-	-	-	1	-	99	-
Cox's Bazar Pourashava	Coastal Area	40	30	-	-	5	25	-
Ullahpara Pourashava	Flood Area	62	16	6	2	-	12	2
Birampur Pourashava	Drought Area	12	56	32	-	-	-	-

Table 15: Cleaning process of underground reservoirs by households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)				
		Brushing and cleaning with water	Cleaning with powdered soap and water	Bleaching powder/chemicals and water	Only water	Other
Naogaon Pourashava	Drought Area	-	-	-	100	-
Cox's Bazar Pourashava	Coastal Area	49	21	7	23	-
Ullahpara Pourashava	Flood Area	88	2	-	10	-
Birampur Pourashava	Drought Area	16	80	-	4	-

Table 16: Frequency of cleaning overhead tanks by households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)						
		Every month	Every 3 month	Every 6 month	Every year	Every 2 year	Irregular	Never
Naogaon Pourashava	Drought Area	-	-	11	19	-	70	-
Cox's Bazar Pourashava	Coastal Area	40	47	-	2	-	11	-
Ullahpara Pourashava	Flood Area	56	26	6	-	-	12	-
Birampur Pourashava	Drought Area	8	60	28	-	-	4	-

Table 17: Cleaning process of overhead tanks by households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)				
		Brushing and cleaning with water	Cleaning with powdered soap and water	Bleaching powder/chemicals and water	Only water	Other
Naogaon Pourashava	Drought Area	46	23	31	-	-
Cox's Bazar Pourashava	Coastal Area	60	29	11	-	-
Ullahpara Pourashava	Flood Area	95	5	-	-	-
Birampur Pourashava	Drought Area	12	88	-	-	-

Table 18: Summary of underground reservoir/overhead tank cleaning frequency and process

Pourashava	Geographic location	Percentage of respondents whose underground reservoir cleaning frequency was less than 6 months	Percentage of respondents whose underground reservoir cleaning process used bleaching powder/ powder soap/cleaning brush	Percentage of respondents whose overhead tank cleaning frequency was less than 6 months	Percentage of respondents whose overhead tank cleaning process used bleaching powder/ powder soap/cleaning brush
Naogaon Pourashava	Drought Area	-	-	30	100
Cox's Bazar Pourashava	Coastal Area	70	77	87	100

Pourashava	Geographic location	Percentage of respondents whose underground reservoir cleaning frequency was less than 6 months	Percentage of respondents whose underground reservoir cleaning process used bleaching powder/ powder soap/cleaning brush	Percentage of respondents whose overhead tank cleaning frequency was less than 6 months	Percentage of respondents whose overhead tank cleaning process used bleaching powder/ powder soap/cleaning brush
Ullahpara Pourashava	Flood Area	84	90	88	100
Birampur Pourashava	Drought Area	100	86	96	100

4.1.5 Information about Water Collection

The respondents were asked about their water collection process which included cleaning of collection pot before taking water, what material used for cleaning and what type of water was used for cleaning. The results are provided in Table 19 to Table 22. Table 19 shows that 100% users in Naogaon and Ullahpara Pourashavas clean their water collection pot before collecting water whereas this percentage is comparatively low in Cox's Bazar Pourashava (78%). 96% users in Birampur Pourashava also follow good practice of cleaning the water collection pot before collecting water.

Table 20 shows how the users cleaned their water collection pots before collection of water. The analysis shows that majority of users only use water to clean their water collection pots. Only in Birampur Pourashava, more than half of the users were found using powdered soap for cleaning their water collection pots.

Table 21 shows water from which source was used for cleaning of the water collections pots before collection of water from the source. The analysis shows that majority of users use water from the same source where water was collected, though the percentage is comparatively lower for Cox's Bazar Pourashava (77%). Table 22 summarizes the findings from this section about the practice of users while collection of water from source using the water collection pots.

Table 19: Practice of cleaning pot before water collection in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)		
		Every time while collecting water	Not every time, but occasionally	Not needed to clean every time
Naogaon Pourashava	Drought Area	100	-	-
Cox's Bazar Pourashava	Coastal Area	78	20	2
Ullahpara Pourashava	Flood Area	100	-	-
Birampur Pourashava	Drought Area	96	4	-

Table 20: Type of material used for cleaning of water collection pot in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)			
		Only water	Powdered soap or detergent	Ash	Other
Naogaon Pourashava	Drought Area	69	31	-	-
Cox's Bazar Pourashava	Coastal Area	60	40	-	-
Ullahpara Pourashava	Flood Area	79	17	4	-
Birampur Pourashava	Drought Area	48	52	-	-

Table 21: Type of water used for cleaning of water collection pot in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Water from the same source from where water is collected	Water from other source at home
Naogaon Pourashava	Drought Area	96	4
Cox's Bazar Pourashava	Coastal Area	77	23
Ullahpara Pourashava	Flood Area	100	0
Birampur Pourashava	Drought Area	96	4

Table 22: Summary of water collection practice from source in different Pourashava

Pourashava	Geographic location	Response from Respondents (% of respondents)		
		Pot was cleaned each time before collecting water	Powdered soap or detergent or ash was used for cleaning	Water from the same source from where water is collected was used for cleaning
Naogaon Pourashava	Drought Area	100	100	96
Cox's Bazar Pourashava	Coastal Area	78	100	77
Ullahpara Pourashava	Flood Area	100	96	100
Birampur Pourashava	Drought Area	96	100	96

4.1.6 Information about Water Transportation

The respondents were asked about their water transportation practices which include how they cover the collection pots and what type of cover is used during transportation. The results are presented in Table 23 and Table 24. Table 23 shows that percentage of users cover their water collection pots during transportation is very low in Naogaon Pourashava, whereas in Ullahpara 100% of the users were found covering their water collection pots during transportation of water after collection. Table 24 shows what type of cover was used while transportation of water from source. The analysis shows that in Naogaon and Birampur Pourashavas, 100% users who cover their water collection pots use either plastic cover or plate/gamla. 96% users in Birampur also use either of these two options for covering the pots. But only 74% users in Cox's Bazar were found using either plastic cover/gamla, whereas 21% used cloth which is not a good practice. The best practices in different Pourashavas for water transportation are summarized in Table 25.

Table 23: Percentage of users who cover water collection pots during transportation in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Cover the pot while transporting	Do not cover the pot while transporting
Naogaon Pourashava	Drought Area	57	43
Cox's Bazar Pourashava	Coastal Area	79	21
Ullahpara Pourashava	Flood Area	100	0
Birampur Pourashava	Drought Area	88	12

Table 24: Materials used to cover the pots during water transportation in households in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)				
		Plastic cover (no hole)	Gamla/cover plate	Cloth	Paper/hard board	Others
Naogaon Pourashava	Drought Area	10	90	-	-	-
Cox's Bazar Pourashava	Coastal Area	3	71	21	-	6
Ullahpara Pourashava	Flood Area	20	76	-	-	4
Birampur Pourashava	Drought Area	9	91	-	-	-

Table 25: Summary of water collection from source in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Cover the water collection pot during transportation	Plastic/metal plate (no hole) or gamla used to cover the container
Naogaon Pourashava	Drought Area	57	100
Cox's Bazar Pourashava	Coastal Area	79	74
Ullahpara Pourashava	Flood Area	100	96
Birampur Pourashava	Drought Area	88	100

4.1.7 Information about Water Storage/Preservation

The respondents were asked about their water storage practices, how they covered the water container during storage and the type of cover they used. The results are illustrated in Table 26 to Table 28. From the analysis presented in Table 26, it can be said that plastic jug/bucket is the preferred option for storing water in households in the Pourashavas. In Ullahpara Pourashava, 44% respondents said that they do not need to store water. Table 27 shows the percentage of users who covered their containers used for storing water in houses. In Ullahpara and Birampur Pourashavas, 100% of users cover the containers used for storing water, whereas in Cox's Bazar and Naogaon the percentage is 95% and 77% respectively.

Table 28 shows type of cover used while storing water in households. The analysis show that in Naogaon, Ullahpara and Birampur Pourashavas, 100% users who cover their pots used for storing water

use either plastic cover or plate/gamla. But only 81% users in Cox's Bazar were found using either plastic cover/gamla, whereas 21% used cloth which is not a good practice. The best practices in different Pourashavas for water transportation is summarized in Table 29.

Table 26: Water preservation system practiced by the respondents in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)					
		No storage	Stored in plastic jug/bucket	Stored in earthen pitcher	Stored in aluminum jar	Stored in glass pot/jar	Others
Naogaon Pourashava	Drought Area	4	96	-	-	-	-
Cox's Bazar Pourashava	Coastal Area	12	50	12	26	-	-
Ullahpara Pourashava	Flood Area	44	50	-	-	-	6
Birampur Pourashava	Drought Area	4	57	-	31	-	-

Table 27: Percentage of households in different Pourashavas who cover the water preservation container

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Cover	Do not cover
Naogaon Pourashava	Drought Area	77	23
Cox's Bazar Pourashava	Coastal Area	95	5
Ullahpara Pourashava	Flood Area	100	-
Birampur Pourashava	Drought Area	100	-

Table 28: Materials used to cover the containers used for storage of water in households in different Pourashava

Pourashava	Geographic location	Response from Respondents (% of respondents)				
		Plastic cover (no hole)	Gamla/cover plate	Cloth	Paper/hardboard	Others
Naogaon Pourashava	Drought Area	3	97	-	-	-
Cox's Bazar Pourashava	Coastal Area	-	81	19	-	-
Ullahpara Pourashava	Flood Area	19	81	-	-	-
Birampur Pourashava	Drought Area	4	96	-	-	-

Table 29: Summary of water storage practices in households from source in different Pourashava

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Cover the water storage pot	Plastic/metal plate (no hole) or gamla used to cover the container
Naogaon Pourashava	Drought Area	77	100
Cox's Bazar Pourashava	Coastal Area	95	81
Ullahpara Pourashava	Flood Area	100	100
Birampur Pourashava	Drought Area	100	100

4.1.8 Health Situation

The respondents were asked about different water related/borne/washed diseases in last week and last year. The respondent's response is presented in Table 30 and Table 31. From the results shown in Table 30, it can be said that number of water-borne diseases in last week prior to this survey was highest in Naogaon Pourashava among the four Pourashavas, and lowest jointly in Cox's Bazar and Ullahpara Pourashavas. In Naogaon Pourashava, incidents of diarrhea and dysentery were found more prevalent than other diseases. Table 31 shows the number of incidents of water-borne diseases in the Pourashavas since June, 2015 from where it was again found that prevalence of water-borne diseases was highest in Naogaon Pourashava. One of the major limitations during collection of number of incidences of water-borne diseases since June, 2015, was respondent's inability to recall past incidents.

Table 32 shows the most affected age group in the Pourashavas according to the respondents. The table shows that in Naogaon Pourashava, children below 5 years are the most vulnerable to water-borne diseases. In other Pourashavas it was found that people of all age group were more or less affected.

Table 33 shows perception of users about the reason for the above mentioned diseases. In Ullahpara Pourashava, 100% of the respondents answered that the above mentioned diseases are water-borne. This percentage is lower in Naogaon (64%) and Cox's Bazar (67%) pourashavas, and lowest among all Pourashavas in Birampur Pourashava (37%). Table 34 shows what percentage of the respondents think that their water supply system is the main reason behind the prevalence of water-borne diseases. The table shows that in Ullahpara Pourashava, 100% of the respondents agreed that the ir water supply system is responsible for the water-borne diseases. This percentage is lower in Naogaon (63%) and Cox's Bazar (71%) pourashavas, and lowest among all Pourashavas in Birampur Pourashava (43%).

Table 30: Number of people affected in four Pourashavas by water-borne diseases in last week

Pourashava	Geographic location	Answer Options [number of affected people (total number of people surveyed)]									Total Episode
		Diarrhea	Dysentery	Typhoid	Jaundice	Skin Disease	Worm	Arsenicosis	Cholera	Other water-borne disease	
Naogaon Pourashava	Drought Area	8 (849)	5 (849)	-	-	-	1 (849)	-	-	-	14
Cox's Bazar Pourashava	Coastal Area	1 (564)	-	-	-	1 (564)	-	-	-	-	2
Ullahpara Pourashava	Flood Area	-	1 (278)	-	-	1 (278)	-	-	-	-	2
Birampur Pourashava	Drought Area	2 (107)	4 (107)	-	-	-	-	-	-	-	6

Table 31: Number of people affected in four Pourashavas by water-borne diseases since June, 2015

Pourashava	Geographic location	Answer Options [number of affected people (total number of people surveyed)]									Total Episode
		Diarrhea	Dysentery	Typhoid	Jaundice	Skin Disease	Worm	Arsenicosis	Cholera	Other water-borne disease	
Naogaon Pourashava	Drought Area	11 (849)	7 (849)	-	-	-	1 (849)	-	-	-	19
Cox's Bazar Pourashava	Coastal Area	1 (564)	1 (564)	-	-	6 (564)	-	-	-	3 (564)	11
Ullahpara Pourashava	Flood Area	1 (278)	1 (278)	-	-	1 (278)	-	-	-	-	3
Birampur Pourashava	Drought Area	5 (107)	7 (107)	-	-	1 (107)	-	-	-	-	12

Table 32: Age group most affected by water-borne diseases in four Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)			
		Children below 5 years	5-12 years old children	Male over 12 years	Female over 12 years
Naogaon Pourashava	Drought Area	85	-	10	5
Cox's Bazar Pourashava	Coastal Area	20	20	35	25
Ullahpara Pourashava	Flood Area	-	50	50	-
Birampur Pourashava	Drought Area	29	14	29	29

Table 33: Perception of respondents about water-borne disease in four Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Yes (diseases were water-borne)	No (diseases were not water-borne)
Naogaon Pourashava	Drought Area	64	36
Cox's Bazar Pourashava	Coastal Area	67	33
Ullahpara Pourashava	Flood Area	100	-
Birampur Pourashava	Drought Area	37	63

Table 34: Perception of respondents about relation between water-borne disease and water supply systems

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Main reason of water-borne diseases **is** water supply system	Main reason of water-borne diseases **is not** water supply system
Naogaon Pourashava	Drought Area	63	38
Cox's Bazar Pourashava	Coastal Area	71	29
Ullahpara Pourashava	Flood Area	100	-
Birampur Pourashava	Drought Area	43	57

The information related to total expenditure for treatment of water-borne diseases for the households in a year was collected from all four Pourashavas. The results are shown in Table 35 below. In Naogaon Pourashava, majority of the affected families (74%) had to spend less than BDT 5,000 for treatment of water-borne diseases in last year. In other Pourashavas, majority of the affected families had to spend BDT 5,000 to 10,000 in last year for treatment purpose.

Table 35: Expenditure for treatment of water-borne diseases in different Pourashavas

Pourashava	Geographic location	Yearly Expense for Treatment of Water-borne Diseases by Percentage of Affected Families		
		≤5,000 BDT	5,000-10,000 BDT	>10,000 BDT
Naogaon Pourashava	Drought Area	74	24	2
Cox's Bazar Pourashava	Coastal Area	37	60	3
Ullahpara Pourashava	Flood Area	6	94	-
Birampur Pourashava	Drought Area	4	88	8

4.1.9 User Satisfaction

A very few percentage of Pourashava dweller's were satisfied with water supply in the different Pourashava (Table 36). The respondent's survey indicated that in only 35% of the Naogaon Pourashava dwellers, 19% of the Cox's Bazar Pourashava Dwellers, 32% of Ullahpara Pourashava dwellers and 20% of Birampur Pourashava dwellers were satisfied with water supply. The reasons for the dissatisfaction were due to un-availability and bad quality of water which is shown in Table 37. The survey also indicated that 100% of the Birampur Pourashava dwellers were aware about the complaint system followed by 92% in Ullahpara Pourashava, 75% in Naogaon Pourashava and only 34% dwellers of the Cox's Bazar Pourashava were aware about the complaint system. The details are presented in Table 38. The water consumer's awareness about the water safety plan varied considering the Pourashava. The results indicated that highest percentage of respondents were aware the water safety plan in Birampur Pourashava dwellers followed by Naogaon Pourashava. The details are presented in Table 39.

Table 36: Percentage of users in each Pourashava satisfied with their water supply system

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Satisfied	Not Satisfied
Naogaon Pourashava	Drought Area	35	65
Cox's Bazar Pourashava	Coastal Area	19	81
Ullahpara Pourashava	Flood Area	32	68
Birampur Pourashava	Drought Area	20	80

Table 37: Reason of dissatisfaction about the water supply system in Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)		
		Quantity	Quality	Both
Naogaon Pourashava	Drought Area	1	-	99
Cox's Bazar Pourashava	Coastal Area	12	74	14
Ullahpara Pourashava	Flood Area	36	21	43
Birampur Pourashava	Drought Area	5	95	-

Table 38: Percentage of users aware of the complaint record system of Water Supply Section

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Know about complaint system,	Do not know about complaint system
Naogaon Pourashava	Drought Area	75	25
Cox's Bazar Pourashava	Coastal Area	34	66
Ullahpara Pourashava	Flood Area	92	8
Birampur Pourashava	Drought Area	100	-

Table 39: Consumers' awareness about Water Safety Plan in four Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)	
		Aware	Not Aware
Naogaon Pourashava	Drought Area	49	51
Cox's Bazar Pourashava	Coastal Area	37	63
Ullahpara Pourashava	Flood Area	40	60
Birampur Pourashava	Drought Area	84	16

Table 40 summarizes the user satisfaction about water supply system, and their awareness about the complaint system and WSP. It can be said from the analysis that in none of the Pourashavas over 35% of users were satisfied about their water supply system. In Birampur Pourashava, majority of users were aware about the complaint system and WSP. In other three Pourashavas, awareness about WSP was below 50%. Awareness about complaint system was found relatively higher in Ullahpara and Naogaon Pourashavas, but low in Cox's Bazar Pourashava.

Table 40: Summary of user satisfaction and awareness in different Pourashavas

Pourashava	Geographic location	Response from Respondents (% of respondents)		
		User satisfaction Reasons for dissatisfaction	Aware about complaint system	Aware about WSP
Naogaon Pourashava	Drought Area	35	75	49
Cox's Bazar Pourashava	Coastal Area	19	34	37
Ullahpara Pourashava	Flood Area	32	92	40
Birampur Pourashava	Drought Area	20	100	84

4.1.10 Water Quality Test

In Naogaon Pourashava, eight samples were collected from eight active production tube wells. From the results presented in Table 41, it is evident that risk for Arsenic (As) and Manganese (Mn) concentration is low, whereas the Iron (Fe) concentration was found high in most of the tube wells. The microbial risk was found "low" in five tube wells and "intermediate" in three tube wells. The Electrical Conductivity shows that salinity is not a problem in this region as far as drinking water is concerned. Table 42 shows the water quality test results for samples collected from the user points in different wards. The results show that E. Coli contamination in supplied water to consumers is concerning as most of the samples tested were found having significant E. Coli concentration in Naogaon Pourashava.

Table 41: Water quality test reports for samples collected from production tube wells in Naogaon Pourashava

Pourashava	Geographic Location	Sl. No.	Ward No	Pump House No.	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Electrical Conductivity (µs/cm)	As (mg/l)	Fe (mg/l)	Mn (mg/l)	Chemical Risk (based on As concentration)
Naogaon	Drought	1	2	6	26	high	639	0.005	1.7	0.125	low
		2	1	3	15	high	458	<MDL	0.5	0.054	low
		3	2	13	0	low	446	0.002	2.5	0.114	low
		4	2	11	0	low	527	0.002	2	0.116	low
		5	5	8	0	low	630	0.002	3.6	0.236	low
		6	5	9	0	low	423	0.005	3.6	0.125	low
		7	8	12	57	high	957	0.004	3	0.17	low
		8	9	14	0	low	743	0.003	2	0.176	low

Table 42: Water quality test results for samples collected from user points in Naogaon Pourashava

Pourashava	Geograp-hic location	Sl. No.	Ward No	Name of the User	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Conductivity (µs/cm)
Naogaon	Drought	1	1	Streed Stand Post (Water Development Board)	207	very high	477
		2	1	Dr Sayeb Uddin	20	high	482
		3	1	Public Health Office	81	high	510
		4	2	Babul Mia	5	intermediate	449
		5	2	Street Stand Post (Chokram Chandra)	3	intermediate	448
		6	2	Street Stand Post (Chak Moktar)	69	high	522
		7	3	Street Stand Post (Mastar Para)	120	very high	634
		8	3	Md. Azizul Islam	188	very high	634
		9	3	Street Stand Post (Chokdeb West Para)	137	very high	635
		10	4	Afzal Hossain	98	high	781
		11	4	Street Stand Post (Arji Naogaon Mridha Para)	21	high	530
		12	4	Jhorna Villa	12	high	445
		13	5	Street Stand Post (South Karitola Bottola)	0	low	419
		14	5	Shib Kumar	2	intermediate	424
		15	5	Street Stand Post (Doptari Para)	1	intermediate	422
		16	5	Md Mukul	13	high	517
		17	6	Street Stand Post (Sahanabagh)	13	high	483
		18	6	Shamsunnahar	5	intermediate	503

Pourashava	Geograp-hic location	Sl. No.	Ward No	Name of the User	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Conductivity (µs/cm)
		19	8	Md Anwar Hossain	77	high	946
		20	8	Street Stand Post (Sultanpur)	42	high	953
		21	8	Torikul Islam	230	very high	963
		22	9	Abul Kashem Akond	32	high	740
		23	9	Abdul Malek	27	high	730
		24	9	Mahbubur Rahman	2	intermediate	735
		25	7	Street Stand Post (Old Regitrar Office)	63	high	442
		26	7	Street Stand Post (Fatehpur)	52	high	946
		27	7	Nuyen Chandra Das	23	high	929
		28	7	Nuyen Chandra Das (DUB)	25	high	929

In Cox's Bazar Pourashava, seven samples were collected from seven production tube wells. From the results presented in Table 43, it is evident that risk for As, Fe and Mn concentration is low in this Pourashava. The microbial risk was found "low" in five tube wells and "intermediate" in two tube wells. The Electrical Conductivity shows that salinity is high in two tube wells where concentration is above 1,000 µs/cm, in ward number 9. Since this Pourashava is located in coastal region, it was expected that the salinity level would be higher in ground water. Table 44 shows the water quality test results for samples collected from the user points in different wards. The results show that E. Coli contamination in supplied water to consumers is concerning as more than half of the samples tested were found having significant E. Coli concentration in the Pourashava.

Table 43: Water quality test reports for samples collected from production tube wells in Cox's Bazar Pourashava

Pourashava	Geographic Location	Sl. No.	Ward No	Pump House No.	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Electrical Conductivity (µs/cm)	As (mg/l)	Fe (mg/l)	Mn (mg/l)	Chemical Risk (based on As concentration)
Cox's Bazar	Coastal	1	11	4	0	low	387	<MDL	0.15	<MDL	low
		2	10	5 (new)	0	low	507	<MDL	0.35	<MDL	low
		3	10	5 (old)	0	low	744	0.014	0.1	<MDL	low
		4	10	6	0	low	863	0.002	0.3	<MDL	low
		5	9	3	0	low	1214	0.004	0.15	<MDL	low
		6	10	8	7	intermediate	672	0.022	0.3	<MDL	low
		7	9	2	7	intermediate	1080	<MDL	0.3	<MDL	low

Table 44: Water quality test results for samples collected from user points in Cox's Bazar Pourashava

Pourashava	Geographic Location	Sl. No.	Ward No	Name of the User	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Conductivity (µs/cm)
Cox's Bazar	Coastal	1	11	Dist Food Office	3	intermediate	387
		2	11	Saikat Bagan Bari	0	low	384
		3	11	Adv. Habibur Rahman	240	very high	381
		4	10	Saidul Haq Azad	0	low	387
		5	10	Prof. G M Shafi	0	low	388
		6	10	President, Dist Press Club	0	low	389
		7	3	Shahpir Residential Hotem	0	low	248
		8	3	Gulshan Ara Begum	480	very high	391
		9	3	Adv. Md Bokhtiar	320	very high	268
		10	8	Bakhtiar Kamal Chwd	49	high	
		11	8	Machang	52	high	
		12	8	Ongchola	520	very high	196
		13	9	Onubroto Dhar	4	intermediate	
		14	9	General Hospital	3	intermediate	
		15	9	Dulal Das	0	low	
		16	9	Dulal Das (DUB)	0	low	

In Ullahpara Pourashava, three samples were collected from the production tube well, and treatment plant; one sample from the production tube well before filtration, one after filtration in the treatment plant and one from the reservoir used to store treated water. From the results presented in Table 45, it is evident that risk for As is low in this Pourashava, but the Fe concentration is very high for which the Iron Removal Plant was needed. The concentration of Fe in samples after treatment show that treatment plant is reducing the Fe concentration from ground water before supplying. The Mn concentration was found relatively higher in this Pourashava. The microbial risk was found "low" in tube well water. The Electrical Conductivity shows that salinity is not a major problem in this area. Table 46 shows the water quality test results for 18 samples collected from the user points in different wards. The results show that E. Coli contamination in supplied water to consumers is concerning as ten out of 18 samples tested were found having significant E. Coli concentration in the Pourashava.

Table 45: Water quality test reports for samples collected from production tube wells in Ullahpara Pourashava

Pourashava	Geograph -ic Location	Sl. No.	Ward No	Pump House No.	E Coli/ 100 ml	Microbiol Risk (based on E Coli concentrati on)	Electrical Conducti vity (µs/cm)	As (mg/l)	Fe (mg/l)	Mn (mg/l)	Chemical Risk (based on As concentrati on)
Ullahpara	Flood	1	5	1	0	low	727	0.013	21	0.77	low
		2	5	Filter (Treatment Plant)	0	low	673	0.006	1.05	0.099	low
		3	5	Reservoir (After Treatment)	0	low	683	0.005	1.2	0.123	low

Table 46: Water quality test results for samples collected from user points in Ullahpara Pourashava

Pourashava	Geographic Location	Sl. No.	Ward No	Name of the User	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Conductivity (µs/cm)
Ullahpara	Flood	1	5	Filter water (Near Pourashava)	0	low	673
		2	5	Reservoir (Near Pourashava)	0	low	683
		3	5	Bolram Chandra Das	0	low	674
		4	5	Noor e Alama Siddiki	1	intermediate	683
		5	5	Nitu Pal	1	intermediate	638
		6	3	Street Stand Post (Kuthi Bazar)	0	low	667
		7	3	Street Stand Post (Shyamoli Para)	0	low	664
		8	3	Abdul Wahab Agabi	1	intermediate	676
		9	6	Abdul Hai	0	low	677
		10	6	Md Mafuf Hossain	1	intermediate	663
		11	6	Md Abu Said	0	low	677
		12	2	Bikash Chandra Saha	28	high	668
		13	2	Md Zahidul Islam	56	high	665
		14	2	Golam Hossain	17	high	671
		15	4	Mst Arifa Khatun	0	low	674
		16	4	Adv. Marup Bin Halim	3	intermediate	660
		17	4	Ullahpara Govt Primary School	1	intermediate	678
		18	4	Ullahpara Govt Primary School (DUB)	1	intermediate	678

In Birampur Pourashava, two samples were collected from the two active production tube wells. From the results presented in Table 47, it is evident that risk for Arsenic (As) and Manganese (Mn) concentration is low, whereas the Iron (Fe) concentration was found high in the tube wells. The microbial risk was found "low" in both the sampled from production tube wells. The Electrical Conductivity shows that salinity is not a problem in this region as far as drinking water is concerned. Table 48 shows the water quality test results for nine samples collected from the user points in different wards. The results show that E. Coli contamination in supplied water to consumers is concerning as most of the samples tested were found having significant E. Coli concentration in this Pourashava.

Table 47: Water quality test reports for samples collected from production tube wells in Birampur Pourashava

Pourashava	Geographic Location	Sl. No.	Ward No	Pump House No.	E Coli/ 100 ml	Microbial Risk (based on E Coli concentration)	Electrical Conductivity (ms/cm)	As (mg/l)	Fe (mg/l)	Mn (mg/l)	Chemical Risk (based on As concentration)
Birampur	Drought	1	3	2	1	intermediate	135	<MDL	5	0.357	low
		2	4	1	0	low	165	0.002	4	0.293	low

Table 48: Water quality test results for samples collected from user points in Birampur Pourashava

Pourashava	Geographic Location	Sl. No.	Ward No	Name of the User	E Coli/ 100 ml	Microbiol Risk (based on E Coli concentration)	Conductivity (ms/cm)
Birampur	Drought	1	3	Saleha Begum	5	intermediate	129
		2	3	Abdul Mazid Chowdhury	278	Very high	128
		3	3	Md. Sajid Ahmed	5	intermediate	125
		4	4	Md. Khademul Islam	2	intermediate	163
		5	4	Md. Mukul Hossain	0	low	163
		6	4	Ashrafuzzaman	1	intermediate	159
		7	5	Md. Shahidul Islam	3	intermediate	157
		8	5	Umesh Kundu	2	intermediate	163
		9	5	Md. Manik	7	intermediate	160

Chapter-5: Conclusion and Recommendation

As one of the major activities under the assignment titled "Identification of the Impact of Climate Variability and Environmental Hazards in Water Supply System," the baseline study was carried out in Naogaon Sadar, Cox's Bazar Sadar, Ullahpara and Birampur Pourashavas. The major objectives of the baseline study were to understand the existing water supply systems in four Pourashavas and impact of climate change on these water supply systems, and to understand the knowledge level, attitude and practice of the consumers of piped water supply systems in four Pourashavas through KAP survey.

From the analysis of water supply systems and few climatic parameters of the area of each water supply system it was found that temperature, rainfall and to some extent together other variables humidity is impacting the existing water supply systems, which lead to health effects. According to participants of the workshop and survey it is found that all Pourashavas are experiencing more diarrheal and dysentery cases though a small number are facing the stomach ache problem. Trend of the temperature, rainfall indicates more vector borne diseases in those areas.

From the survey results regarding safe water, it was found that in Birampur and Naogaon Pourashavas, 100% of the respondents have good knowledge about "safe water," whereas 88% and 57% of respondents in Ullahpara and Cox's Bazar Pourashavas respectively have that knowledge. Therefore, motivation programs for these two Pourashavas will be needed at user level. While answering if the users have any responsibility regarding keeping their water safe, 100% respondents all Pourashavas except Naogaon said that they do have responsibility in this regard, which indicates their good attitude towards water management. It was found from the survey that use of piped water supply for drinking was relatively high in Naogaon and Ullahpara Pourashavas, whereas very low in Cox's Bazar and Birampur Pourashavas which indicate that water supply system needs significant improvement regarding water quality in these two Pourashavas.

The survey results from climate change related understanding indicated that 89% of the water users in Naogaon Pourashava, 76% of water users in Cox's Bazar Pourashava, 65% in Ullahpara Pourshava and 76% of respondents in Birampur Pourashava were aware about the climate change. The respondents in coastal area mentioned that they were observing increase of temperature, excessive flood, increase of salinity, water logging and sea level raise; the respondents from drought-prone areas mentioned that they were observing increased temperature, excessive drought and excessive rainfall, and the respondents from flood-prone area mentioned that they were observing increase temperature and water logging problem due to the impact of climate change. All of these changes of climate have significant impact on the water source considering the quality and quantity of water. The respondents in different Pourashavas assumed that water would be less available due to the impact of climate change, especially during the summer period. The water unavailability has also significant impact on the accessibility. But a few respondents mentioned that non-functionality will be increased and accessibility will be reduced.

From the analysis of response regarding cleaning and maintenance of water reservoirs, it appears that users in Naogaon Pourashava needs motivation regarding proper cleaning and maintenance of their reservoirs tanks. The users of Birampur Pourashava found to have better knowledge and practice regarding cleaning of their water reservoirs. Regarding cleaning of water collection pots, it was found that 100% users in Naogaon and Ullahpara Pourashavas clean their water collection pot before collecting water whereas this percentage is comparatively low in Cox's Bazar Pourashava (78%). 96% users in

Birampur Pourashava also follow good practice of cleaning the water collection pot before collecting water. It can be said from the analysis that users of Cox's Bazar need motivation in this regard.

The respondents were asked about their water transportation practices which includes how they cover the collection pots and what type of cover is used during transportation. The results show that percentage of users cover their water collection pots during transportation was very low in Naogaon Pourashava, whereas in Ullahpara 100% of the users were found covering their water collection pots during transportation of water after collection. To cover the water collection pots during transportation, it was found that in Naogaon and Birampur Pourashavas, 100% users who cover their water collection pots follow good practice. 96% users in Birampur also try to properly cover their pots. But only 74% users in Cox's Bazar were found following good practice. Hence motivation would be needed in Cox's Bazar regarding covering the water collection pots during water transportation. The analysis also showed that in Naogaon, Ullahpara and Birampur Pourashavas, 100% users who cover their pots used for storing water follow good practice. But 19% users in Cox's Bazar were not found following good practice.

In Naogaon Pourashava, incidents of diarrhea and dysentery were found more prevalent than other diseases. It was found in Naogaon Pourashava that children below 5 years are the most vulnerable to water-borne diseases. In other Pourashavas it was found that people of all age group were more or less affected. In Ullahpara Pourashava, 100% of the respondents answered that the above mentioned diseases are water-borne. This percentage is lower in Naogaon (64%) and Cox's Bazar (67%) pourashavas, and lowest among all Pourashavas in Birampur Pourashava (37%). In Ullahpara Pourashava, 100% of the respondents agreed that the ir water supply system is responsible for the water-borne diseases. This percentage is lower in Naogaon (63%) and Cox's Bazar (71%) pourashavas, and lowest among all Pourashavas in Birampur Pourashava (43%).

A very few percentage of Pourashava dweller's were satisfied with water supply in the different Pourashava. It can be said from the analysis that in none of the Pourashavas over 35% of users were satisfied about their water supply system. In Birampur Pourashava, majority of users were aware about the complaint system and WSP. In other three Pourashavas, awareness about WSP was below 50%. Awareness about complaint system was found relatively higher in Ullahpara and Naogaon Pourashavas, but low in Cox's Bazar Pourashava.

From the water quality test results, it was found that As was not posing any threat to water quality in any of the four Pourashavas. Fe concentration was found above acceptable limit in Naogaon, Ullahpara and Birampur Pourashavas. Only in Ullahpara Pourahava Mn was concentration was found above critical limit. Salinity is a threat in Cox's Bazar Pourashava which is in the coastal zone. The microbial risk was found significant in all the Pourashavas at the water collection points for users, as most of the tested samples showed high concentration of E. Coli in tested water. Therefore, the WSP needs to identify the challenges in water supply systems through hazard analysis and take proper control measure to improve the microbial quality of water at user's end.

Annex-I: KAP Questionnaire

Annex-I: KAP Questionnaire
Climate Friendly Water Safety Plan

DPHE-WHO

Baseline Data Collection Form

1: Name of Interviewee:

2: Date of survey:

3 (a):Name of Municipality: 3 (b) Ward #

4: Beneficiary No.:

5:Total # of HH members:

6. Monthly income of HH head:

PART A⇨ Safe water related information

7:What do you mean by safe drinking water?

1	Water that doesn't cause diseases is safe water	2	Arsenic free water
3	Clean odorless water	4	Supply water
5	I don't know what is safe drinking water		
6	If the above options don't match, write down just what the respondent tells:		

8: Water of which source do you use for drinking?

1	Supply water	2	Water of PSF on the pond bank	3	Pond water
4	Rain water	5	Filter water	6	Water of tube well having no platform
7	Water of tube well having platform	8	Water of river	9	Well water
10	Water of reverse osmosis	11	Water of arsenic iron removal plant		
12	Water of other sources:				

9:Do you consider the source of water that you use is safe? Yes 1 No 2

10: If answer t Q # is negative, why your water is unsafe?

Piped water is polluted	1	Water remains muddy	2	Odorous water	3	Insects like small earth worm are available in water	4
Water contains iron	5	Water contains salt	6	Water contains arsenicosis	7	Other reasons	8

11: Water of which source do you use for cooking?

Supply water	1	Water of tube well having no platform	2	Well	3	Rain water	4
Water of tube well having platform	5	Water of other sources	6				

12:Do you think that you have also responsibility to keep drinking and cooking water safe? Yes 1 No 2

PART B⇨ Climate change related information

13:Have you heard about climate change? Yes 1 No 2

14:What issues of climate change have you noticed?

Increase of temperature	1	Excessive rainfall	2	Drought	3	Decrease of temperature	4
Less rainfall	5	Flashflood	6	Increase of salinity	7	River erosion	8
Water stagnation	9	Rise of sea level	10	Increase of cyclone	11	Others	12

15: Is there any effect on your drinking water caused by climate change and when?

Effects	Technologies are being damaged more	Water is to fetch from distant place	Less quantity of water is available	Quality of water is worsening	There is no effect	Others (Please explain)
Month/ season (Yes-1 No-2)						

PART C: Water connection line related information

16:What type of water connection in your house ? (Observation)

Connected with the underground reservoir	1	Directly connected with the rooftop tank	2	Connected with the standpost having no platform inside the house	3	Connected with the standpost having platform inside the house	4
Other types	5						

17: How many times do you clean the underground and overhead reservoir?

Each month	1	Quarterly	2	Half yearly	3	Yearly	4	Biennial	5	Irregular	6	Never cleaned	7

18: Do you clean the reservoir?

Clean with only water after rubbing by the brush	1	Clean with water and detergent	2	Bleaching powder/chemical substances and water	3	Only with water	4	Through other processes	**5**

19: How many times do you clean the rooftop tank ?

Each month	1	Quarterly	2	Half yearly	3	Yearly	4	Biennial	5	Irregular	6	Never cleaned	7

20: How do you clean the rooftop tank?

Clean with only water after rubbing by the brush	1	Clean with water and detergent	2	Bleaching powder/chemical substances and water	3	Only with water	4	Through other processes	5

PART D: Water collection related information

21: Is preservation container washed during collecting drinking water? Yes, during collecting each time [1] Yes, sometimes during collection [2] It doesn't need to wash during collecting each time [3]

22: Which is used to wash preservation container during collecting water? with only water [1] Powder soap/ detergent [2] Ash [3] Others (Please explain) [4]

23: Which water is used to wash preservation container during collecting water? Water of that source from which water is collected [1] Washed by other water collected from the house [2]

PART E: Water carrying related information

24:Is the container/jar is covered during carrying water? Yes [1] No [2]

25:If the answer is yes, which is used to cover the container/jar during carrying water? Perforated plastic cover [1] Bowl/cover (without any hole) [2] Cloth [3] Paper /hardboard [4] Others [5]

PART F: Water preservation related information

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

Not preserved, taking from the tap directly [1] Keeping in the plastic jug or bucket [2] Preserving in the earthen jar [3] Keeping in the aluminum container [4]

Preserving in glass container [5] Others [6] _____

27: Is the preservation container covered? Yes [1] No [2]

28: If the answer is yes, is the preservation container covered during preservation? Perforated plastic cover [1] Bowl/cover (without any hole) [2] Cloth [3] Paper /hardboard © [4] Others [5]

PART G: Health related information

29: How many members fell sick in last 7 days caused by the following water borne diseases? (number of total affected patients have to write in the box beside the disease. If the disease doesn't cause, please write O)

Diarrhea [ ] Dysentery [ ] Typhoid [ ] Jaundice [ ]

Skin disease [ ] Worm [ ] Arsenicosis [ ] Cholera [ ]

Other water borne diseases [ ] [ ]

30: How many members fell sick since June 2015 caused by the following water borne diseases? (number of total affected patients have to write in the box beside the disease. If the disease doesn't cause, please write O)

Diarrhea [ ] Dysentery [ ] Typhoid [ ] Jaundice [ ]

Skin disease [ ] Worm [ ] Arsenicosis [ ] Cholera [ ]

Other water borne diseases [ ] [ ]

31: Who is fell sick most/ repeatedly in the family (by the above mentioned diseases) Children under 5 [1] Children of 5-12 age group [2] Male above 12 years of age [3] Female above 12 years of age [4]

32:Do you think that above mentioned diseases were caused by water contamination? Yes [1] No [2]

33: Do you think that the major causes of these diseases are water supply system? Yes [1] No [2]

34: How much money do you spend to combat those diseases? [ ]

35: When did at least one family member fall sick latest? [ ]

PART H: Opinion of the beneficiaries

36: Are you satisfied with the municipal water supply? satisfied [1] Dissatisfied [2]

37: Why do you dissatisfied with municipal water supply? Quantity [1] Quality [2] Both [3]

38: If you are dissatisfied with municipal water supply, do you know how to complain? Yes [1] No [2]

39: Do you know about water safety plan? Yes [1] No [2]