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Final Report on

Ensuring Sustainable Access to Water Supply in the Coastal Area of Bangladesh

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CEGIS

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Ensuring Sustainable Access to Water Supply for the communities, living in the coastal Bangladesh, especially those of women and youth to bring a qualitative change in their livelihood with special reference to climate change adaptation

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Table of Contents

Acknowledgements i
Table of Contents ii
List of Tables iv
List of Figures iv
Abbreviations and Acronyms v
Glossary vi
Executive Summary viii
1. Introduction 1
1.1 Background 1
1.2 Objectives 1
1.3 Research Questions 2
1.4 Conceptualization 3
1.5 Methodology 4
1.6 Limitations and Assumptions of the Study 6
2. Profile of the Study Area 7
2.1 Introduction: 7
2.2 Population and sex ratio 8
2.3 Land types 8
2.4 Salinity level 8
2.5 Existing rivers and *khals* 9
2.6 Drinking water 9
3. Water Supply Function 11
3.1 Components of Water Supply function 11
3.1.1 Water availability and quality 11
3.1.2 Labor to collect water: men and women of working age 15
3.1.3 Human Capital to access water 15
3.1.4 Financial capital to access water 16
3.1.5 Social Capital to access water 17
3.2 Climatic risks for drinking water, sanitation and hygiene, and adaptations 19
4. WaterSupply and Livelihoods 20
4.1 Livelihoods Profile 20
4.2 Existing Sources and Challenges 22

4.2.1 Water Availability 22
4.2.2 Water Affordability 25
4.2.3 Water Quality 25
4.2.4 Ability to Get Water 26
4.3 Sustainable Access to Water: Role of Institutions, Women and Youth 26
4.4 Climate Change: Risks for Livelihoods and Adaptations 27
5. Knowledge Sharing with Local Stakeholders 28
5.1 Introduction 28
5.2 Presentation of Findings 29
5.3 Suggestions and Complaints 29
6. Conclusions and Recommendations 31
6.1 Conclusions 31
6.2 Recommendations 31
Bibliography and References 33
Appendices 35
Appendix A: Crop calendar in the study area 36
Appendix B: Fishing calendar in the study area 37
Appendix C: Study area map 38
Appendix D: Semi-structured Questionnaire 39

List of Tables

Table 1.1: Sample districts in the coastal zone of Bangladesh by sampling criteria .. 5
Table 2.1: Population and sex ratio in the study area 8
Table 2.2: Salinity level in the study area 8
Table 2.3: Name of rivers and cannels as sources of water in the study area 9
Table 2.4: Sources and coverage of drinking water in the study area (union based) 9
Table 2.5: Major sources of drinking water in the study area (upazilla based) (% of total households) 10
Table 3.1: Union wise existing water sources along with challenges..... 11
Table 3.2: Number of People between 15-59 years old of six unions..... 15
Table 4.1: Cropping pattern in the study area 20
Table 4.2: Available sources of irrigation water along with challenges..... 23

List of Figures

Figure 1.1: Flow chart of the entire study 6
Figure 3.1: Cycle of domestic filtering for drinking water 12
Figure 3.2: Photograph of Pond Sand Filter (PSF) in Char Duanti union 17
Figure 3.3: Photograph of Women are collecting drinking water from PSF at BuriGoalini 17
Figure 3.4: Photograph of Women collecting drinking water from tubewell in Suborno Char union 17
Figure 3.5: Photograph of Rain water harvester in Nishanbaria union 17
Figure 4.1: Photograph of *Aus* rice field in the Nowabpur union 21
Figure 4.2: Photograph of Vegetables field in the Char Clerk 21
Figure 4.3: Photograph of a student is rearing poultry last two years in the Nishanbaria union 21
Figure 4.4: Photograph of duck rearing began again after *Aila* in the Charduanti union 21
Figure 5.1: Photograph of public dissemination meeting at Patharghata upazila 28
Figure 5.2: Photograph of public dissemination meeting at Morrelganj upazila 28
Figure 5.3: Photograph of Public dissemination meeting at Subarnachar upazila.... 28

Abbreviations and Acronyms

BBS	Bangladesh Bureau of Statistics
BDT	Bangladesh Taka
BINA	Bangladesh Institute of Nuclear Agriculture
BRAC	Bangladesh Rural Advancement Council
BRRI	Bangladesh Rice Research Institute
CCDB	Christian Commission for Development in Bangladesh
CEGIS	Center for Environmental and Geographic Information Services
DAE	Department of Agricultural Extension
DO	Dissolved Oxygen
DPHE	Department of Public Health Engineering
DTW	Deep Tube Well
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
GRQ	General Research Question
HYV	High Yielding Variety
ICZMP	Integrated Coastal Zone Management Project
Kg	Kilogram
Km	Kilometer
LLP	Low Lift Pump
MH	Medium Highland
ML	Medium Lowland
NGO	Non-Government Organization
PL	Post Larvae
PSF	Pond Sand Filter
SAAO	Sub-Assistant Agricultural Officer
SDG	Sustainable Development Goal
SRDI	Soil Resource Development Institute
SRQ	Specific Research Question
STW	Shallow Tube Well
UNDP	United Nations Development Programme
WHO	World Health Organization
WSSV	White-Spot Syndrome Virus

Glossary

Aila	A very severe cyclonic storm that hit Bangladesh in 2009
Aman	Group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-December. Mostly rain-fed, supplemental irrigation needed in places during dry spell.
Aus	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed for HYV T. Aus.
Bagda	A variety of brackish water shrimp
Boro	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Climate adaption	Adaptation to climate change refers to a response to global warming and climate change. According to UNFCCC (2010), adaptation refers to the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities".
Cloth filtering	A traditional method for water filtering in which cloth is used as a filter
Drinking water	Drinking water, also known as potable water or improved drinking water, is water that is safe to drink or to use for food preparation, without risk of health problems.
Fitkiri	Alum
Gamsa	A type of towel
Gher	Aquaculture pond
Golda	A variety of sweet water shrimp
Khal	Canal
Kharif-I	Name of cropping season that covers pre-monsoon periods, i.e. March to June.
Kharif-II	Name of cropping season that covers monsoon period, i.e. June to October.
Kolosh	It is a type of earthen water pot
Livelihoods	The conception of livelihood, in this study, goes beyond its conventional definition. Long (2000) defines livelihood as "the idea of individuals and

	groups striving to make a living, attempting to meet their various consumption and economic necessities, coping with uncertainties, responding to new opportunities, and choosing between different value positions " (p. -196).
Magrib prayer	A prayer for Muslim devotees at dusk time
Pateel	A pot in which food is cooked
Rabi	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
Sanitation and hygiene	WHO (2017) defines sanitation as "the provision of facilities and services for the safe disposal of human urine and feces". In line with this, sanitation also implies "the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal".
Sidr	A very severe cyclonic storm occurred in Bangladesh in 2007
Sundarbans	The largest mangrove forest located both in Bangladesh and India
Thitano	It is a kind of sedimentation process in which water is kept in a pot for certain time to sediment heavy particle at the bottom of that pot.
union Parishad	The lowest administrative Institution of Bangladesh
Upazila	Third Level Admistrative Unit
Water and SDG	According to United Nations Department of Economic and Social Affairs (UNDESA), 2015 :Goal 6 of SDG is to "Ensure availability and sustainable management of water and sanitation for all".The SDG 6 targets relevant to this study are as follows: **6.1** by 2030 achieve universal and equitable access to safe and affordable drinking water for all. **6.2** by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. **6.3** by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated waste water, and increasing recycling and safe reuse by x% globally. **6.4** by 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity, and **6.B** support and strengthen the participation of local communities for improving water and sanitation management.

Executive Summary

Water and sustainable development goals set by UN (SDG-6) has asked for universal and equitable access to safe and affordable water for all kinds of uses through a number of proposed measures. Objectives of this study have been set accordingly to assess water supply and situation for household use, drinking, health, hygiene and livelihoods in coastal zones and to propose pragmatic measures to ensure sustainable access to water, at a limited scale, by giving particular focus on women and youth.

The study has been undertaken as a mini- research exercise to set simple research questions around the said issues and seek responses from pre-determined selected communities and individuals through participatory rural appraisal techniques.The sample area for FGDs and interviews has been mainly the rural unions. For semi-urban area, upazila level data have been taken from BBS sources where standard distribution of water supply situations by type of sources have been registered. Selected sample unions have been clustered at two levels: sea-facing and non- sea- facing to capture the variation of accessibility.Climate change phenomena, like exposure to increased salinity, tidal fluctuation, cyclones and vulnerability, have also been considered while selecting sample districts for survey. Thus, six unions from six districts were selected as sample. These are Char Clerk union of Noakhali district, Nawabpur union of Feni district, Ranapasha union of Jhalokati district, Nishanbaria union of Bagerhat district, Char Duanti union of Barguna district and BuriGoalini union of Satkhira district.

Preliminary findings of the study have been shared with local stakeholders in Public Dissemination Meetings held locally at Barguna, Bagerhat and Noakhali. Issues raised during presentation are addressed in this Report.

Findings of the study of existing water supply situation in sample coastal areas are summed up as follows:

- Water availability and quality(the physical capital)

    a. All the sample 6 unions in 6 districts (Noakhali, Feni, Jhalokati, Bagerhat, Barguna and Satkhira) show heavy dependence on STW and DTW during dry period, with severe stress on health of young men and women, in particular, to fetch water;
    b. Unions in Feni, Bagerhat and Satkhira districts show some practices of rainwater harvesting, but storage capacity is low compared to their requirement;
    c. Canal, river and pond dominate as the sources of water in unions of Jhalokati district. Accessibility to limited and preferred source like STW is difficult for women, in particular, for distance as an issue, and this water is also saline in some areas (e.g. in Islampur);
    d. Barguna exhibits excessive dependence on rainwater, but storing capacity is insufficient. Excessive salinity in both ground and surface water, distance from sources etc. push people to such dependency; and
    e. Noakhali shows water-stress and dependence on STW, DTW and pond water as main sources. Excessive withdrawal of groundwater for irrigation renders shallow aquifers dry.

- Affordability and ability to access (social and human capital to access water)

    a. Access to public sector-funded DTWs is free of cost, but in many cases water withdrawn for irrigation is dominant, rendering STWs and hand tube-wells ineffective;
    b. Access to private STWs are restricted (by time and quantity) for other households than owners;
    c. Poor households get restricted access to both government and private tube-wells because of rural power structure;
    d. For rainwater harvesting, powerful households only get large tanks from government
    e. Formal institutions (like existing DPHE, UP, NGOs (BRAC, CCDB etc.) provide tube-wells, tanks, PSF etc. but provisions are inadequate;
    f. As for human capital, current knowledge about collection and preservation of water exists. For example, local technology for filtering, rainwater harvesting, home treatment of water with cloth-filter etc. prevails;
    g. Elevation of knowledge and awareness level is also happening from formal institution; and
    h. Organized pooling of human resources for improving physical sources of water by littoral communities is not yet coming up. Women and young men are now understanding the need for their involvement in maintaining the existing sources of fresh water, while pooling them for O&M of sources of water (PSF, Rainwater Tanks, Ponds, Khals etc.) has only recently been initiated in the sample unions.

- Water for livelihoods situation

    a. Agriculture, livestock, fishery, poultry, kitchen gardening mainly constitute the most common livelihoods based on water supply in coastal districts;
    b. All available sources of water (from ground, surface and rain) are mostly used for irrigation.But sources are uncertain, inadequate and saline. Livelihoods opportunities opening up for last few years around vegetable and fruits production by women population (like in kitchen garden) in coastal area are handicapped by such large scale withdrawal of water;and
    c. Brackish water fish farming is rising as a vibrant livelihood of those who become compelled to convert agricultural land into ponds. Rainwater is also being used to grow freshwater fish in Ghers.

- Climate change and water-based livelihood issues

    a. Agricultural livelihoods for many households in Bagerhat, Barguna and Satkhira are being shifted to fishing livelihoods due to salinity increase and intrusion (presumably due to climate change impacts);
    b. Shifting of monsoon seasonal cycle due to climate change impact has shifted practice among farmers of growing new saline tolerant rice varieties (BRRI and BINA) from earlier varieties;
    c. Open fishery is being replaced by Ghers and Bunds due to increased flooding caused by climate change; and
    d. Livelihood of shrimp cultivators is changing to crab cultivation due to salinity increase to avoid white spot syndrome virus (WSSV).

1. Introduction

1.1 Background

1. The current study is designed to explore the challenges of sustainable access to water in coastal zone of Bangladesh with particular focus on women and youth in reference to the current context of climate change and finally, provide relevant suggestions to ensure sustainable access to water supply in coastal zone.

2. Sustainable access to water is vital for human existence. People require water and sanitation to maintain good health and to continue with their livelihoods. Besides, water beyond the household provides input into the production systems that maintains livelihoods. This means that water permeates all aspects of human development and lack of its sustainable access at household level or for production results in choices and freedoms curtailed manifested in ill health, poverty and vulnerability (Jonah, 2015).

3. In Bangladesh, particularly in the coastal zones, access to water emerges as a crucial issue due to salinity intrusion, extreme weather events and groundwater depletion. These problems are continuously challenging successful command over coastal livelihoods, drinking and domestic water facilities, sanitation, as well as hygiene system. Additionally, Bangladesh is enormously vulnerable to climate change in which the coastal area is likely to be affected severely. In line with this, UNDP report (2013) states that safe water scarcity is an increasing problem in the coastal areas of Bangladesh as it is gradually turning brackish and saline. Here, climate change is exacerbating the situation due to sea level rise, poor rainfall in winter, high rate of evaporation and various disastrous events like cyclone and storm surge. Further, higher saline concentration in the surface water compels coastal people to depend more on ground water. Therefore, the ground water extraction for drinking, household use, health, sanitation and irrigation purposes has been accelerated. However, the water in the shallow aquifer is also being contaminated by salinity intrusion. Thus, the limited availability of fresh water, deteriorated water quality and scanty water quantity ultimately impacted water accessibility for the littoral population.

4. In the coastal zone, women and young girls carry a double burden, since they are the ones who sacrifice time and their education to collect water (UNDP, 2006). In similar line, another UNDP report (2006) argues that the poor are systematically excluded from access to water by their poverty, by their limited legal rights or by public policies. Against this backdrop, the present study is an effort to investigate problems and challenges associated with sustainable access to water supply, keeping in mind the already incipient impacts of climate change and limited adaptation practices. The study also considers women and youths groups specially for investigating their roles and strategies with respect to sustainable access to water.

1.2 Objectives

5. The broad objective of the study is to explore the challenges of sustainable access to water for water related livelihoods, drinking water, sanitation and hygiene, and adaptation practices with respect to climate change in coastal zone of Bangladesh and to derive suggestions and recommendations for ensuring sustainable access to water supply.

6. The specific objectives of the study are to:

- Investigate challenges of sustainable access to water for water-dependent livelihoods of people live in coastal areas,
- Find out challenges of sustainable access to water related to drinking water, sanitation and hygiene for people live in coastal areas,
- Unfold adaptation practices by relevant stakeholders against climate change with respect to sustainable access to water, and
- Derive suggestions/recommendations based on the study to ensure sustainable access to water supply in sample localities and in coastal zone, particularly in rural households.

1.3 Research Questions

7. Research Questions were outlined in alignment with the objectives of the study to derive required information of the coastal zone of Bangladesh.The Research Questions are mentioned under different headings.

Challenges for sustainable access to water for drinking water, sanitation and hygiene

- What are the available sources of drinking water and sanitation at the community level and educational institutions?
- What are the problems community people/youth/women face for drinking water, sanitation and hygiene?
- What levels of adequacies of available drinking water are there and what are the sources?
- How and to what extent does water quality affect drinking water, sanitation and hygiene?
- Whether the community people can afford the cost in getting access to drinking water or not? And what strategies do they follow?
- How and to what extent water availability and unavailability affect drinking water, sanitation and hygiene? Is there any prevalence of water borne diseases (for example, Diarrhea, Jaundice, Typhoid, any female centered problems) for last 5/10 years?
- What are the factors (or constrains) that enable ordisable community people to get access to water for safe drinking, sanitation and hygiene?
- How and to what extent are the relevant stakeholders involved in water management (for drinking water, sanitation and hygiene) in the coastal zone?
- How and to what extent women are involved in water management for drinking water, sanitation and hygiene?

Challenges of sustainable access to water for water-dependent livelihoods

- What are the available sources of water from which people harness their livelihoods?
- Are these sources providing adequate water for water-dependent livelihoods?
- How and to what extent water availability and unavailability affect livelihoods? How and to what extent does water quality affect livelihoods?
- Whether the community people can afford the cost in getting access to water for livelihoods or not? And what strategies do they follow?
- What are the factors (or constrains) that enable and unable community people/youth/women to get access to water for livelihoods?
- How and to what extent are the relevant stakeholders involved in water management (for crop production, fishery, livestock and poultry) in the coastal zone?
- How and to what extent women are involved in water management for livelihoods?

Challenges for sustainable access to water with respect to Climate Change

1. What are the existing adaptation practices for ensuring sustainable access to water with respect to climate change (for example, flooding, storm surges, excessive heat, salinity intrusion)and practices in terms of:
    - Local/Indigenous practice: HH level and Community level
    - Intervention by the government, and
    - Interventions by NGOs
2. What are the main climate change-induced threats that have adverse impacts on sustainable access to water? (for example, flooding, storm surges, excessive heat, salinity intrusion)
3. What are the impacts of these threats on water dependent livelihoods?
4. How do they manage their impacts on livelihood?
5. How do they restore the affected water sources?

1.4 Conceptualization

8. The main concept of the study includes “sustainable access” to water supply. According to WHO (2006), sustainable access comprises of two components with respect to water: one is ‘environmental sustainability’, and the other is ‘functional sustainability’.Environmental sustainability refers to“environmental protection through limiting extraction of water to a capacity below what is actually available” (WHO, 2006; p-67). Functional sustainability refers to “programme sustainability in terms of supply and management” (WHO, 2006; p-67). Drawing idea from this concept, both components are crucial for water access in coastal area of Bangladesh. Here, water is important for livelihoods, drinking, sanitation and hygiene. Thus, sustainable access to water implies water availability, use, quality, management and affordability. Following SDG, goal-6 argues that water scarcity and poor water quality can negatively impact food security and livelihood choice for poor families (UN, 2017).Thus, the study considers four key lenses: water availability, water

affordability, water quality, and ability to get water for assessing the extent of sustainable access to water in the coastal zone.

9. Water Availability refers to existing water sources and whether these sources and water flowsare adequate to meet the local demand or not. Water Affordability refers to whether the people can pay the cost involved in getting access to water or not. Water Quality implies whether water quality impacts on the local people to achieve desired goals for livelihoods, drinking water, sanitation and hygiene. Finally, Ability implies the presence of power or power relation that enables or limits access of local people to water. For achieving the Goal-6 of SDG, uninterrupted access to water with respect to these key lenses (availability, affordability, quality and ability) are important.

1.5 Methodology

10. The steps followed during the study constitute the methodology. They are as follows:

Step-1: Literature Review

11. Available literature from relevant sources have been reviewed to assess the present level of knowledge regarding present availability of safe water to coastal population and their present practices to adapt to the scarcity of supply water for household use, drinking, health sanitation and for livelihoods.

Step-2: Conceptualization

12. The CEGIS multidisciplinary study team met a number of times to(i) understand the study objectives and BWP's objectives of mounting the study, (ii) formulate study design,(iii) visualizethe concept of ensuring sustainable access to water supplyin coastal area, (iv) frame research questions and (v) work out methods to follow for the study.

Step-3: Sampling and Data Collection

13. The study followed cluster sampling to select study locations. In this context, the coastal zonewas divided into two clusters: sea-facing and non sea-facing. Intensity of climate change hazards (salinity, tidal fluctuation and cyclone) was considered for selecting the sample districts from these two clusters. Vulnerability ranking (medium-high to high) was done on the basis of intensity of occurrence of the selected hazards in the two cluster districts. Six districts were selected as sample based on vulnerability analysis of the districts in coastal zone. Thus, the study derived 3 sea-facing districts (Barguna, Noakhali and Satkhira), and 3 non sea-facing districts (Bagerhat, Feni and Jhalokathi) as sample districts in the coastal zone. Subsequently, 6 unions were selected from the sample districts based on water crisis and vulnerability to climate change and natural hazards. The local peopleas per stakeholder analysis were interviewed and relevant data and information were collected from the study unions using participatory rural appraisal techniques (FGD, KII and individual interviews). Case studies were developed on issues around sustainable access to fresh water in the sample locations.

14. Data were collected from both primary and secondary sources. Secondary data was used to understand the study area and associated problems prior to going to the field. Additionally, secondary information contributed to the entire report preparation. Furthermore, the study mainly depended on primary data collected from the local people (target groups) of selected districts. Before going to the field, the study team finalized a semi-structured questionnaire that was followed in the field for data collection. Besides, the team also did

numerous informal interviews with the local people for getting answers to research questions. Along with this, the study team followed a systematic observation method for collecting data.

15. In Table 1.1, the key climate change hazards along with vulnerability rank of the 6 sample districts in 2 clusters of coastal zone are depicted.

Table 1.1:Sample districts in the coastal zone of Bangladesh by sampling criteria

Name of District	Sampling Criteria					
	Climate Phenomena/exposed to			Cluster location		Vulnerability rank
	Salinity	Tidal Fluctuation	Cyclone	Sea-facing	Non-sea facing	
Bagerhat**	✓	✓			✓	Very High
Barguna*	✓	✓	✓	✓		Medium high (Patharghata)
Feni**	✓	✓	✓		✓	Medium high
Jhalokathi**	✓	✓			✓	Medium high
Noakhali*	✓	✓	✓	✓		Very High
Satkhira*	✓	✓		✓		Very High

*** Non-sea facing districts; * Sea facing districts*

Step-4: Triangulation

16. A multidisciplinary study team comprised economist, environmentalist, sociologist, development practitioner, engineer, fisheries specialist and agricultural expert triangulated field findings in two ways. The first one was 'data triangulation' in which interview data (both semi-structured and informal) was cross checked with systematic observation data. Besides, data collected from Key Informants was also taken into account for triangulation. The other was 'researcher triangulation' in which researchers cross checked data of each other to reach conclusive findings.

Step-5: Data analysis, Draft Report Preparation and Dissemination of Findings to Local Stakeholders

17. Data and information collected from field were analyzed and important responses incorporated in the draft report. The findings were shared with local stakeholdersin meetings held at convenient locations which were Morrelganj, Bagerhatdistrict;Patharghata,Barguna district and Subarnachar,Noakhalidisctrict.

Step-6: Finalization of Report

18. The Draft report is finalized incorporating the comments and observations from stakeholders and the Client. Overall, the flow of steps described above is presented in the following figure: (Figure 1.1).

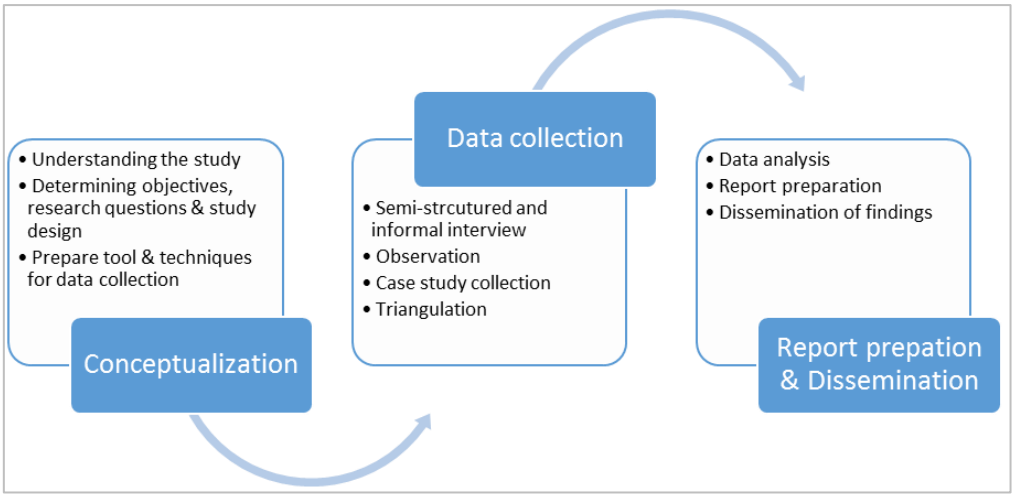

Figure 1.1: Flow chart of the entire study

1.6 Limitations and Assumptions of the Study

19. The study area covers a very small fraction of the entire coastal area. Therefore, this has inadequate representativeness of entire coastal area of Bangladesh. Conclusions and findings may, thus, have inclinations to sample union characteristics which may not be generalized for the coast at large.

20. Limited time and resources for this study, on the other hand, made a built-in limitation in going for statistically reasonable sample size.

21. But the responses and findings elicited from the exercise are quite valuable for undertaking areas of further studies with more emphasis on issues which have surfaced from this study. Moreover, continuously changing physical and social dynamics, particularly around water supply parameters, urge more upon capturing the changes over time than having a single snapshot.

2. Profile of the Study Area

2.1 Introduction:

22. The coastal area of Bangladesh consists of 17 coastal districts encompassing 147 upazilas and constitutes 32 percent of the land area and 28 percent of the population (i.e. nearly 42 million) of Bangladesh (World Bank, 2012). According to PDO-ICZMP (2003), the coastal zone of Bangladesh has been classified into exposed coast and interior coast based on cyclonic storm surges, salinity and tidal influence. Out of 19 districts and 147 upazilas, 12 districts and 48 upazilas are directly exposed to sea. These exposed districts and upazilas together make 23935 sq.km or 50.7% of the coastal zone. The other 7 districts and 99 upazilas are interior of the coast but contain the same physical and environmental features.

23. Regionally, the coastal zone of Bangladesh is an intricate system of biodiversity which includes the Sundarbans, the largest mangrove forest in the world. The coastal zone spans over 580 km of coastline and is prone to multiple hazards. Cyclones, floods, tidal surges, periodic water-logging and land erosion are common throughout this zone significantly shapingthe lives and livelihoods of local communities. According to the World Bank (2012), 'Sixty-two percent of coastal land has an elevation of up to three meters and eighty-three percent up to five meters above mean sea level' making this zone also extremely vulnerable to sea-level rise.

24. The coastal zone of Bangladesh is crisscrossed by a large number of rivers and their tributaries. Deltaic and other low-lying coastal zones are exposed to the intrusion of salt both in surface water and groundwater. As a result, water in the rivers and in the canals cannot be used for consumption. Saline water can originate from various sources. The saline water originates from the marine transgressions at the time of deposition (primary aquifer salinization). If differences in the elevation of the surface waters are created (by reclamation and empoldering) a seepage flow is generated which carries the saline ground water to the surface ('oozing') thus forming a source of salt. (Tudelft, 2017)

25. In coastal zones, scarcity of potable water is severe particularly in rural areas where water supply system does not exist. Although there are a good number of ponds and groundwater storage, but water quality is notsuitable for drinking and sanitation. River water is turbid and saline too. Water in low saline ponds is used only for household purposes. Hand tube-well is the mostly used device to meet demand for drinking water in locations where salinity level at shallow depth is low. But STWs and DTWs are used to draw water from deep aquifers in many locations (see Table-2.5). Additionally, rural poor households arescattered and their affordability is almost nil for accessing water from costly treatment plants or from very deep set tubewells. On the other hand, rainwater harvesting is technically limited due to want of having standard sized overhead tanks at household level. Community initiatives were inadequate in the past to set up appropriate tanks at agreed locations as households are scattered in rural coastal zone. But the practice is already incipient in some areas to have community-based tanks to hold rain water for drinking purposes in dry season. Moreover, piped water is only supplied to semi-urban (upazila) and urban areas which are again very limited in coverage (see Table-2.5).

26. For this study six unions were selected under six districts which are Noakhali, Feni, Jhalokati, Bagerhat, Barguna and Satkhira. Below, the general description of the study areas is demonstrated.

2.2 Population and sex ratio

27. Population and sex ratio of the six sample unions from six different districts are described in Table 2.1 below which is derived from Bangladesh - Population and Housing Census 2011 (BBS, 2012).

Table 2.1: Population and sex ratio in the study area

District	Union	Population(no.)			Sex Ratio
		Both	Male	Female	
Noakhali	Char Clerk	48,733	24,693	24,040	103
Feni	Nawabpur	18,272	8,334	9,938	84
Jhalokati	Ranapasha	11,500	5,373	6,127	88
Bagerhat	Nishanbaria	27,029	13,043	13,986	93
Barguna	Char Duanti	24,563	12,247	12,316	99
Satkhira	BuriGoalini	24,913	12,237	12,676	97

Source: BBS, 2012

2.3 Land types

28. Land type refers to classification of agricultural land based on the seasonal inundation depth of normal flooding. According to Yearbook of Agricultural Statistics-2015 five land types (High land, Medium Highland, Medium Lowland, Lowland and Very Lowland) have been classified in terms of depth of flooding on agricultural land. Field observation indicates that six unions consist of Medium Highland (MH) and Medium Lowland (ML). MHis normally flooded between 0 and90 cm depth of water seasonally for more than two weeks to a few months during the monsoon season and ML land is normally flooded between 90 cm and 180 cm depth during the flood season.

2.4 Salinity level

29. CEGIS' estimation from SOLARIS-SRDI (2006) reveals that soil salinity of the area inside the BuriGoalini, Char Duanti and Char Clerk unions increased gradually. Local farmers reported that most of the *khals* are open and this cannot restrict intrusion of saline water inside the unions which is reported as the major cause of the salinity increment inside the unions. Some Sub-Assistant Agriculture Officers (SAAOs) of DAE and local farmers reported that the soil and water salinity gradually increase with dryness from January and reaches its maximum level in the month of March-April; and intensity of salinity decreases in monsoon due to monsoon rainfall. Detailed soil salinity of the six unions is presented in Table 2.2.

Table 2.2: Salinity level in the study area

District	Union	Unit
Noakhali	Char Clerk	S3=8.1-12.0(ds/m)
	Char Clerk	S4=12.1-16.0(ds/m)
	Char Clerk	S5>16.0(ds/m)
Feni	Nawabpur	S1=2-4(ds/m)
Jhalokati	Ranapasha	S1=2-4(ds/m)
Bagerhat	Nishanbaria	S2=4.1-8.0(ds/m)
Barguna	Char Duanti	S2=4.1-8.0(ds/m)
	Char Duanti	S4=12.1-16.0(ds/m)
Satkhira	BuriGoalini	S5>16.0(ds/m)

Source: SRDI, 2010

30. From the Table 2.2 it is revealed that the highest level of salinity is found in Satkhira and Noakhali, whereas Feni and Jhalokati have the lowest salinity level in the soil.

2.5 Existing rivers and *khals*

31. Name of the major rivers and *khals*(canals)serving as source of water in these six specific unions of the districts is described in Table 2.3.

Table 2.3: Name of rivers and cannels as sources of water in the study area

District	Union	Sources of Water
Noakhali	Char Clerk	Hatia Channel
Feni	Nawabpur	Feni River, Kalidas*Khal*
Jhalokati	Ranapasha	Biskhali River through Khailsa*Khal*, Biskhali River
Bagerhat	Nishanbaria	Baraikhali River through *khal*
Barguna	Char Duanti	Balesware River, Machar*Khal*, Lathimara*Khal*
Satkhira	BuriGoalini	Kholpetua River through Porakatla*Khal*

Source: CEGIS, 2017

2.6 Drinking water

32. There are different sources of drinking water in these six unions such as tap, tube well and other sources. Other sources of drinking water refer to ponds, river, *khal*, rainwater etc. Tube well is the major source of drinking water in Char Clerk (76.5%), Nawabpur (97.7%), and Ranapasha (98.4%), while other sources are major in Nishanbaria (92.1%), Char Duanti (88.7%) and BuriGoalini (75.5%). It is evident from this finding that use of sources of drinking water depends on the level of salinity. Tube well water is used in the area where salinity level is lower; while pond, river, *khal*, and rainwater is used in the area where salinity level is higher. Percentage of source of drinking water use by area is presented in Table 2.4.

Table 2.4: Sources and coverage of drinking water in the study area (union based)

District	Union	Number of Households	Source of Drinking Water (%) of Total Households		
			Tap	Tube-Well	Other
Noakhali	Char Clerk	10759	0.1	76.5	23.5
Feni	Nawabpur	3545	0.1	97.7	2.2
Jhalokati	Ranapasha	2697	0	98.4	1.6
Bagerhat	Nishanbaria	6434	6.3	1.6	92.1
Barguna	Char Duanti	6,547	2.3	9	88.7
Satkhira	BuriGoalini	5737	1	23.4	75.5

Source: BBS, 2012

Table 2.5: Major sources of drinking water in the study area (upazilla based) (% of total households)

Upazilla	Piped into dwelling	Piped into yard or plot	Public tap/spipe	Shallow tubewell(<500 feet)	Deep tubewell(500+feet)	Protected well	Rain water collection	PSF	Unprotected well	Surface water	Others
Patharghata	0.20	0.00	0.40	18.7	41.9	0.00	0.50	14.6	0.00	23.30	0.40
Nalchity	0.20	0.00	0.00	5.40	94.0	0.00	0.00	0.00	0.40	0.00	0.00
Morelganj	0.10	0.00	3.00	24.3	1.80	0.20	3.00	21.4	1.60	44.20	0.40
Shyamnagar	0.00	0.20	0.00	29.4	4.10	0.00	0.00	27.2	0.00	39.20	0
Sonagazi	0.20	2.20	1.00	65.3	30.4	0.00	0.00	0.00	0.00	0.80	0.10
Subarnachar	0.30	0.00	0.00	41.4	57.1	1.00	0.00	0.00	0.10	0.00	0.10

Source: BBS, 2009

3. Water Supply Function

3.1 Components of Water Supply function

33. Water supply (for drinking, sanitation and hygiene) in the study area is a composite function of factors around water supply,water availability, labor power for collection,human capital in terms of their knowledge, education and environment, financial capacity of users, community participation and social behavior. These are briefly highlighted in the following section, each referring to the study area.

3.1.1 Water availability and quality

34. Existing sources and challenges for getting water for drinking, sanitation and hygiene is given in Table 3.1. It shows that shallow tubewell water (STW) is the main source for drinking in Char Clerk, Nowabpur and Ranapasha unions. In general, people use pond water for domestic purposes.

35. However, people of Char Clerk union often use pond water for drinking purpose, if there is no tubewell close to them. STW is mostly used for drinking, and DTW is used for irrigation that might create a challenge for getting drinking water in the case of excessive groundwater withdrawal for irrigation. Moreover, the presence of salinity was traced in some STW of this (Char Clerk) union. People of Nowabpur union often use rainwater for drinking purpose. Previously, they would use pond water for drinking when the coverage and number of tubewell was lower, but now they use water from tubewell and rain water. On the other hand, people living in Char Islampur village of Ranapasha union use pond, river and rainwater for drinking purpose. In this village, salinity is excessive in groundwater. Thus, they retain rainwater inthe pond and harvest rainwater in buckets/drum during monsoon to use/drink in dry season. For purifying pond/river water, they use Alum (fitkiri). People of Ranapasha union stated that often a dead livestock is dumped into the river and *khal*sthat eventually hampers water collection for drinking.

36. People of Char Clerk, Nowabpur and Ranapasha argued that since the coverage of tubewell is low, they (especially women) cannot collect drinking water from distant locations. This mostly happens during the night time because of security problem for collector (women). However, the number of tubewell is gradually increasing in all of these unions (Table 3.1).

Table 3.1:Union wise existing water sources along with challenges

Studied Unions	Existing Water Sources	Challenges
Char Clerk	STW, DTW and pond	The coverage and number of tubewell is low Withdrawal of groundwater for irrigation Distance to collect drinking water During dry season, ponds become dry and provide insufficient water
Nowabpur	STW, pond, rain water	Tubewell malfunctioning Pond water becomes dry during dry season
Ranapasha	STW, Canals, river, pond	Tubewell water is salty in Char Islampur Malfunctioning of STW Distance to collect drinking water
Nishanbaria	Pond, rain water	Distance to collect drinking water Tubewell water is salty

Studied Unions	Existing Water Sources	Challenges
		During dry season, ponds become dry and provide insufficient water Insufficient storage capacity of rainwater harvest
Char Dunati	Rainwater harvest	Non-functional PSF Distance to collect drinking water Tubewell water salty During dry season, ponds become dry and provide insufficient water Insufficient storage capacity of rainwater harvesting
BuriGoalini	Rainwater harvest	Pond water becomes salty Distance to collect drinking water Tubewell water salty During dry season, ponds become dry and provide insufficient water Insufficient storage capacity of rainwater harvesting

37. On the contrary, in saline-prone unions such as Nishanbaria, Char Duanti, and BuriGoalini, the main sources of drinking water are rainwater and pond water. Here, groundwater is saline which limits its usage for drinking. In the same line, surface water (in river and *khals*) becomes saline during dry season. As a result, people use pond water (retained rainwater), and harvest rainwater during monsoon season. However, pond water often becomes dirty during dry season when water level is declining. In that case, people (mostly women) use different traditional technologies for purifying and filtering pond water (Figure 3.1). In Char Dunati union, there is Pond Sand Filter (PSF) which are currently non-functional. In BuriGoalini union, fetching fresh water from distant pond is impossible at night as they are afraid of tiger attacks.

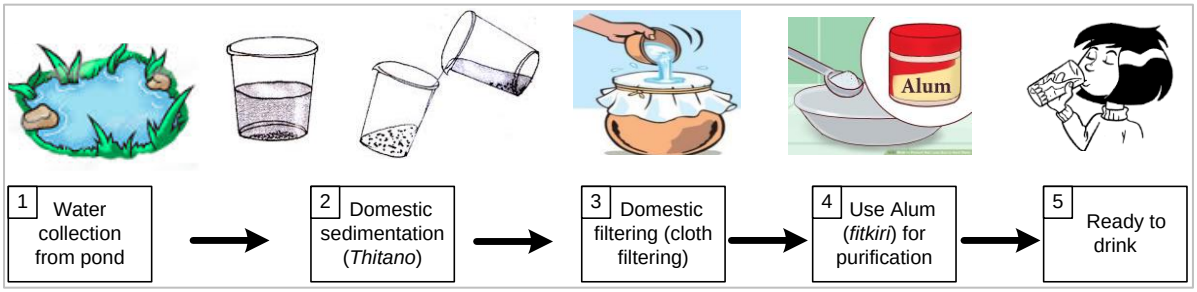

Figure 3.1: Cycle of domestic filtering for drinking water

38. The process of water purification includes (i) collection of water from pond, (ii) domestic sedimentation (or *thitano*) for sometime, (iii) sedimented water filtering with cloth (cloth filtering), and (iv) use of Alum (*fitkiri*) for purification. Finally, water becomes ready for drinking.

39. The study team found that salinity is an increasing challenge in Char Clerk union. In Islampur village of this union, people can not use STW, instead they collect drinking water from adjacent DTW (here DTW is installed for irrigation purpose). In Nowabpur union, the presence of arsenic and iron was found. In this union, although arsenic was detected but no symptoms or cases of arsenicosis was traced out. In Ranapsha, the presence of iron is very common throughout the union. However, in Char Islampur village of this union, the presence of salinity and arsenic in ground water (tubewell) was found to be extreme. As a result, people could not use groundwater, and/or the local Department of Public Health Engineering (DPHE)

office prohibited to use water from arsenic contaminated tubewell. Eventually, people of this union had to use surface water (river and pond). However, river water often becomes polluted due to the dumped dead livestock. They even encounter problem in using pond water during dry season, since water level declines leading to mixture of dirt with water (see Box 2).

Box 1: Char Islampur-Victim to Multiple Water-related Vulnerabilities

40. Char Islampur, a village situated in Ranapashaunion of Jhalokati district, is surrounded by two rivers Gazaria and Bishkhali. The geography of this village makes it a remote region having connected to the union only by waterways. Lack of proper connection to administrative center has made the life of local people difficult.

41. The village consists of forty families having a total of around two hundred and fifty people. This moderate densely populated village has been deprived of most of the basic human facilities provided by both government and other service providing organizations. There is no electricity supply (PalliBidyut) in this village. Some people have started using solar electricity in a small scale these days. The villagers are deprived of having proper water supply for drinking and household purposes and hygienic sanitation system. Even in most cases they do not have any idea of water quality and sanitation system.

42. There are only two shallow tube-wells in the entire village, installed three years ago, of which one is out of order now. Also the shallow tube-well water is salty, therefore, people cannot actually use them as sources of drinking water. Seven years ago the villagers had to drink water only from river. They also used river water for domestic use, even today they are using river water for domestic purposes. Four tube-wells were set up by the government then but after some days of installation those tube-wells became salty. Also those sources are contaminated with iron and arsenic. The authority tested those four tube-wells and prohibited the use five years ago. A deep tube-well has been set up a year ago, but after one month of installation it also has become salty. Again due to absence of electricity supply they cannot install water pump properly which they could maintain as community basis. Nowadays the villagers are again in the situation of using river water for drinking and household purposes.

43. The villagers collect and use rain water especially in rainy season. They store rain water in jar (kolos), bucket and drum. The rain water is used for drinking and cooking. This can be considered as a mitigation step for their drinking water scarcity though lack of proper support from government and other organizations they are unable to utilize rain water to full extent.

44. The sanitation system of the village is very poor. The people use mostly unhygienic latrines. Though the latrines have concrete ring and slab they do not comply with the definition of hygienic latrine. During heavy rainfall and flood the latrines get submerged and water contamination occurs because of the overflown waste. Also during the cycle of tide and ebb the waste gets overflown. This situation has been causing health hazards to the inhabitants. They often suffer from diarrhea, skin diseases, vomiting and other water-borne diseases.

Box 1: Char Islampur-Victim to Multiple Water-related Vulnerabilities

45. The coastal zone of Bangladesh have been affected by a number of natural disasters every year. Char Islampur does not show any safer condition than other areas. Rather additional surrounding by two rivers makes it more vulnerable to natural calamity and climate change. This area has been facing severe flood, river erosion and cyclone. The people said that during Aila and Sidr there were heavy tides and everything was destructed. They had to hold trees so that the mighty tide would not wash them away. Due to climate change these disasters are becoming more frequent nowadays which creates shadow on the villagers face. They even do not have any cyclone shelter to go during natural calamities. The ill and injured villagers do not get local medical support rather have to go to the union headquarter passing an unsuitable waterway which sometimes become life threatening.

46. The presence of salinity and dirt problem in pond water (during dry season) is commonly found in Nishanbaria, Char Duanti and BuriGoalini unions. In these unions, people could not use groundwater due to salinity throughout the year. However, they use surface water (river and pond) during monsoon when rainfall increases/pushes out saline water by replacing fresh water. So people preserve rainwater in the pond to use it during dry season. However, pond water tends to become dirty in extreme dry period (in end-March to mid-April) which limits people of these unions to use those sources. Low water quality and quantity of those areas have also lead towards poor health and hygiene in those areas.

Box 2: Women and Health

47. RoksanaBegum (pseudonym), a woman from Char Clerk union, SubarnacharofNoakhali district is suffering from a complicated disease for more than a decade. She had whitish vaginal discharge at moderate amount during her adolescent period. She was very shy to share all these issues with anyone and accepted that as a part of her life. She also had itching around her private parts. However, with time the girl grew up and stared sharing her story with her female friends and family members. She was convinced that this problem was common among women as well. After few years she became matured and got married. After her marriage she realized that her problems increased significantly. Her yellowish foul smelling vaginal discharge accompanied with fatigue, stress, and vertigo, increased itching around genitals and vagina with soreness and inflammation, and menstruation pain. Her skin became pale and she lost significant weight. Finally, she went to a doctor, and the doctor diagnosed her with leucorrhea and other hygiene related issues. Doctor also stated that her poor hygiene related to cleaning herself in dirty water exacerbated her condition as one of the major preventions of fungal infection is to clean vagina with hygienic water. This woman is under regular medication now, but she is not recovering properly. However Roksana said that “It’s difficult to be recovered fully, because pond is the only source of usable water for domestic purposes. Where else can I take bath? Where will I get fresh water for such luxury?” It is stated that prevention is better than cure. But in this case both prevention and cure are impossible for the single reason which is shortage of fresh water for domestic usage.

3.1.2 Labor to collect water: men and women of working age

48. Women are directly involved in water collection form ponds and tubewells. After collection of pond water, women make it ready for drinking following several procedures. They also use pond water for domestic use. In the case of distant tubewell/ water sources, women cannot go for water collection due to security issues, physical or time limitation etc. In that case, youth are involved in water collection. Besides, if the villagers need to buy water from the market, youths are involved in collection. In many instances, men actually go to the market or very distant places with bicycles and motor bikes for bringing water.

Box 3: Women under Life threatening situation

49. Water collection is one of the major household responsibilities of rural women of Bangladesh. They need to go far away for collecting water for drinking and domestic usage. Women of different age walk far away to fetch water and face different types of physical and mental obstacles. Women from all these districts claimed that it is an arduous job to walk for so long and bring the bucket of water to their house as this job is very much physically demanding. Even when these women are sick, they had no other option left rather than to walk for long and bring water for drinking, but when they are unable to do so, they drink impure water from nearby sources. However, in some places collecting water imposes greater physical threats. In places where there are a lot of canals and rivers, for commuting one needs to cross many bamboo poles and tree trunk bridges. There are many incidences that these women fall down while bringing heavy water buckets from far away, particularly during rainy season. Ms. Maya (pseudonym) from Char Duantiunion of Barguna told that many women fall down from these bamboo poles and get injured while fetching drinking water. Maya was also very concerned about the pregnant women who bring drinking water from far away and counter these risky roads. She said that pregnant women often bring water as they have no other choice, but if they fall down then they might even die or their babies can be aborted as well.

50. The table below shows the number of active population of these six unions who are between 15 to 59 years old. These people are active and mostly engaged in water collection.

Table 3.2: Number of People between 15-59 years old of six unions

District	Union	Number of Population between 15- 59 years old
Noakhali	Char Clerk	24064
Feni	Nawabpur	9848
Jhalokati	Ranapasha	5886
Bagerhat	Nishanbaria	14065
Barguna	Char Duanti	14265
Satkhira	BuriGoalini	15041

Source: BBS,2012

3.1.3 Human Capital to access water

51. People residing in these places are using both traditional and current knowledge to collect and preserve water. People started filtering water through using clothes by imitating others in the same localities. Using Fitkiri is a common practice among the local, particularly

during disaster period for a long time. People are aware of the negative impact of consuming polluted water. Thus, they try to drink water from reliable and safe sources, although in most of the cases these sources are situated far away or they need to buy safe drinking water from market. In situations when they are unable to pay for water and the drinking water sources are far away, they prefer to use fitkiri, along with traditional home treatment for making the water drinkable.

52. Formal institutions have contributed to elevate knowledge of local people and disseminated health and water related education to them which ultimately contributed in ensuring better access to water. These institutions have also worked for awareness building among local people through doing different water quality related tests, providing them with better and modern water infrastructure facilities etc.

53. It was observed during primary data collection period that local people are indifferent to preserve or maintain the community water sources like community tubewells, ponds or PSFs. Women and youth have very little contribution in maintenance and operation of these. Particularly, O&M of sand filtering system in PFS is difficult (washing filter beds) for which these sources of water do not sustain. Although population in active age-bracket is high in the study area (Table 3.1), adequate initiatives are lacking to motivate and engage them in such activities.

3.1.4 Financial capital to access water

54. In Char Clerk, Nowabpur and Ranapasha unions, there is no cost involved in getting drinking water. Very few households can afford installation of STW for themselves. Otherwise, people share tubewell water with neighbours. Besides, the government through Union Parishads provides free tubewell to the local people. However, people in Char Islampur (of Ranapsaha union) need money for purifying and filtering water as they depend on river and *khals* for drinking water. Thus, they have to buy pots for storing and collecting water, they also need cloths and alum (*fitkiri*) to filter and purify the collected water.

55. On the other hand, people in Nishanbaria, Char Duanti and BuriGoalinibuy water from the market and/or from PSF. In general, people have limited purchasing capacity due to the exposure to extreme poverty. Therefore, they have to depend on pond water and rainwater. In Char Duanti union, poor people who depend on pond water cannot collect water if the pond is located at distant place.Thus they are compelled to buy water from the local market. In this case, they have to pay BDT 10 per jar (*kolos*).

56. In Bhamia village of BuriGoalini union, there is a PSF installed by an NGO called Christian Commission for Development in Bangladesh (CCDB). This PSF is operated by a local manager who sells water to the local people at a rate of BDT 12 per drum and BDT 5 per jar (*kolos*). The manager argued that the received money is used for PSF maintenance and salary for the manager. However, there is also a PSF installed by the government to provide free water to the local people. Water from PSF are often sold in the market too. Thus, there are intermediary groups who collect water from PSF (especially from the government-installed PSF) and sell in the market. These intermediate groups also supply PSF water door to door, and/or at a certain place of the village from where local people (women and youth) purchase water.

Figure 3.2: Photograph of Pond Sand Filter (PSF) in Char Duanti union

Figure 3.3: Photograph of Women are collecting drinking water from PSF at BuriGoalini

Figure 3.4:Photograph of Women collecting drinking water from tubewell in Suborno Char union

Figure 3.5:Photograph of Rain water harvester in Nishanbaria union

3.1.5 Social Capital to access water

57. In Char Clerk, Nowabpur and Ranapasha unions, most of the tubewells are installed for a group of households either buying by themselves or getting free from the government. However, people who do not have tubewell facility, usually collect water from neighboring tubewells (of adjacent villages). The study team found that some tubewell owners are not willing to share their water with neighbors. In some cases, the owners make a restriction on collection time of water by neighbors. This restriction often leads to social conflict. In getting free tubewell from the government, poor and powerless people are always deprived. Instead, familiar faces to Chairman and/or Member of Union *Parishads* get preference in allocation of tubewells.

58. On the other hand, most of the ponds are constructed for community usage. Besides, there are some ponds which are constructed personally for individual household usage. For the community level ponds, it is mainly the locally powerful people who control the access. In that case, there is also a restriction on collection time that often leads to social conflict. Although water from PSF is free for the local community, locally powerful people tend to collect large volume of water for selling to the market or to the local communities. This control often leads to social conflict.

Box 4: Drinking Water Scarcity- The Story of a Widow

59. Dhanshagar is a village of Bangladesh situated at Nishanbariaunion in Bagerhat district. A widow Jamila Khatun (pseudo name/anonym) has been living here since she had been married to Faruk Ali (anonym). Her husband died in an accident a decade ago. Since then the hardship of her life has swelled. Her family consists of two sons and a daughter.

60. Drinking water, like the other coastal zones of Bangladesh, has always been a precious concern in this village. The main sources are ponds and rain water (especially in rainy season). Jamila has to collect water from distant ponds every day, even more than once a day. The ponds are 1 to 1.5 kilometers away from her home. Moreover the ponds are dirty and contain insufficient water to serve a large number of poor people of the village like Jamila. Those ponds are owned by two or three adjacent families. They limit the collection time for others, as Jamila said that she has to collect drinking water before the 'Magrib' prayer in the evening. If she needs water after evening or at night somehow, in most cases she won't be permitted to collect water then and even a quarrel may arise. To comply with social harmony she always collect or actually forced to collect water in morning and noon. The distance of the ponds along with the time barrier creates a lot of physical stress.

61. There are a few shallow tube-wells in the village. Jamila cannot use those for drinking because thewater from these tubewellsis salty, especially in the dry season. The scarcity of drinking water in the dry season has become more acute. The tube-wells become salty and ponds contain the least possible amount of water and consequently the pond water remains mixed with dirt and clay. This type of pond water cannot be used for drinking directly. Jamila collects the water and then she allows the water to settle in a pot for some time. This allows the clay and dirt in the water to gather in the lower portion of the pot. Jamila then separates the upper comparatively clean water portion and throw away the dirt. She then filters the water with the help of a cloth called 'Gamsa' in Bengali. Then the water becomes drinkable, but from health and hygiene point of view this water cannot be called potable.

62. In the rainy season, the people have to collect and store rain water for drinking purpose. Jamila does this and she stores rain water in pots called 'Pateel' in Bengali and in small buckets. She cannot store much water as she is not well-off enough to buy water tank or drum and even she cannot afford to buy more pots or buckets. Though some tanks for collection and storage of rain water have been provided by DPHE-WB, the ill political influence has made the project less poor friendly. The local political community always force facility provider illegally to facilitate their kith and kin. Thus Jamila is deprived of having access to such a rain water tank.

63. Sometimes situation arises that people need to buy water for drinking, but unfortunately Jamila cannot afford to do so. What she does is to use the dirty pond water. Also the water sources sometimes get contaminated with waste from toilets when submerged due to natural disasters like excessive rain, flood and cyclone. Due to these disasters the ponds are affected; the bank destruction and consequent water contamination occur. For using such unhygienic water she and

Box 4: Drinking Water Scarcity- The Story of a Widow

her family suffer from diarrhea and skin diseases sometimes. Thus Jamila is striving for collection, storing, purifying and using water for drinking purpose.

64. Nowadays, the natural disasters have become more frequent and of higher intensity. The ill effect of such situation on drinking water supply and availability has been a point of concern for Jamila Khatun. She thinks that collection of drinking water will be tougher in near future. Also she is anxious about the quality of the drinking water.

65. In the case of rainwater harvesting, the government provides large tanks to households. However, only politically powerful people control the distribution, and as a result, prefer to meet their own demand first. In that case, poor and powerless people are usually deprived of getting tank for rainwater harvesting.

66. With respect to formal institutions, the government institutions, local government office (Union *Parishad*) and NGOs are involved in ensuring water supply . The government provides free tubewell to local people through union *parishads*. The government also provides tanks/drums for rainwater harvesting, and in constructing pond for rainwater retention and use by local people. DPHE, a government organization is involved in developing water infrastructure such as PSF. NGOs such as BRAC and CCDB are involved in providing PSF, tanks for rainwater harvesting.

3.2 Climatic risks for drinking water, sanitation and hygiene, and adaptations

67. The climate change-associated problems for drinking water, sanitation and hygiene are given below:

- Heavy rainfall leads to latrine submergence that eventually contaminates water source.
- Extreme weather events such as *Aila* and *Sidr* destroy embankment and pond dykes and pushing saline water in.
- Temperature increase leads to dryness of ponds.

68. For adapting to these changing climatic conditions, local people follow several measures. In most cases, people start using pond water as soon as the flood water is drained out, and they use alum (*fitkiri*) to purify water for drinking. A few cases have been found where people use lime directly in the pond to maintain water quality. In Nishanbaria and BuriGoalini unions, a practice was found in which the entire pond water was pumped out after flooding, and then refilled it with rainwater. Thus, the pond was restored. Rain water harvesting and use is the most significant attempt to adapt to the climatic impacts for drinking and domestic water. They collect and store rain water, especially in the rainy season, in drums, buckets and tanks. In Nishanbaria union, DPHE (under the World Bank funding) provided plastic tanks for rain water storing. In dry season, people follow traditional filtering method (Figure 3.5) to filter/purify pond water from dirt.

4. WaterSupply and Livelihoods

4.1 Livelihoods Profile

69. The study considered water-dependent livelihoods in the coastal zone. Here, livelihoods have been identified in terms of major activities. Thus, livelihoods activities include: farming, livestock, poultry and duck rearing, and fishery. Based on these activities, several livelihood groups have emerged in the study area over the years.

70. **Farming:**Farming activities include crop/vegetables production. In the study area, crops namely paddy are produced in the cultivable land, whereas vegetables are mostly produced in the kitchen garden. In Char Clerk union, vegetables are also produced commercially in the field. The following table shows study area-wise cropping pattern in different seasons. There are three major cropping seasons viz.*Kharif-I*, *Kharif-II* and *Rabi*. The *Kharif-I* season is characterized by the uncertainty of weather of alternating dry and wet spells. In this season, agricultural potential land remains fallow in four out of six studied unions. On the contrary, *Aus* rice is grown in Nowabpur and Ranapasha unions in this season.The*Kharif-II* season comprises wet and cloudy environment and heavy rainfall but uneven distribution, low solar radiation, high temperature and humidity. In this season, local improved varieties of *Aman* are grown under rain fed condition, and sometimes with supplemental irrigation. During the *Rabi* season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield. HYV *Boro*, pulses, oilseeds, spices and winter vegetables are grown in this season in the study unions except in Char Duanti union (Table-4.1) (Appendix A).

Table 4.1: Cropping pattern in the study area

Studied Unions	Kharif-I Season	Kharif-II Season	Rabi Season
Char clerk	Fallow	Aman	Vegetables, HYV Boro
Nowabpur	Aus	Aman	Vegetables
Ranapasha	Aus	Aman	Spices, pulses, oilseeds
Nishanbaria	Fallow	Aman	Vegetables
Char Dunati	Fallow	Aman	Fallow
BuriGoalini	Fallow	Aman	Vegetables

Source: CEGIS, 2017

71. Irrigation is essential for HYV T. *Aus* production. However, irrigation is not possible during *Kharif-I* season for some unions (such as Char Clerk, Nishanbaria, Char Duanti and BuriGoalini) since water become saline. For watering/irrigation to the vegetable gardens, cultivator used pond water/retained rainwater. All producers are smallholders and most of the farming activities are run by family laborer.

Figure 4.1: Photograph of *Aus* rice field in the Nowabpur union

Figure 4.2: Photograph of Vegetables field in the Char Clerk

72. Livestock and Poultry Rearing: Rearing of livestock, poultry and duck at the household level is a common practice in all studied unions. Mostly youths are involved in livestock rearing, whereas women are involved in poultry and duck rearing. Crisis of fodder was found acute in saline-prone **areas** like Nishanbaria, Char Duantia, and BuriGoalini as salinity decreases growth of grass. In these areas, people use separate pond for livestock (for bathing and feeding). Foot and Mouth Disease (FMD) of livestock is commonly found in these saline prone areas. This disease is due to the exposure to salinity. FMD in some cases causes death of livestock also.

Figure 4.3: Photograph of a student is rearing poultry last two years in the Nishanbaria union

Figure 4.4: Photograph of duck rearing began again after *Aila* in the Charduanti union

73. **Fishery:**This sector includes people who are involved in fishery related activities in several ways. Thus, there is a group called 'fish farmer' who cultivate fresh water white fish and Goldain ponds, and brackish water shrimp and crab in *ghers* (shrimp aquaculture pond) (see Appendix B). Besides, there are also traditional fishermen who usually capture/catch fish from open water sources such as canals, river etc. There are also part time fishermen who are mainly from other occupations but tend to catch fish when there is abundance of fish in open sources (e.g. canals etc.). There is a group of fisher called subsistence fishermen who usually catch from their own pond for their own consumption.

74. Out of the study unions, traditional fishermen of Char Clerk, Nawabpur and Char Duanti unions catch fish from Hatia Channel, and Feni, Biskhali Rivers round the year. On the other hand, part-time fishermen of these unions catch fish from June to October from Kalidas, Machar and Hogla*Khals*. Subsistence fishermen of these unions catch fish from their own ponds for their own consumption round the year. On the other hand, fishermen of Nishanbaria and BuriGoalini depend on fish culture in their *ghers* (see Appendix B).

4.2 Existing Sources and Challenges

75. Existing sources of water (for agriculture, fishery, livestock and poultry) and associated challenges are described below in terms of four key concepts: water availability, water affordability, water quality and ability to get water.

4.2.1 Water Availability

76. This section describes available sources of water, and challenges people encounter to get water from those sources. The following table (Table 4.2) presents union wise water sources, their usage for crop production and associated challenges. Farmers use groundwater, surface water and rainwater for crop/paddy production. Rainwater is largely used for Aman production (rain-fed Aman). Main challenges for getting irrigation water include: (i) siltation of river and khals, (ii) drying up of waterbodies during dry season, and (iii) salinity-led decreases of cropping area. An alarming challenge is salinity intrusion in Char Clerk union (Box-5).

Box 5: Increase of salinity and future risk for agriculture

77. Mr. Islam (pseudonym) is a farmer who lives in Islampur village of Char Clerk union of Noakhali district. According to him, there are deep pumps since the last three years in this village to irrigate the agricultural fields. This facility enables the farmer nowadays to cultivate vegetable and Boro rice in Rabi season which was not possible previously. In this area, farmers can now grow vegetables commercially. Thus, total crop production is increasing day-by-day. However, this enabling situation is under gradual threat as salinity is increasing in this union. During dry season, there is a presence of salinity in open waterbodies, although ground water is still good in quality. According to Mr. Islam, vegetables and Boro production would not be possible in future, if salinity intrudes into the ground water.

78. The study team found that local people of all the studied unions adopted a practice of homestead plantation (fruit trees and vegetables) after being severely affected with *Aila*. For this cultivation, they use surface water, groundwater and often, rainwater.

Table 4.2: Available sources of irrigation water along with challenges

Studied Unions	Irrigation Sources	Usage	Challenges
Char clerk	Ground water, rainwater	*Boro* and vegetables(DTW),*Aman*(Rain-fed)	- Siltation - Unavailability of water in open waterbodies during dry season - Saline water often comes through STW
Nowabpur	Ground water, Surface water (*khal*), rainwater	*Aus* and vegetables (STW& LLP)	- *Khal*might be silted up without maintenance - Unavailability of water in open waterbodies during dry season
Ranapasha	Surface water (mostly canals; often, from pond in October, November & December), and rainwater	*Aus* and vegetables (LLP)	- Siltation - Unavailability of water in open waterbodies during dry season
Nishanbaria	Rainwater	*Aman* (Rain-fed), vegetable (harvested rainwater)	- Salinity lead to decrease of *Aman*/crop field
Char Dunati	Rainwater	*Aman* (Rain-fed)	- Salinity lead to decrease of *Aman*/crop field
BuriGoalini	Rainwater and surface water (pond)	*Aman* (Rain-fed), vegetables (use pond water, often harvested rainwater)	- Salinity lead to decrease of *Aman*/crop field

79. The following case (Box-6) shows a process of permanent land conversion from crop production to shrimp aquaculture pond. In this case, extreme disaster like *Aila*was a key event that affected soil and water sources and eventually pushed farmers to convert their land into shrimp *ghers*.

Box-6: Extreme disaster-led salinity ingress leads to land conversion

80. *BuriGoaliniunion is under Shyamnagarupazila of Sathkhira district which is close to Kholpetua River. Total area of this union is 4224 ha. Before the union was hit bycyclone Aila and a very severe storm surge in 2005, about 60% people of this village used to cultivate local transplanted Aman, and also grow vegetables along with brackish water shrimp cultivation. Contrarily, about 15%*

people used to cultivate brackish water shrimp in the ghers permanently. The remaining people of this union were involved in open water fishing (e.g. nearby Kholpetua River or PorakatlaKhal) and/or laboring activities. However, after Aila, salinity intruded into the cropland and waterbodies that eventually led to the presence of salinity in soil and water round the year. As a result, crop production was gradually decreasedleading to conversion of about 1500 ha (rotationally) cultivable land into shrimp aquaculture ponds. Vegetables and fruit trees are now cultivated in kitchen garden rather than in the field.

81. With respect to fishery, fish is grown in ponds in Char Clerk, Nowabpur and Ranapasha unions, whereas fishermen catch fish from river and *khals* in these unions. Regarding challenges, it was found that siltation of river and *khals* lead to decrease of fish habitats, fish migratory routes and spawning grounds. Besides, water is scarce in the river and *khal* during dry season, and this unavailability of water leads to decrease in fish species. On the other hand, saline water is gradually increasing in waterbodies in Nishanbaria, Char Duanti and BuriGoalini unions. As a result, the crop field is being converted into shrimp aquaculture ponds.

Figure 4.5: Photograph of a four year old Guava fruit tree in the Suborno Char union

Figure 4.6: Photograph of a four year old Jamrulfruit tree in the BuriGoaliniunion

Figure 4.7: Photograph of vegetable cultivation in the homestead area at BuriGoaliniunion

Figure 4.8: Photograph of pit crops in the homestead area at Ranapasha union

4.2.2 Water Affordability

82. As mentioned before, Deep Tubewell (DTW) is the main source for irrigation in Char Clerk union. DTW is operated in Rabi season for the cultivation of commercial vegetables as per requirement by farmers. One DTW can irrigate 20-25ha of land. Per ha land irrigation cost varies from 9000-9500 BDT. In most cases farmers pay 50% of the cost during irrigation, and the rest 50% is paid after harvesting and selling crops (*Boro* crop). Partial irrigation is required for vegetable production in which cost varies from 4000-4500 BDT per ha.

83. In Nowabpur and Ranapasha unions, many farmers have their own LLP for producing Rabi crops. Farmers irrigate their field through long pipe with no visible loss of water. The cost for LLP including pipe varies from 10,000 to 12,000 BDT including pipe. Only farmers who can afford, purchase and use LLP. Additionally, farmers of Nowabpur union use water from STW. The cost for STW installation varies from 35,000-40,000 BDT. Some farmers who can afford install and use STW individually. In most of the cases, a group of farmers install STW by sharing cost.

84. In Nishanbaria and BuriGoalini, vegetables are cultivated at the kitchen garden. For gardening, there is a need for small scale water that is given from harvested rainwater. Women usually harvest rainwater for drinking purpose, but tend to use for vegetable production in Rabi season. Additionally, in BuriGoalini people often use water from pond for vegetable production. On the other hand, there is no cultivation of Rabi crops (*Boro* or vegetables) in Char Duanti union due to unavailability of freshwater (or abundance of saline water).

85. With respect to fish culture in Char Clerk, Nowabpur and Ranapasha, there is no cost involved in getting water from pond. People usually connect their ponds to adjacent khals and or retain rainwater for fish culture. On the other hand, fish farmers in Nishanbaria, Char Duanti and BuriGoalini cultivate brackish water shrimp, fresh water fish and crab in their *ghers*. For shrimp cultivation, fish farmers push saline water by creating channel connecting to the adjacent *khals*. For getting water, there is no cost involved. On the other hand, farmers retain rainwater in their *gher* during wet season and cultivate fresh water fish; therefore, no cost is involved in this case as well. However, if there is excessive water in the *gher* due to heavy rainfall and/or flooding, farmers are to fence with net to protect their fish that involved some cost.

4.2.3 Water Quality

86. In Char Clerk and Ranapasha unions there is no water quality related problem for irrigation. However, in Nowabpur, the presence of iron was found in STW. Due to iron in water, the number of tiller per hill became less that might results in production loss. Furthermore, salinity is gradually increasing in Char Clerk union that might lead to decrease of crop land in future. On the other hand, salinity associated problem is acute in Nishanbaria, Char Duanti and BuriGoalini unions. This has led to the conversion of cultivable land into shrimp aquaculture ponds. Besides, salinity decreases fodder, vegetation,and rural infrastructures. Saline water matters for livestock as well. It was found that Foot and Mouth Disease (FMD) of livestock is common in saline-prone unions.

87. With respect to fishery, no water quality related problem was found in Char Clerk, Ranapasha and Nowabpur unions. On the other hand, salinity emerged as an opportunity for brackish water fish cultivation in Nishanbaria, Nowabpur and BuriGoaliniunions.Salinity decreased fresh water fish culture although small scale cultivation is in practice.Furthermore,

excessive salinity level lead to shrimp to be infested with white-spot disease (WSSV: White-Spot Syndrome Virus).

88. Local people of Char Clerk and Nawabpur unions argued that a good number of fish species was present when fresh water was available in all *khals* round the year before being hit by *Aila* (severe storm surge. These*khals* had also abundant fish, from where local people could catch commercially and seasonally. However, water of these *khals* became saline immediately after *Aila* and thus, salinity is still present in these sources. As a result, freshwater capture fish species were decreasing gradually.

4.2.4 Ability to Get Water

89. In Char Clerk union, Sub Assistant Agricultural Officer (SAAO) of Department of Agricultural Extension (DAE) is responsible for suggesting priority in irrigation water use. Alongside, there is a committee comprising local farmers who control irrigation. Thus, the SAAO makes a priority list according to who needed irrigation in terms of dryness of the field. Following the list, the local committee irrigates land. In this union, all beneficiary farmers were happy with this arrangement, therefore, no social conflict was found. In Nowabpur and Ranapasha unions, there was no social conflict related to sharing or getting water.

90. In saline-prone areas such as Nishanbaria, Char Duanti and BuriGoalini, water comes from river through *khals* to *ghers*. Almost all *khals* here have no functional regulators that often lead to social conflict related to water pushing in/out among shrimp cultivators.

4.3 Sustainable Access to Water: Role of Institutions, Women and Youth

91. With respect to formal institutions, the local Department of Agricultural Extension (DAE) is involved in decision making for water allocation. For example, in Char Clerk union, SAAO of DAE decides which farmer needs irrigation. Until now, SAAO decides based on the demand of that paddy field (dryness) rather than political or personal biases. However, the main control of for water distribution is not in his hand. Instead, there is a local committee comprising of local farmers who distribute irrigation water. Most of the LLPs were found to be installed by individual farmer. However, some LLPs are installed and managed by a group of farmers with shared cost basis.

92. Women are involved in vegetable production in the kitchen garden. They are also involved in fruit tree cultivation, and duck and poultry rearing. In those cases, women collect water from ponds and use for gardening. Even, women use harvested rainwater (collected for drinking) for kitchen garden and poultry. On the other hand, youths are involved in paddy production and livestock rearing. They are directly involved in irrigation in the field, and in collecting fodder for livestock.

93. With respect to fishery, there is no formal institution actively involved in fishery management. The study team did not find any fish pass in the studied unions although there are some sluice gates. Most of these sluice gates are inactive and maintained by local farmers/fishers. In saline-prone unions, sluice gates are maintained/operated by *gher* owners/shrimp cultivators. Women are involved in feeding fish (in *ghers*). They are also involved in clearing weeds of shrimp *ghers* and sorting actual shrimp fry (fry of *Bagda* and Golda). On the other hand, youths are involved in *gher* preparation, fry collection, watering, fry releasing, fish harvesting and selling.

4.4 Climate Change: Risks for Livelihoods and Adaptations

94. The following climatic risks are perceived to be crucial for coastal livelihoods:

- Sea level rise
- Temperature fluctuations
- Precipitation changes
- Salinity changes

95. With respect to these climatic risks, salinity was found increasing gradually in the river and *khals* of Char Clerk union due to sea level rise. As a consequence, farmers kept their cultivable land fallow. Besides, farmers use water from DTW for commercial vegetable production. On the other hand, salinity intrusion in Nishanbaria, Char Dunati and BuriGoalini union was increasing due to sea level rise. As a result, farmers are converting their cultivable land into shrimp aquaculture pond.

96. Changes in precipitation were found all over the studied unions. According to local people, previously rainy season used to begin in April to May, but now it starts in May to June and often, shifts to July as well. For this late raining, farmers tend to use new varieties of rice developed by BRRI & BINA to maintain crop production.

97. Due to increasing salinity, fresh water fish species is decreasing in saline prone unions. Fish cultivators build dyke and/or use net around the *gher* and pond to protect fish from flooding. Dissolved Oxygen (DO) level may be reduced due to temperature fluctuation that can cause insufficient oxygen in pond/*gher* water leading to death of fish species. For adapting to this situation, fish cultivators often change water from pond/*gher*.

98. Due to variation in salinity level in the end of March-mid May, excess salt is present in water which is harmful for shrimp. If temperature is > (25-30)0c, salinity is> (5-25) ppt., shrimp might be affected with WSSV (White Spot Syndrome Virus) disease. For adapting to this situation, shrimp cultivators usually harvest and sell cultivated shrimp frequently. They often, also replace shrimp cultivation with crab cultivation (Box-7).

Box 7: Salinity induced disease and changing livelihood

99. Moinul Islam (pseudonym) is a shrimp cultivator. He along with his family lives at Datinakhali village of BuriGoaliniunion in Satkhira district. Mr. Islam converted his agricultural land into shrimp gher more than one decade ago. Since then, he cultivated shrimp in his gher with family labor and maintained livelihood. For cultivation, he usually pushes saline water into the gher from Kholpetua River through PorakatlaKhal. However, after Aila's severe storm surge, excessive salinity intruded in the gher that resulted in deterioration of water quality. As a result, most of the shrimp was affected with White Spot disease (WSSV: White-Spot Syndrome Virus) leading to death of shrimps. For this reason, Mr. Islam faced a huge loss in that year that compelled him to replace shrimp cultivation with crab culture.

5. Knowledge Sharing with Local Stakeholders

5.1 Introduction

100. Three Public Dissemination Meetings were arranged to fully share the findings of this study with the relevant stakeholders and to register their responses to develop the conclusions and recommendations. Stakeholders of Patharghata and Barguna met at Patharghataupazilaon 2nd August, 2017; those of Morrelganj and Bagerhat met at Morrelganjupazila on 3rd August, 2017 and those of Noakhali and Subarnacharmet at Subarnacharupazila on 12th September, 2017.

101. In the meeting at Patharghataupazila, Upazila Agriculture Officer was the Chairperson; Chief Guest was Upazila Chairman, Patharghataupazila and Special Guest was Executive Director of CEGIS. Similarly, the meeting which was arranged at Morrelganjupazila, UpazilaNirbahi Officer (UNO) conducted the role of Chairperson, whereas Chief Guest was the UpazilaParishad Chairman, Morrelganj, Bagerhat and Special Guest was Executive Director of CEGIS. Finally, the meeting which was conducted in Subarnacharupazila of Noakhali, the Chairperson was Upazila Livestock Officer, Chief Guest was UpazilaParishad Vice-Chairman, Subarnacharupazila and Special Guest was UpazilaParishad Vice-Chairman (female), Subarnacharupazila.

Figure 5.1: Photograph of public dissemination meeting at Patharghata upazila

Figure 5.2: Photograph of public dissemination meeting at Morrelganj upazila

Figure 5.3: Photograph of Public dissemination meeting at Subarnachar upazila

5.2 Presentation of Findings

102. The CEGIS study team presented its findings to the stakeholders who attended those meetings. Following findings were mainly presented for discussion:

- Present level of access to water supply is low in general at all six sample Union Parishad areas.
- Water availability is restricted by salinity and distance from community residences.
- Water quality is poor in general.
- Present sources of water are highly limited and unsustainable (PSFs and TWs, rivers and canals).
- Livelihoods of all types are threatened by water scarcity.
- Social power structure around water supply (DTWs or PSFs) is unfavorable for the poor and disadvantaged groups.
- PSF and other sources of water are highly expensive to maintain and society has not adequate knowledge, motivation and resources to keep the sources effective for usage.

5.3 Suggestions and Complaints

103. The audience took interest in the presentation, agreed to the findings in general and gave their suggestions and complaints in the following lines:

A. Patharghata Meeting

Suggestions for improvement: -

- Groundwater use for irrigation has to be rationalized to allow for drinking water;
- More ponds are to be excavated near homesteads for drinking water without pollution;
- Sluice gates are to be constructed to stop saline water entry into ponds; and
- Training on community awareness and management for water collection has to be imparted.

Complaints for Redress:-

- Locations of deep tube wells are difficult and costly to access due to distance, requiring hiring of transports,
- Pond Sand Filter devices are under influence of the power-holder groups, chasing money for water.

B. Morrelganj Meeting

Suggestions for Improvement:-

- Salt-tolerant rice varieties are to be encouraged;

- More canals are to be excavated, more sluice gates are to be placed to stop saline water intrusion into ponds;
- PSF maintenance committee is required with local UP Chairman;
- Rainwater harvesting supports (supply of big drums and overhead tanks etc.) are needed;
- Drainage systems have to be improved and more NGO's involvement (10 to 12 NGOs are working now in the area), and
- Awareness training is needed, particularly for women regarding proper use of water.

Complaints for Redress:-

- Tubewell water is saline,crops damaged due to salinity;
- PSFs are mostly abandoned, and
- DPHE wells are out of work

C. Subarnachar Meeting:

Suggestions for Improvement: -

- More deep ponds should be excavated and more tube wells should be installed after conducting the water quality tests,such as iron and arsenic tests or salinity tests ;
- More tube wells should be installed at locations where powerless or poor people can have easy access to water.
- PSFs should be installed.
- Practice of rainwater harvesting should be increased.
- Trainings should be given for water preservation, rain water harvesting, and public awareness should be built.

Complaints for Redress: -

- Unplanned canals and dams have been created, which lead to water logging.
- During summer, surface water becomes unavailable and water scarcity arises.

6. Conclusions and Recommendations

6.1 Conclusions

104. Safe water scarcity is an alarming problem/issue in the coastal zone. Salinity intrusion in groundwater is the main reason behind this scarcity. In addition to this, inundation of tube-wells and ponds due to flood and tidal water intrusion, is also a big challenge. Nowadays, the coastal zone is becoming more affected with climatic variability, which adds another challenge to water access. This water scarcity affects all, regardless of age and gender, but women are highly vulnerable to this as they are mostly responsible for collecting water for drinking and domestic purposes. Women are exposed to both physical and mental stress particularly due to distance of water sources, social barriers and security issues. In many cases of water collection when the distance is very long, men are involved in collecting water as well. The process of water collection is time consuming as well. Although pure water is the necessity of everyone, due to shortage of tubewells,these people are forced to use polluted water both for drinking and domestic purposes; and thus, they are susceptible to health hazard.

105. Although the profile looks discouraging, the study reflects that potentials for augmentation of water resource, social engagement and infrastructural development exist. These potentials are to be harnessed, utilized and maintained to ensure such access to fresh water in sustainable way.

106. Finally, from the situation analysis of existing levels of access to water supply for the coastal population, it can be derived that for Ensuring Sustainable Access to Water Supply in the coastal zone it is highly important to take the necessary actions which will be suggested in the following section of the report.

6.2 Recommendations

107. Drawing upon the above context, ensuring sustainable access to water supply in coastal zone of Bangladesh, requires actions on four major fronts which are as follows:

Water Resource Augmentation

- Excavate new ponds, particularly in saline prone area, for community usage, and restore/recover ponds those are unsuitable to use (due to salinity, methane concentration and such others);
- Ensure proper maintenance of relevant infrastructures such as tube-wells, ponds, and filters (PSF) through community participation, appropriate motivation, and training to young men and women in localities
- Ensure rivers and other water sources areclean by discouraging and/or prohibiting people not to throw dead animals and kitchen or household waste in the rivers;
- Re-excavate rivers and *Khals* to increase the fish habitats, and to protect capture fish species particularly in dry season;
- Make surface water sources free from encroachment;

Infrastructural Support

- Install deep tube-wells considering the household coverage and accessibility of local people;
- Provide equipment for water filtering at household level;
- Introduce improved rainwater harvesting technology, and provide rainwater collection tanks of technically suitable size at community level and harvesting equipment and training to the poor people;
- Test water sources for determining arsenic, iron, salinity and other possible hazardous elements;
- Introduce new technologies to check salinity intrusion into irrigation water and crop fields;
- Introduce new saline tolerant crop varieties, and ensure availability of seeds in the local market;

Social Empowerment

- Local women and youth should be engaged in operation and maintenance of PSFs such as Washing Filter Bed;
- Arrange training for the farmers on agriculture, farming, proper seeding use, and efficient irrigation system at time of water scarcity etc.;
- Train up fishermen/ fish cultivators about the excessive salinity and temperature, and how to adapt with changing situation;

Policy and Regulatory

- Prepare a post-disaster recovery plan to recover affected water sources, Install PSF with improved technology for water purification, provide water to local people for free, and ensure access to all by eliminating political interference;
- Initiate a policy to maintain a balanced water withdrawals for drinking and irrigation purposes, and also train the users; and
- Control unplanned brackish water shrimp cultivation.

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Appendices

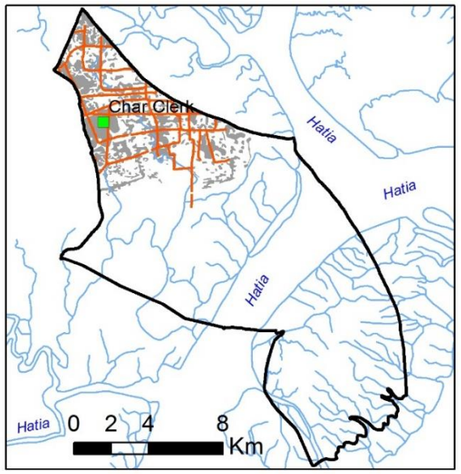
Appendix A: Crop calendar in the study area

Appendix B: Fishing calendar in the study area

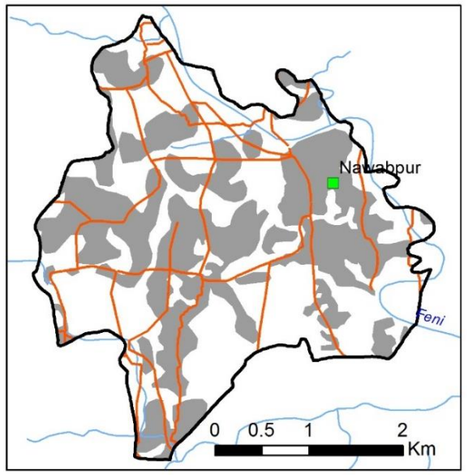
Union	Sources of water		Jan.	Feb.	March	April	May	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.
Char Clerk	Rainfed	Culture Fisheries in pond												
		Capture Fisheries												
	Hatia Channel	Fish catch by Traditional fishers												
	Hatia Channel	Fish catch by Part-time fishers												
Nawabpur	Kalidas Khal	Culture Fisheries in pond												
		Capture Fisheries												
	Feni River, Kalidas Khal	Fish catch by Traditional fishers												
		Fish catch by Part-time fishers												
Ranapasha	Biskhali River through Kailshakhal	Culture Fisheries in pond												
		Capture Fisheries												
	Biskhali River	Fish catch by Traditional fishers												
	Biskhali River through Kailshakhal	Fish catch by Part-time fishers												
Nishanbaria	Baraikhali River through khal	Fresh water species (Golda and White fish in gher)												
	Baraikhali River through khal	Brackish water species (Shrimp in gher)												
Char Duanti	Rainfed	Culture Fisheries in pond												
		Capture Fisheries												
	Balesware River,	Fish catch by Traditional fishers												
	Balesware River, Machar Khal, Lathimara Khal	Fish catch by Part-time fishers												
BuriGoalini	Kholpetua River through Porakatla Khal	Fresh water species (Golda and White fish in gher)												
	Kholpetua River through Porakatla Khal	Brackish water species (Shrimp in gher)												

Legend:			
Fry Release		Cultivation	
Traditional fishers		Part-time fisher	
Capture Fisheries		Harvesting	

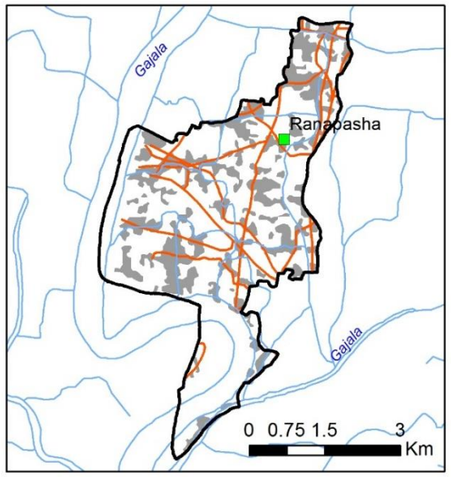
Appendix C: Study area map



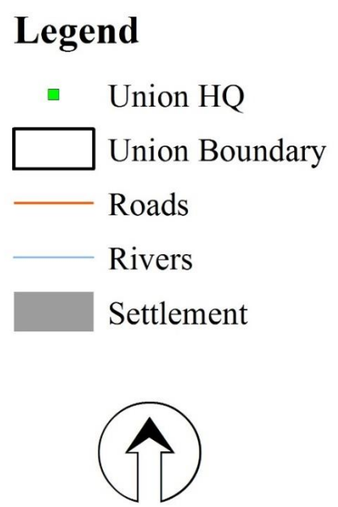
Char Clerk Union, Subarnachar Upazila
District Noakhali

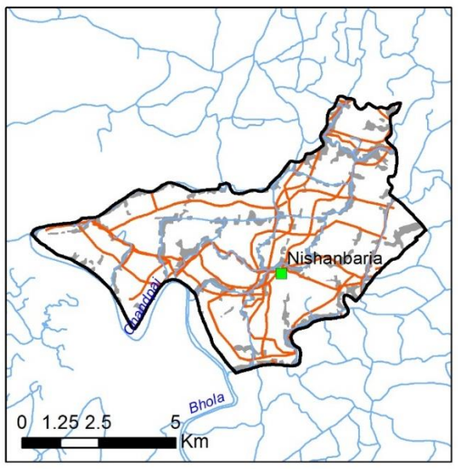


Nawabpur Union,Sonagazi Upazila
District Feni

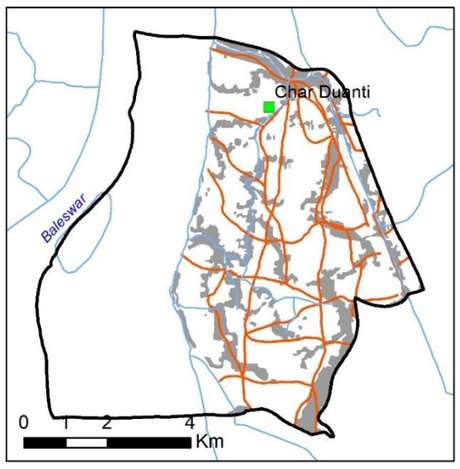


Ranapasha Union, Nalchity Upazila
District Jhalokati

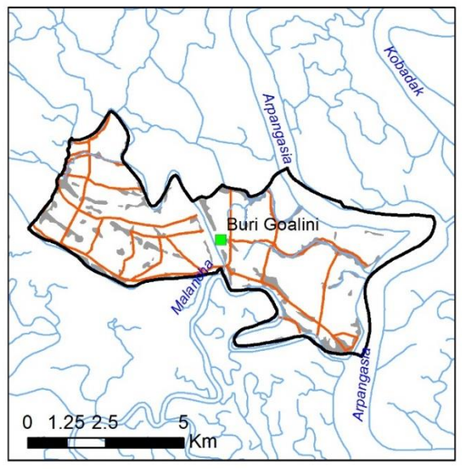




Nishanbaria Union, Morrelganj Upazila
District Bagerhat



Char Duanti Union, Patharghata Upazila
District Barguna



Buri Goalini Union, Shyamnagar Upazila
District Satkhira

Location of Study Area

Appendix D: Semi-structured Questionnaire

DcK~jxq AÂ‡j cvwb mieivn I RxweKvi Dci Rjevqy cwieZ©‡bi cÖfve wbiæc‡bi cÖkœcÎ

1. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (%)

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২.	□□□□□□□□□□ (০.৫০-১.৪৯)		
৩.	□□□ (১.৫০-২.৪৯)		
৪.	□□□□□□□ (২.৫০-৭.৪৯)		
৫.	□□ (৭.৫০+)		

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৫.১□□□□□□□□□□□□□□□□□(□□□□□□□□□□□):

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7. □□□□□□□□□□□□□□□□□ (□□□□□□, □□□□□□, □□□□□□□□□□□) □□□?

8. □□?

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□□□□□□□□□□□			

১০[illegible]			

9. [illegible]? (১[illegible])

[illegible]	[illegible] ([illegible]- [illegible])	[illegible]-১ ([illegible]- [illegible])	[illegible]-২ ([illegible]- [illegible])
[illegible]			
১০[illegible]			

10. [illegible]?

[illegible]	[illegible] [illegible] (%)	[illegible](%)	[illegible] [illegible] (%)
[illegible]			

২০10			

11. [illegible]?

[illegible]	
[illegible]	
[illegible]	
[illegible]	

12. [illegible]?

13. [illegible]?

14. [illegible]?

[illegible]	২০[illegible]	[illegible]
[illegible]		
[illegible] ([illegible], [illegible])		
[illegible] ([illegible]/[illegible], [illegible])		
[illegible]		

15. [illegible]১০[illegible]?

16. [illegible]/ [illegible]
([illegible])?

১৬.১. [illegible]?

- [illegible]?
- [illegible]?

17. [illegible]?

[illegible]	[illegible]	[illegible]
[illegible]		
[illegible]		

18. [illegible]

19. [illegible] ([illegible])

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]			
[illegible]			

20. Mevw` cïi aiY:

aiY	msL¨v		‡iv‡Mi aiY		‡iv‡Mi KviY		‡iv‡Mi cÖwZKv‡i M„nxZ e¨e¯’v	
	10 eQi c~‡e©	eZ©gvb	10 eQi c~‡e©	eZ©gvb	10 eQi c~‡e©	eZ©gvb	10 eQi c~‡e©	eZ©gvb
Miæ								
gwnl								
QvMj								
‡fov								
nuvm								
gyiMx								
KeyZi								

21. gvQ Pv‡li Rb¨ cvwbi Drm:

22. cvwbi Dr‡mi aiY:

23. cªavb gv‡Qi cÖKvi I bvg:

	cÖavb gv‡Qi cÖKvi I bvg		gvQ Pv‡l e¨eüZ GjvKvi cwigvY		gvQ Avni‡Yi cwigvY	
	10 eQi c~‡e©	eZ©gvb	10 eQi c~‡e©	eZ©gvb	10 eQi c~‡e©	eZ©gvb
AvniY						
Pvl						

24. gv‡Qi cªvc¨Zvq cwigv‡Yi cwieZ©b:

	PvlK…Z gv‡Qi cwigvY		gvQ Avni‡Yi cwigvY	
	10 eQi c~‡e©	eZ©gvb	10 eQi c~‡e©	eZ©gvb
AvniY				
Pvl				

25. gvQ aiv cÖavb †ckv Kx-bv? (bv n‡j, †ckv cwieZ©‡bi KviY)

26. GB GjvKvq †Kvb& cvwbi gv‡Qi AvwaK¨ †ekx? jebv³ cvwb/wgwó cvwb

27. MZ 10 eQ‡i b`x/Lv‡ji cvwbi jebv³Zvq †Kv‡bv ai‡Yi cwieZ©b jÿ¨ K‡i‡Qb Kx? cwieZ©b n‡q _vK‡j Zv D‡jøL Kiæb|

28. GB cwieZ©b Avcbv‡`i †ckvq Kx cÖfve †d‡j‡Q?

29. Rjevqy cwieZ©‡bi d‡j cyKz‡i jÿYxq cwieZ©b mg~n Kx Kx?

30. cyKz‡i GK (01) wgUvi ev Kgc‡ÿ `yB (02) nvZ MfxiZvq cvwb eQ‡i Kq gvm ¯’vqx nq? 10 eQi c~‡e© K‡Zv gvm ¯’vqx n‡Zv?

31. GB BDwbq‡b grmRxex I grmPvlxi msL¨v K‡Zv? GmKj RxweKvq gwnjv‡`i Dcw¯’wZi nvi †Kgb?

32. grmRxexiv gvQ aiv Qvov RxweKv wbe©v‡ni Ab¨ †Kvb& Kv‡R ¯^v”Q›`¨ †eva K‡i|

33. Rjevqy cwieZ©‡bi mv‡_ Awf‡hvwRZ n‡Z wK wK e¨e¯’v MªnY Kiv n‡q‡Q?

34. grm¨ Pv‡l Kx ai‡Yi cÖwkÿ‡Yi cÖ‡qvRbxqZv Av‡Q e‡j g‡b K‡ib?

35. Awf‡hvRb cÖwµqvq grm¨ Pv‡l mdjZv _vK‡j ejyb| G cÖwµqvq grm¨ Pv‡l Amyweav _vK‡j ejyb I Amyweav `~ixKi‡Y Kx e¨e¯’v †bqv †h‡Z cv‡i e‡j g‡b K‡ib?

36. □□?

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- □□□□□□□□□□□□□□□:

37. bZzb cÖwkÿ‡Yi d‡j gvQ Pv‡l †Kvb ai‡Yi cwieZ©b n‡q‡Q wK bv?

□□□□□□□□□□	□□□	□□□□□□□□□□□□□
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প্রশ্নাবলী

	শুষ্ক মৌসুম	বর্ষা মৌসুম
১. এলাকায় পানির বর্তমান অবস্থা		
১.১) আপনাদের খাবার পানির প্রধান উৎস কি কি?	নলকূপ/ পুকুর/ খাল/ নদী/ বৃষ্টির পানি/ pond sand filter/iron removal plant অন্যান্য (উল্লেখ করুন)ঃ বৃষ্টির পানি খাবার জন্য কি পদ্ধতিতে সংরক্ষণ করা হয়?	নলকূপ/ পুকুর/ খাল/ নদী/ বৃষ্টির পানি/ pond sand filter/iron removal plant অন্যান্য (উল্লেখ করুন)ঃ বৃষ্টির পানি খাবার জন্য কি পদ্ধতিতে সংরক্ষণ করা হয়?
১.২) পানির কোন উৎসের উপর আপনারা বেশী নির্ভরশীল? (বেশি থেকে কম গুরুত্বপুর্ণ)	১) ২)	১) ২)

	শুষ্ক মৌসুম	বর্ষা মৌসুম
	৩)	৩)
১.৩) এলাকায় খাবার পানির উৎসের প্রাপ্যতা কি রূপ?	১) ভাল ২) মোটামুটি ৩) কম	১) ভাল ২) মোটামুটি ৩) কম
১.৪) উৎস থেকে খাবার পানি প্রাপ্তিতে আপনারা কি ধরণের সমস্যার সম্মুখীন হন?		
১.৫) উৎসে খাবার পানির পর্যাপ্ত কিনা ? অপর্যাপ্ত হলে কারণ কি?		
১.৬) খাবার পানি অপর্যাপ্ত বা দুষ্প্রাপ্য হলে আপনারা সাধারণত কি করে থাকেন?		
১.৭) এ সমস্যা সমাধানে কি করা উচিৎ বলে মনে করেন?		
১.৮) আপনার এলাকার খাবার পানির উৎস কারা নিয়ন্ত্রণ করে? (উদাঃ ব্যক্তি, গোষ্ঠি, এনজিও,সরকারি অফিস ইত্যাঃ)		
১.৯) এই নিয়ন্ত্রণ কিভাবে হয়ে থাকে?		
১.১০) নিয়ন্ত্রণ-জনিত কোন সামাজিক সমস্যা আছে কি		

	শুষ্ক মৌসুম	বর্ষা মৌসুম
না? (উদাঃ সামাজিক কলহ, মামলা ইত্যাঃ)		
১.১১) খাবার পানির গুণগত মান কেমন? (উদাঃ ১) লবণাক্ত: ২)আয়রন মুক্ত: ৩) আর্সেনিক মুক্ত: ৪) অন্যান্য (উল্লেখ করুন)		
১.১২) খাবার পানির গুণগত মান বজায় রাখতে কি ধরণের সমস্যা হয়?		
১.১৩) খাবার পানি সংগ্রহে কি ধরণের সমস্যা হয়?		
১.১৪) এ সকল সমস্যা সমাধানে কি ধরণের পদক্ষেপ নেয়া হয়?	খানা পর্যায়েঃ স্থানীয় পর্যায়েঃ সরকারীভাবেঃ বেসরকারিভাবেঃ	খানাপর্যায়েঃ স্থানীয়পর্যায়েঃ সরকারীভাবেঃ বেসরকারিভাবেঃ
১.১৫) সমস্যা সমাধানে আরও কি করা উচিৎ বলে মনে করেন?		
১.১৬) খাবার পানি কিনতে হয় কি? হলে আপনাদের আর্থিক সামর্থ্য আছে কি?		

	শুষ্ক মৌসুম	**বর্ষা মৌসুম**
১.১৭) যদি সামর্থ্য না থাকে তাহলে কিভাবে সমাধান করেন?		
১.১৮) দৈনন্দিন গৃহস্থালি কাজে কোন উৎসের পানি ব্যবহার করা হয়? (গৃহস্থালি কাজ=গোসল, রান্না, ধোয়া-মোছা ইত্যাদি)	উৎসের নামঃ	উৎসের নামঃ
১.১৯) গৃহস্থালি কাজে ব্যবহৃত পানি নিরাপদ ও পর্যাপ্ত কি?		
১.২০) গৃহস্থালি কাজে ব্যবহৃত পানি অনিরাপদ ও অপর্যাপ্ত হলে আপনারা কি করেন?		
১.২১) গৃহস্থালি কাজে ব্যবহৃত পানি সংগ্রহে কি ধরণের সমস্যার সম্মুখীন হন?		
১.২২) এই সমস্যা সমাধানে কি করা হয়?	খানা পর্যায়েঃ স্থানীয় পর্যায়েঃ সরকারীভাবেঃ বেসরকারিভাবেঃ	খানাপর্যায়েঃ স্থানীয়পর্যায়েঃ সরকারীভাবেঃ বেসরকারিভাবেঃ
২। স্বাস্থ্য সংক্রান্ত		
২.১) পানিজনিত ও পানিবাহিত কি কি ধরণের রোগ-বালাই হয়?		
২.২) মৌসুম ভেদে রোগ সংক্রমনের কোন তারতম্য হয় কি?		

	শুষ্ক মৌসুম	বর্ষা মৌসুম
(রোগের নাম উল্লেখ করুন)		
২.৩) কোন বয়সের ও লিঙ্গের লোকজন বেশি আক্রান্ত হয়? (উদাঃ ১) বয়স, ২) পুরুষ, ৩) মহিলা,		
২.৪) আপনাদের পয়নিষ্কাশন ব্যবস্থা দ্বারা পানির উৎস দূষিত হয় কি?		
২.৫) দূষণ রোধে কোন ব্যবস্থ্যা আছে কি? থাকলে কি কি? (উদাঃ ব্যক্তি, সমাজ, ইউনিয়ন, এনজিও ইত্যাদি পর্যায়ে)		
৩.পানি ও জেন্ডার		
৩.১) পরিবারের কোন বয়সের কে কে খাবারপানি সংগ্রহ করেন? [(উদাঃ লিঙ্গ-পুরুষ, মহিলা) (বয়সের সীমাঃ- ১০-১৫; ১৬-২০; ২১-২৫; ২৬-৩০; ৩১-৪০; ৪১-৫০)]		
৩.২) পানি সংগ্রহে নারীদের কি ধরণের সমস্যা হচ্ছে? (উদাঃ১)সামাজিক/ধর্মীয়, ২) রাজনৈতিক, ৩) স্বাস্থ্যগত)		
৩.৩) পানি ব্যবস্থাপনায় নারীর অংশগ্রহণ আছে কি ? থাকলে তাদের ভুমিকা কি?		
৩.৪) যদি না থাকে, তাহলে সমস্যা/প্রতিবন্ধকতা কি?		
৩.৫) পানি ব্যবস্থাপনায় নারীর অংশগ্রহণ কি করে নিশ্চিত করা যায়?		

	শুষ্ক মৌসুম	বর্ষা মৌসুম
৪) পানি, জলবায়ু পরিবর্তন ও অভিযোজন		
৪.১) আপনাদের এলাকার প্রধান কি কি প্রাকৃতিক দুর্যোগ রয়েছে?		
৪.২) প্রাকৃতিক দুর্যোগের কারণে পানির উৎস কিভাবে ক্ষতিগ্রস্ত হচ্ছে		
৪.৩) ক্ষতিগ্রস্ত পানির উৎসগুলো পুনরায় ব্যাবহার উপযোগী করতে আপনারা কি করছেন? (উদাঃ ১) খানা, ২) কমিউনিটি,৩) এনজিও, ৪) সরকারি ইত্যাদি)		
৫.পানির সমস্যা সমাধানে অংশগ্রহণকারী প্রতিষ্ঠানসমূহ		
৫.১) পানীয় জলের সমস্যা, এর প্রভাব এবং তা প্রতিকারের জন্য কোন কোন সংস্থা কাজ করছে?	সংস্থাসমূহের নামঃ	
৫.২) সংস্থা সমূহ কি ধরণের সেবা প্রদান করছে?	সেবার ধরণঃ ১) ২) ৩)	
৫.৩) পানির সার্বিক সমস্যা সমাধানে আর কি কি কাজ করা যেতে পারে?		