Where We are

Wash situation in South-West part of Bangladesh

WASH SDG 6 Programme

WASH ALLIANCE International
Accelerating WASH

Simavi
Powerful women, healthy societies

Uttaran

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Overall Supervision

Shahidul Islam

Report preparation team

Gouranga Nandy
Jahin Shams Sakkhar
Zahid Amin Shashoto
Hasina Parvin
Hedayet Ullah
Nazma Akter
Rushated Ullah

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House # 32 (1st Floor), Road # 10/A
Dhanmondi R/A, Dhaka -1209, Bangladesh.
Tel: 88-02-91222, Cell: 88-01711828305
e-mai: uttaran.dhaka@gmail.com
web: www.uttaran.net

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Director's Message

Uttaran has been working for the rights of the underprivileged communities around the coastal region of Bangladesh for long three and half decades. Uttaran is a people centered grass root organization with a vision to establish a society with gender, class, and caste equality.

Uttaran works with the most extreme poor, landless and climate vulnerable communities who constantly suffers from water logging, sedimentation of river, frequent cyclone and tidal surge, drinking water crisis and extreme salinity. In the past decade, the situation here is further aggravated due to climate change and sea level rise coupled with poor planning and coastal infrastructure.

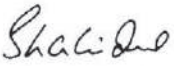
Since our inception ensuring people's basic need "Water, Sanitation and hygiene" has always been a key priority of Uttaran. Due to Southwest's climate vulnerability and frequent disaster this has always been a major challenge especially for the underprivileged communities. Over the years our work for the overall development of WASH facilities around the Coast has been praised nationally and internationally. Our key strategy does not only limit to providing WASH service rather we prioritize our activity through a right based approach and creating a market system for ensuring the development and availability of WASH facilities for people from all walks of life.

Uttaran with the assistance of Netherland Government and Simavi has been implementing a project to improve the overall WASH conditions of Satkhira and Barguna district last few years.

In recent times, the project has become an exemplary action to develop the WASH facilities in climate vulnerable regions.

This report is produced under the project and provides key insights about the WASH situation of the project's implementing area. The report also looks through environmental situation of the area as well as key obstacles to achieve 100 per cent WASH target and what needs to be addressed.

I am very much grateful to the Netherlands Government who have always been a great friend for the people of Bangladesh and now have extended their cooperation and continuing support to the development of the coastal people. I truly believe the project will play an integral role in achieving 100% coverage around the coast of Bangladesh.



Sahidul Islam
Director
Uttaran

Abbreviations & Acronyms

BBS	Bangladesh Bureau of Statistics
Beel	Low Land
BWDB	Bangladesh Water Development Board
CEP	Coastal Embankment Project
DMB	Disaster Management Bureau
EC	Electric Conductivity
EP-WAPDA	East Pakistan Water and Power Development Board
FGD	Focus Group Discussion
FSM	Fecal Sludge Management
FY	Financial Year
Gher	Shrimp Firm
GIS	Geographical Information System
GoB	Government of Bangladesh
HHS	House Hold Survey
HYV	High Yield Varieties
JICA	Japan International Cooperation Agency
Kancha	The houses made with mad/soil
km	Kilometer
Kobadak	The main river of the study area
LGED	Local Government Engineering Department
LGIs	Local Government Institution's
LPG	Liquid Petroleum Gas
NGO	Non-Government Organization
O&M	Operation & Maintenance
PSU	Policy Support Unit
PWD	Persons with Disability
SDP	Sector Development Plan
SPARRSO	Space Research and Remote Sensing Organization
SWM	Solid Waste Management
ToR	Terms of Reference
WASA	Water Supply and Sewerage Authority
WASH	Water Sanitation and Hygiene
WATSAN	Water Supply and Sanitation
WHO	World Health Organization

Executive Summary

This study incorporates a detail exploration of Water Sanitation and Hygiene related issues like environmental condition,drinking water scarcity, probable sources, sustainability in the south-western coastal area of Bangladesh. The objectives are to recognize and identifythe existing WASH (Water Sanitation and Hygiene) situation, water sources, challenges towards mitigate these basic needs considering environmental condition in south-west part of Bangladesh.

Water is a fundamental resource for life and livelihood. The distribution, allocation, and management of water resource remain a significant concern. Especially, in many water-stressed regions of the world, it plays a vital role in social, financial and political strategies. Access to safe drinking water is a basic well-being and financial advancement issue at national, regional and local levels. The world's population is expected to reach eight billion by 2025, growing demands on drinking water supplies and water for food production are evident, and competing uses of limited resources are inevitable.

In the coastal areas of Bangladesh, the deficiency of drinking water is intense as the freshwater aquifers are not available at reasonable depths and the surface water is profoundly saline and turbid. Shrimp farming has been increased over the past two decades by essentially changing the local land use, and adversely influencing surface and groundwater resources. Salinity intrusion due to natural causes e.g., storm surge, sea level rise and estuarine tidal action, as well as anthropogenic reasons, e.g., abstracting saline water for shrimp culture, is affecting both surface and groundwater sources. Water and sanitation infrastructure damage due cyclone, tidal surge and inundation of low lands and off-shore islands.

Bangladesh is a low-lying deltaic country. Topographically the country may be divided into alluvial plains and hilly areas. More than 90% of the total area of Bangladesh is low land, an alluvial plain formed by the sediments of the several great rivers and their tributaries and distributaries which traverse the country.

Elevations of the plains are less than 10 m above the sea level; elevation furthers decline to a near sea level in the coastal south. Most of the coastal parts and associated inland of Khulna and Barisal divisions lie within 1 m from sea level. A Digital Elevation Model study that the southwest region of Bangladesh is dominated by flat topography. The landscape has a low ridge and a basin relief crossed by many tidal rivers and creeks.

Water exists in solid, liquid and gaseous form. Oceans and seas are the main sources of water on earth, but this water is salty. The fresh liquid water sources on land surfaces and in the ground, constitute only 1% of the total water on earth. These fresh water sources have been formed by condensation of water evaporated mainly from the oceans and seas. The main sources of water in Bangladesh are surface waters in rivers, reservoirs, lakes, canals and ponds, and groundwater in shallow and deep aquifers. The rainwater is an alternative source of water. Both the surface and ground water sources may be fresh or saline.

People often have a poor understanding about the relationship between health, water and sanitation. In some areas, this understanding may exist but people of some areas still practice unsanitary habits. Experience have shown that it is often easier to change technology than people's behavior and practices. Though situation has already been developed but mortality from water-borne diseases are still a significance number and achievement in behavioral changes in sanitation leaves much to be desired.

The most influence word is sustainability in development arena. The World Commission for Environment and Development initiated the sustainability discussion in their 1987 report. The focus of the concept is that the activities by the present generation should not compromise the resources, or the environmental conditions of future generations. This report has influenced the thinking in development cooperation and several definitions have emerged for sustainable water and sanitation. The success or sustainability of a project is achieved when it meets its objectives and is maintained by its users over a significant period.

The primary reasons for the expansions if salinity and freshwater shortage in the south-western coastal region are the withdrawal of water from major rivers in the upstream and siltation on the river bed, drainage congestion and water logging caused by the improper polder management. Many causes have been identified to examine the difficulties of supplying fresh water i.e. saline water intrusion, reduction of upstream flow, sea level rise, disasters, polder, arsenic contamination, brackish shrimp cultivation, excessive use of underground water in an unplanned way, lack of appropriate aquifer etc.

WASH is a key public health within international development and is the focus of the first two targets of sustainable development 6. Targets 6.1 and 6.2 aim at equitable and accessible water and sanitation for all. 'Access to WASH' includes safe water, adequate sanitation and hygiene education.

No doubt, improving access to WASH services can improve health, life expectancy, student learning, gender equality, and other important issues of international development. This can reduce illness and death, and affect poverty reduction and socio-economic development. Challenges include providing services to semi-urban and waterlogging area like Satkhira, Khulna and part of the Jashore distict in south-west part of Bangladesh. If we want to achieve the fulfillment of WASH target then it is necessary to consider above scenario.

1. Background

Access to safe water and sanitation are recognized human rights (UNICEF 2021). Uttaran and many other like-minded organizations work towards the progressive change of these rights with a focus on priority interventions for children, vulnerable families and communities especially backward or outcast families in the south-west region of Bangladesh. However, still do many things to achieve the goal. So, it is necessary to analyze the situation and address the needs of vulnerable populations; ensure arrangements are in place to prevent the most vulnerable households from using unsafe water sources; incorporate a stronger equity lens in planning, monitoring and evaluation, including targeting geographic areas and communities with the lowest coverage and greatest vulnerability.

All of we know that water is a fundamental resource for life and livelihood. The distribution, allocation, and management of water resource remain a significant concern. Especially, in many water-stressed regions of the world, it plays a vital role in social, financial and political strategies (Arsel and Spoor, 2009). Access to safe drinking water is a basic well-being and financial advancement issue at national, regional and local levels (World Health Organization, 2011; Cvjetanovic, 1986). The world's population is expected to reach eight billion by 2025, growing demands on drinking water supplies and water for food production are evident, and competing uses of limited resources are inevitable (UNDP, 2006).

Bangladesh is a small, lush country in South Asia; located on the Bay of Bengal. The country is divided between three regions. Most of the country is dominated by the fertile Ganges Delta, the largest river delta in the world. The northwest and central parts of the country are formed by the Madhupur and the Barind plateaus. The northeast and southeast are home to evergreen hill ranges.

The Ganges delta is formed by the confluence of the Ganges (Padma), Brahmaputra (Jamuna, main channel of the Brahmaputra) and Meghna rivers and their respective tributaries. The Ganges unites with the Jamuna and later joins the Meghna, finally flowing into the Bay of Bengal. Bangladesh is called the Land of Rivers, as it is home to over 57 trans-boundary rivers. However, this, makes the resolution of water issues politically complicated, in most cases, as the country is a lower riparian state to India.

Bangladesh is predominantly rich fertile flat land. Most of it is less than 12 m (39 ft) above sea level, and it is estimated that about 10% of its land would be flooded if the sea level were to rise by 1 m (3.3 ft). 17% of the country is covered by forests and 12% is covered by hill systems. The country's haor wetlands are of significance to global environmental science.

Bangladesh is home to much of the Sundarbans, the world's largest mangrove forest, covering an area of 6,000 squire-km in the southwest region. The forest is a UNESCO World Heritage Site. All around one out of seven individuals has needed access to even least supplies of safe drinking water to fulfil their fundamental personal and residential needs. Several millions are left with no decision, however stroll for a considerable length of time to gather water from hazardous sources, for example unprotected well, streams or lakes utilized by animals (WASH United, Freshwater Action Network and WaterLex, 2012).

However, significant achievement has been achieved over most recent couple of decades in giving safe drinking water, but mostly withdrawing groundwater in Bangladesh. Yet in the recent years, groundwater based water supply in the coastal areas have been experiencing various significant issues, principally arsenic sullying, bringing down of the water table, salinity and unavailability of reasonable aquifers (PDO-ICZMP, 2004). The extent of utilizing and improved drinking water source was 97.9% in 2012-13, 98.5% in 2013 and 86.9% in 2015 (Bangladesh Bureau of Statistics, 2014; BBS, 2015; World Bank, 2016). Lack of safe drinking water has been identified as the number one issue in the daily life of the coastal population (Islam and Ahmad, 2004).

Arsenic and saline contamination make difficulties for supplying potable water to the underprivileged people of the country. The poor and destitute people cannot bear the cost of water technologies due to the financial crisis. Another measurement of hard to reach areas is the shortage of land for establishing the water technologies as they live on a small piece of land on street or embankment. In such cases, despite having the ability, individuals can't ensure safe water for themselves (NGO Forum for Public Health, 2012).

In the coastal areas of Bangladesh, the deficiency of drinking water is intense as the freshwater aquifers are not available at reasonable depths and the surface water is profoundly saline and turbid (Islam et al., 2014). Shrimp farming has been increased over the past two decades by essentially changing the local land use, and adversely influencing surface and groundwater resources (Datta et al., 2010).

Actually, salinity intrusion due to natural causes e.g., storm surge, sea level rise and estuarine tidal action, as well as anthropogenic reasons, e.g., abstracting saline water for shrimp culture, is affecting both surface and groundwater sources. Water and sanitation infrastructure damage due cyclone, tidal surge and inundation of low lands and off-shore islands.

WHO (2004) found that the groundwater is inadmissible for human consumption due to high salinity in the south- western region of the country (Khulna, Satkhira and Bagerhat district). Further, Ali (2006) reported that, saline water intrusion has caused issues in terms of severely declining the supply of potable water. Both surface and groundwater have been polluted by saline in this area. For this, rainwater is the most suitable for meeting drinking water needs. Islam (2015) also reported that rain water harvesting system (RWHS) is an important innovative livelihood option for safe drinking water in the exposed salinity-prone coastal area. The dwellers can collect water in monsoon and use for next five months in drought season only for drinking purpose.

2. Study Objectives

The objective of this study was to identify the existing WASH (Water Sanitation and Hygiene) situation, water sources, challenges towards mitigate these basic needs considering environmental conditionin south-west part of Bangladesh.

Specific objectives of this study were:

a) To identify existing environmental situation in southwest region of Bangladesh;

b) To identify and establish evidence of existing water sources;

c) To identify the sustainability of the WASH program; and

d) To identify major challenges in WASH activities.

3. Approach and Methodology

Both primary and secondary data were generated in this study. Together qualitative and quantitative approaches were applied for data collection, analysis, and presentation. In this study, Satkhira, Khulna, Bagerhat and Jashore district was selected. The environmental situation of this area is analyzedbased on secondary documents, constraints of safe water supply and sanitation situation have been identified by reviewing different published, unpublished documents and consulting the key personnel of this area. The approach and methodology followed and major specific activities carried out under the study are summarized below:

3.1 Document Review

The study team collected, compiled and reviewed necessary relevant documents, particularly those on WASH situation in urban and national level surveys (PMID-WSUP, 2013; PSU-ICDDR'B-WaterAid, 2014; WHO-UNICEF, 2014).

3.2 Field Visits And Consultations

The study team had meetings with Uttaran officials. The meetings were very useful for better understanding of the assignment and getting a clear overview of the projects implemented by Uttaran. The study team finalized the modalities of work in consultation with Uttaran. Special emphasis was placed on the WASH facilities along with other important issues. The study team also visited the possible project locations to have an overview of the present situation in the field. Focus Group Discussions (FGDs) were finalized based on the findings of the field visits by the study team and discussions carried out with Uttaran officials.

3.3 Focus Group Discussion

A total of 8 Focus Group Discussions (FGDs) in the 4 selected areas were carried out in accordance with the ToR. The main purpose of the FGDs was to get views of the people of the Uttaran's working areas on different aspects of wash related activities, its uses and difficulties are usually facing people. Participation of different stakeholders including member of different professions, age groups, genders and social groups were ensured in the FGDs.

FGDs being conducted at: (a) Two FGD's -one is women group and another is male at Satkhira municipality; (b) Two FGD's (male, female mix group) at Khulna; (c) Two FGD's at Bagerhat and (d) the rest two FGD's are taking place in Jashore.

To understand the peoples' view and their understanding and observation about the WASH situation, environmental problem, water sources and availability and WASH related problem twenty key informant interview has also been taken.

4. Result and Analysis

4.1 An Overview of the areas

Bangladesh is a low-lying deltaic country. Topographically the country may be divided into alluvial plains and hilly areas. More than 90% of the total area of Bangladesh is low land, an alluvial plain formed by the sediments of the several great rivers and their tributaries and distributaries which traverse the country. Elevations of the plains are less than 10 m above the sea level; elevation furthers decline to a near sea level in the coastal south. Most of the coastal parts and associated inland of Khulna and Barisal divisions lie within 1 m from sea level. Adhikary et al. found from a Digital Elevation Model study that the southwest region of Bangladesh is dominated by flat topography. The landscape has a low ridge and a basin relief crossed by many tidal rivers and creeks. Local differences in height are generally less than 1 m. Maximum tidal ranges vary from 2.5 to 3.5 m (spring tide). During the tide, the variation ranges from 1.5 to 2.5 m.

Rainfall

It is clear from monthly rainfall distribution that minimum rain occurs from November to April-the period which is regarded as the dry period (i.e. non-monsoon) in Bangladesh. In contrast, most rain occurs during the remaining months which regarded as wet period (i.e. monsoon). Nevertheless, the period from June to September (i.e., peak monsoon) receives the lion share of the total rainfall throughout the year. The rainfall of Khulna division during the peak monsoon period was remarkably lower as compared to that at national average.

It is evident from future projection (by linear regression) that although summer rainfall is found almost static but autumn rainfall is in increasing trend in Khulna Division as well as throughout the country i.e., national average. Recently, Mondal et al. have also analyzed the rainfall data for a period of 63 years (1948-2010) at Khulna region and found that the number of rainy days in a year and the maximum number of consecutive rainy days are found to be increasing in the southwest coastal region of Bangladesh. They also found that the rainfalls have increasing trends where most increment will be occurred during monsoon.

Like the result of the present study, there are some evidences also found from Mondal's study that the monsoon is strengthening towards the end of the season. These along with increasing future projection in autumn rainfall suggest that water congestion in the days to come would be prolonged in the locality even after end of the monsoon.

Urbanization

Level of urbanization or simply urbanization may be defined as the proportion of a region's population that lives in towns and cities. Urbanization is the increasing number of people that migrate from rural to urban areas. It predominantly results in the physical growth of urban areas, be it horizontal or vertical. As per recent UN data, approximately 25% of Bangladesh population currently lives in urban areas. Level of urbanization in Bangladesh in 2011 was found as 28.4%. Urbanization process is relatively slow in Khulna areas due to collapse of the major industries like jute, pulp, paper and match industries etc in the region.

Drainage system

Geographically a lot of rivers-crisscrossed the study area that are used for draining water from the locality. Some of the main catchments and their drainage divides are mentioned.

Khulna-Jessore Drainage Area (K-JDA): It is one of the major waterlogged areas (100,600 ha) in the region that comprised the south-eastern part (27,200 ha) and north-western part (73,400 ha). PDO-ICZMP broadly explained the drainage system of K-JDA. Briefly, the south-eastern system of K-JDA is comprised of three main catchments: Beel Dakatia or Polder 25 (14,300 ha), Polder 27 (4,900 ha) and Polder 28 (8,000 ha). Previously the western part of Polder 27 drained towards the Hamkura River. This river is no longer functioning, and all drainage has been diverted into the Upper Sholmari. Beel Dakatia also drains into the Upper Sholmari. Polder 28 drains into a constructed canal named Ramdia-Joykhali Khal.

The north-western part of K-JDA comprised (i) Mukteswari?Teka ?Hari River basin (45,200 ha) that consists of 8 large beels (low-lying pockets of the landscape) such as Kedaria, Kapalia, Paira, Barunia, Khukshia, Rudagara, Madhugram and Bhaina, and (ii) Harihar? Upper Bhadra River basin (28,200 ha) that contains some small and medium sized beels such as Pajia, Patra and Baruli etc. The former basin comprised two main catchments:

Mukteswari (29,200 ha) and the Hari (16,000 ha). The Hari drains water of its own catchment, plus the discharge from the Mukteswari. The later basin also comprised two main catchments: Harihar (16,500 ha) and Upper Bhadra (11,700 ha). The Upper Bhadra drains water of its own catchment, plus the discharge from the Harihar.

Kobadak River basin: Kobadak River is 180 km length that originated from Bhairab River at Chaugachha, Jashore and outfalls at Khalpetua River at Koyra, Khulna. It is one of the major inland rivers in southwest region of the country. Total catchment area of Kobadak River is 800 square km. It drained water from the many catchments from Chaugachha, Jhikargachha and Keshabpur upazilas of Jashore District and Tala Upazila of Satkhira District. Following the siltation of Kobadak, water logging problem began to appear seriously in some of those catchments.

Atharobaki-Chitra Rivers basin: Bhuter beel that constituted from Shachiadah, Chagladah and Terokhada unions of Terokhada Upazila in Khulna District drained to adjacent Chitra River. The Chitra finally drained to Atharobaki River and Kaliabordia River. Atharobaki River partially dead due to siltation however Kaliabordia River is still alive. Nevertheless 5329 ha crop land of Bhuter beel become waterlogged due to recent siltation of Chitra River.In order to drain Bhuter beel the central part of Chitra was excavated by the BWDB but that was silted-up again.

The responsibility for water management is carried out by the BWDB. To remove water congestion people wants to implement TRM but the BWDB is not so interested to implement it due to some legal issues like compensation process/method of suffering people. The BWDB maintains about 37 polders with 1566 km of embankments and 282 drainage sluices that constructed by CEP in the study areas.

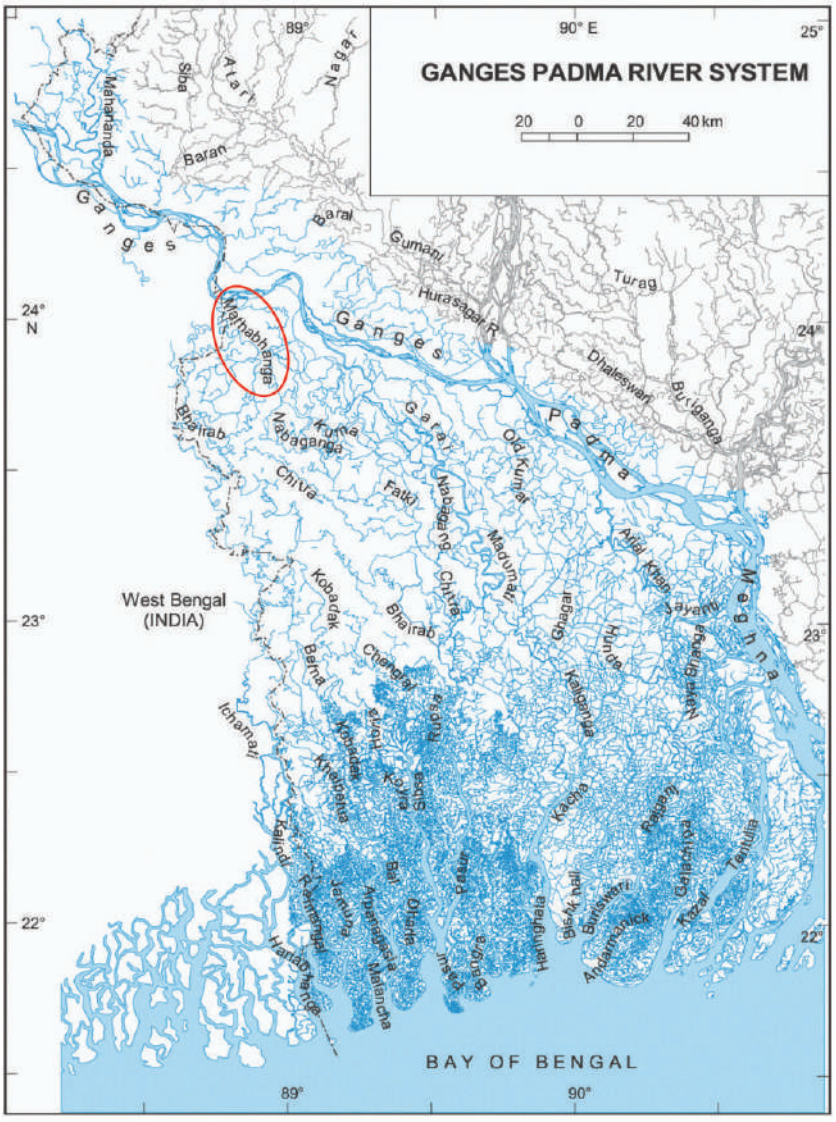
Causes of water logging in south-west Bangladesh

The major cause for water logging can be explained as rising of riverbed due to siltation as influenced by retardation of upstream river flow for human intervention, as well as deprivation of floodplain (low land, locally so called beel) to silt deposition due to embankment or polderization.

The main source of river flow of the southwest rivers of Bangladesh is Ganges. The rivers of that region were much living and the ecosystem was rich with sweet water due to strong upstream pressure. During the nineteenth century, the rivers of that region were detached from the source Ganges due to death of Mathabhanga (a branch of Ganges). Hence, some rivers named Kobadak (locally Kopotakho), Bhairab and Betna (which had linkage with the Mathabhanga River) begun to lose their speed thus siltation occurred at the time of ebb-tide due to the lack of upstream river pressure. Gradually the silt is started to deposit into those rivers and can't pass the upstream water flow.

River course is a dynamic process which governs any agro-ecological system. In course of time, however, the aforesaid silted up rivers became a curse instead of a blessing.

In early 1960s, EPWAPDA established the CEP to convert the seasonally flooded coastal wetlands into reclaimed land for permanent agricultural production under the Green Revolution Programme (GRP), as well as to protect human settlements from the cyclone, tidal surge and associated floods, saline water intrusion etc.



Map of river system in south-west Bangladesh. Mathabhanga River is shown inside the elliptic closure

A series of embankments and polders were constructed around the southern coastal region of the country as a part of the CEP. With that Water Master Plan 37 polders, and associated 1566 km embankment and 282 sluice gates were constructed in the Khulna, Satkhira and part of Jessore districts.

Before establishing the embankment, boat was only the single type of vehicle used for communication in the region. After polderiation, the embankments are used as roads for communication. During construction of embankments, many cannels and discharge path of water being closed but relatively less number of culverts, bridges or opening is developed at that time. Additionally, maximum culverts didn't construct with necessary height for water discharge and pillars of bridges also help to siltation. Therefore, problem arises for discharging the water from those regions. Because the slope of land in those regions is north-south oriented but maximum embankments are developed to east-west face. So, rivers and channels lost their natural flow and create water logging at that region.

The polder/enclosure system was developed and implemented in line with the "green revolution" paradigms of "grow more food". The idea was to promote cultivation of HYV crops in dry lands with controlled irrigation, thus the output of that large-scale engineering intervention was found obviously good with producing rice 2 to 3-fold higher than ever before. It was also noticed that the CEP area was out of food insecurity even when the whole country fall scarcity of foods. But day by day, the improper operation and poor management of polders/embankments and their sluice gates have caused a series of problems, and accordingly within a few years, the negative impacts of the project began to appear including the siltation of riverbeds, increased saline intrusion, the narrowing of river estuaries and changes in the normal morphological processes of river. Consequently, river flows were affected and many rivers silted up, affecting navigation. The biodiversity especially for flora species of the region became degraded.

Bhabodah Sluice gate

By the early eighties polders became a bane rather than a boon for the people, as rivers failed to maintain their natural courses. Tides deposited silt on the riverbeds and sluices, rather than the floodplains, for more than two decades, halting the natural flow of the rivers and sluices of the polders. The consequent dearth of land formation left floodplains inside the polders lower than riverbanks i.e., inside the polders, the wetlands subsided due to non-deposition of silt and gradually took the shape of lakes (i.e., beel). As a result, river flow discharges to over the beel. Thus, rainwater could not drain from the area's leading to chronic water logging. Over a hundred thousand hectares of land in Khulna, Jessore and Satkhira districts became waterlogged, and agriculture became impossible.

Another concern is that the elevation of greater Khulna area is much lower (even less than a meter) than that the other coastal parts, a significant proportion of which again falls below high-tide level. Moreover, the embankments are at risk of overtoppingdue to storm surge, high tide or sea-level rising, leading to saline water-logging within the polderized areas.

Sea level Rise

Global warming is raising sea levels around the planet by 2-3 mm each year. However, the distribution will not be uniform due to ocean density and circulation changes. The rise along the Bangladesh coast could be 0-5 cm more than the global average. That only adds to bigger problems in the Ganges-Brahmaputra delta, which is sinking so rapidly that the local, relative sea level may be rising by up to 2 cm each year. It is found from the analysis of satellite data that relative sea-level rise is occurring for Bangladesh is 8-18 mm/yr. whereas the tide gauge analysis from southwest Bangladesh found that mean sea level is climbing at 5 mm/yr. but high-tide level has risen by 15-20 mm/yr. in some spots. Mondal et al. analyzed tidal water levels of the Rupsa-Pasur River at Khulna and at Hiron Point that located near to the Bay of Bengal for a period of 74 years (1937-2010) and found that the annual maximum tidal high-water level is increasing and the annual minimum low water level is decreasing at a rate of 7-18 mm and 4-8 mm/yr. depending on the locations, respectively. The possible reasons for the decreasing trends in annual minimum water levels could be the reduction in the sweet water flow from upstream areas or the reduction in storage areas of saline tidal water or both. The increasing trends in annual maximum water levels could result either from silting up of the rivers, reduction in flood tide propagation areas, or a rise in the sea level, or a combination of these factors.Sea level rise will aggravate the drainage congestion, water logging and flooding problems that are already severe in the urban and peri-urban areas of Khulna.

River system

The rivers of Bangladesh mark both the physiography of the nation and the life of the people. About 700 in number, these rivers generally flow south. The larger rivers serve as the main source of water for cultivation and as the principal arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but overworked soil. The rivers also drain excess monsoon rainfall into the Bay of Bengal. Thus, the great river system is at the same time the country's principal resource and its greatest hazard.

The second system is the Padma-Ganges, which is divided into two sections: 258 kilometers (160 mi) segment, the Ganges, which extends from the western border with India to its confluence with the Jamuna some 72 kilometers (45 mi) west of Dhaka, and 126 kilometers (78 mi) segment, the Padma, which runs from the Ganges-Jamuna confluence to where it joins the Meghna River at Chandpur. The Padma-Ganges is the central part of a deltaic river system with hundreds of rivers and streams-some 2,100 kilometers (1,300 mi) in length-flowing generally east or west into the Padma.

The Ganga-Brahmaputra rivers contribute nearly 1000 million tons/yr. of sediment.The sediment contributed from these two rivers forms the Bengal Delta and Submarine fana vast structure that extends from Bangladesh to south of the Equator which is up to 16.5 km thick, and contains at least 1130 trillion tones of sediment accumulating over the last 17 million years at an average rate of 665 million tons/yr. The Bay of Bengal used to be deeper than the Mariana Trench, the present deepest ocean point.

During the annual monsoon period, the rivers of Bangladesh flow at about 140,000 cubic meters per second (4,900,000 cu ft./s), but during the dry period they diminish to 7,000 cubic meters per second (250,000 cu ft./s). Because water is so vital to agriculture, more than 60% of the net arable land, some 91,000 square kilometers (35,000 sq. mi), is cultivated in the rainy season despite the possibility of severe flooding, and nearly 40% of the land is cultivated during the dry winter months. Water resources development has responded to this "dual water regime" by providing flood protection, drainage to prevent over flooding and water logging, and irrigation facilities for the expansion of winter cultivation. Major water control projects have been developed by the national government to provide irrigation, flood control, drainage facilities, aids to river navigation and road construction, and hydroelectric power. In addition, thousands of tube wells and electric pumps are used for local irrigation. Despite severe resource constraints, the government of Bangladesh has made it a policy to try to bring additional areas under irrigation without salinity intrusion.

Water resources management, including gravity flow irrigation, flood control, and drainage, were largely the responsibility of the Bangladesh Water Development Board. Other public-sector institutions, such as the Bangladesh Krishi Bank, the Bangladesh Rural Development Board, the Bangladesh Bank, and the Bangladesh Agricultural Development Corporation were also responsible for promotion and development of minor irrigation works in the private sector through government credit mechanisms.

Flood

About 80% of Bangladesh's rain falls during the monsoon season. The monsoons result from the contrasts between low and high air pressure areas that result from differential heating of land and water. During the hot months of April and May hot air rises over the Indian subcontinent, creating low-pressure areas into which rush cooler, moisture-bearing winds from the Indian Ocean. This is the southwest monsoon, commencing in June and usually lasting through September. Dividing against the Indian landmass, the monsoon flows in two branches, one of which strikes western India. The other travels up the Bay of Bengal and over eastern India and Bangladesh, crossing the plain to the north and northeast before being turned to the west and northwest by the foothills of the Himalayas.

There are no precautions against cyclones and tidal bores except giving warning and providing safe public buildings where people may take shelter. Necessary expert services, equipment, and training facilities were expected to be developed under the United Nations Development Program.

Natural hazards that come from increased rainfall, rising sea levels, and tropical cyclones are expected to increase as the climate changes, each seriously affecting agriculture, water and food security, human health, and shelter. Sea levels in Bangladesh are predicted to rise by up to 0.30 meters by 2050, resulting in the displacement of 0.9 million people, and by up to 0.74 meters by 2100, resulting in the displacement of 2.1 million people.

4.2 Sources of Water

Water exists in solid, liquid and gaseous form. Oceans and seas are the main sources of water on earth, but this water is salty. The fresh liquid water sources on land surfaces and in the ground, constitute only 1% of the total water on earth. These fresh water sources have been formed by condensation of water evaporated mainly from the oceans and seas (Ahmed and Rahman 2000). The main sources of water in Bangladesh are surface waters in rivers, reservoirs, lakes, canals and ponds, and groundwater in shallow and deep aquifers. The rainwater is an alternative source of water.

In Bangladesh, the sources of water are surface water and ground water. Both the sources may be fresh or saline.

Surface water

Surface water sources are categorized as rainfall, transboundary flow, water on standing water bodies (water storage in reservoir, water bodies such as river, lake and pond), water on seasonal wetlands, and in-stream storage. These are describing below:

i) Rainfall Average annual rainfall of the country is about 2360 mm (1960-1997). In recent years northwest and southwest region of the country receives less rainfall compared to other parts. About 20% of the average annual rainfall occurs in dry season (November-May) in northwest region but the monthly distribution of this amount is highly uneven.

ii) Transboundary flow Bangladesh shares 57 transboundary rivers, 54 incomings from India, 3 from Myanmar. Among the rivers, the Ganges, the Brahmaputra and the Meghna drain about 1.08 million sq.km., 0.58 million sq.km. and 0.09 million sq.km. respectively. Total annual volume of water that enters the country from the transboundary rivers is about 1000 billion cubic meters. Crucial issue of the transboundary flow is the diminishing values of the lean season inflow to Bangladesh. Due to indiscriminate and unilateral upstream withdrawal of water of common rivers during lean period when the country needs it (in absence of any rainfall), a water crisis is prevailing in Bangladesh. The southwest part (Ganges Dependent Area) of the country is the most affected region due to upstream withdrawal of the Ganges at Farakka where irreversible environmental degradation is happening.

Peak monsoon flow is often causing flood in Bangladesh. In normal year, about 20% of the country is inundated which in extreme cases may rise to 60% like 1987, 1988, 1998 flood.

iii) Water on standing water bodies in addition to natural rivers, water is retained in localized low pockets (beels/baors) and ponds in dry season. Kapatai lake is the lonely reservoir in the country that has storage capacity. Total volume of such standing water bodies is about 0.61 billion cubic meters.

iv) Water on seasonal wetlands Floodplains (about 80% of the total area of the country) become seasonal wetlands during monsoon (July-October) because of slow drainage of huge transboundary flow and local rainfall excess. The seasonal wetlands remain inundated from a few days to if several months (May-November). Estimated volume of water stored in these seasonal wetlands/floodplains is about 2.69 billion cubic meters. This seasonal storage has virtually no contribution during dry season.

v) The numerous channels crisscrossing the entire country, in flowing stage, store water till these are completely dries. Estimated volume of channel storage is of the order of 0.5 billion cubic meters.

It can be mentioned that, traditionally, before and during the early stages of tube wells installation, rural water supply was largely based on protected ponds. There are about 1,288, 222 ponds in Bangladesh (BBS, 1997) having an area of 0.114 ha per pond and 21.5 per mouza. About 17% of theses ponds are derelict and probably dry up in dry season. The pond was the basic water sources both drinking and other uses in the south-west coastal region of Bangladesh. Not only this, here is a traditional practice of rain water harvesting system. People usually collected rainwater through roof of houses and preserve it mud-made container.

Groundwater

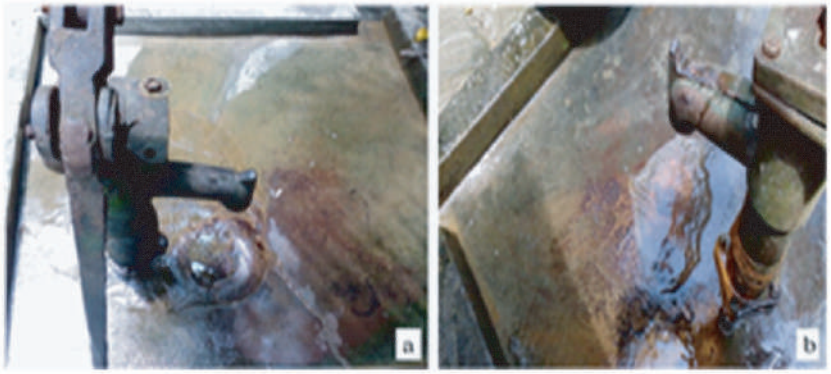
The main source of ground water is the recharge from surface water. Most of the areas of Bangladesh have been formed from the sedimentary alluvial and deltaic deposits of three major rivers. These alluvial deposits have formed mainly an unconfined aquifer for most of the area of the country. Groundwater was supposed to be one of the major natural resources of the country except the safe drinking water supplies. But the presence of Arsenic in shallow aquifer has completely changed the situation. It is estimated that about 16% of present population of 123.15 million is exposed to arsenic contamination exceeding Bangladesh standard (0.05 mg/l). About 74452 sq.km. of groundwater use area (about 50% of the country) is unsuitable for use by hand tubewells (as a source of drinking water according to WHO standard) due to arsenic.

The amount of ground water which can be obtained from an area depends on characteristics of the underlying aquifer and the extent and frequency of recharge. An aquifer has interconnected pores filled with water which may be considered as a network of interconnected pipes through which water flows at a very slow rate. These interconnected pores provide both storage and flow, or conduit functions in an aquifer (Ahmed and Rahman 2000).

Groundwater is the main source of water supply in urban and rural areas of Bangladesh. Groundwater in Bangladesh is available abundantly, but the availability of groundwater for drinking purpose s has become a problem for the following reasons:

* Arsenic in groundwater;
* Excessive of dissolved iron;
* Salinity in the coastal areas;
* Lowering of groundwater level;
* Rock/stony layers in the hilly areas.

Arsenic in groundwater: The concentration of arsenic more than permissible limit is toxic to human body. According to the WHO guideline value the desirable maximum acceptable concentration of arsenic in drinking water should be 0.01 mg/l. In Bangladesh, the maximum acceptable concentration in drinking water is 0.05 mg/l. Symptoms of arsenic toxicity leading to cancer may occur due to excessive intake of arsenic in the human body over a longer period.



Excessive dissolved iron: In Bangladesh, the permissible limit of iron in groundwater is 1 mg/l but iron content up to 5 mg/l is acceptable for rural water supply. It has been observed that iron content exceeds this limit in many handpump tubewells. People are reluctant to drink this water mainly due to its bad taste. Water with high iron content is not used for cooking, washing and other domestic purposes.

Salinity in coastal areas: The concentration of dissolved minerals in groundwater is higher than that in surface water. The coastal belt of Bangladesh, extended over 86 upazilas, is identified as a problem area where complex hydrogeological conditions and adverse water quality make water supply difficult as compared to other parts of the country. Unlike other areas of Bangladesh, groundwater of acceptable quality at relatively shallow depths, which can be easily withdrawn by conventional handpump tube wells is not available in most parts of the coastal area. In some places, low salinity water has been found in deep aquifers. Based on the availability of fresh groundwater, the DPHE has divided the coastal regions into three types of areas. There are still many areas in coastal belts where low salinity groundwater is not available within a depth of 1,100 ft. In rural water supply chloride content, up to 1,000 ppm is acceptable for coastal belts where the normal acceptable limit is 250 ppm (Ahmed and Rahman 2000).

Lowering of groundwater level: A considerable area of Bangladesh faces scarcity of groundwater. It is widely known that due to over-exploitation of groundwater for irrigation purpose and meeting water demand for city dwellers the water level declines. These areas are increasing with abstraction of more groundwater for irrigation in the dry season.

Rock/Stony layers in hilly areas: Drilling of tube wells for rural water supply in Chittagong Hill Tracts districts of Bangladesh is difficult due to the presence of hard formations in the subsurface. In most cases conventional drilling methods for the installation of handpumps cannot penetrate these hard rock formations.

Rainwater

Bangladesh is a tropical country and receives heavy rainfall due to north-easterly winds during rainy season. Rain water is a potential source of Bangladesh. In the coastal districts, particularly in the offshore islands of Bangladesh, rainwater has been used for drinking purposes since time immemorial. The protected ponds annually replenished by rainwater are a main source of water supply in the coastal area. On the other hand, rainwater harvesting is one of the traditional system of coastal districts like Satkhira, Khulna and Bagerhat. But the existing collection, storage and use of rainwater system are not scientific so need to proper attention to developing the system. Rainfall in our country is not equally distributed in every month or every area of the country. So, a water supply system completely based on rainwater requires large rainwater storage reservoirs.

Overall Scenario

The natural surface water resources in Bangladesh are mainly derived through the major river systems and their tributaries. The flow distribution characteristic in the river system is a combination of upstream inflows and run-off generated from rainfall within Bangladesh. In the southern regions, the distribution is also affected by tidal conditions. Surface water is abundant in the wet season in Bangladesh. An estimated 795,000 million cubic meter (Mm3) of surface water is discharged per year through the Ganges-Brahmaputra system, in the downstream of the confluence of the Ganges and the Brahmaputra. This is equivalent to 5.52m deep water over a land area of 144,000 square km. There are other rivers discharging surface water into the Bay of Bengal. In dry season country suffers from acute shortage of both surface and groundwater (BUET, 2004).

Bangladesh experiences four main types of floods: monsoon floods from the major rivers; local flooding due to drainage congestion, flash floods in the eastern and northern rivers; floods caused by high tides and storm surges in the coastal areas.

During the June-September monsoon, Bangladesh receives about 80% of annual precipitation, averaging 2300mm, but varying from as little as 1200mm in the west to over 5000mm in the east. Runoff from adjacent riparian is generated by rainfall which averages 5000mm over the Himalayas, and exceeds 10,000mm over the Meghalaya plateau north to Sylhet. Together inflows and rainfall causes peak floods in the Ganges, Brahmaputra and Meghna rivers in the period July-August, and on average 22% of the country is flooded annually. Drought is also a problem in Bangladesh, particularly in the North-West regions during the spring where there are few surface water resources, and agricultural production is heavily reliant on groundwater resources.

Groundwater is the main source of water supply in urban and rural areas of Bangladesh. Except for few hilly regions Bangladesh is entirely underlain by water bearing aquifers at depths varying from zero to 20m below ground surface. Groundwater in Bangladesh is available in adequate quantity, but the availability of groundwater for drinking purposes has become a problem some specific reasons which are describe earlier. So, it may be said that despite heavy rainfall, readily accessible groundwater and large river systems in this country, at present water scarcity for drinking purpose is the major problem in Bangladesh due to arsenic contamination in groundwater and surface water pollution by point sources and non-point sources.

4.3 Health and Hygiene

People often have a poor understanding about the relationship between health, water and sanitation. In some areas, this understanding may exist but people of some areas still practice unsanitary habits. Experience have shown that it is often easier to change technology than people's behavior and practices. Though situation has already been developed but mortality from water-borne diseases are still a significance number and achievement in behavioral changes in sanitation leaves much to be desired.

The discovery of arsenic contamination in tube-wells even aggravates the situation. Perhaps as many as 15% of the population does not have access to water free from arsenic contamination and may return to other bacteriological contaminated sources.

Water and sanitation-related diseases include various types of diarrhoea, worm infestations, skin and eye infections and vector-borne diseases. It is important to be familiar with the various transmission patterns, to be able to identify which hygiene behaviors and measures can help to interrupt disease transmission.

The water-related infections are grouped in accordance with their transmission route. Since the impact of water supply and sanitation improvements on a disease depends on its transmission route, water supply and sanitation facilities can be expected to affect the diseases in each groupin a similar way.

Classification of water-related diseases

Transmission route	Description	Disease group	Examples
Water-borne or water-washed	Transmission by consumption of contaminated water or person to person transmission due to lack of water and domestic cleanness.	Fecooral	Diarrhoeal diseases Dysentery Typhoid
Water-washed	Person to person transmission due to lack of water and domestic cleanness.	Skin and eye infections for personal	Trachoma Scabies
Water-based	Transmission via an intermediate host (i.e. a snail) which lives in water.	Water-based	Schistosomiasis
Water-related	Transmission by insects which breed insect vector in water or bite near water	Water-related insect vector	Malaria Filariasis

Over the years many studies have been carried out to increase our insight into prevention of the transmission of these diseases (Esrey, 1990). These studies indicate that, dependent on the type of disease and local circumstances, the preventive measures listed in the box below ae particularly helpful in interrupting disease transmission:

* Safe human excreta disposal;
* Personal hygiene;

* Domestic hygiene (and animal management);
* Food hygiene;
* Water hygiene/consumption of safe water;
* Safe wastewater disposal and drainage.

Hygiene educationinterventions often target too many behaviors that would have an impact in reducing the disease burden. Therefore, WHO has identified three priority measures for cutting off transmission of several diseases. These are:

* Safer disposal of excreta;
* Maintaining drinking water free from faecal contamination; and
* Hand washing after defeaction, before feeding, eating and preparing food after handling babies excreta.

Our health-related behavior is not only determined by a complex mix of our knowledge, beliefs, attitudes, norms, and customs. Socio-economic determinants like social values and structure, income, resource constraints and education and even political factors also play a dominant role.

Access to water supply and sanitation facilities

Without the resources to construct and maintain water supply and sanitation facilities it is difficult to attain levels of personal, domestic and environmental hygiene conducive to health. Resources relate not only to money, but also to the availability of land, time, materials, and technical and management skills for achieving improved facilities. In the south-western parts of Bangladesh, the study area, water collection often a responsibility of women, and usually also children, can be very time-consuming and hard work. Water carrying over long distances can absorb a quarter or more of the daily food intake.

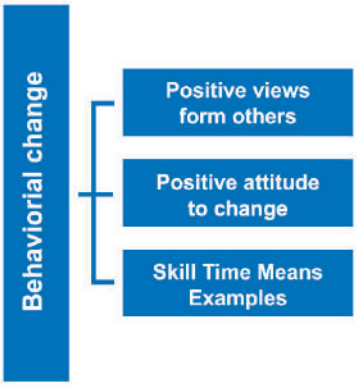
Hygiene behavior and the prevention of water and sanitation-related diseases are influenced by socio-economic factors, such as proper housing, nutrition, clothing, education, and time. Adequatehandwashing is very important for good health. It has already been proved in COVID 19 situation of all over the world. Good hand washing behavior is positively associated with better social and economic indicators including education of the women.

Hygiene Education

Hygiene education is an important component of water supply and sanitation program because it:

* Helps users to appreciate the need for proper water supply and sanitation facilities;
* Maximizes the potential health benefits of improved water supply and sanitation facilities;
* Helps users appreciate the need for proper operation and maintenance of improved water supply and sanitation facilities;
* Creates a willingness to contribute to the operation and maintenance costs.

An individual will take up a new practice when he or she believes that the practice has net benefits, for health and other reasons, and considers these benefits as important. He or she will develop a positive attitude towards the change.



There are three common communication strategies important for hygiene education approaches which are advocacy, social mobilization and program communication.

Advocacy consists of many what are traditionally known as information and public affairs activities, such as lobbying with decision makers through personal contacts and direct mail; holding seminars rallies and news-making evens; ensuring regular newspaper, magazine, television and radio coverage and obtaining endorsement from popular people. The goal of is to make the program a political or national priority that cannot be swept aside with a change in administration.

Social mobilization involves the creation of a social movement for a program by mobilizing many of allies at the national, regional and community level. The aim is to create a demand and activate a wide range of groups, for instance for sanitation improvements.

Program communication is the process of facilitating behavioral change, using all available communication channels.

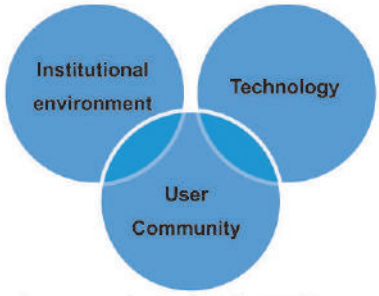
4.4 Sustainability

In the development arena, the most influence word is sustainability. The World Commission for Environment and Development initiated the sustainability discussion in their 1987 report. The focus of the concept is that the activities by the present generation should not compromise the resources, or the environmental conditions of future generations. This report has influenced the thinking in development cooperation and several definitions have emerged for sustainable water and sanitation. Warner (1990), for example, states that 'the success or sustainability of a project is achieved when it meets its objectives and is maintained by its users over a significant period of time.'

The definition that has evolved indicates that: a water supply or sanitation system is sustainable when it:

* Provides an efficient and reliable service at a level which is desired;
* Can be financed or co-financed by the users with limited but feasible external support and technical assistance;
* Is being used in an efficient and effective way, without negatively affecting the environment.

This definition indicates four dimensions: the user community wanting an efficient and reliable service, the technology that must provide it, the institutional environment and efficient use of service.



Key elements of sustainable WSS systems

The User community

The user community is composed of different groups of people with common but often also conflicting interests and ideas. The water supply system may be one such common interest, but at the same time can be a major source of conflict. Some of them, often the economically better off, may be better informed and may not be willing to change the situation or to solve certain problems. Some of these richer families may become the 'owners' of water points, discouraging or refusingother users who have the same needs and rights. Poor women often are in the worst position when it comes to possibilities to change their lives and to gain access to resources.

Technology

Technology focuses on the knowledge, the culture, the infrastructure and the tools actors can use to ensure that the users receive good water supply and sanitation services that reduce the health and environmental risks the community is facing. The actions can be taken to reduce the contamination in the water sources or reduce the risk of spreading feacal contamination. This may also entail the identification of priority activities that focus on behavioral change in relation to issues such as management of the catchment areas and personal hygiene. It encompasses discussions with the community concerning the best possible water (rain water, surface water or ground water), if needed, combining them to ensure an effective supply and use.

The institutional environment

The institutional environment needs to be considered in setting up a water and sanitation system. To ensure that the level of service is sustained over time, it is necessary that the management of the systems is adequate. This is easiest to achieve if the management capacity at the local level matches the operation and maintenance requirements of the system, requiring only a minimum of support from government and external institutions. The administrative entity should have knowledge of the staff and material required to maintain the system in optimal condition. It requires that the financial aspects are properly addressed. This includes a good accounting system and adequate communication channels to share information with the community and supporting agencies.

Good management is only feasible if a monitoring system is in place and being used. Performance monitoring and evaluations are helpful tools to ensure sustainability and obtain insight into the system but also into project achievements. From the beginning of a project it is important to define the indicators and levels to be attained. This must be done within the legal context and consider the specific conditions of the area under review that are difficult to generalize from the national level.

The efficient and effective use of water and sanitation facilities is another key dimension in sustainability. Communities have different 'water cultures', the form in which they see and use their water resources. This is often related to history and local conditions. Understanding the beliefs, and local customs related to the utilization, protection, and care of the water supply sources is an important basis to help facilitate a reflectionprocess of the communities. Spillage of water around water points is very common and may result in infiltration of contaminated water into the well or unhygienic conditions for the users.

People have also very different perspectives about sanitation and sanitary facilities. Some practices have already existed for a very long time and may be very persistent. Interest in obtaining sanitary facilities may exist, but may differ among men and women.

Motivations may also be very different. It is essential to combine water sector interventions with activities to improve basic sanitation, hygiene behavior and environmental management.

A demand responsive approach is now very much being promoted at the international level. The summery of the Community Water Supply & Sanitation Conference, May 5-8, 1998, organized in the World Bank in Washington indicates that a demand responsive approach contributes to the sustainability of water supply and sanitation facilities. They define this approach as users having to have an informed choice that should result in them obtaining a water and sanitation service that they can afford and are willing to sustain. Still we need to learn a lot about the effective application of this approach in large scale government-supported programs and particularly how to ensure better equity.

Sustainable performance

The sustainability definition indicates that the system must provide a reliable service over time, which are five criteria:

* Coverage
* Continuity
* Quantity
* Quality and
* Cost

Three of these, coverage, continuity and cost can also be used for sanitation systems.

Coverage refers to the access that people in the community must water supply and sanitation systems. The water and sanitation services should be equally distributed to the greatest number of users possible in an area.

Continuity in service provision is needed to help avoid the risk of people returning to contaminated water sources. This may be the case if handpumps go out of order and are not very quickly repaired.

In piped water systems where the water supply is sometimes or frequently interrupted, the risk of contamination in the distribution network should be investigated very carefully and prevented by making proper designs and identifying protective actions with the community. Equally so latrines must provide continuity as numerous examples exist of latrines being abandoned when they have filled up. Similarly, latrines should be in operation 12 months a year which can be a great challenge in areas that are prone to waterlogging or flooding.

Quantity of water is an important factor for health improvement. Enough water should be provided and used for drinking, cooking, food preparation and good personal and household hygiene. Bringing water close to the user reduces the time and efforts involved in water collection, a benefit which is particularly important for women and children. In coastal area, particularly villagers of Sundarbans adjacent area having to walk long distances to fetch drinking water that is not contaminated.

Quality of water key factor for public health, for the acceptance by the users and for operation and maintenance of the water supply system. Water quality can be reviewed by a combination of systematic observations in sanitary inspections combined with water quality analysis.

Cost of systems will be largely determined by the level of service that is chosen and the type of technology that can be applied. The implanted technology should, if possible, be in harmony with the socio-economic conditions and above all with the willingness of the users of the system to pay. As a minimum, the tariff should cover aspects such as operation and maintenance, and, if agreed upon between the financing body and the users, recovery of the initial investment.

5. Major Challenges

Water plays a crucial role for improving human well-being (Crow and Sultana, 2002). It is considered 'safe' when it's free from pathogenic agents, and harmful chemical substance, and satisfying to taste i.e. ideally free from color and odor, and usable for domestic purposes (Park, 2015). Scarcity of water must be comprehended by considering the whole measurement.

Firstly, water is a sustainable asset and its accessibility relies upon the hydrological cycle. Secondly, scarcity of water is temporal and diurnal. Thirdly, there are distributional and social parts of water shortage. The fourth dimension is characterized as the anthropogenic (political, social and institutional) measurement that highlights the intervention and management practices (Mehta, 2003). The importance of institutional and political factors and conjointly emphasizing on the difference in availability and accessing water for explicit users clarify the context of freshwater deficiency in the coastal area and therefore the contestation of saline water and fresh water (Alamgir, 2010). The primary reasons for the expansions if salinity and freshwater shortage in the south-western coastal region are the withdrawal of water from major rivers in the upstream and siltation on the river bed, drainage congestion and water logging caused by the improper polder management (Islam and Kibria, 2006). Many causes have been identified to examine the difficulties of supplying fresh water i.e. saline water intrusion, reduction of upstream flow, sea level rise, disasters, polder, arsenic contamination, brackish shrimp cultivation, excessive use of underground water in an unplanned way, lack of appropriate aquifer etc.

Saline water intrusion

Potable water is most likely going to become up a serious issue especially in the coastal area due saline water intrusion (NGO Forum for Public Health, 2012). A natural appalling situation caused by saline water instruction is a noteworthy issue and that renders the groundwater unfit for consumption in south-western coastal region of Bangladesh (Ahmed, 2006; NWPo, 1999). It owing to decrease of freshwater spill out of upstream (mostly inferable from the establishment of the Farakka Barrage on the Granges River, near the border of Bangladesh) is required to be irritated by climate change and sea level rises, that has brought about the saline water intrusion being pushed further toward the north (Nicholls et al., 2007).

The effect of saline water intrusion is highly seasonal while minimum during the monsoon when the GBM (the Ganges, Brahmaputra and Meghna) Rivers release around 80% of the annual freshwater flow.

In the winter months, the saline water starts to penetrate inland and the influenced regions rise forcefully from 10% in the monsoon to more than 40% in the dry season (DMB, 2000).

Reduction of upstream flow

Reduction of the stream flow of the River Ganges happens (the Ganges along with the Padma is the largest river system that flows over Bangladesh) in dry season due to over withdrawal of water in the upstream. India diverts at least 40,000 cusecs water through a feeder canal from the Farakka Barrage to the River Hugli to ensure proper navigation at Kolkata port. The flow through the River Gorai, the perpetual distributaries of the River Ganges has been declining since the mid-1970s and the dry season flow has quit from the end of 1980s.

This has already risen the salinity level of the water in Khulna and the Sundarbans (the largest mangrove forest in the world). It has additionally increased salinity in the River Balashar and associated rivers and canals of the country (CEGIS, 2003; Tran and Shaw, 2012). During dry season, a mix of extremely low flow and increased salinity quickened the procedure of sedimentation in the river bed, which eventually stifled the river and radically lessened its drainage capacity. This is how drainage congestion turned into a usual nature of that river, consequently in the overbank spillage during each peak season. Thus, the area becomes waterlogged for a certain period of the year (Ahmed, 2008).

Sea level rise

Sea level rise due to global warming continued sedimentation of the rivers and floodplains and subsidence of the Ganges basin are all factors those might result to raise the sea level with respect to land. It has been estimated that the increase of mean sea level from 4.5 to 23.0 cm by 2025 and from 6.5 to 44.0 cm by 2050 (NWMP, 2001). The rising sea level will create new salinity affected areas, which might generate further scarcity of potable water.

Disasters

The south-western region of Bangladesh often experiences to natural disasters (e.g. water logging, cyclones, tidal surges, floods, river erosion etc.) which are responsible for the decimation of drinking water sources. The annual recurrence of disasters is 6.11, making Bangladesh the prominent disaster-prone countries of the world. The country receives the end of about two-fifths of the world's total impact from storm surges (Murty and El-Sabh, 1992; World Bank, 2005). During and immediately after cyclone AILA (hit on 25 May, 2009), all freshwater sources were contaminated with dirty saline water. Supply of drinking water became the most striking challenge and people were forced to drink that unsafe water in the affected area (Kumar et al., 2010; Haque et al., 2010; Halder and Zaman, 2010).

Polder

Bangladesh is shaped by the deltaic processes and the formation of its significant south-western coastal part is yet active (Agarwal et al., 2003). A total of 123 flood control polders including 5,107 km of embankment have been constructed covering approximating 1.5 million ha of the coastal area under the Coastal Embankment Project (CEP) to prevent tidal flooding. Among them, about one million ha lies in the south-western part (Islam et al., 2006; Guimaraes, 2002; Chowhury and Rasul, 2011). The polder/enclosure systems disconnected the lowlands from the rivers (Haq, 2000). Because of the construction of the polders on both sides of the rivers, the natural process of tidal inundation was stopped and resulting into water logging as well as drainage problem caused by the rising of channel bed due to siltation. During the dry season, accumulation of salt in the topsoil through capillary action is gradually increasing the salinity in the areas which were formerly wetlands (Islam and Kibria, 2006; Haq, 2000).

Arsenic contamination

Severe arsenic tainting of groundwater has disrupted the idea of using shallow tube-wells for safe drinking water throughout the country (Safiuddin and Karim, 2003). The southwest coastal region has been facing for the crisis of pure drinking water due to arsenic contamination in groundwater.

However, the number of arsenic affected rural villages is lower than the saline affected villages in the coastal area. (Harun and Kabir, 2013; Rahman etal., 1997; Uttran, 2003; WHO, 2004).

Cultivation of brackish water shrimp

Shrimp cultivation in brackish water is a serious concern which allowing saline water intrusion into the adjacent agricultural land, groundwater acquirer and waterways in the coastal area of the country (Flaherty et al. 2000). This salinization process reduces fresh water supplies not only for agriculture but also for drinking and domestic needs (Deb, 1998; Patil and Krishnan, 1998).

Excessive use of underground water in an unplanned way

The absence of surface water for irrigation during dry season has constraints to the agriculturists to exploit underground water extensively leading to a lowering water table beyond the suction limits of shallow tube-well, making millions of shallow tube-wells dysfunctional. This over-extraction of groundwater is one of the possible reasons for the contamination of shallow aquifer (Setu et al., 2014). In addition, thousands ha of land has been being irrigated based on groundwater for rice cultivation since last few decades.

Lack of appropriate aquifer

Groundwater stores in impervious layers due to porous geological arrangements in the upper soil strata. For extraction of groundwater, medium sand is suitable. This sand has considerable porosity and can store a huge of water. Fine sand also can store a considerable amount of water. However, as the study area situated in the lower parts of the Ganges delta, the sediments of the region have very low permeability and don't seem to be able to store water (NWRPo, 1999). Moreover, Department of Public Health and Engineering (DPHE) officials of Dhaka said that the underground permeable layer of the coastal area isn't suitable for using as potable water due to having much fine sand. In some areas, tube-wells are not successful especially in the coastal belt because of saline water intrusion in the aquifer to a depth of 700-1000 feet (DPHE and UNICEF, 1989).

Although, deep tube wells provide a relatively reduced level of saline water in the coastal areas but containing sand makes it undrinkable (Ahmed, 1996).

Identification of potable water scarce zone

Accessibility to potable water within a suitable distance is a common problem in the coastal area of Bangladesh. Another means of scarcity is inadequate supply of water. In the study area, there are total 28 community water sources for drinking purpose. Among them 15 were PSFs and 13 tube-wells. Though, there have a debate about the quality and uninterrupted supply over the year from those sources.

Distance from the sources is an important matter of water collection. Though, the criterion of Bangladesh government is having the safe drinking water source should be within 50 meters of household premise (GoB, 2005).

Distance of water source point from household

Collection of drinking water from a far distance is the main problem in the coastal area. Generally, the family members mainly housewives collect drinking water from another part of the village or from another village. The actual distance of the nearest water source from each household was determined in between the comparison of the user's reply and the author's observation.

Usually people are facing manifold problem in water collection where one of the major problem is distance. The suitable area of water supply is that, where the people can collect sufficient water without facing any trouble. Threshold area of water supply from existing sources is determined by the buffer of expected distance from the households. People are normally collect water minimum 50 m from their household premise.

6.Conclusion

WASH is a key public health within international development and is the focus of the first two targets of sustainable development 6. Targets 6.1 and 6.2 aim at equitable and accessible water and sanitation for all. "Access to WASH" includes safe water, adequate sanitation and hygiene education. No doubt, improving access to WASH services can improve health, life expectancy, student learning, gender equality, and other important issues of international development. This can reduce illness and death, and affect poverty reduction and socio-economic development. Challenges include providing services to semi-urban and waterlogging area like Satkhira, Khulna and part of the Jashore distict in south-west part of Bangladesh. If we want to achieve the fulfillment of WASH target then it is necessary to consider above scenario.

The people of this area are facing acute problem for safe drinking water. This study presents a detailed investigation of the geo-morphological condition, potable water scarcity, relation between health and hygiene, sources of water and sustainability in a coastal community of Bangladesh.

Many root causes, those create the difficulties for safe drinking water supply has been identified in this area. The constraints to potable water supply have been incorporated by reviewing relevant literatures.

The factors from reviewed literatures showed that those are highly persuasive for the limitation of potable water supply. The result also showed that a significant part (about two-thirds) of homestead area and a considerable number of households are beyond the suitable water zone, formulated by observation. The groundwater is not feet for consumption in most of the parts of this area. Moreover, the surface water especially large-pond water use is more suitable in considering environmental perspective.

To run smoothly the WASH program in order to development of the existence situation we may consider following things:

* Ongoing interventions play a positive role in community mobilization and participation in decision making, in the development of facilities and their O & M.

* Active community participation promotes sustainability of WASH services. Future interventions should put more emphasis on community mobilization and participation of the community in implementation and management of WASH services.

* Water quality remains an area to be addressed more comprehensively in future interventions.

* Sustainability of water sources/options e.g. common reservoir, individual connections, etc. needs to be assessed in greater detail in future interventions. Entrepreneurship model for water point/water distribution management should be considered in future interventions.

* Sustainability of sanitation services is an important issue; both technology and management affect sustainability, and hence both should be addressed adequately in future interventions.

* Poor hygiene practices (e.g., disposal of children's faces, cloth in toilet) affect sustainability of sanitation services, and should be addressed in future interventions.

* Gender issues (e.g., separate toilets for women/girls, ensuring easy/convenient access of women/girls especially during night) and access of persons with disability (PWD) and children are often not addressed adequately. These issues need to be mainstreamed in future interventions.

* Household garbage management including recycling should also be emphasized in future interventions to avoid clogging of drains as well as generate livelihood opportunities.

* Large pond should be considering as a dependent water-source;

* The existing PSF should be made proper functional by taken appropriate initiatives;

* The use of rainwater can be increased by the installation of more RWHS,

* PSF can be installed on the reserve ponds, make assurance the quality of supply water, and

* Other areas of development that were not within the scope of this study, e.g., internal road network and connectivity, access to electricity supply, education, etc. are also important issues to be addressed through integrated development approach to ensure sustainability.

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Uttaran

House # 32 (1st Floor), Road # 10/A
Dhanmondi R/A, Dhaka -1209, Bangladesh.
Tel: 88-02-91222, Cell: 88-01711828305
e-mai: uttaran.dhaka@gmail.com
web: www.uttaran.net