2030 Water Resources Group

Consolidation and Analysis of Information on Water Resources Management in Bangladesh

2030 WATER RESOURCES GROUP
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International Finance Corporation (IFC)
2121 Pennsylvania Avenue, NW
Washington, DC 20433

Contract under PO: 7171848
Vendor No: 15398

Subject: Submission of the Revised Final Draft Report on Consolidation and Analysis of Information on Water Resources Management in Bangladesh

Dear Mr Jakob,

We are pleased to submit our revised report outlining the key messages and our analysis of the water resources management issues in Bangladesh.

Please feel free to get in touch with us for any further information or clarification.

Regards

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Foreword

We (the team at PwC and BCAS) take this opportunity to appreciate 2030WRG's enthusiasm, keenness, and understanding shown for facilitating solutions to Bangladesh's sustainable water resource management challenges. The team at WRG was continually in the field, managing their already-busy travel schedules occupied with similar considerations and enthusiasm for work in other countries as well.

Our interaction with 2030WRG has not only helped us to learn more about Bangladesh, but also enabled us to develop deep ties with the country and its people. Everyone (from Bangladesh as well as from 2030WRG) we met in the course of this assignment has been exceedingly kind, considerate, humble, and helpful to us.

We believe that this sensitivity and concern being exercised professionally as well – for arriving at sustainable solutions to Water Resource Management challenges in Bangladesh – will certainly bear the intended fruit.

We feel glad and privileged to be a part of this process of collaborating with multiple key stakeholders to design these solutions.

With this positive feeling, we present the Revised Final Report based on our work. We look forward to the report's journey forward as a guide map for action by multiple stakeholders, facilitated by 2030WRG, and most importantly, owned by the people of Bangladesh.

Executive summary

A team of experts from PwC and BCAS supported the 2030 Water Resources Group in consolidating and analysing information on water resources management in Bangladesh. The first objective of the analysis was to identify key water resource challenges and priorities today and in 2030. The second objective was to raise awareness, mobilise and engage 'new actors' from the private sector and civil society to take steps for sustainably managing water resources in the future. Existing data sources and secondary literature were assessed and consolidated to ensure that the analysis is based on solid data. Building on this analysis, stakeholder consultations (2 focus group discussions, 55 face-to face interviews, and a high-level meeting), were held to identify stakeholder-specific challenges to sustainable water management, as well as to identify existing and potential business cases which promote sustainable water management. Finally, recommendations were made to support Bangladesh in moving towards sustainable water management.

The scale and urgency of Bangladesh's water resources challenge

Bangladesh faces challenges related to flooding and inundation predominantly during the monsoon season, while experiencing water shortages and droughts predominantly in the dry season. Estimating practically available water resources and demand in the dry season for the years 2010 and 2030 shows that water supply was sufficient to meet the demand on a national scale in 2011. However, assuming that the practically available water supply, i.e. considering current infrastructure, to remain equal to what it is today, water demand is expected to exceed water supply by 21% in the dry season by 2030 (see Figure 2 below). Requiring 93% of total water demand, agricultural water demand is mainly driven by Boro rice production. Given population growth and dietary changes, agricultural water demand is expected to increase by 46% in 2030. Driven by the textile industry, industrial water demand is expected to increase by 109% in 2030.

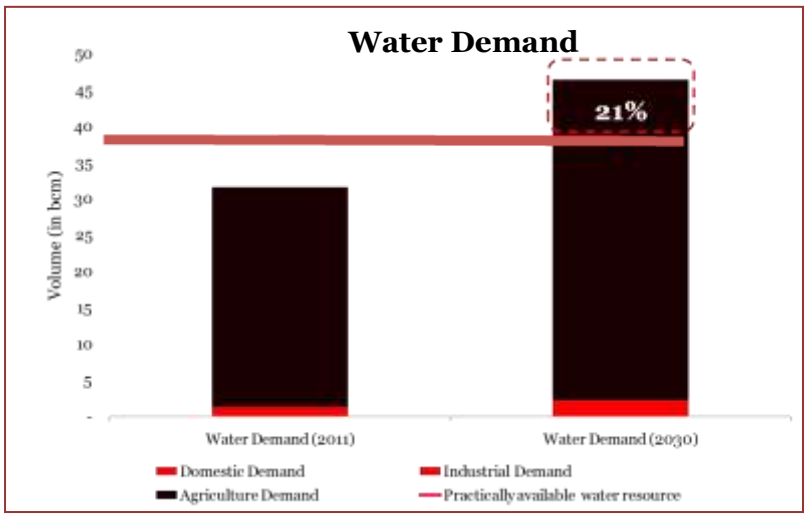

Figure 1 Water supply/ demand balance (dry-season, practically available water resources)
Source: PwC Analysis

Figure 2 Dhaka's water quality situation in the dry season

Source: Prof Dr. A. B. M. Badruzzaman

The water supply-demand gap in 2030 is expected to widen when also considering water quality aspects. 33% of Bangladesh's population is exposed to arsenic contamination of groundwater, while the increasing salinity levels from seawater intrusion and agricultural runoff pose challenges for industries and farming activities in the southern regions.

Untreated wastewater and effluent discharged into water bodies further reduce usable water resources, particularly in urban and industrial centres. In the dry season, the rivers in and around Dhaka are practically void of aquatic life, as dissolved oxygen levels of around zero prohibit any form of life from sustaining. Importantly, the severity and diversity of the water resource management challenges depends on the region. With 80% of the water demands being met by groundwater resources, abstractions in some regions exceed the groundwater recharge rate, resulting in falling groundwater tables. This is particularly a challenge around the capital city Dhaka, where the groundwater table is falling by 2 meters every year, and in the Barind Tract.

The quantity of groundwater recharge is still uncertain in Bangladesh, with estimates ranging from 21 billion cubic metres to 65 billion cubic metres per year. Similarly, the sustainable total yield of extraction of groundwater has not yet been assessed. Further, 92% of all water resources are external, i.e. entering Bangladesh via transboundary waters, resulting in high dependency and uncertainty on future water availability. Thus, the water supply-demand gap could be greater than what the estimates project.

While recharges in groundwater resources only form 2% of Bangladesh's renewable water resources, only 0.4% of the total surface water is stored. Bangladesh's flatland topography, and the resultant challenges for construction of required infrastructure, is one of the main reasons for these low levels of surface water storage.

Role of the private sector: Sustainable water management as a business case

The physical water risks for companies in Bangladesh is high, comprising the risks of termination or disruption of water supplies, deterioration of water quality, and resultant increased costs of sourcing and water treatment. Cases of companies having to shift their manufacturing units due to the constantly falling groundwater table or deterioration of groundwater quality have already occurred. The potential for business cases to reduce these risks is high, ranging from introducing water efficient technologies, reusing wastewater, to rainwater harvesting. However, few private sector businesses have recognised the benefits of sustainable water management and have integrated measures into their core business strategy. Currently observed business cases are predominantly driven by international compliance requirements within multi-national organisations. The constraints preventing the adoption of sustainable water resource management as business case were found to be threefold: 1) Lack of (financial) incentives and enforcement of rules and regulations, 2) Low level of awareness of (future) water management challenges and 3) Insufficient stakeholder cooperation.

Stakeholder-specific challenges

The achievement of sustainable water management needs to consider the interests of, and address the challenges faced by, various stakeholders. To understand the underlying challenges for sustainable water management, we consulted stakeholders from the public sector organisations (government, and independent organisations established by Acts of Parliament), civil society, and private sector.

Besides stakeholder-specific challenges, common challenges were identified. Effective planning and sound decision making by all stakeholders is constrained by availability of data and sound knowledge on water resources management. Unclear institutional responsibilities and lack of coordination amongst institutional bodies (intra-governmental as well as cross-sectoral), lack of effective enforcement of laws and regulations, and a lack of capacity in water-related areas are common challenges faced by all stakeholders.

Recommendations for the way forward

Having identified stakeholder-specific challenges and constraints, it is critical to address these underlying causes of unsustainable water management, rather than their symptoms. To address these, recommendations on potential focus areas for the future 2030 WRG engagement in Bangladesh have been made. These include functionally cross-cutting recommendations, such as a) Establishing a multi-stakeholder platform for the private and public sector, as well as civil society to address the challenges in a holistic manner in order to achieve its social and economic development targets b) Raising public awareness of (future) water resource management challenges and c) Building a sound knowledge base, including the introduction of mechanisms to share existing knowledge. Further, recommendations are made on three key thematic areas, namely a) Exploring the potential of surface water and rainwater usage, b) Enhancing wastewater/ effluent treatment and surface water quality and c) Improving agricultural water use efficiency and water productivity.

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1. Background

The 2030 Water Resources Group (2030 WRG)[1] is a public-private-expert-civil society partnership and a platform for collaboration, supporting governments to initiate and catalyse reforms designed to ensure sustainable water resources management for sustained long-term economic growth and development. The Group supports sustainable water sector transformation by mobilising a wide range of key stakeholders, and providing comprehensive water resources analyses, to which both politicians and business leaders can relate.

Bangladesh is a country which faces diverse water-related challenges in the midst of experiencing strong economic growth. To respond to these, a partnership between the Government of Bangladesh and the 2030 WRG is being explored.

In order to support the Government and the 2030 WRG in identifying, aligning and catalysing joint initiatives to work towards sustainable water resource management which will also enable long-term economic growth, a consulting project for "Consolidating and analysing information on the Water Resources Management in Bangladesh" was commissioned to an international team of PwC India, PwC Germany, and Bangladesh Centre for Advanced Studies (BCAS).

1.1. Our Objective

The objective of this project is to undertake a targeted analysis, which aggregates various sets of existing public data and delivers key messages targeted to Bangladesh's government, private sector companies and local communities.

The analysis creates a knowledge base and identifies key water resource challenges and priorities today and in 2030 to enable Bangladesh to move towards sustainable water management. Further, key underlying causes hindering sustainable water resource management in Bangladesh are assessed. To mobilize the private sector to engage in sustainable water management, drivers for potential business cases and the constraints which prevent the private sector from achieving their full potential in addressing the water resources challenge were identified. In addition to the high level analysis, a deep dive on the potential and future of sewage treatment options in and around Dhaka was conducted. Finally, a set of recommendations are made to address Bangladesh's water resource challenge.

Based on the targeted analysis and stakeholder consultations, this project shall raise awareness, mobilize and engage 'new actors' from the private sector and local communities to engage in sustainable water activities, and in the partnership between 2030 WRG and the Government of Bangladesh.

To avoid duplication of efforts and to streamline the suggested next steps with the ongoing initiatives, an overview of recently completed and ongoing initiatives around water resources management has been compiled as part of the project work. These results are presented in section 1.3.

1.2. Our Approach

Our approach strikes the balance between building a sound basis on available data sources, secondary literature and former projects, and further expanding this basis via multiple stakeholder consultations, including interviews and focus group discussions.

[1] www.2030wrg.org.

1.2.1. Building on a sound data basis

The availability of comprehensive, integrated and up-to-date information on hydrological characteristics and water usage statistics is restricted across the country. The most comprehensive hydrological water resource and water use data originates from a recently completed study by Kirby et al (2014) "Bangladesh Integrated Water Resource Assessment: Final Report" and its supplemental documents. Where found adequate, data have also been used from other secondary sources, such as the National Water Management Plan (2001) and the IWMI Research Report (2014) "Water for Food in Bangladesh: Outlook to 2030".

1.2.2. Going beyond the known: multi-stakeholder consultations

Stakeholder consultations were used to understand stakeholder-specific risks and challenges related to Bangladesh's water resource challenge as well as to identify its underlying causes and potential solutions.

Stakeholders were identified based on their influence and impact on water resource issues in Bangladesh, as well as on their vulnerability with respect to future water resource challenges. In total, 40 in-depth interviews were conducted with key stakeholders, equally representing the private sector, the public sector and civil society.

Stakeholder interviews were based on stakeholder- group-specific questions, including:

- Stakeholders' views and role related to water resources management
- Identification of stakeholder risks and challenges, and the bottlenecks while aiming to run sustainable (business) operations
- Stakeholders' views on actual and possible solutions to these challenges

For a comprehensive list of consulted stakeholders see appendix B.2.

1.2.3. Verifying and expanding knowledge: Focus group discussions and high-level conferences

Two Focus Group Discussions (FGDs) were undertaken, each focusing on a specific stakeholder group: (1) the private sector, and (2) NGOs, international development agencies and international organizations.

In particular the objectives of the FGDs included the following:

- Introducing findings of past stakeholder interviews and receiving feedback on the same (**sounding**)
- Gathering additional information from new stakeholders which could not be covered in prior interviews (**increase coverage**).
- Raising awareness and involving more stakeholders (**increase awareness**)
- Providing a platform for stakeholders to identify common issues and to connect (**allow for communication**)
- Receiving information on stakeholder interrelations or dynamics (**understand dynamics**)

During the final phase, two high-level conferences were organised, with participants being decision makers from the public and private sectors as well as from civil society. At the first conference, the interim project findings were presented and a fruitful discussion across stakeholder groups provided valuable insights into the analysis. At the second conference, the final report and the deep dive were presented, while additional presentations from key stakeholders (Ministry of Water Resources, WARPO, WWF&H&M) and table group discussions resulted in ideas on potential next steps of the

Bangladesh 2030 WRG partnership. An overview of the participants and summaries of the FGDs can be found in Appendix B.4 and B.5 respectively.

1.3. Initiatives related to water resources management in Bangladesh

In spite of multiple activities and initiatives in water resources management, there is still a need for nationwide overview and coordination of these initiatives. In order to avoid duplication of efforts and to streamline the suggested next steps of the 2030 WRG engagement with the ongoing initiatives, a thematic overview of recently completed and ongoing initiatives has been compiled in this section. This list is not exhaustive, but shall provide an overview of the key projects. Further details can be found in B.6.

As can be seen in Figure 3, the share of ODA for funding water related initiatives (WRM) between 2004 and 2012 is comparatively lower than for non-WRM initiatives[2]. The WRM initiatives supported through ODA include those aiming for water resources protection, development of large water supply and sanitation schemes, water resources policy and administrative development, basic drinking water supply and sanitation schemes, river basin development, and regional cooperation for sustainable water resource sharing etc.

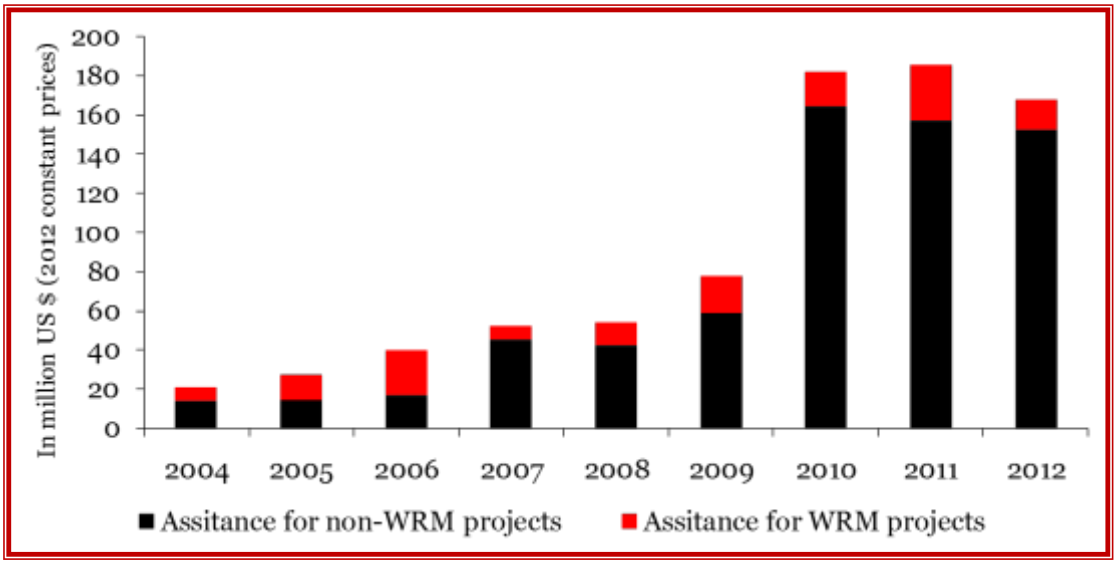


Figure 3: Official Development Assistance provided to Bangladesh from 2004-2012

Source: http://stats.oecd.org/

Note: The significant increase in ODA from year 2009 to 2010 is largely due to the commencement of official reporting of the ODA data by the Asian Development Bank to the OECD statistics database.

According to UN Water, in 2007, 80 percent of Official Development Assistance (ODA) to water sector in Bangladesh was channelled to flood prevention/control programs. Interestingly the focus changed over the years, with drinking water supply and basic sanitation projects receiving the highest percentage of ODA disbursements in 2011.

Some of the key initiatives aimed at improving water services include projects undertaken by the **Asian Development Bank (ADB),** which is assisting the Local Government Division of Ministry of Local Government, Rural Development, and Cooperatives (MoLGRD&C) in establishing a regulatory framework for water supply and sanitation sector in Bangladesh. Further, DSK and ITN-BUET, funded by Bill & Melinda Gates Foundation, are currently working on drafting **Regulations**

[2] As recorded in the Creditor Reporting System of the Organization for Economic Cooperation and Development (OECD)

for Fecal Sludge Management in Bangladesh**ADB** assists Dhaka WASA's water supply sector development project (2009 – 2014) in establishing and operating water treatment plants. ADB also supports the Bangladesh Water Development Board (BWDB) in the Jamuna-Meghna (Borak[3]) Erosion Mitigation Project, and Southwest Area Integrated Water Resources Management which aims to enhance and sustain productivity of selected existing Flood Control Drainage (with or without Irrigation) systems suffering from low performance and high incidence of poverty. **Bangladesh Water Development Board (BWDB)** in association with a **Chinese firm**, Changjiang Survey, Planning, Design and Research (CSPDR) is executing the **Ganga Barrage project** for increasing agricultural productivity and addressing salinity intrusion in south-west region of Bangladesh. In addition, **BWDB** has initiated construction of 162 km of river channels from Jamuna to Buriganga to rejuvenate the Buriganga River by providing better stream flow. The Department of Environment and Forests is currently preparing a project on 'Eco restoration of four rivers around Dhaka'.

The **Japan International Cooperation Agency (JICA)** is assisting the Chittagong Water Supply and Sewerage Authority (CWASA) in taking initiatives to reduce Non-Revenue Water (NRW), expand water supply services and improve the operational and environmental sustainability of the WASA. The **Government of Japan, the Danish International Development Assistance (DANIDA), the Government of Korea, and the World Bank** partnered together with Local Government Division (LGD) to prepare the Sectoral Development Plan 2011 by Policy Support Unit (PSU) of LGD. **DANIDA** also provides technical assistance to implement Dhaka WASA's Saidabad Water Treatment Plant project. On the other hand, **Swiss Agency for Development Cooperation (SDC)** has also undertaken Water and Sanitation projects to construct improved water supply and sanitation systems which will support at least 3 million people (predominantly poor) in rural areas.

Similarly, on water resource management front there have been a number of key initiatives. These include, **SDC** closely engaging with the Government of Bangladesh on designing rules and regulations under the Water Act 2013. **The Japan Bank for International Cooperation (JBIC)** is assisting the Government through Local Government Engineering Division (LGED) since 2007 in the Small Scale Water Resources Development Project to enhance agricultural and fisheries output through effective water resource use. **World Bank (WB)** in its country assistance strategy has emphasised the importance to

The Bangladesh Delta Plan 2100

The ***Governments of Bangladesh and the Netherlands*** have joined forces in drawing up a **Delta Plan** for Bangladesh, which is implemented by the Planning Commission General Economic Division (GED). It is a long term, integrated and holistic plan, which aims to ensure sustainable living and sound economic development in the delta, considering climate change. The Bangladesh Delta Plan aims to provide a 100-year strategy for development of Bangladesh's delta region. It aims to create an institutional setting which will guarantee continued commitment, and implementation of the Delta Plan, as well as coordination between the various stakeholders. These stakeholders include the Government of Bangladesh, NGOs, research/ academic institutes, and the private sector. The approach recommended for these stakeholders to take for planning encompasses socio-economic, water management, and climate change aspects. The Delta Plan Preparatory Team in cooperation amongst Dutch and Bangladeshi agencies has engaged with a wide range of stakeholders to secure their engagement with this approach. These stakeholders will approach the challenges of salt water intrusion, need

[3] Borak and Meghna are interchangeably used to name the same river. *Source: Studies on geo-morphology, ecology and fish production of the92 rivers of Rajshahi Division, Bangladesh; Bangladesh]. Fish. Res., 7(2), 2003: 141-150*

strengthen water resource management in Bangladesh. The Bank is supporting strategy to strengthen capacity of water-related institutions and support institutional reforms and capacity building in key water resources areas. Recently, the WB assisted Government of Bangladesh in drafting and promulgating the Water Act 2013. Further, WB assisted DWASA in developing the recently completed Dhaka Sewage Master Plan 2035 and is planning to continue this engagement by financing selected sewage treatment plants in Dhaka. At the international level, **United Nations Development Program (UNDP)** provides support to the South Asia Water Initiative (Abu Dhabi Dialogue) on water cooperation between India, Bangladesh, Bhutan and Nepal. This initiatives aims at bring these four different countries to one table to discuss and agree on cross-border sustainable water resource management.

World Bank, through International Development Association (IDA), has also been engaged in areas involving restoration of embankments and livelihoods recovery. The Integrated Environment and Water Resources Management Project by WB in partnership with DWASA is one such example. Apart from this, the Bank aims to enhance Bangladesh's capacity to protect coastal embankments, upgrade and modernize the water information system, expand water infrastructure for more reliable and productive water uses.

Global Water Partnership (GWP), a global action network founded by World Bank, the United Nations Development Programme (UNDP), and the Swedish International Development Cooperation Agency (SIDA) is supporting social change processes that further sustainable management and development of water resources, acts on the ground via its Bangladesh Chapter – the **Bangladesh Water Partnership (BWP)**. BWP collaborates with organisations from the country to share and collaborate on sharing knowledge related to water management issues. Similarly, The **Government of Netherlands** supported the **Government of Bangladesh** in establishment of Centre for Environmental and Geographic Information Services (CEGIS) to encourage knowledge generation and sharing.

The **International Fund for Agricultural Development (IFAD)** has been working in Bangladesh in areas of infrastructure, inland fisheries, agriculture, market access, microfinance and gender, targeting the poor. For instance, the Haor Infrastructure and Livelihood Improvement Project has been designed to help reduce poverty in five districts of the Haor basin, an area which is flooded for six months of the year (see section 1.3.1 for details).

The **South Asia Urban Knowledge Hub** is an initiative on regional capacity development developed by ADB and the governments of India, Bangladesh, Nepal and Sri Lanka. ITN-BUET is the national centre in Bangladesh.

1.3.1. Private sector initiatives

Business Initiatives Leading Development (BuILD), an IFC-supported platform aims to contribute to policy making building on the experience of private sector businesses and companies. BuILD holds dialogue amongst its private sector members to arrive at policy recommendations, fine-tuning policies, or even new policy initiatives that are envisaged to support business initiatives. It was reported that BuILD has been able to achieve significant success in various business sectors such as textiles, garments etc., where government policies were fine-tuned to better accommodate and encourage private sector interests and increase the synergies between private and public interests.

The **Bangladesh: Water PaCT: Partnership for Cleaner Technology is** an effort to bring about systematic, positive, and environmental change in the wet processing industries in Bangladesh. It is being implemented by **International Finance Corporation (IFC),** which focuses to channel strengths of different industry players such as global apparel buyers, factory units, and raw material suppliers towards cleaner textile production by facilitating environment-friendly procurement and manufacturing practices.

In September 2013, **Dhaka Chamber of Commerce and Industry (DCCI)** held a round table conference with the **Dutch Delegation to DCCI**. The round table meeting, amongst other objectives, aimed to demonstrate agro food and water management business practices in Bangladesh to the Dutch delegation, and to identify **business opportunities for the Dutch businesses to engage in the agro food and water** businesses in Bangladesh.

DFID and the Forum for the Future organised a workshop titled “Adapting to climate change in developing countries – what role for private sector finance?" in February 2007. Private sector companies participated in this workshop, and one of the key points discussed was private investments in businesses (including insurance, **water management**, and agricultural practices) which are sensitive to climate change.

The World Wide Fund for Nature (WWF) is driving a **water stewardship initiative** across the world, where private sector businesses are encouraged to reduce their water impacts and risks by improving their practices and supporting shared water solutions and improved water governance - while civil society and public sector agencies are encouraged to work together and with the private sector to undertake stewardship at the river-basin level. In Bangladesh, WWF is collaborating with leading research institutions and key water actors to analyse the water situation and create recommendations for shared solutions. WWF is also collaborating with other NGOs and the private sector on implementing water stewardship approaches within Bangladesh (see section 1.3.1 for details).

2. Setting the scene: Water management in Bangladesh

2.1. Bangladesh's water resources situation

Bangladesh mostly consists of a low lying, flat flood plain at the confluence of the Ganges (Padma), Brahmaputra (Jamuna) and Meghna (Borak) Rivers and their tributaries. The country is divided into eight hydrographic regions (see Figure 4) with slightly different rainfall and evapotranspiration patterns. The 710 km (441 mile) coastline of the Bay of Bengal is largely populated with Sundarbans, which is a UNESCO World Heritage Site. Based on data availability, the following analysis excludes the Eastern Hill region and analyses the South-West and South-Central regions.

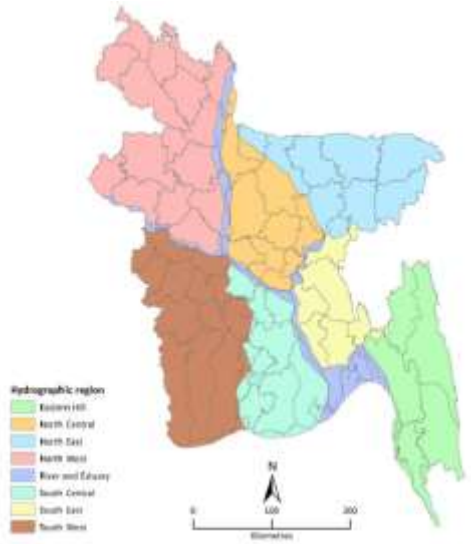


Figure 4 Hydrographic regions and 64 districts of Bangladesh

Bangladesh has a monsoonal climate, characterised with a hot, humid wet season, a cooler dry season and a hot dry pre-monsoon season. According to estimates, the country receives an average rainfall of 284 bcm, of which close to 11% is received during the dry season. The dry season can be said to span from November to March, with least rainfall occurring in December and January, while the strong monsoon peak of rainfall occurs between May and September/ October.

While Bangladesh is often perceived to be a water abundant country, droughts are a frequent phenomenon and can often impose more economic damage than floods (Shahid and Behrawan, 2008). Figure 4 illustrates that evapotranspiration (the evaporation of water stored in soil, surface water or via plant transpiration to the atmosphere) exceeds rainfall during the dry season. This results in a net deficit of water during this period. The northeast and southeast regions are considered most water abundant, with highest rainfall levels and lowest evapotranspiration levels. On the other hand, the southwest/ south-central and northwest regions have the lowest rainfall and highest evapotranspiration, resulting in these regions being the driest. It needs to be mentioned that other studies came to slightly different conclusions on the annual regional rainfall. Further, experts remain uncertain on the general trend of rainfall patterns – some claiming the rainfall to have decreased in the past, while others claim to have identified an increase in rainfall[4]. These differences in trend can be explained by different periods being analysed as well as rainfall data being derived from different gauging stations. It highlights the inherent uncertainty of hydrological analyses which needs to be kept into consideration.

Out of Bangladesh's 405 rivers, 57 are trans-boundary, including the main rivers (the Ganges, Brahmaputra and Barak) which are shared with India. The combined inflows of all transboundary rivers is about 1260 bcm annually, out of which only 186 bcm (15%) flow in the dry season5. During the wet season, the rivers receive an additional flow of about 113 bcm from the combined regional runoff. Thus, only 8% of Bangladesh's water resources are produced internally. Total dam storage capacity amounted to 6.5 bcm in 2013 (Aquastat, 2014; Kirby et al, 2014), allowing only 0.4% of

[4] Compare for example, Kirby et al (2014), Shahid and Kairukmini (2009) and Basak et al (2013).
[5] Out of this, the three main rivers, Ganges, Jamuna and Meghna carry a combined discharge of 1100 bcm annually.

annual surface water to be stored. The combined volume of inflows and runoff which is not consumed (1300 bcm) discharges to the sea annually.

Bangladesh has an aquifer system with both deep and shallow aquifers. However, estimates of annual groundwater recharge in Bangladesh vary widely, ranging from 21 bcm to 65 bcm[6] (Kirby et al, 2014). Following a more conservative estimate, we assume the net recharge rate for groundwater resources of 32 bcm annually for our further analysis (Kirby et al, 2014). Thus, groundwater only makes up 2% of Bangladesh's total renewable water resources. Similarly as with surface water, groundwater availability and recharge significantly differ between seasons. In the wet season, as aquifers are recharged by rainfall and river inflows, the groundwater table of the shallow aquifer nearly rises to the surface. Contrary, the groundwater table falls in the dry season, due to groundwater consumption and discharges to rivers, even resulting in a negative recharge. Thus, during the dry season, the available groundwater resources are those recharged during the wet season.

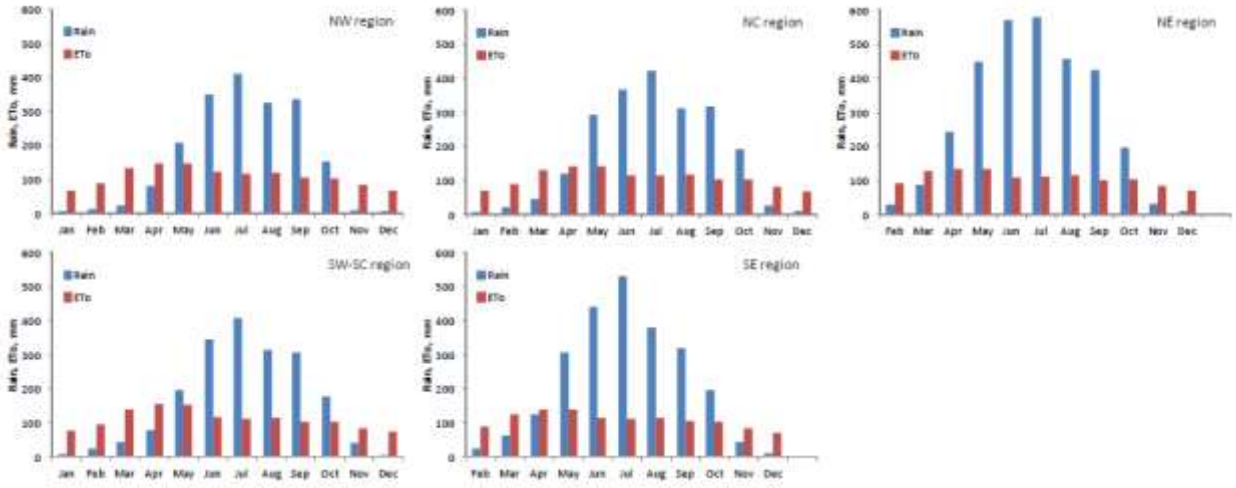


Figure 5 Monthly average rainfall and evapotranspiration in five hydrographic areas (1985-2009)

Source: Kirby et al (2014)

On a national level it can be said that the groundwater table fluctuates within the top 10 meters below the surface, with the highest level being post-monsoon (i.e. November) and lowest levels being pre-monsoon (i.e. April/ May). From Figure 6, it can be considered that groundwater aquifers recharge with monsoon rains. However, in some regions, such as Dhaka district and the Barind tract (northwest), the groundwater table is constantly declining (Kirby et al, 2014). To our knowledge, no extensive assessment of total available (i.e. beyond renewable, including fossil) groundwater has been undertaken in Bangladesh to date.

Further, due to Bangladesh being located in a flat flood plain and with its monsoonal climate, it is prone to three types of floods: river flooding over the banks, flash floods caused by intense storms, and coastal flooding due to storm surges. With the Bay of Bengal being one of the world's most active areas for cyclone development, Bangladesh frequently and severely suffers from tropical cyclones causing destructive storm surges, along with flooding events.

During the wet season, every year around 20% of the country is flooded on average, with most of the country being affected in particularly wet years (Mirza, 2002). While the peak flows of Bangladesh's

[6] See for example: Rajmohan and Prathaper (2014), Hodgson et al (2014), Kirby et al (2014), FAO Aquastat (2014): http://www.fao.org/nr/water/aquastat/countries_regions/bangladesh/index.stm

major rivers are usually separated by one month, it does happen that these coincide, resulting in major floods (e.g. in 1988 and 1998)[7].

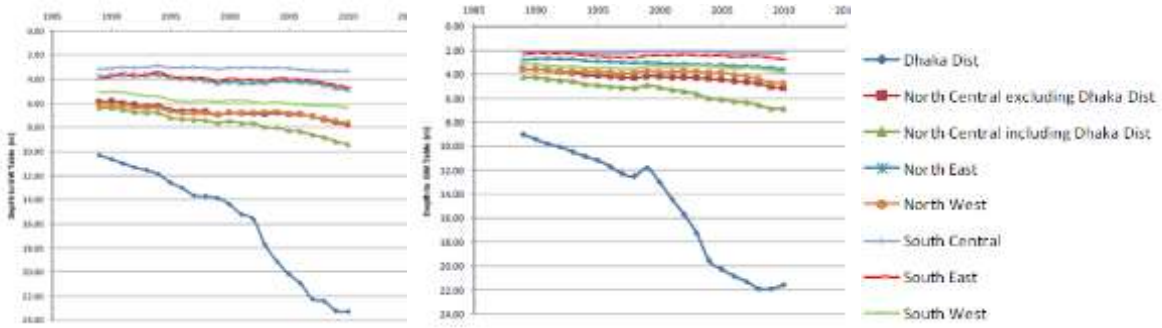


Figure 6 Variation of pre-monsoon (left) and post-monsoon (right) groundwater table (5 year moving averages)

Source: Kirby et al (2014)

2.2. Effects of climate change on available water resources

To understand Bangladesh's future water resources situation, it is crucial to understand the potential impact of climate change on available water resources. For sake of understanding, we compare surface water and groundwater recharge.[8]

Climate change is expected to have an effect on temperatures and rainfall, and consequently on evapotranspiration, crop water demand, runoff and recharge. While temperatures are expected to increase in the Indian subcontinent region, and more particularly in the Ganges basin, the effect on precipitation is less certain[9]. A study by Kirby et al (2014) compares the impact of four climate change scenarios (2030 wet and dry; 2050 wet and dry) on the regional water balances to understand the extent of the potential impact (see Figure 7).[10]

In the **wet climate change scenarios,** water availability is expected to increase in future. Surface water is projected to increase by 11% in both years. Despite the increase in evapotranspiration, irrigation water demand is expected to decrease by 9% in 2030 and by 1% in 2050 when compared to the base climate.

Generally, it can be observed that changes in the **drier climate change scenarios** are expected to result in less change than the wet climate change scenarios. Recharge increases by 3% while surface water is expected to decrease by 2% by 2030. Irrigation requirements are expected to increase by 4% in 2030.

To understand the relative impact of the future projected changes, these values are contrasted to climate variability, i.e. "naturally" occurring past wet and dry years (see Figure 7). For this analysis, the two wettest years of 1991 and 1993 and the driest year of 1994 were analysed. Data for river inflows and outflows, however, is only available for the base case and climate change scenarios.

In the wet years, recharge increased by 11% and 9% in 1991 and 1993 respectively and decreased by 17% in the dry year of 1994. Surface water flows increased by 26% and 28% in 1991 and 1993

[7] See Mirza (2003)
[8] As calculated as the sum of base flow, runoff and river inflows.
[9] Kirby et al (2014a), Kumar et al (2006) , Moors et al. (2011), Mulligan et al (2011).
[10] Projections for wet years are based on IPCC A1B scenarios; the projections for drier years are based on the FGOAL model. These projections were prepared by the Institute for Water Modelling (IWM, 2014).

respectively and decreased by 32% in 1994.

It needs to be noted that this analysis does not include changes from river inflows of the three major rivers, the Ganges, Brahmaputra and the Barak. Separate analyses, as discussed in Kirby et al (2014), project that the dry season flows of these three major rivers are expected to increase slightly, while the peak flows are expected to intensify, resulting in an increase of flood events.

Thus, climate variability is expected to have a dominant impact on water resources when compared to climate change. Given this and the inherent uncertainty in climate change predictions, we have not included the climate change impact in our further water balance assessment (see next section).

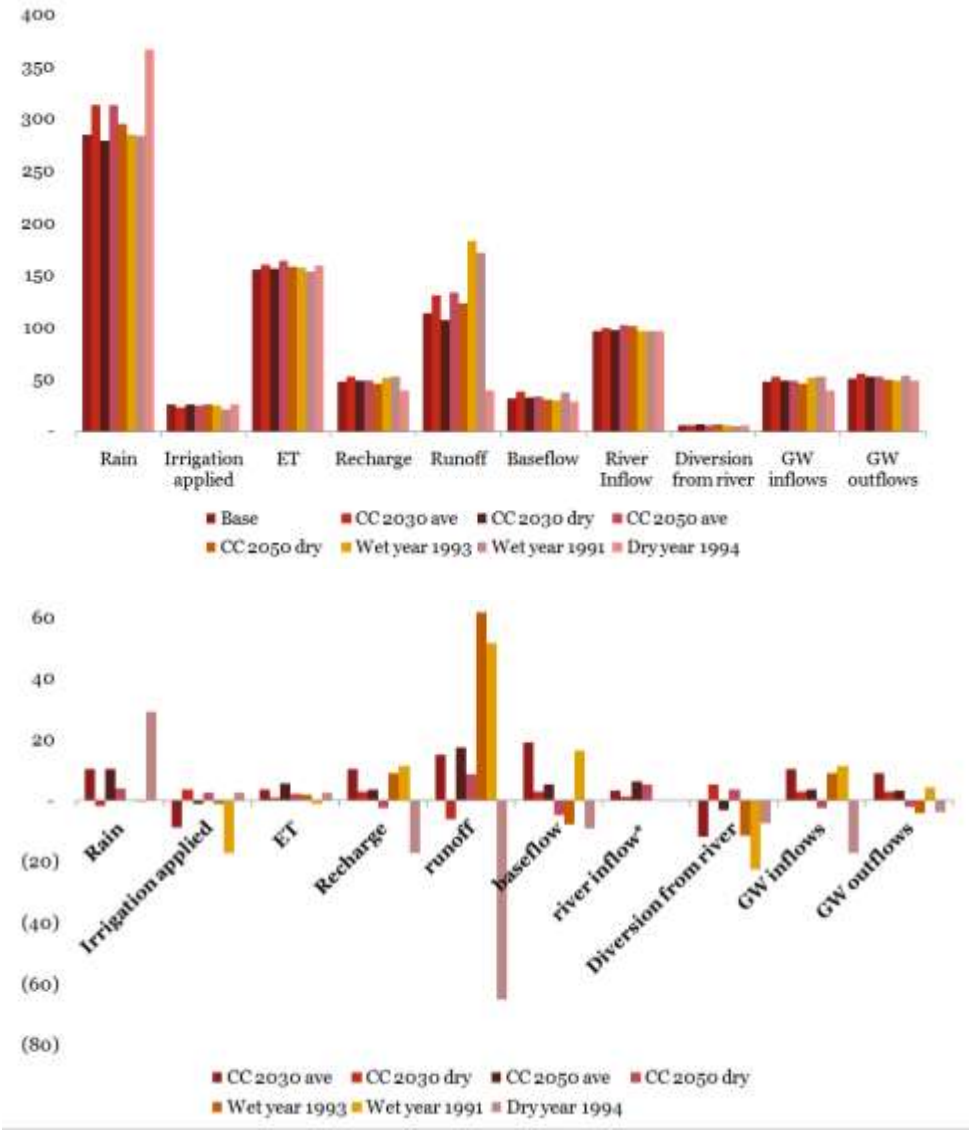


Figure 7 Impact of climate change and variability on water resources (volumes in bcm (top) and % change to base scenario (bottom))

Source: Kirby et al (2014/ 2014b)

2.3. Current and future water demand

Agriculture has a pivotal role to play in Bangladesh's economy. Across the country, 47% of the labour force is occupied in agriculture, while the majority of the 70% of country's population residing in the rural areas are either directly or indirectly involved in agricultural activities. However, agriculture only contributes 17.2% to national GDP (UN Statistics Division, 2014). Fisheries play a significant

role in Bangladesh's agrarian economy, contributing 4.37% to national GDP, i.e. 25% of the agricultural contribution to GDP. An estimated 11% of Bangladesh's population are either directly or indirectly involved in this sector to secure their livelihoods. Shrimp, e.g. are a major export product. Beyond its economic relevance, the produced fish provides an estimated 60% of animal protein intake, making it key for Bangladesh's food security[11]

Agricultural water demand, with water withdrawals of 32 bcm/ year (93% of total withdrawals), is the largest water user in Bangladesh. [12] The dominant share of agricultural water withdrawals (23.6 bcm/ year or 72%) is used for irrigation. The remaining 28% are used for watering livestock, aquaculture and forests. [13] Instream water is required for ensuring ecosystem health and for inland open water fisheries.

Table 1 Current and future annual water demand (water withdrawals)[14]

(BCM)	2011	2030	% change
Domestic Demand	2.4	4.2	75%
Industrial Demand	0.09	0.18	109%
Agricultural Demand	32.32	46.26	43%
of which Irrigation Demand	*23.6*	*34.47031*	*46%*
Instream Water Demand / Environmental Flows	106.16	106.16	-

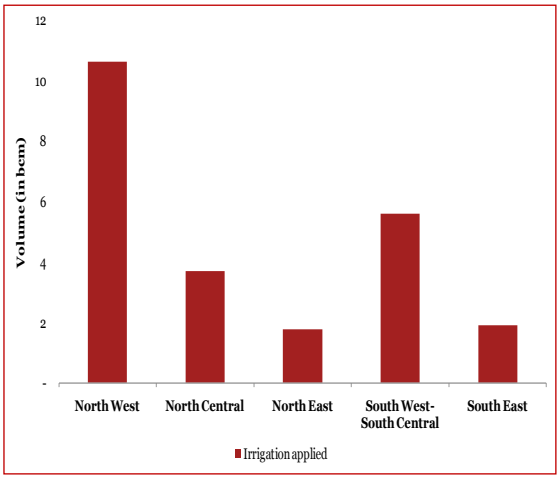
The greatest volume of irrigation is used in the North West (45%) and South West/ South Central (24%) regions in Bangladesh (Figure 9, left). As is illustrated in Figure 8 (right), rice is the dominant crop, with 80% of the cropped area and 77% of the irrigated area being used for its production. Looking at the volumes of consumed water per crop, 90% is consumed by the rice production (IWMI, 2014). While 60% of irrigation water was sourced from surface water in 1983, in 2010 80% of irrigation demand is met through groundwater (Kirby et al, 2014).

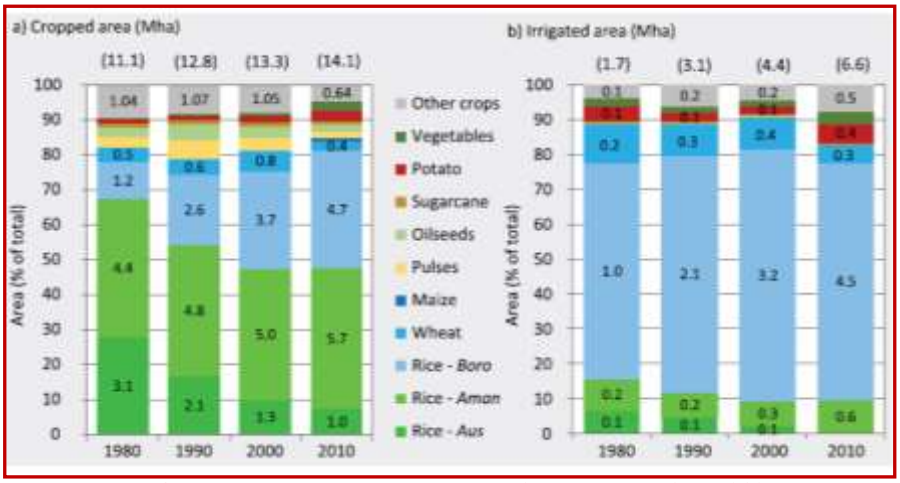
Bangladesh cultivates primarily three varieties of rice : 1) 'Aus' rice, which is grown in the wet season and only requires supplementary irrigation to buffer unreliable rainfall, 2) 'Aman' rice, which has no consumptive water usage and 3) 'Boro' rice, which is grown in the dry season. 'Boro' rice is a dry season crop requiring irrigation and is accountable for almost all the consumptive water demand for rice in Bangladesh (IWMI, 2014).

As part of the vision to achieve food security, Bangladesh's agricultural sector has made considerable progress in terms both production (17 mn MT in 1968-72 to 49 mn MT in 2008-12) and mean yields of crops (1.7 t/ha in 1968-72 to 4.3 t/ha in 2008-12). This growth in production and yields has been a result of increased cultivation during the dry season. Boro (or dry season) farming of rice was made possible by using shallow tube wells for extracting groundwater for irrigation. The irrigated area increased from 1.7 Mha in 1980 to 6.6 Mha in 2010. In 2010 Bangladesh produced a surplus of rice

[11] Ministry of Fisheries and Livestock, Department of Fisheries, Bangladesh (2014), Fisheries Statistical Report of Bangladesh 2012-2013.
[12] Irrigation water demand (Kirby et al, 2014); Total agricultural water withdrawals and irrigation requirement (FAO Aquastat, 2008 values). Ratio of irrigation requirement to total agricultural water withdrawals is taken and used to scale Kirby's irrigation demand to include non-irrigation agricultural demand.
[13] FAO Aquastat (2014), Kirby et al (2014), PwC Analysis in footnote above.
[14] Please note that literature offers different estimates for water withdrawals. FAO Aquastat, e.g. quotes 31.5 bcm for agricultural withdrawals, 0.77 bcm for industrial water withdrawals, and 3.6 bcm for municipal water withdrawals for 2008. While the correct numbers cannot be verified at this stage, this underpins the finding that more research is required.

(5%) and achieved its objective of self-sufficiency for the first time. The area and yield of rice production is expected to increase further until 2030 (from 4.5 Mha in 2010 to 6.7 Mha in 2030) with consumptive water demand increasing by 48% between 2010 and 2030.





Notes (right graphs): Cropping patterns indicate the three-year averages of 1979-1981, 1989-1991, 1999-2001 and 2009-2011. Values within parenthesis at the top of the bars are the gross cropped and irrigated area of Bangladesh. Values inside the bars are the absolute cropped area.

Source: Mac Kirby et al (2014) (left), IWMI (2014), Bangladesh Bureau of Statistics (right)

Figure 9: Irrigation water demand in dry season across regions

Figure 8: Overview of cultivated and irrigated area by region and crop type

Agricultural water demand is mainly composed of water demanded by Boro rice. Further, Due to lack of reliable growth estimates for other crops, we assume Boro rice demand to be the underlying driver for the 2030 agricultural water demand (see Table 1).

Domestic water withdrawals amount to 2.3 bcm annually, 7% of total water withdrawals. The highest domestic water demand, in direct relation to population distribution, is in the northwest, while the lowest is in the south central zone. Dhaka, as largest city requires between 0.7 and 0.8 bcm each year meeting domestic demand. From this, around 83% is abstracted from groundwater (Kirby et al, 2014). Bangladesh's population is expected to increase from around 150 million today to around 214 million by 2050, with around 45% of the population living in urban areas by 2030.[15] Jointly, these factors drive domestic water demand up by 75% in 2030.

Industrial water demand amounts to 0.09 bcm annually (0.2% of total water withdrawals). [16] With the rapid economic growth of Bangladesh's economy expected to continue, industrial water demand is projected to increase by 109% in 2030.

Instream demand considers the required water for navigation & fisheries, salinity control, pollution control (dilution) and the environment (NWMP, 2001). The water requirement for each category is calculated for all regions. Water requirements for the environment are calculated as 40% of the combined trans boundary flows, (inter-)regional inflow and internally generated flows under average flow conditions. The highest water requirement between the categories is adopted as the instream demand. [17] In the following, instream demand is referred to as environmental flows.

[15] Sector Development Plan (2011-2025) Water Supply and Sanitation Sector in Bangladesh (p.24)
16 Kirby et al (2014)
[17] National Water Management Plan Project (2000) Draft Development Strategy. Appendix C, Annex 5.

2.4. Bangladesh's water resource management challenges

Comparing available water resources demand in 2011 and projections for 2030, the available water resources exceed demand when considering the water balance on an annual basis, i.e. including dry and wet season water supply and demand (see Figure 11).

However, as discussed above, only 15% of the surface water is available in the dry season, coinciding with the peak in water resources demand for irrigation. [18] To understand the criticality of this seasonal imbalance, Figure 11 contrasts water supply and demand for the dry season only.

Assuming that all surface and groundwater can be utilized, on national level total available water resources, i.e. total water resources minus environmental flows, still appear to be sufficient to meet demand in 2011 and 2030 (dotted horizontal line). However, looking at today's situation, only 20% of water demands are met by surface water abstractions. Using surface water requires small-scale and large-scale infrastructure for abstraction, treatment (if necessary) and distribution. Understanding that this infrastructure is currently only available to meet 20% of demand, we consider *practically* available water resources to be reduced to 38 bcm/ annually. Considering practically available[19] water resources for the dry season water balance, and assuming that surface water usage will remain constant until 2030, water demand is expected to exceed practically available resources by 21% in 2030.[20]

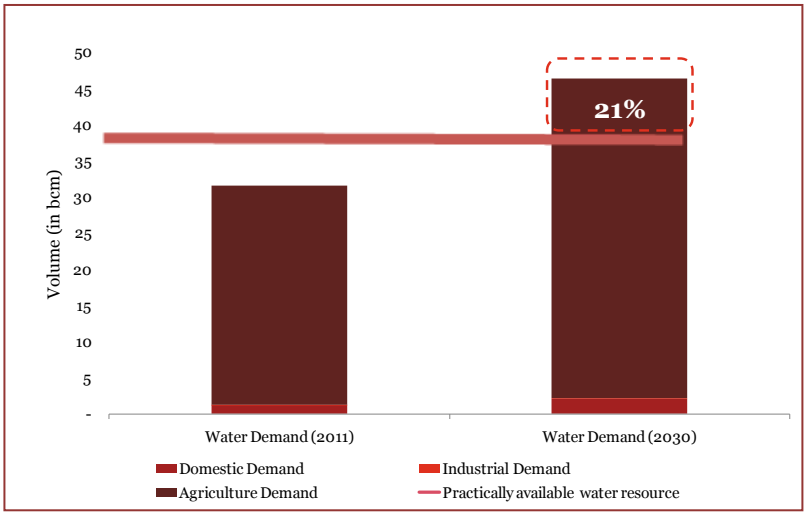


Figure 11: Practically available water resources and water demand (during dry season)

Sources: *PwC Analysis, CSIRO (2014), National Water Management Plan (2001), IWMO (2014)*

Note: *Environmental flow requirements are considered in total available water resources, i.e. water resources are reduced by water demands required by the environment. Environmental flow requirements are included indirectly in practically available water resources, as only 20% of surface is assumed to be abstracted, leaving sufficient water to meet in-stream demand.*

Figure 10 Critical Water Pollution around Dhaka

Source: *Prof Dr. A. B. M. Badruzzaman*

As described above, groundwater aquifers are recharged in the wet season, with most abstraction occurring in the dry season. Thus, in this study total groundwater is assumed to be available in the dry season. Understanding the sustainable yield of groundwater abstraction is critical for sustainable

[18] Kirby et al (2014)

[19] Return flows from various uses are not directly considered for practically availability, since significant treatment may be required to use such water.

water resource management. However, as to our knowledge no studies on the sustainable yield of groundwater abstraction in Bangladesh have been undertaken, we consider the total groundwater recharge volume as available groundwater resources. Thus, it is highly likely that the water supply-demand gap will be even greater when considering only the sustainably available groundwater resources. Further, this analysis does not consider water quality aspects, which could further reduce usable water resources and thus increase the water supply-demand gap. For example, Figure 10 illustrates the critical water pollution around Dhaka, which is mostly caused by discharge of untreated sewage and industrial effluents; a situation which is further analysed in the deep dive section. Factors which are assumed to additionally widen the water supply-demand gap, as well as additional challenges to Bangladesh's water resource management are provided in the overview below and further expanded in Annexure B.7.

Overview of Bangladesh's Key Water Resource Management Challenges

- Plentiful **surface water resources from the wet season cannot be saved** for dry season water usage due to inadequate infrastructure. Currently only 0.4% of total surface water is stored.
- **Water quality concerns limit usage of available water resources:**
  - **Arsenic contamination** is the most **pressing water quality related issue, with 1/3 of Bangladesh's population exposed**. It is observed predominantly in shallow tube wells as compared to deep tube wells.
  - **Concentration levels of iron and manganese** have been detected in various parts of the country with high concentration in south west, south east and north east region of Bangladesh.
  - **High salinity of water resources** have been repeatedly reported in the southern region of Bangladesh. Besides health related negative effects, it also reduces agricultural productivity.
  - Long term risks related **to saline intrusion** to groundwater pose a serious challenge and are expected to increase with climate-change induced sea level rise.
  - **Industrial pollution, discharge of untreated sewage, agricultural run-off as well as shrimp farming** severely impact surface water quality, in some cases, such as in Dhaka, even preventing further usage (see complimentary deep dive on sewage treatment in Dhaka).
  - **Water quality concerns are more acute in the dry season** than in the wet season, as low flows reduce the potential for dilution of pollutants.
- Bangladesh's recently gained **food security** is mostly based on Boro (dry season) cultivation of rice. **Boro rice is the most dominant water consumer** in Bangladesh, of which 80% is irrigated with groundwater.
- Water- logging poses a major threat to agricultural production, especially in the southwest coastal region of Bangladesh, having affected close to one million people of eight upazilas in the last thirty-five years.[21]
- **Unsustainable groundwater abstractions are leading to aquifer depletion,** as heavy dependence on groundwater result**s in aquifers not being** sufficiently recharged in the wet season (see Figure 6). Key affected areas are Dhaka with **falling water tables of 2 meters each year** and the Barind tract.
- Bangladesh's economy is growing, driven by its textile industry. As one of the main global producers of textiles, **key concern is to produce at low prices to maintain its competitiveness**. Little attention is given to environmental concerns, such as effluent discharges, resulting in severe water pollution.

[21] December 2006, The Development Disaster, Water-logging in the Southwest region of Bangladesh, The Innovators/Unnayan Onneshan

- **Water pollution** has been found to be a **contributor to food contamination by heavy metals,** including cadmium (used in the battery industries), chromium (used in tannery industry) and aluminium. Further, water pollution is one factor threatening inland capture fish production. Between 1985/86 and 2012/13 inland capture fish production reduced from 55.7% to 28.2% of total fish production, with a strong increase in aquaculture.[22]
- The drop in the groundwater table necessitates **considerable capital investments to ensure future water supply and higher energy costs related to pumping**.
- 92% of Bangladesh's water resources come from trans-boundary water resources, resulting in **high dependence and uncertainty of future flows**.
- **Bangladesh is essentially a delta country, making it imperative for delta principles to be considered.** Located in a low-lying, flat delta flood pain at the confluence of three major rivers, Bangladesh is prone to **flooding rivers, flash floods and coastal flooding**, leaving much of the country flooded in particularly wet years and causing considerable (economic) damage. **Deforestation in upstream catchments aggravates the situation.** Between 1980 and 2010, 68 disasters due to flood were registered, making it after storms (108 events) the second most frequent natural disaster. The other delta principles[23] that need special focus include (a) impacts of climate variability and uncertainty in predicting long-term impacts of climate change, (b) siltation of channels and tributaries, (c) inundation of coastal zones, (d) conservation of haors and wetlands, and (e) institutional and governance aspects of implementing these principles.
- **Droughts and floods** in Bangladesh resulted in agricultural production losses leading to risks of food insecurity and economic implications. While **climate change** is expected to have negligible impact on the water balance as such, it is projected to lead to an **increase in extreme weather events**, such as droughts and floods. Further estimates say that if **sea levels were to rise by 1 m, 10% of Bangladesh would be flooded**.
- While access to improved sanitation and drinking water has increased over the years, it still leaves **15 % urban population with no access to improved drinking water and 43% without access to improved sanitation** in 2012.
- **Limited data availability, and avenues/ platforms** to share data and co-ordinate across various stakeholders are a major challenge towards moving to informed decision making.
- **Service delivery** has been identified as one of the key areas of improvement in urban water supply in Bangladesh:
    - **Wastewater is not sufficiently treated –** the only wastewater treatment plant in Dhaka works at 40% capacity.
    - **Intermittent water supply is a key challenge**, particularly in the dry season. The situation is aggravated by intermittent power supply. **An additional expenditure of more than US$ 700 mn** will be required to meet water requirements
    - **Leakages and low pressure** in the **water distribution** system **cause extensive contamination of the water** within the network **and increases non-revenue water**
    - **Low tariffs and limited collection** of revenues **leads to financially unsustainable utilities,** unable to make required investments to increase coverage and improve water supply
    - **Accounting and management systems** are outdated, inefficient, and often not transparent
    - **High turn-over of (senior) executives and perceived low capacity** of staff in WASAs limits performance and consequently services offered.

[22] Ministry of Fisheries and Livestock, Department of Fisheries, Bangladesh (2014), Fisheries Statistical Report of Bangladesh 2012-2013.
[23] Bangladesh Delta Plan 2100 Formulation Project: Delta Plan Initiatives; Input for 7th Five Year Plan: June 2015

2.5. Institutional and organizational overview

To set the context of the identified constraints which underlie sustainable water resource management, which will be discussed in the following sections, the basic institutional and organisational structure of Water Resource Management in Bangladesh will be introduced below.

Bangladesh gained its independence in 1971 and reinstated its democracy, exercised through a unitary parliament system, in 1991.

Administratively, Bangladesh is divided into seven divisions (Dhaka, Khulna, Rajshahi, Barisal, Chittagong, Sylhet, and Rangpur). The divisions are further divided into 64 districts, 482 Upazilas (sub-districts), and 4498 Unions.[24] Urban and rural local governments are separate in the country. The urban local governments are either at the level of medium to large towns (paurashavas – there are 308 paurashavas) or city corporations (seven city corporations). The rural local governments are either union parishad (lowest tier – and 'parishad' means council; union consists of 9 villages each, from where 1 council member each is elected), sub-district parishad, and district parishad.

There are 35 ministries and seven divisions[25] of the Government. The **Ministry of Water Resources (MoWR)** as well as the **Ministry of Local Government, Regional Development and Cooperatives (MoLGRD&C)** and their departments and divisions are directly involved in Bangladesh's water resource management. The MoWR is responsible for water sector development and management including expansion of irrigated areas, water conservation, surface and groundwater use, and river management. The MoLGRD&C oversees design and implementation of the policies related to water supply and sanitation through local government divisions. The **National Water Resources Council (NWRC)**, an inter-ministerial highest decision-making body, is mandated to policy-making, policy direction, coordination for effective Water Resources Planning, and approving and ensuring implementation of the National Water Resources Plan[26], which is prepared by the **Water Resources Planning Organisation (WARPO).**[27] The **NWRC** acts via its **Executive Committee (ECNWRC)** which is mandated to run the activities of the Council, including publication of directives of the Council on water resources, advising the NWRC on issues in water resources management, coordinating amongst concerned authorities, and other functions as the NWRC determines[28]**.** In addition to these agencies, more agencies are indirectly involved with water resources management. Figure 12 provides an overview of the involved agencies. Their mandates and responsibilities are listed in Annex B.1.

The **Water Resources Planning Act** was passed in 1992, aiming to provide for development of water resources and ensuring sustainable use of the water resources. As a response to the lack of coordination amongst various development programs and to bring order and discipline in exploration, management, and use of water resources in Bangladesh, the **National Water Policy (NWP)** was passed. As part of the NWP, a **National Water Management Plan** should be prepared by WARPO, which was completed in 2001. The Water Act 2013 legalized some provisions of the NWP, such as the establishment of the **National Water Resources Council** and provides for mechanisms for approval of plans, and enforcement of decisions related to execution of the plan and its monitoring. Following the National Water Management Plan (2001), a **National Water Resources Plan (NWRP)** is currently being prepared by WARPO and estimated to be completed by 2015. The NWRP provides a framework at the national and the regional level for all concerned

[24] Sector Development Plan (FY 2011-25), Water Supply and Sanitation Sector in Bangladesh, Local Government Division, Ministry of Local Government, Rural Development, and Cooperatives
[25] Some ministries are divided into divisions, each division is headed by a Secretary.
[26] Section 10, Section 15, Water Act 2013
[27] Section 5, Water Act 2013
[28] Section 10, Water Act 2013

stakeholders to plan and implement their activities in the water sector[29]. The **National Policy for Arsenic Mitigation** (adopted in 2004), the **National Policy for Safe Water Supply and Sanitation** (adopted in 1998), the National Sanitation Strategy (2005) and **National Strategy for Water Supply and Sanitation (2014)** complement the National Water Policy. The latter policy and strategy states the Government's goal to ensure access to safe water and100% sanitation service coverage at affordable cost for all. To reduce Bangladesh's dependence on groundwater usage, the National Agriculture Policy (2013) encourages surface water irrigation. The **Bangladesh Water Supply and Sanitation Regulatory Commission Bill** (2013), aiming to establish an independent and impartial regulatory commission for the water supply and sanitation sector, as well as the **Regulatory Framework for Water Supply and Sanitation Sector in Bangladesh** are currently in the process of drafting. In addition, the Local Government Division under LGR&C has formulated a comprehensive Sector Development Programme for the water and sanitation sector in Bangladesh for the next ten years. To manage the water usage of households, industry and agriculture alike, the Government can introduce licenses, permits and economic instruments. The latter, if designed such, can incentivise water users to engage in sustainable water management.

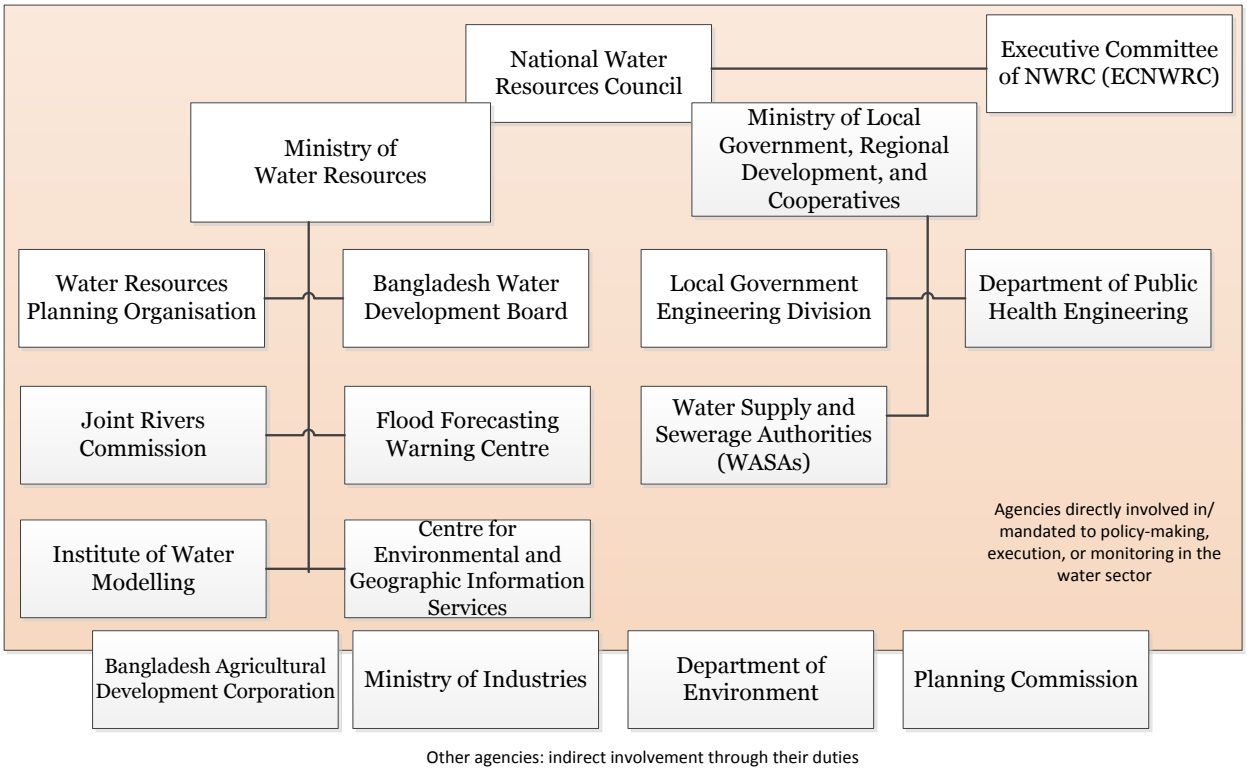
In Bangladesh, sinking tube wells in WASA areas requires a license from the responsible WASA. Similarly any undertaking related to water conservation or preservation measures requires approval from the ECNWRC. The Water Act also mandates the ECNWRC to control activities such as construction obstructing natural water flows and over-extraction of water that can potentially dry surface water sources. The Act also includes **Ministry of Industries (MoI)** and **Ministry of Environment and Forestry (MoEF)** as key stakeholders in NWRC to address related to pollution and sustainable management of water resources. The Environment Conservation Act 1995 and the Environment Conservation Rules 1997 specify the standards of effluent quality for textile industries with investment greater than Tk. 30 Mn. More details can be found in Annex B.2.

In Bangladesh, tariffs are imposed for water supply, effluent treatment as well as charges for using the sewerage system. WASAs charge tariffs for water supply and sewerage services in their jurisdiction, BEPZA charges for water supply and effluent treatment within the Export Processing Zones, while DPHE charges tariffs for water supply and sewerage services in all areas except for those serviced by the WASAs.

The Executive Committee of the National Water Resources Council (ECNWRC) has been charged with the responsibility of enforcing the penal provisions to offences and violations. More details target groups and height of charges can be found in Annex B.2.

[29] Pp.1 Vol.1, National Water Management Plan 2001, WARPO

Figure 12 Agencies involved in water resources management



The Government takes a plan-based approach to the development of the country. Budgeting and development planning is carried out every year. In addition to the national budget prepared for each financial year (July to June), the **Planning Commission (General Economic Division) prepares five-year plans that direct economic priorities**, and also touch on and impact water resources management. [30]The five-year plans are financed through the Government's development or capital budget, separate from the revenue or administrative budget.

Five-year Planning and Water Management in Bangladesh[31]:

The Sixth Five Year Plan (FY 2011-15) envisages (as part of the priorities) water resource management as an important tool to address core development objectives such as mitigating poverty, encouraging industrialisation, pursuing (especially environmentally) sustainable development, and progressing towards building a digital Bangladesh.

Therefore, in order to address these objectives, the FYP emphasizes undertaking activities which directly relate to water quality and availability. For instance, activities related to treating all urban waste water to clean rivers, promoting zero discharge systems in industries, restoration of urban wetlands, increasing water security to poor communities, enhancement of coastal green belts, restoration of natural water flows (canals/ lakes/ rivers) especially in the Dhaka region, and incorporation of disaster/ climate change mitigation measures have been captured in the plan. The plan includes programs/projects in the water resources sector which would require approximately Tk.235 billion (~US $ 3 billion) for planning, and implementation. In addition, the plan stresses on sustainability of water resources in Bangladesh by highlighting issues such as basin-wide water resources development, and requirement to monitor and update data related to water resources etc.

[30] According to the Perspective Plan of Bangladesh (2010-2021)[30], the strategy for rural development is establish a powerful autonomous local government body to initiate and provide coordination among private and public rural development institutes *(Rural Planning Commission)*.
[31] Please see pp 37-41 in Part 2 of the 6th FYP for further information.

General Economics Division (GED) of the Planning Commission is in the process of preparing the 7th Five Year Plan (2015-16 to 2019-20)[32]. The following significant points are observed to be included in the background to the 7th FYP, concerning water resources management[33]:

a. Extended producers' responsibility policy would be formulated: this would mean that the businesses using water would have to be responsible for the ultimate water quality as well, i.e., in the process of their products being used by the end-customer.

b. Polluters pay principle would be strictly followed: polluters pay principle involves the polluter bearing the costs for restoring the environment to its non-polluted state. This means for water sector that the polluters will have to bear the full cost for restoring water resources to their non-polluted state, to the extent of the volume of pollutants produced.

c. A budget of 62 Bn Bangladeshi Taka has been earmarked for conservation of surface water sources, as well as control of river basin pollution.

[32] http://www.plancomm.gov.bd/7th-five-year-plan/, last accessed 26 Nov 2015, 00:29hours

[33] Pp 46, http://www.plancomm.gov.bd/wp-content/uploads/2015/02/11b_Environment-Forestry-and-Bioderversity-Conservation.pdf, last accessed 26 Nov 2015, 01:07hrs

3. Sustainable water management as a business case

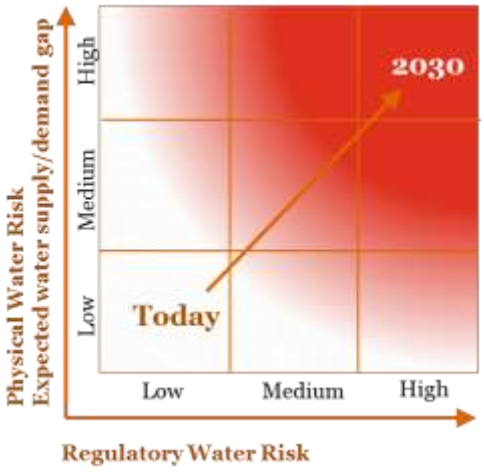
The private sector plays an integral role in working towards sustainable water management in Bangladesh. Not only is the private sector a main water user and (currently) polluter, it also has the financial resources to potentially have a significant impact on improving the water resources situation.

Acting as profit-driven entities, companies need to mitigate water-related risks of the future, and find ways to reduce costs and increase revenue streams. In the following section, potential business cases following these objectives while furthering sustainable water management are introduced. In addition, constraints which hinder some of these business cases from materializing in Bangladesh are analyzed.

Business cases are defined as profitable investment opportunities undertaken by economic agents. Other activities around sustainable water management, e.g. driven by corporate social responsibility, are not the prime focus of this project and are not seen as business cases per se in this analysis.

3.1. Sustainable water management – need for integrating into the core business strategy

In light of various issues in Bangladesh's water resources management sector, companies and businesses face real challenges from physical, regulatory, and reputational aspects of risks associated with water. Incorporation of sustainable water resources management into the core of their businesses will not only help them mitigate these risks, but also help improve profit margins and cost competitiveness.



3.1.1. Physical water risks

As illustrated in Figure 2, 21% of the demand is expected to remain unmet by practically available supply in the dry season by 2030. Further, climate change is not expected to have a significant impact on the water balance, weather extremes such as (coastal) flooding are expected to further pose risks to companies. Physical water risk has already materialised in Bangladesh with businesses having to shift their manufacturing units (especially bottling plants) due to falling groundwater tables and deteriorating water (ground) water quality. Such examples demonstrate that the following drivers exist for the companies to build sustainable water management into core of their businesses:

Drivers for companies:

- Risk of termination or disruption of reliable water supply in required water quality
- High costs of extracting and treating water

Business propositions/ potential business cases:

- Forecasting the water availability and investing into research for devising low-water processes
- Investing in reduction of water footprint
- Investing in treatment and reuse of wastewater
- Investing in rainwater harvesting

Case Study 1: Integrating sustainable water management practices into the core business strategy

DBL, a leading garment manufacturer, produced **35 metric tons** of cloth each day using **3,400 cubic meters (or about 900,000 gallons**) of water. In 2011, DBL decided to upgrade its production equipment as part of a **Water PaCT program backed by DFID, Norad and IFC**. Prior to upgradation, DBL used **120 liters, or 32 gallons, of water to produce a kilogram, or 2.2 pounds**, of cloth which later substantially reduced to **60 liters**. Upgradation and measures such as fixing leakages also saved electricity and gas used to pump and treat water, which translated into a total financial saving of **$500,000/year.**

The physical risks due to unavailability of water are reportedly reduced to that extent. The practice to manage such risks is also institutionalised through clear calculation of savings and costs.

3.1.2. Regulatory water risks

Public, private, as well as civil society stakeholders voiced that the increase in competition amongst users for access to water is slated to become even faster with growing economy and population. This will evidently mount higher pressure on the regulatory and legislative initiatives (such as the Water Act 2013 and the Environment Protection Act) to be implemented more stringently. While currently the enforcement of these legislative and regulatory initiatives may be weak, companies and businesses face the risk of being penalised by the legal and regulatory instruments in the future if sustainable water management initiatives are ignored.

Drivers for companies:

- Risk of being charged significant amounts for licence to extract groundwater/ treat effluents
- Risk of being penalised for not treating effluents and wastewater
- Risk of closure or relocation of production facilities

Business propositions/ potential business cases:

- Inclusion of principles of water efficiency, water treatment, and water recycling as part of decision process for new investments.
- Cooperation with government to identify most effective regulatory practices which do not unnecessarily disrupt businesses' operation.
- Use of compliance with environmental and social standards as a chance to be eligible for loans from certain (development) banks which offer lower interest rates.
- Collaboration with government agencies (such as Local Government Engineering Department) to develop low-cost local surface water solutions.

Case Study 2: *Reusing water for reducing water footprint*

Cityscape International, a construction company of high repute in Dhaka aims to reduce the water footprint (intake of treated water) for construction and operation of their commercial complex in Dhaka. This is for complying with an international certification. This certification adds brand value to them, and builds their reputation as an environment-friendly and sustainable business.

The company uses two solutions on its construction site for reducing water footprint of their commercial building. First, reusing the on-site water for gardening and flushing; second, harvesting and storing rainwater in on-site sumps; and consequently, reducing the dependence on groundwater extraction. This enables the company to meet 25% of its demand with the recycled water. Their expenses for water intake have reduced to 75% of earlier.

These and such initiatives need close monitoring and skilled manpower to operate. The costs to deploy and operate the systems are also higher. However, they share with their customer's information on benefits (reduced water demand, reduced pumping energy usage of the building) of sustainable water management. As a result, the customers are willing to pay as much as 33% more for commercial space in their building than other options.

The firm thus appears to be ready for a future wherein regulations for reducing water footprint are strictly enforced. The water-efficient initiatives by Cityscape is one of the key initiatives for undertaking 'green' construction, earning the reputation that they have, and subsequently also being able to charge higher from their clients.

Case Study 3: *Treating wastewater centrally in an Export Processing Zone*

A number of Export Processing Zones (EPZs) established by the Bangladesh Export Processing Zones Authority (BEPZA) house central effluent treatment plants (CETPs). These CETPs collect and treat effluent from all connected companies within the EPZ. The connection to the CETP is provided by BEPZA. Further, the CETP establishment has also been promoted as a business unit within the EPZ, which is expected to make profits on the treatment of ETPs (In Dhaka EPZ, the CETP has been established on a PPP basis by a Singaporean company, which started operations in 2012.).
The tariff of the CETP is determined by BEPZA. For example, in Comilla EPZ, the CETP facility is chargeable at Tk. 38.8 per m^3 of effluent.

The CETP initiative of BEPZA is in addition to the effluent treatment mechanisms the industries may construct. Thus, the units within BEPZA facilities get economic benefits (improved brand value, and greater compliance with international standards). On the other hand, the industrial operations outside the BEPZA-established zones do not have such reinforcement mechanisms for treating their effluents. Their operations are subject to standard compliance procedures carried out by the Department of Environment.

The BEPZA (in addition to the industrial units) is an executing agency within the EPZs (BEPZA constructs the connections between industrial plots and the CETPs as part of the infrastructure built on-site), and DoE is the monitoring agency. Outside the EPZs, the industries are expected to execute treatment initiatives, and DoE remains the monitoring agency. In sum, while the industrial units within BEPZA have economic incentives (thanks to BEPZA's efforts) in addition to the regulatory disincentives (from the DoE) to treat their effluents, the units outside are subject to the normal system of regulatory disincentives enforced by the DoE alone.

3.1.3. Reputational water risks

Two of the subcontinent's largest rivers (Ganges and Brahmaputra) join in Bangladesh. Over 4500 rivers, and innumerable small lakes, inundated areas, and other water bodies exist in the country. Therefore, the importance of various water bodies in the economic, political, and social fabric of the

country cannot be overemphasised. With this in context, companies and businesses failing to build on sustainable water resources management and either directly or indirectly causing damages to the environment will be criticised. This, coupled with the increasing competition amongst user categories for access to water, can also spark painful conflicts. These often have the potential to involve public interests, and to tarnish the reputation of businesses and companies involved.

Drivers for companies:

- Risks of losing reputation, by being termed as an 'irresponsible' organisation
- Risks of being in the midst of conflicts and protests
- Risks of losing customer faith followed by brand value

Business propositions/ potential business cases:

- Investing in dissemination of information related to sustainable water management practices adopted by the company (indirect benefits of improved brand value and customer faith)
- Investing in reducing water footprint
- Engaging and investing in initiatives to alleviate conflicts in water allocations and access to water
- Collaborating with public sector (possibly through PPP) for wastewater treatment and reuse
- Investing in development of rainwater harvesting techniques that can function within the constraints of available space and other resources,
- Strengthening corporate risk policies to avert water-related reputational risks; additionally promulgating initiatives taken by the businesses to adhere to their corporate water risk policies, and
- Investing in multi-stakeholder platforms for sharing data and information.

Cast Study 4: *Devising a Key Performance Indicator to benchmark water use reductions*

Coca Cola, who has bottling units in Bangladesh, has developed a KPI that depicts the total (processing + raw) water used per unit produced by the company. This figure is constantly monitored and annually reported to the international parent company. Over the last few years, they have achieved a reduction of about 40% in this KPI (reduction in the KPI means betterment of performance). This is a quantifiable, measurable, and objective aspect of how the company has deployed sustainable water resources management initiatives in their operations. This will certainly help them gain foothold and limelight as a sustainable business.

With such initiatives, worldwide brands can build a reputation as a sustainable business, thereby gaining stakeholder confidence.

3.2. Constraints in realising the potential business cases

The potential business cases or the lucrative business propositions are still a sort of an ideal scenario. A number of constraints need to be addressed if the potential in those is to be realised. These constraints can be clubbed into the following categories:

- Lack of incentives and enforcement of legal and regulatory framework
- Low public awareness of (future) water challenges
- Insufficient stakeholder cooperation.

Lack of incentives and enforcement of legal and regulatory framework

All business operations function within the given legal frameworks and incentive systems. The legal framework determines systems for granting approvals, licences, and permits for business operations.

The other component of the framework is the system of economic instruments that comprise tariffs, taxes, charges, subsidies etc. If designed as such, these economic incentives can provide a (financial) rationale for companies to engage in sustainable behaviour. A system of fines, penalties, or even closure of businesses (when enforced) ensures that the regulatory and economic frameworks are complied with.

In Bangladesh, the system of tariffs and charges for (ground) water extraction and availing piped water from service providers exists only in the jurisdictions of WASAs. For the Dhaka area, e.g., this implies that while the city of Dhaka falls under these regulations, some of the industrial areas in the outskirts of Dhaka, such as Gazipur, are not liable to these regulations. Even within the WASA jurisdictions, it was found that the regulatory framework focuses on continuing the business-as-usual approach, rather than incentivizing sustainable water usage. Under the existing system of licence fees, groundwater is steadily extracted and surface water quality or treatment is not strongly emphasised.

Likewise, most agricultural production does not lie within a WASA jurisdiction and thus is not required to pay licence fees for drilling a borehole, nor pay water usage charges (to the government). Interestingly, agricultural water users tend to pay charges to private vendors who extract groundwater using their systems and sell it to the farmers rather than the government or any higher authority charging for the agricultural water use.

Businesses observe that the enforcement of current legal and regulatory framework is rather weak. The lack of implementation, monitoring, and enforcement of the regulatory framework (especially fines and penalties for non-compliance) originates from the limited technological and manpower-related capacity of Department of Environment and WASA to strictly monitor and enforce the standards and charges. Further, the Environment Conservation Rules 1997[34] specify that the standards for sector-wise industrial effluent and emission shall not be violated at the time of sample collection. This provision may possibly imply that there could be a window for violation of the standards at times other than those for sample collection[35]. Further, schedule 12 of the Environment Conservation Rules 1997 states the standards for effluents discharged by textile processing units. However, the standards are qualified for those units where the capital investment is at least Tk. 30 million[36]. Further to this, specificity in terms of what exactly the businesses should do, and ability to actually monitor and evaluate those actions of businesses needs to be improved to achieve concrete results.

Consequently, companies are not incentivised to comply with rules and regulations, nor does unsustainable behaviour result in (adequately severe) financial implications. As compliance with rules and regulations comes at a cost, compliant companies can be said to have a competitive disadvantage. Low charges for water abstraction, water usage, as well as no distinction in the quality level of effluents consequently does not incentivise the much needed investments, such as water efficient technologies, effluent treatment plants, etc., due to low – or no – returns to investment when only considering regulatory costs.

Further, Bangladesh faces severe price competition on its products, with only few buyers in the international markets demanding for sustainably produced goods. Thus, the rationale of investing in sustainable production to enhance brand value is only applicable for selected multi-national companies with international compliance standards.

[34] Note 3 to Schedule 12, Environment Conservation Rules 1997
[35] A legal review of the language used in the instrument may be needed to draw further detailed and concrete conclusions
[36] Section B of Schedule 12 of the Environment Conservation Rules 1997

Given that there is insufficient knowledge on the opportunity costs of unsustainable behaviour and its financial consequences, avoiding physical water risk alone is not a sufficient driver for investments at this point in time.

Willingness to pay for treating the effluent

A leading food processing company fully agrees to incorporate treatment of effluent at the core of the business. An ideal arrangement in this aspect is that a treatment plant operator charges a per-unit tariff to the industrial unit. The industrial unit therefore pays a fixed charge, not incurring the capital expenses for construction of the facility.

The constraint in realizing this arrangement is the lack of initiative to actually establish a treatment plant and to have a tariff that will be affordable and also at the same time appropriate to support the capital and operating costs of the treatment facility.

The impact of this arrangement, when realized, will be far-reaching to demonstrate effluent treatment as a business case. The mechanisms in which this can be done need to be carefully devised and made operational.

For instance, load-based tariff pricing for effluents needs to be institutionalized. Load of effluents means not the volume, but the concentration of the contaminants. Having a tariff pricing based on the load will improve financial sustainability of CETP initiatives since often times small volumes of strong and/ or concentrated and/ or complicated contaminants could be much more expensive to treat.

Need for further stakeholder cooperation

It was reported that companies collect data and information related to their operations and initiatives, but do not tend to share these or make them publicly available. During the stakeholder consultations it was frequently stated that they were keen on learning lessons from existing initiatives implemented by other stakeholders to learn about problems encountered, and costs and benefits incurred. As to now there is no mechanism to share this non-competitive information. However, it was felt that access to this information would allow other companies to follow suit.

Further, it became apparent that the private sector would appreciate more cooperation with the public agencies holding information on the water resource situation, such as groundwater levels and availability. One company which had to shift the production site due to the falling groundwater table stated that it would have considered taking measures, such as water harvesting or aquifer recharge, if it had been aware of the impending risk.

The idea was voiced to start joint efforts for establishment of capital intensive projects such as central effluent treatment plants (CETPs - even outside EPZs – there are examples of CETPs within the EPZs but not outside) which can be shared between a number of companies. Costs for and management of the construction and limitations to available land inhibit the construction of such facilities. Companies stated that they were keen to connect to an effluent treatment plant and pay an appropriate service fee for the treatment if the facility is constructed and managed by another stakeholder, such as the government. The mechanisms for sharing capital costs, O&M costs, as well as the connection costs need to be devised considering all stakeholders inputs.

Stakeholder cooperation may also catalyse certain projects, as is described in Best Practice 5 below.

Case Study 5: The case of policy advocacy by Dushto Shasto Kendra (DSK)

DSK, an NGO, was advocating supply of piped water and sewerage services to the low income areas of the capital city. The service provider in the jurisdiction had reservations regarding realization of payments from the low income areas. This reservation was effectively handled by a sustained dialogue between the NGO and the service provider, with a sort of a guarantee being provided by the NGO (this was akin to a guarantee with its legal status to the extent of building confidence of DWASA that payment for service provision shall be made) to the service provider for collection of charges towards the cost of services. After confidence was built amongst the target audience and the service provider, the service of the provider was extended to the low income areas as well.

Private stakeholders who attempt to incorporate sustainable water management at the core of their businesses face challenges in the process. As regulators, enablers, supporters, or customers of the businesses involving private sector, public sector and civil society stakeholders also face challenges related to incorporation of sustainable water management at the core of business cases.

In this context, Chapter 4 presents the challenges faced by stakeholders in public sector, private sector, and the civil society.

4. Challenges in sustainable water management

The causes underlying the challenges in sustainable[37] water management were identified for specific stakeholder groups, to allow for identifying targeted and customised solutions. The analysis of causes was split across three stakeholder groups: 1) Public sector, 2) Civil society and 3) Private sector.

Referring to available data wherever possible, these challenges were subsequently verified with secondary literature. Based on these findings, 'mind-maps' were created, in which challenges, as perceived and opined by the stakeholders, were grouped into four challenge categories. The summary across these categories of challenges faced by various stakeholders is presented below, while the stakeholder-specific and more detailed mind maps are available in Annex A.10. The challenges identified by the public sector and civil society can be grouped into four categories, as illustrated in Figure 13 below.

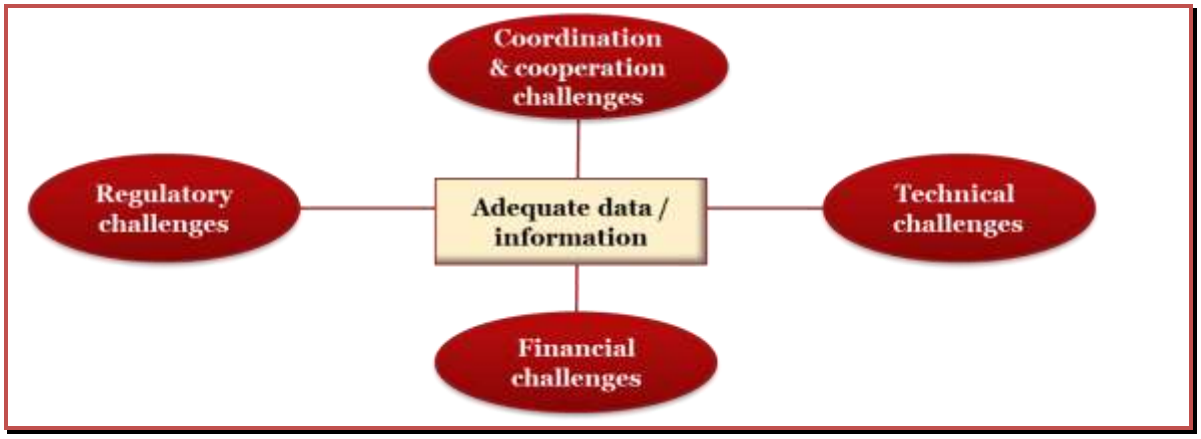


Figure 13 Overview of challenges faced by the public and private sector as well as civil society

A few common challenges are faced by all stakeholder groups. Effective planning and sound decision making by all stakeholders is constrained by availability of data and sound knowledge on water resources management. Unclear institutional responsibilities and lack of coordination amongst institutional bodies (intra-governmental as well as cross-sectoral), lack of enforcement of laws and regulations, and a lack of capacity in water-related areas are common challenges faced by all stakeholders. Additional challenges are presented below.

Coordination & cooperation challenges

- **Various Ministries**, such as the Ministry of Water Resources, the Ministry of Agriculture, Ministry of Local Government, Rural Development, and Cooperatives, as well as the cross-ministerial body of National Water Resources Council either directly or indirectly influence water resources. However, it was found that these stakeholders **do not consistently cooperate or coordinate**, resulting in potentially negative outcomes with respect to water resource management. For example, in recent years, Bangladesh followed and achieved its goal of food security. This food security, however, was achieved by increasing irrigated area and predominantly increasing cultivation of Boro (dry season) rice. The **achievement of food security can be said to have impacted water security in certain regions, necessitating an alignment of food security/ agricultural and water resource management policies.**

[37] This term should be construed in this chapter as to imply (a) scalable initiatives, and (b) initiatives that can run successfully over a considerable length of time.

- **Institutional complexity** of public institutions leads to **unclear responsibilities between functions** at national and local level. This in turn increases the time required for clearances and approvals related to water resource management for the private sector and civil society. Unclear responsibilities can lead to **delays in the development and sustainable water resource management**. For instance, water resource development in the RAJUK-developed areas remained undecided since the area being developed fell outside the jurisdiction of DWASA, but was well within the sectoral functions entrusted to WASA. Further, unclear assignment of responsibilities between government and civil society may lead to **uncoordinated on-ground efforts**, leading to **unnecessary delays in project execution** or even **terminating or narrowing the scope of the projects**.
- Public sector and civil society have shown an increased interest in engaging with the private sector over the past years. However, **private sector engagement with the public sector has been limited,** as communication and cooperation channels are limited between stakeholders. Further, there is a **lack of involvement of the private sector in the policy process**, while some stakeholders from the private sector stated their interest in being involved to represent their challenges and needs.
- While much research has been undertaken by academia and research institutes, the findings are not frequently used to inform the policy process – a phenomenon known as the **science-policy interface**. Further, while some private sector stakeholders have engaged in sustainable water management practices, **information on best practices, costs and benefits are not publicly available.** To date there is **not sufficient cooperation between researchers and the public and private sectors** to allow for the transfer of knowledge and to benefit from lessons learnt.
- There is **limited awareness on the importance of sustainable water resource management across all stakeholder groups** and the broad public. Unsustainable habits are perceived difficult to change. Similarly, stakeholders thought the idea of paying for wastewater/ effluent discharges as not relevant as they "just discharge" the water.

Regulatory challenges

- The complexity in the institutional structure leads to **challenges of coordination, execution and enforcement of the laws, regulations, and policies.** While regulatory and economic instruments are in place in WASA jurisdictions their enforcement poses a challenge. Capacity and technical skills are perceived too low to discover non-compliant behaviour, while penalties for non-compliance were found to not being imposed to adequate extent. This results in **high levels of non-compliant behaviour** by water users, such as abstracting without considerations to sustainability, and discharging untreated effluent. **Compliant water users**, e.g. some international companies with global compliance standards, **have a competitive disadvantage due to additional costs** as compared to their non-compliant competitors, and lack of benefits provided for compliance. Further**, no regulatory or economic instruments for water resource management exist outside the WASA jurisdictions**.
- In order to effectively regulate water abstractions, wells and boreholes need to be registered. In Bangladesh, the public utilities face difficulties in identifying these wells. A recent survey on boreholes in Dhaka uncovered a **substantial number of unregistered wells**. Water users have little incentive to register their boreholes as, in the WASA jurisdictions, a license fee will be imposed for any new borehole.
- Further, some stakeholders perceive that, besides other challenges, there is **limited interest** by the government to **enforce the laws and regulations** to address challenges and issues related to groundwater abstraction and wastewater discharges. This reduces the motivation of stakeholders to launch initiatives to promote compliance with regulations, such as supporting the government in monitoring water abstractions.
- Research institutions, academia, donor agencies, and NGOs develop recommendations on how to improve aspects of the regulatory environment. **Creating coherence** between these suggestions and actually implementing these proves to be challenging for the public sector.

- Public agencies face challenges related to **complying with conditions as determined by donor agencies**, e.g. appropriate utilisation of funds, and thus jeopardize project sustainability due to premature closure of project support.
- Introducing **regulatory and economic incentives** requires change of mind-set of all stakeholders, which is perceived as difficult to change.

Technical challenges

- Finding technical solutions to water resource management challenges are **aggravated by Bangladesh's topography**, characterised by clayey soils (reducing permeability and thus aquifer recharge options) and by the flat land (making surface water storage more difficult).
- **Groundwater abstractions are seen by private sector as the only reliable, uninterrupted, and regular water supply,** resulting in depletion of groundwater and deterioration of water quality. Due to over-abstraction from groundwater aquifers, **water tables are falling** in some areas, e.g. around Dhaka, with salinity increasing in other areas. Further, the **concentration of arsenic, cadmium, and iron** in the groundwater is a growing concern. This requires companies to make additional investments for water treatment plants, replacing pumps, and results in higher electricity costs for pumping water from deeper boreholes. In some cases, production sites even had to be shifted, resulting in high expenditures for the companies.
- **Seasonal extremes,** such as floods, have caused **disruption to companies' operations**. Identifying low-cost technical solutions to these challenges has been perceived as a particular challenge.
- **Knowledge gaps exist related to sustainable water resource management and technical (low-cost) solution customised to the Bangladeshi context.** For example, little is known on the interaction of groundwater aquifers in the Dhaka region, the existence of fossil groundwater resources in Bangladesh or the (measured) quantities of water being abstracted by boreholes across the country, especially for agriculture. Likewise, R&D holds much potential to reduce agricultural water usage by optimizing agricultural inputs, cropping patterns and methods. Further, low cost water treatment and rainwater harvesting technologies, which only require little space for construction, given Bangladesh's land scarcity, require further research.

Financial challenges

- **WASAs do not fully recover their costs (including costs required for major maintenance)**. Due to contesting stakeholder interests and the political nature of water and effluent/ wastewater prices they are not able to charge tariffs which can recover their operational and maintenance costs, let alone capital costs. This poses a serious challenge to expand and improve their services.
- **Limited knowledge about impending risks and opportunity costs related to unsustainable WRM practices** results in these costs not being factored into investment decisions or considerations related to water usage habits. This, together with lack of enforcement of water laws, policies and regulations, **make investments which could support sustainable water resource management,** such as rainwater harvesting, wastewater treatment and switching to surface water usage, **financially unattractive.**
- The domestic market faces no pressure from consumers to engage in sustainable water management due to low awareness regarding clean production, **low willingness and ability to pay** for clean production initiatives, thus limiting potential for brand/ reputation enhancing sustainability initiatives. While some buyers in the international market require the production to be clean and sustainable, other buyers seek the cheapest prices regardless of the environmental, or social, impact this may cause. This results in **a highly price-sensitive market in which investments in "non-essentials"** such as sustainable water management practices, **cannot be passed on to the consumer**.
- Projects implemented with **assistance from civil societies/ donor organizations** run into danger of being discontinued once the civil society/ donor agency hands the projects over to the

public sector. It is perceived that the **sustainability of these transferred donor projects is endangered** due to **insufficient funds and capacity** from the government.

5. Recommendations for way forward

This report illustrates the challenges and risks Bangladesh is facing with respect to its water resource management. Based on stakeholder consultations, this reports attempts to analyse the underlying causes of these challenges for three stakeholder groups. Understanding the relevance of the private sector in addressing the water resource challenge, the report outlines the risks businesses are facing, or will be facing in future. Identified business cases furthering sustainable development are introduced while constraints preventing more business cases from materialising are identified.

This report suggests addressing the underlying causes leading to unsustainable water management rather than just focusing on the symptoms. This section of the report offers recommendations along these lines, while keeping the way forward for engagement of 2030 WRG in Bangladesh in mind. Recommendations 5.1, 5.2, and 5.3 are cross-sectoral recommendations, i.e. applicable across all suggested focus areas and independent of topic. Recommendations 5.4, 5.5, and 5.6 suggest targeted actions for identified key sectors.

5.1. Setting up a multi-stakeholder platform

5.1.1. The Challenges

- Multiple stakeholders directly and indirectly impact sustainability of water resources management. Currently, not all stakeholders are involved in efforts for achieving sustainability of water resources management. For example, Local Government Engineering Division aims to incorporate public participation in planning and execution of water resource development initiatives, National Water Resources Council and boards of directors of Bangladesh Water Development Board, Water Resources Planning Organisations etc. aim to involve multiple stakeholders at the level of the government in the activities of the respective organisations. However, no evidence demonstrates wider involvement of stakeholders and especially the public in the water resources management sector at a single point.
- Government officials often are either over-burdened with responsibilities and functions, or lack the technical/ financial capacity to make informed decisions on policies, laws, rules, standards, or regulations by involving all stakeholders. This leads to stakeholders not feeling as parties owning the decisions made. This in turn may lead to lack of compliance by the stakeholders who are 'left out'.
  To provide for effective coordination amongst all stakeholders and to ensure ownership of decisions by all stakeholders, a multi-stakeholder platform and mechanism is yet to be established.

5.1.2. Vision

Short term: Explore key stakeholders which can act as catalysts for change in Bangladesh's water resource management and establish a steering committee to select the most pressing challenges the Bangladesh 2030 WRG Partnership should focus on in its further work. Specialised work streams, consisting of equal representation of the public and private sector, as well as civil society shall steer further work on identified priority areas. Platform with key stakeholders will strive to avoid duplication of work amongst development partners.

Long term: The multi-stakeholder platform will work as an independent body to continuously identify and work on water resource management issues in Bangladesh in an inclusive manner. An effective coordination amongst all stakeholders will be achieved as well as a sense of ownership of decisions and actions, allowing for sustainable, holistic and integrative initiatives.

Once the cause and the impact of the platform are established and demonstrated, the private and public representatives can engage effectively in the platform and take it forward. Donor funds can cover the phase during which this establishment will be done. An example of this kind can be

observed from Maharashtra (India), where CSOs, NGOs, and research organisations started with their own funder projects contributing to the common cause of Lokabhimukh Pani Dhoran Sangharsh Manch (vernacular for Action Forum for Pro-people Water Policy). The operations of the Manch are now streamlined into establishment of a secretariat that has a rotating host based on availability of funds. The Forum has been functional for over 4 years now.

5.1.3. Recommended actions

Short term:

- Based on this initial analysis, **conduct wider stakeholder consultations** (with prominent stakeholders from all sectors and categories) **to identify** the most adequate set-up, objective and members for a multi-stakeholder platform and its relevant work streams. For example, NWRC could be supported in conducting more and widely publicised meetings, which can be attended by multiple stakeholders by invitation.
- Consultations with ongoing (multi-stakeholder) initiatives, as described in Chapter 1.3, should be undertaken to avoid duplication of initiatives and create synergies.
- All development partners should be identified. Their action points should be clearly noted and shared amongst the key stakeholders. Plan to avoid duplication of work should be clearly spelled out, with focus on coordinating ongoing and future initiatives.

Long term:

- Provide for a country-wide multi-stakeholder platform to enable involvement of all concerned stakeholders, including the private sector, civil society, and the public sector. Project the platform as the driving force behind designing and implementing solutions challenges via specific work streams.

5.2. Raising public awareness

5.2.1. The Challenges

- Not all stakeholders are adequately aware of the costs and risks of continuing business as usual, which leads to (a) lack of pressure on the government to take steps to enforce laws and regulations, (b) unsustainable habits of water management, (c) a mind-set that hinders full compliance by all stakeholders with the laws/ regulations/ standards, and (d) lack of international consumers' awareness and emphasis on buying sustainable goods vs. Bangladesh's "cheap" products, preventing the businesses from investing in sustainable water management initiatives.
  Currently, no sustained widespread initiative to educate the international market or community (of risks of business as usual) is observed. Hard, quantitative evidence of risks and opportunity costs associated with neglecting sustainable water resources management has not been repeatedly presented.

5.2.2. Vision

Short term: A solid understanding of the opportunity costs and benefits related to (un-) sustainable water resource management is gained, targeted at key sectors.

Long term: Stakeholders will consider water risks as a component in their decision making process while the domestic and international demand for sustainably produced goods will increase.

5.2.3. Recommended actions

Short term:

- **Assessment of** (a) **future implications** such as opportunity costs and risks involved in business-as-usual (groundwater abstraction in overexploited areas such as Dhaka and Barind Tract, and from water pollution in urban and industrial areas) water resource practices, (b)

quantitative evidence of benefits of incorporating sustainable water management practices.

- **Use of opportunity cost analyses, to run stakeholder-oriented awareness campaigns** to create awareness amongst and pressure on various stakeholders (international as well as domestic) to take action by demanding sustainable water management. The campaign materials would need to target e.g.,
  - Industry, e.g., through Bangladesh Textile Mills Association and other networks and associations as multipliers
  - Agriculture, e.g. through Bangladesh Agricultural Development Corporation
  - General Public and domestic water users, e.g. through easily understandable material that could be spread through television slots, billboards, radio advertisements, mosques or schools

Long term:

- **Explore joint action with major international brands** already active in sustainable sourcing, on sensitising the international market about the importance of sustainable production in Bangladesh. This sensitisation may be used for the customers to buy from sustainable Bangladeshi sources, rather than buying only from the cheapest ones. The joint action can also include cooperation with Water PaCT initiative. This will bring in benefits from the network established under PaCT, as well as from the technical and managerial know-how achieved under the same.

5.3. Facilitating collection and sharing of knowledge and data

5.3.1. The challenges

- Lack of reliable knowledge/ data about Bangladesh's water resources limits efforts for making informed decisions, (e.g., on production sites, new (donor-funded) projects, water resource management measures). This lack of data and knowledge leads the businesses to making decisions without being aware of the impending problems. For example, a bottling plant has had to shift their plant well after its operations commenced, due to (a prior unknown) lack of groundwater availability
- Further, currently, there is no platform for sharing data, or for sharing information on best practices targeted at Bangladesh. This lack of data sharing prevents learning from others' experiences including best practices. This may further lead to duplication or wastage of efforts by the companies.
- Lack of such platform for data sharing inhibits initiatives such as research, policy designing, planning and implementation, which require continuous data flow and sharing in order to recognise areas (both geographical and sectoral) of interventions for sustainable water resource management. *Current lack knowledge and sharing of existing knowledge related to the water resource situation, challenges, experiences, and best practices involved in water resources management practices hinders learning and collaboration amongst various public and private sector agencies, and may result in duplication and/ or wastage of effort.*

5.3.2. Vision

Short term: An open database is developed which includes all publicly available data, which has undergone a quality assurance process.

Long term: An interactive platform is established for accessing publicly available data and for sharing of information and data between all stakeholders.

5.3.3. Recommended actions

Short term:

- **Coordinate efforts** to (a) obtain sector-specific information on issues in sustainable water management, and (b) establish mechanisms for sharing the information amongst interested stakeholders.
- **Collect information and data** on (i) total groundwater availability, i.e., verifying recharge rates and non-renewable groundwater, (ii) the sustainable yield of groundwater abstraction, (iii) surface water and groundwater interactions (iv) surface water quality (biochemical oxygen demand, chemical oxygen demand, heavy metal pollution, salinity etc.).
- **Explore potential for joint projects between the academia and the private sector businesses** to identify the most suitable mechanisms for finding technical solutions to collect, update, and share data, e.g. with ADB South Asian Knowledge Hub/ ITN-BUET. These projects can also provide the students with opportunities to directly apply their learning and skills. **Identify systems and frameworks for incentivising data sharing**. Building on international portals, e.g. the WWF Water Stewardship Initiative, the Water Action Hub or waterscarcitysolutions.org, stakeholders should be incentivised to share their experiences.

Long term:

- **Develop technical solutions and mechanisms such as cloud computing as mechanism to allow sharing data and knowledge.** Best practices and business cases can be shared on this platform. In this system the owner of the data will have control on updating and sharing the data, addressing the concern of ownership and control of individuals over data.
- **Categorise information available as classified and non-classified;** this will help in maintaining control on access to the data that may be confidential/ sensitive.

5.4. Exploring potential of surface and rainwater utilisation, and reducing reliance on groundwater

5.4.1. The challenges

- In the business-as-usual scenario, water demand will exceed water supply by 21% by 2030. However, there is significant unutilised potential to increase surface water usage and to increase available water by rainwater harvesting.
- High levels of dust or clay complicate rainwater harvesting. To date, insufficient storage, e.g. for rainwater harvesting in urban areas, exists. Clayey soils and Bangladesh's flatland topography aggravate challenges to surface water storage. So far, technological solutions which fit the Bangladeshi context are not implemented, nor do incentives exist to consider these options.

5.4.2. Vision

Short term: A clear understanding of the potential and optimal level of surface water usage has been gained for key areas with water risk, such as Dhaka and the Barind Tract. Incentive structures to reduce untreated effluent/ wastewater discharges, as well as promoting increased surface water usage and rainwater harvesting to meet the identified optimal level, are in place.

Long term: Technological solutions to increase surface water storage, treatment and distribution, to increase rainwater harvesting, as well as to reduce untreated effluents are implemented. Incentive structures to promote sustainable water resource management are implemented and enforced.

5.4.3. Recommended Actions

Short-term

- **Assessment of opportunity costs and physical water risks** caused by business-as-usual groundwater abstractions. Opportunity costs and physical water risks should be analysed specifically for sectors at risk, including agriculture, textile and beverages. These risks need to be publicised so that stakeholders can make fully-informed decisions related to setting up business operations, and investing in sustainable water management initiatives.

- **Assessment of optimal level of surface water usage,** as compared to groundwater usage, **and differentiated water quality requirements**, for key urban centres and economic sectors, considering (seasonally specific) available surface water quantifies and quality, required water quantities and quality levels as well as required treatment and distribution costs. One suggested focus can be the cost of switching to surface water usage for water users requiring low quality water, such as tanning and textile, in Dhaka Metropolitan area. Further, the potential of augmenting surface water storage, via identifying technological solutions of e.g. decentralised surface water storage, and combination of pumping and gravity flow processes to optimise storage, shall be assessed.
- **Exploration of the potential to include rainwater harvesting systems into the building approval process** to ensure wide adoption of these systems. For this, international cases should be studied and adapted to the Bangladeshi context. For example, in the Indian city of Pune, reforms under the Jawaharlal Nehru National Urban Renewal Mission mandated new constructions to establish rainwater harvesting systems. This was incorporated into the building approval process, meaning that a new construction would not be approved unless accompanied by rainwater harvesting mechanism. This has been proved to work considerably towards bridging the gap between the supply and demand for water in the city. Based on this experience, support may be provided to the town planning authorities in Bangladesh to design and enforce similar development control regulations. This will ensure that the development and construction in the country has sustainable water management practices built into its business models, to mitigate the regulatory risks arising due to such development control regulations.
- **Hydro-economic analysis to select the most cost-effective set of solutions,** based on assessments mentioned above. This shall consider the different building types (such as high-rise buildings, residential buildings, government and university buildings, industrial complexes etc.), storage requirements and solutions, actual quantity of rainwater harvested considering periods of heavy rainfall, cost savings for water users etc.

Long-term

- **Development, implementation and enforcement of an incentive system** to a) reduce overall water usage, b) reduce emissions of untreated effluents to surface waters, c) encourage rainwater harvesting and surface water storage and d) use surface water to (at least) meet low water quality requirements.

5.5. Cleaning Dhaka's Waters - Enhancing wastewater and effluent treatment

5.5.1. The challenges

- Dhaka's surface waters are critically polluted, rendering them unfit for aquatic life, let alone human consumption. Surface water pollution is increasingly threatening groundwater quality – Dhaka's key water source. Discharges of untreated sewage and industrial effluent are the main drivers of the pollution.
- Currently, the wastewater and effluent treatment infrastructure is not sufficient to treat required volumes of wastewater/ effluent. Existing laws and regulations do not incentivize stakeholders to act (and thus invest) in a sustainable and responsible way. Existing infrastructure to treat industrial effluent is in most cases not sufficiently used, while septic tanks/ sewage containers in households are connected to the drainage system due to insufficient enforcement and monitoring of laws and regulations. Current regulations do not mandate effluent treatment plants in industrial areas outside BEPZA-managed EPZs, while regulations on faecal sludge management are currently being drafted. *Institutional and regulatory frameworks need to be improved and enforced.*
- To date, investing in or operating effluent treatment plants do not have sound business rationale for the private sector. In addition international investors have difficulties in identifying investment opportunities, incl. PPPs. *A value proposition, considering benefits of potential re-use of sewage/ effluent treatment outputs needs to be developed*.

- Access to (long-term) finance is a key bottleneck for implementing the Sewage Master Plan 2035 and for enabling private sector engagements. *A reliable source of finance needs to be accessible for potential investors*.

5.5.2. Vision

Short term: Awareness campaigns on the criticality and importance of cleaning Dhaka's waters; Development of business plans for profitable activities along the sewage and industrial effluent value chain; Improvement of the regulation and design of a clear action plan on enforcement and monitoring thereof; Assessment of cost-effective technologies for industrial effluent treatment and sewage treatment in areas not covered by the planned water-borne sewerage networks; Exploration of options to improve access to finance, such as blended interest rates, water bonds, political risk insurance products etc.

Long term: Create commitment to join the "Clean Dhaka's Waters Campaign" among key stakeholders with concrete and measurable actions and by potentially establishing a water fund to finance key actions beneficial for all stakeholders; Implementation of identified business cases and development of "package deals" to benefit from lessons learnt and facilitate investments; Enforcement and monitoring of improved regulations to create incentives for sustainable water resource management; Identification and – where possible – local production of identified technologies; Easy access to long-term finance for strategic sewage and effluent initiatives.

5.5.3. Recommended actions

Short term:

- Create a private-public-civil society platform with key stakeholders to develop and **launch a "Clean Dhaka's Waters" campaign**.
- Explore potential to reuse bio-solids, heavy metals, chemicals and treated wastewater from sewage/ effluent and **develop replicable business models to invest in sewage/ effluent treatment** along its value chain.
- In cooperation with key stakeholders active in R&D on sanitary solutions, such as the ADB Knowledge Hub/ ITN-BUET, Bill & Melinda Gates Foundation, Mirpur Agricultural Workshop and Training School, Center for Study of Science, Technology and Policy (CSTEP) India **identify sewage/ effluent technologies for local circumstances and undertake a cost-benefit / marginal cost curve/ cost effectiveness analysis on identified solutions to prioritize technologies.**
- Explore **opportunities to reduce the interest rates for strategic investments**, e.g. by blending interest rates and/ or by providing political risk insurance products and options for foreign currency risk mitigation to reduce costs of international finance. Further, options to introduce green finance bonds and measures to incentivize PPPs **to raise capital** can be explored.
- Identify mechanisms to support the Department of Environment in its mandate to **regulate untreated discharges to the environment**, in addition to **building capacities of regulatory staff and supporting ongoing initiatives on improving regulations** (Bangladesh National Building Code, Faecal Sludge Management, mandatory ETPs for all industries etc.). **Incentives**, including the "carrot" (rebates in water bills, recognition and promotion of "green products") and the "stick" (increasing penalties of discharge of effluents beyond foregone OPEX costs") **need to be designed**.
- **Establish the planned independent and impartial regulatory commission for water supply and sanitation sector as priority** and determine an acceptable way to increase water supply and sewage **tariffs to phase in full cost recovery** (incl. capital expenditures).
- **Enhance capacity of the government and other stakeholders** to (a) design and build customised ETPs/ WWTPs, (b) manage the operation of ETPs/ WWTPs, and (c) design and execute PPP and other contract related arrangements.

Long term:

- As part of the **Clean Dhaka's Waters stakeholder platform**, identify concrete actions which will result in quantifiable benefits for members of the stakeholder platform and explore options of **establishing a water fund** from which these concrete actions will be financed *from (see Kenya's private-public water fund for Tana-Nairobi catchment for inspiration).*
- **Based on initially successfully implemented business cases along the sewage/ effluent treatment chain, create "package deals"** to allow investors to easily assess the opportunities and thus roll out the initiatives on a broader scale.
- **Enforce and monitor laws and regulations** by creating capacity and man power at the Department of Environment.
- Assess potential to **move towards full cost recovery of water supply and sanitation services** via increasing the tariffs, considering socio-economic and equity concerns.
- **Assessment of potential to produce identified technologies for sewage/ faecal sludge /effluent treatment locally** to reduce costs and create "green" employment or alternatively to reduce import tax and excise waivers for clean technologies.
- **Explore potential of establishing joint effluent treatment plants**, to which industrial water dischargers can connect to while paying appropriate service charges – an option which was commonly mentioned in the course of the stakeholder consultations. The joint efforts will either result in shared capital costs amongst private sector businesses promoting the ETPs, or encouraging the Government to establish effluent treatment plants (outside BEPZA areas) that operate like other Government-owned network service providers. To assess potential for joint ETPs, initiatives need to be taken to (a) identify the ideal location, for building joint ETPs, (b) identifying potential subscribers or users of the ETP services, (c) identifying optimal technology for the ETPs, and the costs involved, and (d) devising an optimal model for funding the construction and operation of the ETP. For example, the funding and management mechanism could be based on Build Operate Transfer (BOT), Design, Build, Finance, Own, Operate, Transfer (DBFOOT), Management Contract (MC) etc. This will contribute to the business model for ETP services being more robust and viable.

5.6. Improving agricultural water use efficiency and water productivity

5.6.1. The challenges

- 93% of total water demand is required by agriculture. The increase in agricultural water demand to keep with growing population and demand for food will be mainly by an increase in Boro (dry season) rice cultivation. Such and other current cropping patterns are not optimally suited to regional or seasonal conditions.
- Most agricultural water providers charge a bulk water fee, i.e. depending on the size and produce of the agricultural fields. With the absence of volumetric water abstraction and water usage charges, farmers have little incentive to reduce their water consumption. Further, unreliable and intermittent water supply incentivizes the farmers to use more water than is required – resulting in high evaporation rates – to safeguard themselves from "bad times" and risk crop failure. The so called "water lords" providing the water to the farmers, are not charged for water abstractions.
- Agricultural sector depends heavily on energy-intensive irrigation, especially during the dry season. Nearly 87 per cent of the irrigation equipment is operated on diesel, which is heavily subsidized for all users (79.4 BDT cost per unit/ 51 BDT selling price per unit). [38] This "hides" the true cost of pumping and further incentivizes groundwater abstraction.
- The actual amount of water used for agriculture is not monitored or measured, mostly because bore-wells for agricultural water use are privately operated and scattered across the country. Water that cannot be traced often gets classified as water used for agriculture. This may lead to

[38] BIDS & IISDGSI (2012) A Citizen's Guide to Energy Subsidies in Bangladesh

overestimation of water used for agriculture. Thus, assessing local future water supply-demand gaps is challenging while overestimation of agricultural water use may lead to a misdirected/ unwarranted investment in advanced irrigation technologies.

5.6.2. Vision:

Short-term: Focus on North West region due to criticality of water challenges and relative "scarcity" of donor activities; Knowledge on ground and surface water abstractions will be improved; Existent technological solutions to increased agricultural water use efficiency shall be scaled up and rainwater harvesting shall be introduced in strategic locations building on community driven programs.

Long-term: : Expanding focus to Coastal and North East region; Strengthening of research capacity to explore the local adaptation and development of adequate technologies and identification of ideal cropping patterns; Gradually shifting cropping patterns and substituting paddy production with high-value, but low water intensive crops; Developing less water intensive hybrid species; Revising energy subsidies; Utilisation of mobile phone technologies in improving agricultural techniques; Introducing tariff and incentive systems for sustainable groundwater usage.

5.6.3. Recommended Actions:

Short term:

- Initial **focus on North West region**, as 48% of total agricultural water is demanded in this region and groundwater tables are falling rapidly due to over-abstraction of groundwater. Further, most donor activities are targeting the coastal region, thus offering additional scope to impact where it matters most.
- **Improve knowledge on actual local ground and surface water situation.** As a first step, assess status quo by e.g. cooperating with BADC and BAWB to map the location and capacity of deep and shallow tube wells, assess cultivated crops etc. Further, cooperate with research institutes to gain localized knowledge on groundwater (fossil and recharge) and surface water potential. Actual groundwater abstraction can be monitored by leveraging on the high level of mobile phone usage in the country. The operation of the groundwater extraction pumps can be monitored through solutions linking the pump switches to the mobile phones. Push notifications and other systems of notifications can be used to communicate the (a) amount of water use, (b) pattern of water use, and (c) optimal levels of water use based on standards of water use for agriculture. *A similar system has been introduced by a research team from Oxford University in Kenya.*
- **Existent technological solutions to increase agricultural water use efficiency shall be scaled up** while **rainwater harvesting shall be introduced** in strategic locations. To increase uptake, **community driven water saving/ harvesting programs in selected hotspot areas** should be developed as pilot initiatives, in which water resources (e.g. depth groundwater) is mapped with the community and selected water saving/ harvesting measures are introduced. Measurable objectives will be set to monitor progress. Lessons learnt from past community driven successes, e.g. community led total sanitation or micro-finance can be built upon. Once successful, model can be spread to other regions.

Long term:

- **Expand focus to Coastal and North East region;**
- **Strengthening of research capacity to explore the local adaptation and development of adequate technologies and identification of ideal cropping patterns**, e.g. in cooperation with leading research institutes, such as Rice Research Institute and ITN- Bangladesh University of Engineering Technology (BUET);
- **Gradually shifting cropping patterns and substituting paddy production with high-value, but low water intensive crops and/ or higher value adding sectors.** The option to import a share, such as 20%, of national rice demand from neighboring countries shall be explored, giving due consideration to food security dependencies, export

earnings, foreign exchange rate risk etc. Further, market access for high value crops needs to be enabled for farmers.

- **Development of less water intensive hybrid species** of key crops in cooperation with research institutes and private sector enterprises. **Partnership between local government bodies and private sector enterprises** shall be developed to encourage farmers to adopt cultivation of hybrid variety of seeds and irrigation optimizing practices
- **Revision of energy subsidies.** Diesel subsidies should be revised to dis-incentivize overuse of groundwater. While 11 percent of diesel subsidy beneficiaries belong to the poor and lower middle (per capita income max BDT 7999) groups[39], decreasing the subsidy is not expected to have the maximum impact on the most vulnerable section of the society. Safeguarding measures, however, should be put in place to protect this section of society.
- **Dissemination through mobile technology channels of information related to water availability** in particular areas and the cropping pattern that suits the water availability. For example, with changing water availability (either season-wise or over a period of time) mobile solutions can be used to advise farmers to select (a) crop selection, and (b) timing for planting, to optimise the water use. *For instance, in India, a farmers' call centre has been established which has a toll-free number and professionals available during stipulated timings, who advise the farmers on what crops they should choose, the fertiliser application, and the watering cycles etc.* This will ensure optimal selection of crops, optimal level of water application to the crops, and appropriate selection of irrigation systems, thereby improving the efficiency of water use in agriculture. On similar lines, establishing a call centre to (a) communicate to the farmers project and policy decisions and how those can impact the farmers, and (b) providing a platform for bringing together the farmers and ensuring they have a channel to voice their concerns
- **Introduction of tariff and incentive system for groundwater usage**, by targeting the private sector operators who own pumps and supply water to the farmers. This system can also be based on the technological solutions linking the pump with unique IDs to mobile phones. Mobile payment systems can be integrated with this linking of the pumps with the mobiles. Technological solutions can be devised to ensure that only those private sector operators' pumps are allowed to run who have paid for the groundwater they extract. The system can start targeting deep tube well owners and expand to shallow tube wells. It is suggested to set up a separate regulating agency in charge for enforcing and monitoring payments of tariffs.

[39] Bangladesh Bureau of Statistics (2010)

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Appendix B. - Annexure

B.1. Brief of the institutions involved in the water sector of Bangladesh

The key stakeholders include agencies that are directly mandated to make policies, execute those, or monitor implementation of the policies:

- The **National Water Resources Council (NWRC)** – Established under the Water Act 2013, NWRC is an inter-ministerial highest decision-making body. The NWRC is mandated to policy-making, policy direction, coordination for effective Water Resources Planning, and approving and ensuring implementation of the National Water Resources Plan[40]. The Executive Committee of NWRC (ECNWRC) is the agency mandated under this Act to execute the decisions made by the NWRC.
- The **Water Resources Planning Organisation (WARPO):** Established under the Water Resources Planning Act 1992, WARPO is a body corporate, mandated with formulation of water resources plans, formulating policies, coordinating with other agencies for development of water resources, and advise on water resources management[41]. The Board of Directors of WARPO is chaired by the Minister responsible for Irrigation, Water Development, and Flood Control, and the vice-chairperson of the Board is the concerned person from the Planning Commission.
- The **Bangladesh Water Development Board (BWDB):** established under the BWDB Act 2000, BWDB is a body corporate responsible for executing flood control, drainage, and irrigation projects. BWDB is empowered to charge tariffs, sign contracts, and seek expert advice to carry out its responsibilities[42].
- **Ministry of Local Government, Rural Development, and Cooperatives (MoLGRD&C)**: From water management perspective, MoLGRD&C is policy-making ministry of the government that oversees design and implementation of the policies related to water supply and sanitation (through Local Government Division). The Rural Development and Cooperatives Division is also under this ministry.
- The **Local Government Engineering Department (LGED)** is responsible for planning, development, and management of small water resources projects (beneficiary area less than 1000ha.), such as construction of bridges, culverts, or canals. LGED by mandate is a highly decentralised organisation, with a majority of its staff being at the district and sub-district levels. LGED also professes its mandate to engage people and plan in a bottom-up manner.
- The **Ministry of Water Resources (MoWR)** is the ministerial body responsible for water sector development and management including expansion of irrigated areas, water conservation, surface and groundwater use, and river management. The Minister of Water Resources is a member of NWRC, while Secretary of MoWR is a member of board of directors of BWDB, WARPO etc. This is the mechanism through which MoWR engages with the planning and executing bodies in the water management sector.
- The **Institute of Water Modelling (IWM)** is a trust established by the Government, which deals with mathematical modelling of Bangladeshi river systems, GIS, environment and groundwater modelling;

[40] Section 5, Water Act 2013
[41] Section 3, Water Resources Planning Act, 1992
[42] Section 5, Bangladesh Water Development Act 2000

- **Centre for Environmental and Geographic Information Services (CEGIS)**: CEGIS is also a trust established by the Government of Bangladesh as a public trust. Started with support from Dutch Government, USAID, as well as Government of Bangladesh, CEGIS aims to function as a centre of excellence for supporting environmental analysis, geographic information systems, and remote sensing etc.
- **Joint Rivers Commission (JRC)**: The JRC Bangladesh was established to address issues related to sharing and management of water of Trans-boundary Rivers amongst the co-riparian countries of India, China, Bangladesh, and Nepal. Additionally, JRC also is the secretariat of Bangladesh National Committee of International Commission Irrigation and Drainage (ICID). It is also the focal point of Inter-Islamic Network on Water Resources Development and Management (INWRDAM) and Organization of Islamic Cooperation (OIC) on water issues.
- **Flood Forecasting Warning Centre (FFWC)**: The FFWC is a centre under the BWDB responsible for emergency response to flood situations with an objective of minimising loss of life and damage to properties. FFWC aims to achieve this through enhancing the capacity of the community and the government to effectively manage flood-related disasters.
- **Department of Public Health Engineering (DPHE)**: DPHE, a department of the MoLGRD&C, is responsible for provisioning of water supply and sanitation services in the whole of Bangladesh, except for jurisdictions of WASAs.
- **Water Supply and Sewerage Authorities (WASAs)**: WASAs were established by the WASA Act 1996 in four cities of Dhaka, Khulna, Chittagong, and Rajshahi. The WASAs are responsible for planning, construction, and operations and maintenance (O&M) of water supply and sewerage service provisioning within their jurisdiction. WASAs such as Dhaka and Chittagong are also mandated to issue licences for sinking deep tube-wells in their jurisdiction.

The other agencies whose mandated functions and duties are indirectly related to water resources management are:

- **Planning Commission**: The Planning Commission has a procedural responsibility of approving projects and programme initiatives proposed by the government.
- **Department of Environment (DoE)**: DoE is the body mandated under the Environment Conservation Act 1995 to monitor operations of the activities affecting environmental quality (water, air, land pollution etc.) and enforce the standards of environmental conservation.
- **Ministry of Industry**: Ministry of Industry oversees the processes and procedures involved in establishment of industries. This is relevant from the perspective of establishment of industries that may be significant water users or factors affecting water quality through discharge of effluents in water bodies etc.
- **Bangladesh Agricultural Development Corporation (BADC)**: BADC is responsible for providing irrigation facilities to farmers, using surface water and groundwater sources.

B.2. Brief summary of economic and other instruments impacting water resources sector

The economic instruments of charges, tariffs, fees etc. come into force after the relevant activity commences. The commencement of the activities is governed by a system of licences and permits as briefed in the table below.

S. No.	Licence/ permit/ approval for	Details of the licence/ permit required	Authority responsible for granting the licence/ permission/ approval
1	Sinking tube well in a city with WASA – for extraction of groundwater	6″ diameter tube well: Licence fee for domestic – Tk. 80,000, for Non domestic- 2,25,000 Yearly licence renewal fee for domestic – Tk. 75,000, Non Domestic- Tk. 1,37,500	Chittagong WASA
2	Undertaking water conservation/ preservation measures	Approval is required for undertaking measures for preservation of water, under Water Act 2013 (section 24 of the Water Act 2013)	Competent authority (ECNWRC)
3	Undertaking water supply or sewage service provisioning	Not applicable currently	Not applicable
4	Establishment of treatment facilities	Not applicable currently	Not applicable
5	Extraction of water, construction that may potentially change the direction of flow of water in a natural water body	All activities harming the water resources are disallowed as part of the Water Act 2013	ECNWRC

The economic instruments including tariffs and other charges are as depicted in the table below.

No.	Service for which the instrument is applicable	Economic instrument applicable[43]	Agency/ authority responsible for enforcement of the instrument
Water tariffs and charges			

[43] Cited as an example the prominent instruments

No.	Service for which the instrument is applicable	Economic instrument applicable[43]	Agency/ authority responsible for enforcement of the instrument
1	Use of water from a piped connection from WASA	Domestic water use tariff: Tk. 7.33/ m^3 for metered connection, Tk. 47.21 for non-metered connection: there are further slabs based on the diameter of the connection pipe. Industrial water use tariff: Tk. 24.44/ m^3 for metered connection, Tk. 52.52 for non-metered connection	Dhaka WASA
2	Water supply fees in towns where City Corporations provide the services	Tk. 50 per month for a 0.5" diameter pipe connection	Rangpur City Corporation
3	Water supply fees in paurashava (town council)	Tk. 80 per month for a 0.5" diameter pipe connection	Chapai Nababganj Paurashava
4	Fees for new connection in Chittagong city	Tk. 8225 for a new metered connection including VAT, connection fees, and cost of meter	Chittagong WASA
5	Water supply within Export Processing Zone	Tk. 25.89 per m^3	Bangladesh Export Processing Zones Authority – charges applicable at Comilla EPZ
Sewerage charges			
6	Sewerage charges for sewerage services from WASA	Sewage charges are equal to water supply tariff, i.e. the bill will be doubled.	Dhaka WASA
Effluent treatment charges			
7	Charges for effluent treatment plant within Comilla Export Processing Zone	Tk. 38.8 per m^3 of effluent	Bangladesh Export Processing Zones Authority
Fines, penalties, and corrective actions			
8	Penalties for violating the provisions of the Environment Conservation Act 1995	Imprisonment up to 10 years or fine up to 1 Million Taka or both; or closure of the activity causing the violation	Department of Environment

No.	Service for which the instrument is applicable	Economic instrument applicable[43]	Agency/ authority responsible for enforcement of the instrument
9	Penalty under Water Act 2013 for carrying out or supporting any activities hindering or disrupting the normal flow of water	Imprisonment up to 5 years or fine of Tk. 10,000	Executive Committee of the National Water Resources Council
Other remedies and measures			
1	Corrective action under the Water Act 2013	Removal of obstacle or stopping any activity (such as construction) that obstructs natural flow of water or harms the natural water courses may be removed by order	Executive Committee of the National Water Resources Council

B.3. Participants list: Stakeholder interviews

Following is the list of key stakeholders interviewed during the project.

Table 2: List of interviewed stakeholders

S #	Existing Stakeholders/ Organisation	Overview of the agency's role/ functions	Date of meeting
1.	Department of Public Health Engineering (DPHE)	• Mr. Emaduddin Ahmad, Team Leader, Ground Water Management and Feasibility Study of 148 Pourashavas	August 19, 2014
2.	Ministry of Environment and Forests (MoEF)	• Dr. Sultan Ahmed, Director, Natural Resources Management & Research, Department of Environment (DoE)	August 24, 2014
3.	Local Government Engineering Department (LGED)	• Mr. Moshiur Rahman, Project Director, Integrated Water Resource Management (IWRM) • Mr. Alan K Clark, Team Leader, Small Scale Water Resource Development Project	August 24, 2014
4.	Water Resource Planning Organisation (WARPO)	• Md. Salim Bhuiyan, Director General • Mr. Saiful Alam, Director, Technical Division	August 19, 2014/ March 8, 2015
5.	River Research Institute	• Mr Razaul Karim, Principal Scientific Officer, Dhaka office	August 26, 2014
6.	Institute of Water and Flood Management	• Dr. Mashfiqussalehin	October 01, 2014
7.	Bangladesh Water Development Board (BWDB)	• Mr. Md. Shahidur Rahman, Director General	August 25, 2014
8.	Rajdhani Unnayan Kartripakkha (RAJUK)	• Mr. M. Emadadul Islam, Chief Engineer	August 25, 2014
9.	Bangladesh Agricultural Development Corporation (BADC)	• Mr. Md. Atahar Ali, Joint Secretary, Member Director (Irrigation) • Mr. Md. Khalilur Rahman, Chief Engineer, Minor Irrigation	August 20, 2014
10.	Bangladesh Export Processing Zones Authority (BEPZA)	• Mr. Khandaker Akhtaruzzaman, Additional Secretary, Member (Eng.) • Mr. Md. Shah Alam Sarker, General Manager, Maintenance • Mr. Md. Mehboob Ali, General Manager, Adamjee EPZ • Mr. Md. Golam Farooque, Deputy General Manager, Accounts and Finance	August 20, 2014 & August 27, 2014
11.	Dhaka Water and Sewerage Authority	• Mr. Balzur Rahman, Chief Engineer	September 15, 2014
12.	Bangladesh Small and Cottage Industries Corporation (BSCIC)	• Eng. Harunur Rashid Bhuiyan Chief Engineer	September 21, 2014
13.	BRAC	• Milan Kanti Barua, Program Head Water Sanitation and Hygiene	September 18,2014
14.	Dhaka Water and Sewerage Authority	• SDM Quamrul Alam Chowdhury, DMD	September 29, 2014
15.	Joint River Commission	• Mir Sajid Hossain, Chairman	October 01, 2014
16.	DWASA	• Engr. T A Khan, MD & CEO	October 02, 2014

S #	Existing Stakeholders/ Organisation	Overview of the agency's role/ functions	Date of meeting
17.	Department of Fisheries	• Dr. Syed Arif Azad	October 02, 2014
18.	Bangladesh Institute of Development Studies	• Mr. Mustafa K. Mujeri, Ph.D., Director General	August 28, 2014
19.	Bangladesh University of Engineering and Technology (BUET)	• Prof. Md. Mujibur Rahman, Professor, Department of Civil Engineering	August 25, 2014
20.	Institute of Water Modelling (IWM)	• Mr. S. M. Mahbubur Rahman, Director • Mr. Abu Saleh Khan, Deputy Executive Director	August 18, 2014
21.	Center for Environmental and Geographic Information Services (CEGIS)	• Md. Waji Ulah, Executive Director • Mr. H.S. Mozaddad Faruque, Water Resource Expert • Mr. Malik Fida A Khan, Director, Climate Change Study Division • Mr. Shaheen Afrose, Deputy Manager, Public Relations • Mr Fida Khan, Director, Climate Change Study Group	August 18, 2014
22.	United Nations Development Programme	• Mr. Ahmadul Hasan, Programme Coordinator, JP-Integrated Water Management	August 28, 2014
23.	Global Water Partnership	• Dr. Khondaker Azharul Haq	August 18, 2014
24.	Water Aid	• Dr. Khairul Islam, Country Representative	August 19, 2014
25.	Department for International Development (DfID) UK	• Dr Liyakat Ali, Climate Change and Environment Adviser	September 2, 2014
26.	International Fund for Agricultural Development	• Mr. Nicholas Syed, Country Programme Officer - Bangladesh	September 16, 2014
27.	Dutch Embassy	• Mr. Carel-de-Groot, Mr. A.T.M. Khaleduzzaman	September 18, 2014
28.	Swiss Development Cooperation	• Mr. Sohen Ibn Ali, Programme Manager, Local Governance	September 21, 2014
29.	South Asia Water Initiative	• Mr. Ahmadul Hasan, Programme Coordinator, JP-Integrated Water Management	October 01, 2014
30.	Prominent figures involved in WRM such as independent researchers	• Prof. Ainun Nishat, BRAC University • Dr. Md. Efterkharul Alam, Safeguard & Governance Officer, Project Management Unit	August 19, 2014 & August 20, 2014
31.	International Union for Conservation of Nature (IUCN)	• Dr. Istiak Sobhan, Programme Coordinator	August 26, 2014
32.	Food and Agriculture Organisation	• Wais Kabir , Team Leader, Mapping Exercise of Water Logging in SWB	September 28, 2014
33.	Krishok Maitry (Farmers' Association)	• Partha Hefaz Shaikh, Expert	September 28, 2014
34.	Dhaka Chamber of Commerce and Industry	• Mr. Nafees Imtiaz Islam, Deputy Secretary, Research	August 25, 2014

S #	Existing Stakeholders/ Organisation	Overview of the agency's role/ functions	Date of meeting
	(DCCI)		
35.	CityScape International Limited	• Mr. Md. Asraful Islam, Senior Engineer • Mr. Shaikh Asaduzzaman, Senior Engineer	August 27, 2014
36.	Business Initiative Leading Development (BuILD)	• Mrs. Ferdaus Ara Begum, CEO	August 25, 2014
37.	GAP international Sourcing (BD) Pvt ltd.	• Mr. Tamanna Sarwar, Manager, Global Responsibility Dept.	September 11, 2014
38.	Apex Footwear Ltd	• Mr. Syed Gias Hossain, AMD	September 11, 2014
39.	Silver Wave Tours	• Mr. Wahid Ullah, MD	September 14, 2014
40.	Sigma Pumps	• Mr. Mizanur Rahman, Director	September 15, 2014
41.	Coca cola	• Shadab Ahmed Khan, Country Manager; • Ms. Shamima Akhter, Public Affairs and Cmmunication Consultant	September 18, 2014
42.	Pepsi	• Gollum Chowdhury, MD	September 22, 2014
43.	Nestle Bangladesh	• Shaumitra Kumar Mondal, Senior Chief Engr	September 23, 2014
44.	Pran Group	• Eliash Mridha, Director	October 2, 2014
45.	IDLC Finance Limited	• Mr. Mesbah Uddin Ahmed, Head of Structured Finance	March 9, 2015
46.	IDLC Finance Limited	• Mr. Mehbuboor Rahman, Assistant Manager, Corporate Division	March 9, 2015
47.	Department of Public Health Engineering	• Mr. Shishir Kumar Biswas, Assistant Engineer	March 9, 2015
48.	Dhaka WASA	• Mr. SDM Quamrul Alam Chowdhury, Deputy Managing Director, O&M	March 10, 2015
49.	Dhaka WASA	• Mr. Md. Serajuddin, Deputy Managing Director, Research & Planning	March 10, 2015
50.	Department of Fisheries	• Dr. Md. Sainur Alam, Assistant Director	March 10, 2015
51.	NGO Forum	• Mr. Ziaul Haque, Head of Field Operations	March 11, 2015
52.	NGO Forum	• Mr. Shams Uddin Md. Rafi, Project Coordinator, Enhancing Governance & Capacity in WSS	March 11, 2015
53.	NGO Forum	• Engr. Salahuddin Ahmmed, Programme Engineer,	March 11, 2015
54.	DPHE	• Engr. Md. Wali Ullah, Superintending Engineer, Feasibility Study & Design Circle	March 11, 2015
55.	Ministry of Environment & Forests	• Dr. Sultan Ahmed, Joint Secretary, Director, Natural Resources Management and Research	March 11, 2015
56.	Sigma Pumps	• Mr. Md. Mizanur Rahman, Director	March 14, 2015
57.	Sigma Pumps	• Engr. Tazul Islam, Deputy General Manager	March 14, 2015
58.	Water and Sanitation Program, World Bank	• Mr. Abdul Motaleb, Dhaka Water Supply and Sanitation Project	March 16, 2015

S #	Existing Stakeholders/ Organisation	Overview of the agency's role/ functions	Date of meeting
59.	WaterAid	• Mr. Shamim Ahmed, Head of Policy and Advocacy	March 18, 2015
60.	WaterAid	Mrs. Hasin Jahan, Director, Programmes & Policy Advocacy •	March 19, 2015
61.	DSK	• Mr. Md. Abdul Hakim, Senior Project Co-coordinator (WaSH),	March 19, 2015
62.	SNV Netherlands Development Organization	• Mr. Rajeev Munankami, Senior Advisor/Programme Leader	March 24, 2015

B.4. Participants list: Focus group discussions

Following is the list of participants who attended the FGD on September 24, 2014 and September 25, 2014.

Table 3: List of participants in the FGD

Name	Organisation	Email address	Category of participant	Participated in discussion on
Md Rasel Kabir	Pran RFL Group		Private sector	24.09.14
ASM Shafiqur Rahman	Pran RFL Group	de1@prangroup.com	Private sector	24.09.14
Shadab Khan	Coca Cola	shadkhan@coca-cola.com	Private sector	24.09.14
Dr C S Ahmed	BCAS	salehahmed4081@yahoo.com	Host	24.09.14
Ranen Banerjee	Executive Director, PwC India	ranen.banerjee@in.pwc.com	Host	24.09.14
Ahsan Reza	GAP Inc	ahsan_reza@GAP.com	Private sector	24.09.14
Tazul Islam	Sigma Engineers Ltd	tazul@sigma-bd.com	Private sector	24.09.14
Sabrin Reza	Sigma Engineers Ltd	sabrin.reza@gmail.com	Private sector	24.09.14
Dr Azharul Haq	Global Water Partnership Bangladesh	kahaq@dhaka.net	Host	24.09.14
Engr. M Abu Taher	Chairman, BRLLFEA	mataher@fortunebd.com	Private sector	24.09.14
Nazrul Islam Bachchu	Pugmar Tours and Travels	nibachchu@gmail.com	Private sector	24.09.14
Syed M Islam Bulu	Riverain Tours	info@riveraintour.com	Private sector	24.09.14
Name	**Organisation**	**Email address**	**Category of participant**	**Participated in discussion on**
Nicolas Syed	IFAD	nsyed@ifad.org	Research	25.09.14
Asif Zaman	IWM	amz@iwmbd.com	Research	25.09.14
Theophil Nokrek	Caritas Development Institute	theophil.cdi@gmail.com	NGO	25.09.14
Golam Mainuddin	Caritas Development Institute	mainuddin_dayapur@yahoo.com	NGO	25.09.14
Tanvik	IFC	tanvikaltazd@yahoo.com	Donor	25.09.14
Abdus Salam	BRAC	abdus.salam02@brac.net	NGO	25.09.14
C S Ahmed	BCAS	salehahmed4081@yahoo.com	Research/ Host	25.09.14
Michiel Slotema	Dutch Embassy (EKN)	michiel.slotema@minbuza.nl	Donor	25.09.14
Tanuja Bhattacharjee	GIZ	tanuja.bhattacharjee@giz.de	Donor	25.09.14
S M Wahiuzzaman	ActionAid Bangladesh	sm.wahiuzzaman@actionaid.org	NGO	25.09.14
Md Abdul Hakim	Dushto Shasto Kendra	1711308978	NGO	25.09.14

Md Ziaul Haq	NGO Forum on Public Health	1720090669	NGO	25.09.14
Engr. Salahuddin Ahmed	NGO Forum on Public Health	1795137585	NGO	25.09.14
Dr Azharul Haq	Bangladesh Water Partnership/ PwC	1819212996	Research/ Host	25.09.14
H S M Faruque	CEGIS	1915608789	Research	25.09.14

B.5. Summary of Focus Group Discussion

Focus group Discussion: Private Sector (Sept 24, 2014)

Based on the focus group discussion held with the private sector on September 24, 2014 following key points have been identified:

I. Current scenario

a. Utilisation of surface water needs higher costs and higher initial investments. Therefore the focus of extraction of water is apparently on ground water
b. Various industries use a standardised water use reporting mechanism where water used per unit of their production is reported to concerned agencies (such as parent international corporation)
c. Some companies had to construct new wells due to lower water tables. For instance, PRAN Group had to build four new wells over past 8 years
d. In Gazipur area, many companies operate ETPs in presence of regulatory officials
e. Degrading water quality due to water effluents from agriculture (pesticides, fertilizers) and from industry (e.g. cadmium, chromium, zinc, lead, negatively impact food chain: traces found in agricultural produce
f. Textile/ leather companies along the river do not invest due to uncertainty of re-allocation to other areas
g. 80% of current irrigation infrastructure is privatized in Bangladesh. Of these 80%, around 90% cater for small scale irrigation

II. Key issues identified

a. Treated wastewater is also about 3.5 times more expensive than fresh water.
b. Tighter regulation may harm economic feasibility of export industry
c. Government is often perceived by the industrial stakeholders as a significant stakeholder who can achieve sizeable objectives by acting precisely and taking firm steps.
d. PRAN Group and Pepsi Co both mentioned difficulties in raising awareness of staff to act responsibly

III. Recommendations

a. Cheaper and customized technologies, e.g. ETPs, recycling, rainwater harvesting etc., are required for Bangladeshi market
b. Usage of flat roofs for recharging groundwater needs to be explored. The challenge here is to ensure space-effective technological measures. (This challenge is aggravated by flooding etc. which affects the land available.)
c. Significant reuse of water is possible for gardening and flushing purposes. This must be explored further.
d. Ability and willingness to pay for sustainable WRM initiatives needs to be bolstered by appropriate regulatory and policy framework.
e. Mind set of all water users needs to be reoriented towards ensuring future sustainability of water resources management. This means that information, education, and communication (IEC) activities need to reach all strata and sections of

the society. (This set of IEC activities can also include risks to businesses such as relocation of factories.) Conservation of water resources should be the responsibility of each water user.

f. Rationalised payment for water used by all stakeholders will contribute to financial sustainability of efforts to ensure sustainable WRM
g. Awareness Raising: Change of mind-sets of industries and consumers
    - Need to raise awareness of implications of current behaviour
    - Need to increase willingness of companies to self-regulate and implement existing regulation
    - Need to create feeling of ownership of resources and projects
    - The scale of water lost due to unsustainable water resource management practices needs to be widely known.)
h. Incentivize sustainable water management practices by rewarding best practices
i. Wastewater treatment
    - Need for major infrastructure overhaul and expansion
    - Need for cheaper, innovative technologies, tailored to Bangladesh's context
    - Public ETPs should be constructed in industrial areas (e.g. Gazipur) to which all surrounding companies would be connected to. These companies would then pay per m^3 of water treated.
    - Suggestion to advise commercial banks to incentivize investments in clean tech or to introduce preferred loans for clean tech
    - The industries need to focus more on tertiary treatment of their wastewater. Their efforts could be complemented by financial institutions by providing 0% interest loans for targeted initiatives, etc., on the same lines as the subsidies for fertilisers, popularisation of CFLs, etc.
j. Irrigation
    - Agriculture and related businesses face the challenge of higher content of Arsenic in the water.
    - Increase in dry season crops to extent that wet season crops are not cultivated anymore/ to a far lesser extent

Focus Group Discussion: Civil Society (Sept 25, 2014)

Based on the focus group discussion held with the civil society on September 25, 2014 following key points have been identified:

I. Current Scenario

- The Department of Environment (DoE) classifies industries into green, orange and red categories - all of which face different regulatory implications.
- Unreliable WASA network necessitates companies to arrange for own water supply
    - ADB & WB have recently invested in water network to reduce leakage and increase pressure
    - It is expected that by 2025/2030 more companies will switch from own tube wells to WASA supplies (assuming the network continues to improve)
- Lack of ownership and lack of continuity of initiatives, etc.
- WARPO holds the National Water Resources Data Base and shall be given more power in the Water Act of 2013 to manage this data.
- NGOs are working closely on the ground to address some of the issues in water resources, such as policy advocacy to ensure better access for poor households to water and sanitation.

- Some of the stakeholders [such as bottlers] are cautious in taking stand and decide their influence-interest combination based on the prevailing conditions

II. Key issues identified

- In theory DoE have the power to close down operations if non-compliant. However following key issues have been identified:
  - "Strong in mandate, weak in execution"
  - Lack of man power
  - Out of date tube wells in Dhaka is much out of date
  - Dysfunctional meters
- Improvement of data (management)
  - Currently, (public) data is not collected by one institution: multiple institutions hold fragments of data which have to be purchased prior to usage
  - Not sufficient data/ information to manage water: no information on groundwater interactions (deep, medium, shallow aquifer) and/ or water levels within each layer of aquifer

III. Recommendations

- Environmental impact assessments are required for each new project (questionable objectivity) and annual reports should be submitted
- Improve data collection and data management, civil society can provide Government with technical support in collecting information from meters, gauging stations etc. and preparing it for general usage
- Support and encouragement from private sector is needed for academic institutions to invest into developing local solutions to sustainable WRM challenges
- Raising Awareness
  - Need for awareness of implications of unsustainable WRM
  - Need that water is considered a "product/ input to production" similar to energy which resources are finite and should have a "proper" price tag
  - Need incentives/ benefits to reduce water consumption/ treat wastewater etc.
  - Suggestion to undertake water footprint of the industry
- Sustainable urban water usage
  - Consider options of rainwater harvesting
  - Consider incentives, standards etc.
- The goals of donor agencies and borrowing agencies need to be aligned well with each other's.
- The government agencies need to better coordinate amongst themselves for effective implementation of all the schemes
- Sustainable O&M of the systems installed and invested in by the civil society agencies is a crucial point that needs to be considered and addressed
- Key action points include high level policy advocacy and support to the government to draft and implement focused and strict regulatory and legal measures to ensure sustainable WRM

B.6. Selected water related initiatives, programmes and projects

The following list includes initiatives in the water resource development, management (including conservation), or regulation sectors.

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
1.	Government of the Netherlands	Blue Gold Initiative	2013-2019	Improved living conditions for coastal people via integrated water resources management aimed towards enhanced production and integrated business linkages	Patuakhali, Khulna, and Satkhira districts	Focuses on reducing poverty for selected households living in selected coastal polders by creating a sustainable socio-economic environment/ Under implementation
2.	World Bank/ IDA	Improve water management, enhance institutional performance of the Country's principal water institutions, including Drafting Water Act 2013	2012	Water resources management	National	Aimed at improving institutional management by performance monitoring and efficiency enhancement/strengthening of water related utilities
3.	Bangladesh Water Development Board/ Changjiang Survey, Planning, Design and Research (CSPDR)	Ganga Barrage		River Management	South-West region	The project aims to towards regional socio-economic development, by increasing agricultural productivity, fish production, inland water navigation and addressing salinity intrusion
4.	Asian Development Bank	Establishing a regulatory framework for water supply and sanitation sector in Bangladesh	2013-15	Transparent, participatory, and accountable regulation of water supply and sanitation	National	To support regulation and sustainability of water and sanitation services/Under implementation

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
5.	Water Aid/ BUET	Research Study on Storage and Recharge Potential of Rainwater in Dhaka City to Promote Ideal Practice of Rainwater Harvesting System in Urban Areas	2015	Rainwater harvesting in urban areas	Dhaka City	The project aims to establish proper operation and maintenance of the rainwater harvesting systems at four sites in Independent University Bangladesh (IUB), Village Education Resource Centre (VERC), University of Information and Technology Science (UITS) and Bangladesh University of Engineering and Technology (BUET). Among other activities this project includes, water quality testing of stored rainwater and groundwater from monitoring wells at all four sites is one of the major tasks.
6.	Bill and Melinda Gates Foundation/ DSK/ ITN-BUET (as part of K-Hub)	Formulation of regulatory framework for faecal and sludge management in Bangladesh	Ongoing	Sludge management	National	To formulate framework for institutionalising faecal and sludge management in Bangladesh/Under implementation
7.	Swiss Agency for Development Cooperation (SDC)	Effecting the Water Act 2013	ongoing	Institutional strengthening	National	Supporting the WARPO in designing the regulations and rules under the Water Act 2013
8.	Bangladesh Water Development Board (BWDB	Construction of 162 km of river channels from Jamuna to Burignanga	2011	Buriganga conservation	Urban settlements in and around Dhaka city	Rejuvenate the Buriganga river by providing better stream flow, especially during dry months/ Implementation delayed due to construction related challenges
9.	Department of Environment	Feasibility study about initiatives for conservation	2015	Buriganga conservation: Focus on management	Urban settlements in and around	Rejuvenate the Buriganga river taking into consideration opinion from different

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
		of Buriganga		of industrial and urban discharge	Dhaka city	stakeholders/ Under implementation
10.	Global Water Partnership	Bangladesh Water Partnership	Ongoing	Sustainable water management practices	National	Support water resource and service management in Bangladesh/ Under implementation
11.	World Wide Fund for Nature (WWF)	Water Stewardship initiative	Ongoing	Sustainable water management practices	National, sectoral and local depending on presence of partner NGOs, initiatives and companies.	Encouraging good water management and governance by creating multi-stakeholder initiatives and leveraging private sector influence and impact reduction
12.	World Bank/ Dhaka WASA	Formulation of the Drainage Master Plan	2015	Urban wastewater management	Area under jurisdiction of Dhaka WASA	Planning rehabilitation of the drainage system in Dhaka/ Completed
13.	World Bank/ Dhaka WASA	Formulation of the Dhaka Sewerage Master Plan	2015	Urban sewage management and treatment	Area under jurisdiction of Dhaka WASA	Planning initiatives for sewage management and treatment in urban areas / Under implementation
14.	World/ RAJUK	Formulation of the Dhaka Metropolitan Area Plan	2015	Urban planning with focus on housing	Dhaka Metropolitan Plan	Planning of development of future plans for providing housing and allied services in Dhaka/ Under implementation
15.	Department of Environment	Buriganga Re-conservation Committee	2014	River management and pollution control	Dhaka and adjoining areas	The initiative aims to address pollution related issues for Buriganga (including both industrial and domestic discharge)/ Under Implementation
16.	Asian Development Bank/ DWASA	Khilkhet Water Treatment Plant	2012	Urban Water Supply	Dhaka	The project aims to carry out due diligence on technical, economic, financial, governance, poverty and social, and safeguards for the ensuing loan. It will

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
						explore feasibility of public-private partnership (PPP) and propose the most viable alternative with specific institutional, legal, and financial arrangements for improving the service delivery of water supply in Dhaka/ Under implementation
17.	Japan Bank for International Cooperation (JBIC)	Small scale water resources development project	2007-ongoing	Water resource development	Beginning with SW and NW regions, now the focus is national	Supporting effective water resources utilisation in the fisheries and agriculture sector through development of small scale water resources project
18.	Government of the Netherlands	Bangladesh Delta Plan	Ongoing	Sustainable and holistic development of the coastal region	Southern region (the delta)	Sustainable development in the delta region of the country/ Under implementation
19.	DANIDA	Water Resources Sector Policy Support Component	2012	Institutional Strengthening	National	Policy Support Unit (PSU) to assist government in shifting from being a provider to becoming a facilitator, and facilitate donor harmonisation
20.	Swiss Agency for Development Cooperation (SDC)	Tanguar Haor wetlands conservation and livelihood	2012	Haor development	Tanguar/ Ramsar	Multi-level coordination amongst district and union administrations to conserve Tanguar Ramsar Haor and supporting sustainable livelihoods
21.	Government of Australia/ AusAID	Water Quality Partnership for Health Phases 2 & 3	2008-2012	Water and sanitation services	National	Supporting Water and Sanitation Initiative (WSI) to enhance coordination amongst donors and improve impact of WSI
22.	SDC	Water and Sanitation Programme	2012	Institutional Strengthening	National	Enhancing processes of governance, accountability, and

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
		(WSP-SA), Bangladesh				poverty alleviation by focusing on the WSS service delivery responsibilities
23.	Government of Australia/ AusAID	South Asia Water Initiative Phase 2	2012	Transboundary river co-operation	National, trans-boundary approach at basin-level	Promoting regional cooperation for sustainable water of the Himalayan rivers considering the challenges of development and climate change
24.	Government of the Netherlands	DHA Integrate Planning for Sustainable Water Management (Technical Assistance)	2012	Sustainable water management	National level	Strengthen the multi-disciplinary and participatory project planning capacity of BWDB, WMOs and LGIs to implement NWP/GPWM 2. Transfer responsibility for O&M and for rehabilitation of water-sector infrastructure from central to local level
25.	United Kingdom (UK)	Financial Aid to Sanitation, Hygiene, Education & Water Supply in Bangladesh (SHEWA-B)	2011	Water Hygiene and sanitation	National	Supporting adoption of better hygiene standards by poor (unserved and under-served) communities
26.	DANIDA	Saidabad Water Project, Phase II	2011	Urban Water Supply	Dhaka	Improving the water supply in Dhaka by building a water treatment system
27.	Government of the Netherlands	Dialogue for Sustainable Management of Trans-Boundary Water Regimes in South-Asia: A Bangladesh-India	2011	Transboundary water co-operation	National, regional	Enhancing coordination for effective and sustainable management of trans-boundary river basins

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
		Initiative				
28.	DANIDA	Sector Capacity Building Component	2011	Capacity building	National, decentralised level	Capacity building support to Government, NGOs and university institutions for decentralized governance including at the village level
29.	Government of Japan	Technical cooperation and aggregated activities for water resources protection and waste management	2011	Waste management and water conservation	Selected region of the country	Effective waste management and supporting protection and conservation of water resources
30.	Asian Development Bank	Secondary Towns Water Supply And Sanitation Project	2010	Water institutional improvement	Selected region of the country	Improved water supply and sanitation services through strengthening local water utilities' operational efficiency and financial sustainability
31.	SDC	Water and sanitation partnership project	2010	Water and sanitation service improvement	Selected northern region of the country	Pursuing initiatives for improving water and sanitation services in Bangladesh focussing on community participation and employment / Under implementation
32.	UNICEF	Evaluation of water and sanitation initiatives/ support for policy & strategy development	2010	Water and sanitation service improvement	Selected regions of the country	Proposing policy and strategy for improving water and sanitation improvement in Bangladesh
33.	EU Institutions	Integrated community based arsenic mitigation	2010	GW quality improvement	Arsenic-affected areas	Improving the overall quality of life of arsenic groundwater affected communities

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
		project				
34.	Government of Germany	Integrated Project of Arsenic Mitigation and Promotion of Public Health	2010	GW quality improvement	Arsenic-affected areas	Improving the overall quality of life of arsenic groundwater affected communities
35.	Government of Norway	PRIO-BIPSS collaboration on Water scarcity in Bangladesh & South Asia	2010	Knowledge management	National, regional amongst India, Bangladesh, and Nepal	Bridging knowledge gaps related to water security and promoting information sharing amongst Bangladesh, India and Nepal.
36.	Asian Development Bank	ADB-designed and Government of Bangladesh (GoB) funded project related to sludge management in sub urban areas	2011	Sludge management in sub0urban areas	Selected sub-urban towns	The project designed and operationalised a mechanical and mobile sludge management system for 11 towns in Bangladesh/ Implementation complete
37.	Asian Development Bank	Third Urban Governance and Infrastructure Improvement (Sector) Project	2013	Urban infrastructure development including water sector	Selected pourashavas in Bangladesh	The project aims to carry out due diligence on technical, economic, financial, governance, poverty and social, and safeguards for the ensuing loan. It focuses on capacity building of target pourashavas is an integral part of project preparation/ Under Implementation
38.	Asian Development Bank/ DWASA	Dhaka Environmentally Sustainable Water Supply Project	2013	Urban Water Supply	Dhaka	The project aims to provide reliable and improved security in Dhaka by developing a new surface water supply scheme for supply augmentation, by development of a water intake at Meghna

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
						(Borak) River/ Under Implementation
39.	Asian Development Bank	Strengthening Monitoring and Enforcement in the Meghna (Borak) River for Dhaka's Sustainable Water Supply	2014	Urban Water Supply	Dhaka	The project aims to support establishment of an independent regulatory commission for water supply, to monitor efficient operation of water utilities in a financially sustainable way/ Under Implementation
40.	BRAC	Water, Sanitation and Hygiene (WASH) programme in partnership with the government.	2006	Water, Hygiene and Sanitation	Rural Bangladesh	The goal is to provide sustainable and integrated WASH services in the rural areas. WASH provides technical support to those who are willing to construct latrines, ensuring proper design and site selection.
41.	DSK	Integrated community-based water, sanitation and hygiene promotion	1992	Water, Hygiene and Sanitation	Urban slums	DSK imparts participatory community-driven hygiene promotion methods to improve hygiene knowledge and behaviour change in the family and community.
42.	WaterAid	Community-led total sanitation approach		Water, Hygiene and Sanitation	Urban slums	Focuses on developing understanding in communities of links between unsafe sanitation, health hazards and thereby, motivating the community to take initiatives
43.	Water Supply & Sanitation Collaborative Council	Enhance participation of marginalised population in water and sanitation related		Water and sanitation	National level	The council aims strengthen the participation of poor people in water and sanitation-related policies and activities. The chapter organizes grassroots consultations so that poor and

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
		policies				marginalized people can be better informed about and yield greater influence in sanitation and water policy.
44.	Water.org	Improve water related services across Bangladesh		Provide innovative market-based solutions for water related services	Rural areas	Conducting a community-led total sanitation and safe water improvement program
45.	SNV	Modernising Urban Sanitation in Bangladesh		Pro-poor market based solutions for faecal sludge management in urban centres	Southern Bangladesh	With funding support from the Bill & Melinda Gates Foundation and the UK Department for International Development, SNV has initiated the project. It aims to reform the way that human waste is managed in Bangladesh by developing faecal sludge management services in Khulna City Corporation area and the two small towns of Khustia and Jhenaidah in Khulna division.
46.	ADB/ITN-BUET/ Bill and Melinda Gates Foundation (BMGF)/ Governments of Bangladesh, India, Nepal and Sri Lanka	South Asia Urban Knowledge Hub (K-Hub)	2015	Knowledge centre	Coverage across nations such as India, Bangladesh, Nepal and Sri Lanka	The main objective of the K-Hub is to build capacity to generate and apply knowledge to city management according to principles of sustainable development and to influence policy and decision-makers in this direction. The K-Hub will facilitate information and experience exchanges within South Asia for city managers, utility staff, policy makers, academia and private sector to improve the urban environment and services delivery. The K-Hub also aims (i) to make recommendations

No.	Supporting Institutions & Organisations	Name of the project/ initiative related to	Year	Sector or focus area	Target region in Bangladesh	Objective of the project
						to improve University-level curricula for urban planners and managers in South Asia, and (ii) strengthen national centers' capacity for outcome oriented research and influencing intended audiences. The regional center of the K-Hub will be based in India. This institution in India will play the dual role of regional and national center for India; and each participating country, including Bangladesh, will have a national center that has been endorsed by the respective government.

B.7. Focus areas for issues in sustainable water management

Following are selected issues related to sustainable water resource management in Bangladesh.

Focus Area 1: Drinking water quality - arsenic, iron, and manganese contamination

Arsenic contamination is the most pressing water quality related issue in Bangladesh. It is observed predominantly in shallow tube wells as compared to deep tube wells. According to the National Hydro-chemical Survey, conducted by Department of Public Health Engineering in 1998-99, around 46% of shallow tube wells and about 5% of deep tube wells surveyed exceeded the WHO-GV limit of arsenic (10 µg/L), with most of these wells being situated in southern region (South Western - SW, South Central - SC and South Eastern - SE) of Bangladesh (see Figure 14). Some of the most severely arsenic affected districts are Munshiganj, Lakshmipur, Noakhali, Chandpur, Gopalganj, Shariatpur, Faridpur, Rajbari, and Satkhira. In the affected areas, concentrations have been observed to range from below detection level to as high as 4730 µg/L. Figure 14 shows the arsenic contamination in Bangladesh according to DPHE survey in 2010 which clearly highlights the southern region of the country.

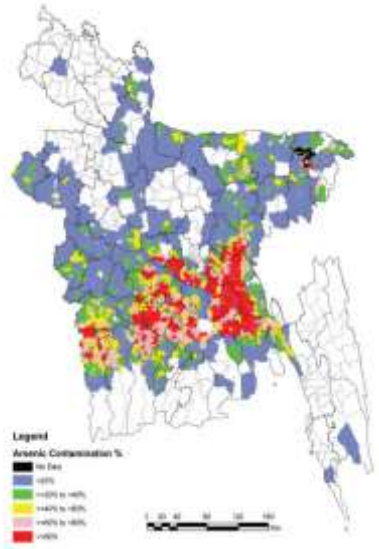


Figure 14: Arsenic contamination in Bangladesh (Source of data: DPHE, June 2010)

Apart from arsenic, concentration levels of iron and manganese have been detected in various parts of the country. Similar to arsenic, iron concentration is mostly found in shallow tube wells as compared to deep tube wells. Iron concentration in water sources have been observed in south west, south east and north east region (including Jamuna flood plain) of Bangladesh with level exceeding to 1.0 mg/L as compared to WHO-GV limit of 0.3 mg/L. On the other hand, manganese has been found to coexist with iron and arsenic concentrations in Western and North Central (NC) region of the country. In the NHS, 39% of shallow and 2% of deep wells exceeded the WHO-GV limit of 0.4 mg/L. On the other hand, 79% of the shallow and 22% of deep wells exceeded Bangladesh standard limit of 0.1 mg/L.

Source: Ravenscroft et al 2013, Sector Development Plan (FY 2011-25), Water Supply and Sanitation Sector in Bangladesh, Working Document #9, Groundwater: Quantity and Quality Issues Affecting Water Supply; Saima Hedrick , Water in Crisis - Spotlight on Bangladesh

Focus Area 2: Increasing salinity levels of freshwater resources

High salinity of water resources has been extensively been observed in Nabinagar, Muradnagar, Daudkandi and Chandina located in south east (SE) region, and Khulna, Bagerhat and Satkhira located in South West (SW) region of Bangladesh. In Khulna, the aquifer has been detected to be saline at levels 5,000 µS/cm, as compared to the WHO recommended maximum level of 800 µS/cm.

The increase in salinity levels is driven by three factors. First, the low surface water flows in the distributaries of the delta in the dry season, allow seawater to intrude up the tributaries and groundwater aquifers of the delta (see Figure 15). The situation is expected to aggravate with increase in seawater levels due to climate change. Second, runoff from agriculture and shrimp farms further leads to increased salinity levels. Thirdly, reduced surface water flows, e.g. due to high abstractions and water held back by the Farakka Barrage in India, decrease the dilution potential and thus lead to higher salinity concentrations.

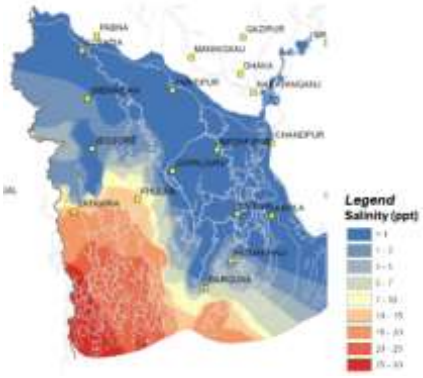


Figure 15: Salinity intrusion in South West region

Loss of agricultural productivity due to salinity has been identified as a growing concern in the southern regions of Bangladesh. According to a survey conducted by Bangladesh Centre for Advanced Studies, around 96% of the farmers identified salinity as a major cause of decreasing productivity in the Satkhira region.

Source: *Ravenscroft et al 2013, Sector Development Plan (FY 2011-25), Water Supply and Sanitation Sector in Bangladesh, Working Document #9, Groundwater: Quantity and Quality Issues Affecting Water Supply; BCAS, December 2013, Loss and Damage from salinity intrusion in Sathkira District, coastal Bangladesh; 'Everybody needs water', by Water Care, Government of South Africa and Save the Murray (http://www.murrayriver.com.au/pdf/water_for_life.pdf)*

Further, the following aspects[44] were observed qualitatively, which closely correlate climate change (a significant aspect of delta management principles in Bangladesh), and salinity intrusion:

1. River salinity is directly proportional to rise of seawater levels, and therefore impacted by climate change
2. Since significant area of the country is river delta, soil quality is directly affected by river water quality. Increasing salinity therefore would directly affect rice production practiced in the coastal areas.
3. Salinity, would also intrude groundwater sources, thereby affecting not only drinking water supplies, but also ambient parameters of physical environment of public infrastructure such as roads.

Focus Area 3: Groundwater depletion and pollution of surface water

According to the data collected by DPHE in 2009, gradually declining groundwater table is a growing concern in selected regions on Bangladesh (see Figure 16). Data suggest that areas in north-west (NW) and north central (NC), consisting of Nawabganj, Rajshahi, Naogaon, Tangail, Netrakona, Mymensingh, Dhaka and Narayanganj have been the most affected. Dependence on groundwater to meet irrigation, industrial and urban water requirements has led to over-extraction in these regions. The average rate at which the groundwater table is declining in Dhaka region is expected to be 2 m/ year.

[44] Source: various relevant studies as referred to in the feedback received from 2030WRG

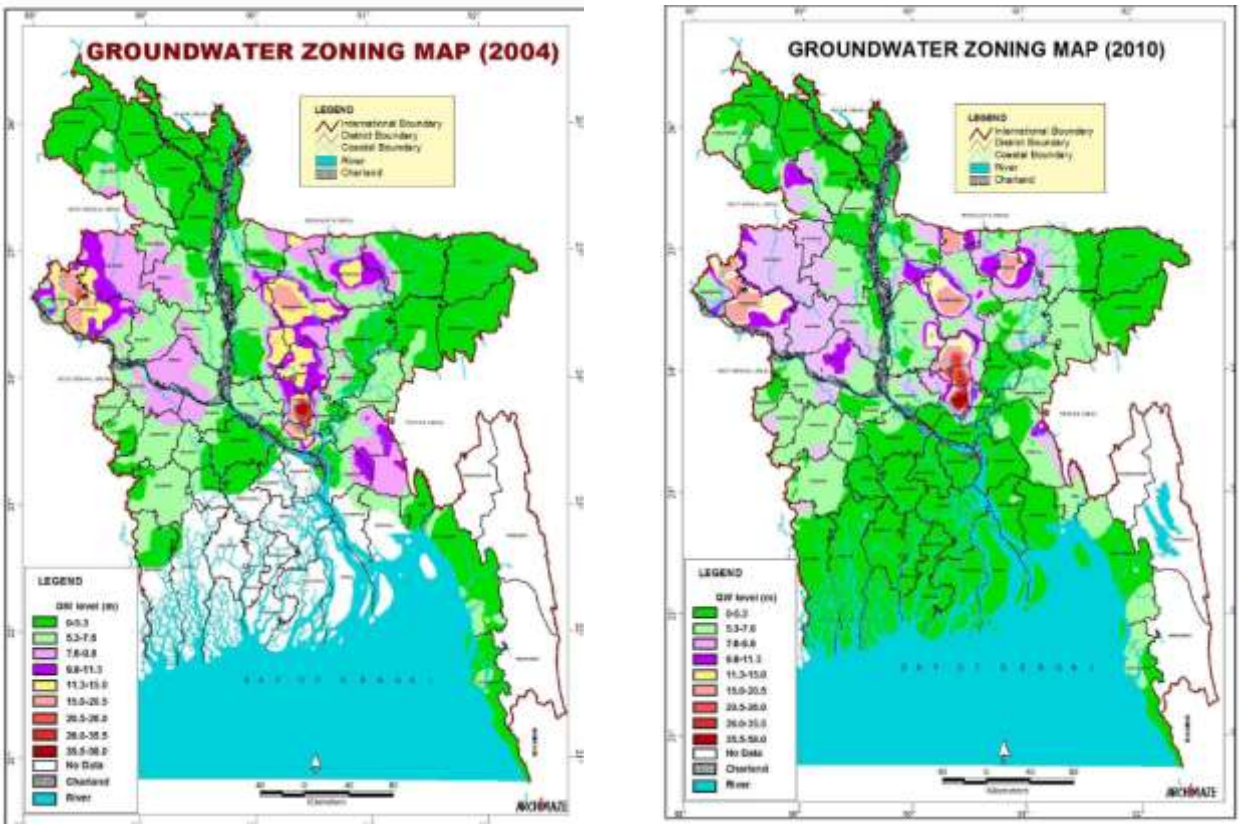


Figure 16 Falling groundwater tables between 2004 and 2010

Source: *Bangladesh Agriculture Development Corporation; Department for Public Health Engineering, Bangladesh;*

Focus Area 4: Industrial pollution of surface water

Major industrial areas of Bangladesh are based in the NW and NC region with concentration in Dhaka, Chittagong, Khulna, and Bogra districts. These industries release untreated effluents in more than 200 rivers of Bangladesh directly or indirectly. Pulp and paper, pharmaceuticals, metal processing, food industry, fertilizer, pesticides, dyeing and painting, textile, tannery etc. are the major contributing industries to the pollution. According to sources, approximately 155 operational tanneries in Dhaka city are discharging about 20,000 cubic meters of untreated effluent on daily basis. The Department of Environment has listed 1,176 factories that cause pollution throughout the country.

Source: *Ravenscroft et al 2013; Sector Development Plan (FY 2011-25), Water Supply and Sanitation Sector in Bangladesh, Working Document #9, Groundwater: Quantity and Quality Issues Affecting Water Supply; Paul, H., Antunes, A., Covington, A., Evans, P., & Phillips, P. (2012). Bangladeshi Leather Industry: An Overview of Recent Sustainable Developments. Society of Leather Technologists or Chemists, 25-32.*

Focus Area 5: Water pollution, water-borne diseases and health

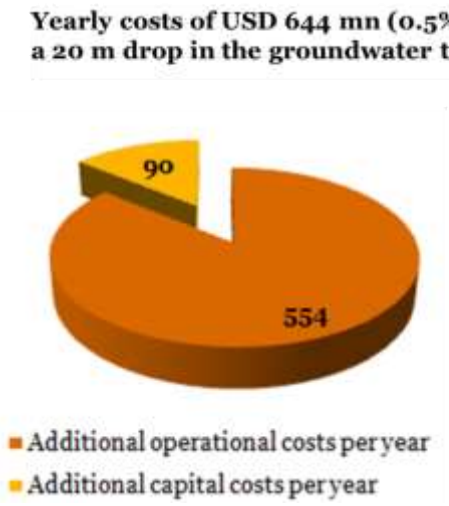
Water has been identified as one of the major medium for food contamination by heavy metals like cadmium (used in the battery industries), chromium (used in tannery industry) and aluminium. According to study undertaken by Ministry of Food, the Government of Bangladesh indicates growing concern of intake of heavy metals through food is irrespective of income in Bangladesh. For instance, 94% of poor households and 78% of non-poor households surveyed were detected with cadmium level excess of provisional tolerable monthly intake of 0.025 µg/kg to 106 µg/kg for poor households and 40 µg/kg for non-poor households. The survey points at irrigation water as one of the major carriers of such heavy metals into the food chain. According to the Bangladesh Agricultural University

at least one or more heavy metals in five out of 16 food groups, namely cereals, fish, meat, fruits and vegetables and spices. Further, according to reports by South Asian Water Initiatives, people living close to industrial settlements are at twice the risk of being infected by water-borne diseases such as jaundice, diarrhoea and other skin related diseases.

Source: *G. M. Jahangir Alam, BUET , 2009, Spatial and temporal analysis of groundwater fluctuations in Dhaka City, Bangladesh. Asian Journal of Earth Sciences; Ravenscroft et al 2013, Sector Development Plan (FY 2011-25), Water Supply and Sanitation Sector in Bangladesh, Working Document #9, Groundwater: Quantity and Quality Issues Affecting Water Supply; September 2014, Food Security and Policy Brief, Food Planning and Monitoring Unit (FPMU) of the Ministry of Food of the Government of Bangladesh, with the assistance of the National Food Policy Capacity Strengthening Programme (NFPCS), 2014; April 2014, The Bangladesh Responsible Sourcing Initiative, A New Model For Green Growth, SAWI, World Bank,*

Focus Area 6: Increasing costs

With decreasing ground water level, both operational costs (for pumping water from greater depths) and capital cost (for installation of new water pumps) increase. Considering these costs, it is estimated that a 20m drop in the water table will result in total additional expenditure of US$ 644 mn (0.5% of GDP) annually, assuming country-wide 100% demand for water being met with groundwater.



Sources: *April 2014, The Bangladesh Responsible Sourcing Initiative, A New Model For Green Growth, SAWI, World Bank; PwC Analysis*

Focus Area 7: The impact of flooding

Loss of lives

Out of the 234 natural disasters, which occurred between 1980 and 2010, storms (108 events) were the only disaster more frequent than floods (68 events). Eight out of the top ten (by the number of people affected) natural disasters reported were floods. On an average, about 182 people have been killed per instance of flood. Inundation of land is another major outfall due to flooding. Therefore, flood/ cyclone protection is a critical issue to be addressed in the north east, north central and some parts of south east region of the country. In addition, protection of natural barriers to climate change/flooding/cyclones such as forest conservation (Sunderbans in south west) and bank protection of rivers such as Brahmaputra in the northwest and central region are critical issues.

Impacts on livelihoods

On an average, around 32% of land is inundated under 90 cm of water during floods with instances of 68% in the year 1998. Since 1974, around close US$ 14.5 bn has been lost due to flood and storm

related disasters. Loss of soil productivity, aqua-agriculture and shrimp cultivation due to inundation and flooding have majorly affected the economically weaker sections of the society. Figure 17, illustrates how climate change is expected to aggravate flood events when compared to the 1988 flood. Therefore, initiatives such as Haror protection in the north eastern region and protection of polders in the south eastern region are vital for protecting livelihood for people associated with agriculture and fishing.

Figure 17: Increase in depth of flooding for the 1988 flood due to the additional impacts of projected 2030

Source: *A S Khan (2014) Water Resource Management- Bangladesh Perspective; Kirby et al (2014) Bangladesh Integrated Water Resources Assessment: final report; Disaster Statistics, Bangladesh, by Prevention Web (http://www.preventionweb.net/english/countries/asia/bgd/?x=12&y=5);*

Focus Area 8: Issues related to water supply services in Bangladesh

Availability of water services

In Bangladesh, urban water supply is characterized by certain key attributes, which include a high ratio of unaccounted produced water; tariffs fixed below average costs; and low billing and collection rates. Majority of the households rely on private shallow tube wells and with limited dependence on piped-water connections. Water shortages will be more apparent with increasing water demand, and unregulated groundwater extraction.

Service delivery has been identified as one of the key areas of improvement in urban water supply in Bangladesh. Apart from the attributes stated above, some key reasons for shortcomings in service delivery are absence of demand management; lack of financing and autonomy, especially in setting tariffs and staffing; and lack of involvement of users in water utility planning and operation. Upon taking a pilot project in Manikdi area in Bangladesh, almost all the households had substandard and leaking connections which accounted for physical water losses up to 50%. Currently, the distribution network cannot sustain pressure required for transmitting treated water. In terms of the water accounting, only 59% of household connections have water meters to account for consumption. Most of the installed meters are often inaccurate or inaccessible—making effective management of demand difficult.

Quality of water services

It was observed that water quality deteriorates, as it is distributed through the piped network. Leakages and pilferages affect the hygienic conditions of the pipes and connections. In addition, private suction pumps or service connections installed at the bottom of underground tanks cause low and limited pressure leading to extensive contamination of the water within the network. The current treatment plants are not working optimally and require pre-treatment facilities. In such scenario,

reliability of supply is severely hampered by unreliable power supply to the pumps, without backup generators.

Case Study: Dhaka Region

Dhaka Water and Sewerage Authority (DWASA) serve close to three-fourth of residents of the Dhaka Metropolitan Areas (DMA). According to the country's national Water Supply and Sewerage Authority (WASA), Dhaka requires 2.4 billion litres of water a day, but can only produce 2.1 billion. Population to be given service via DMA is expected to reach 17 million in 2025. This would leave less than 45% of the people in DMA covered by the DWASA water supply system resulting majority of the remaining uncovered population to opt water from their private wells, using the same aquifer. Currently, more than 80% of Dhaka's water supply comes from groundwater, with the top aquifer (out of the three levels) of Dhaka. Withdrawal from this aquifer has already exceeded its limit. On the financial front, only one third of the water that enters the network is ever paid for. DWASA has one of the lowest water tariffs in the world, which limits the utility's capacity to invest.

Source: *Mushifique Wadud, 2011, Article 'Dhaka turns to rainwater harvesting to ease water crisis; ADB (Nov 2007): Proposed Loans and Technical Assistance Grant People's Republic of Bangladesh: Dhaka Water Supply Sector Development Program Dhaka; Saima Hedrick, Water in Crisis - Spotlight on Bangladesh, http://thewaterproject.org/water-in-crisis-bangladesh*

B.8. Assumptions regarding water demand projections

We have calculated the projections for water demand for the agricultural sector based on following key assumptions:

- **Assumption 1:** 95% of irrigation demand obtained from Kirby, et al. (2014) is assumed to be used for Boro rice cultivation. Potential implications from future policies incentivising rained agriculture are not considered.
- **Assumption 2:** Ratio of consumptive water usage demand[45] and irrigation demand for Boro season cultivation (0.73595) is considered to be constant across years
- **Assumption 3:** Irrigation of other crops (rest of the 5% from Assumption 1) is kept constant across years 1.18 bcm.
- **Assumption 4:** Ratio of water demand (0.779683) between irrigation water consumption and agriculture water consumption is kept constant to obtain agriculture water demand (irrigation demand including water demand for livestock and fisheries)
- **Assumption 5:** During the dry season, 20% of available water surface is assumed to be usable and meeting required standards

B.9. Data for calculation of water demand

Table 4 and Table 5 present data for annual water supply and demand for the year 2011 and 2030.

Table 4: Annual water demand and availability

(in bcm)	Groundwater Total	Surface Water Total	Domestic Demand	Industrial Demand	Agriculture Demand	Instream Demand
Water Supply	32	1362				
Water Demand (2011)			2.385	0.087	32.32084691	106.16
Water Demand (2030)			4.165	0.182	46.26280981	106.16

Table 5: Dry season water demand and availability

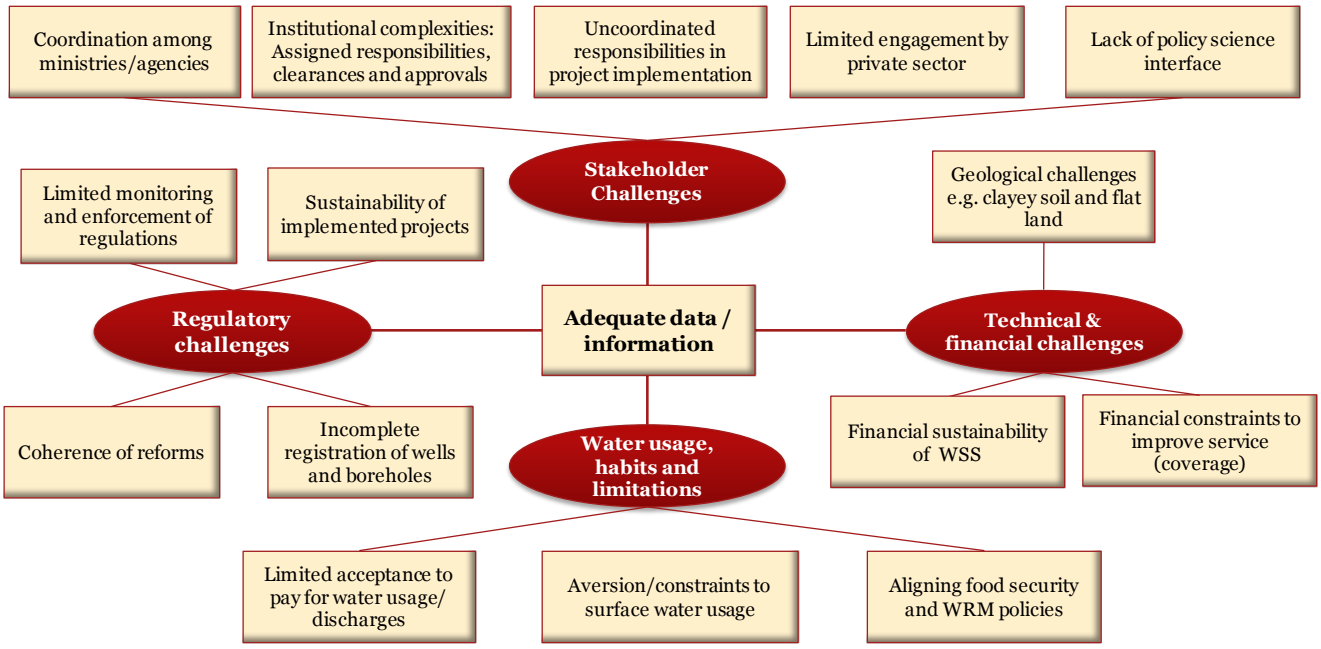
(in bcm)	Groundwater Total	Surface Water Total	Domestic Demand	Industrial Demand	Agriculture Demand

[45] Water for Food in Bangladesh: Outlook to 2030, 158, IWMI, Sri Lanka

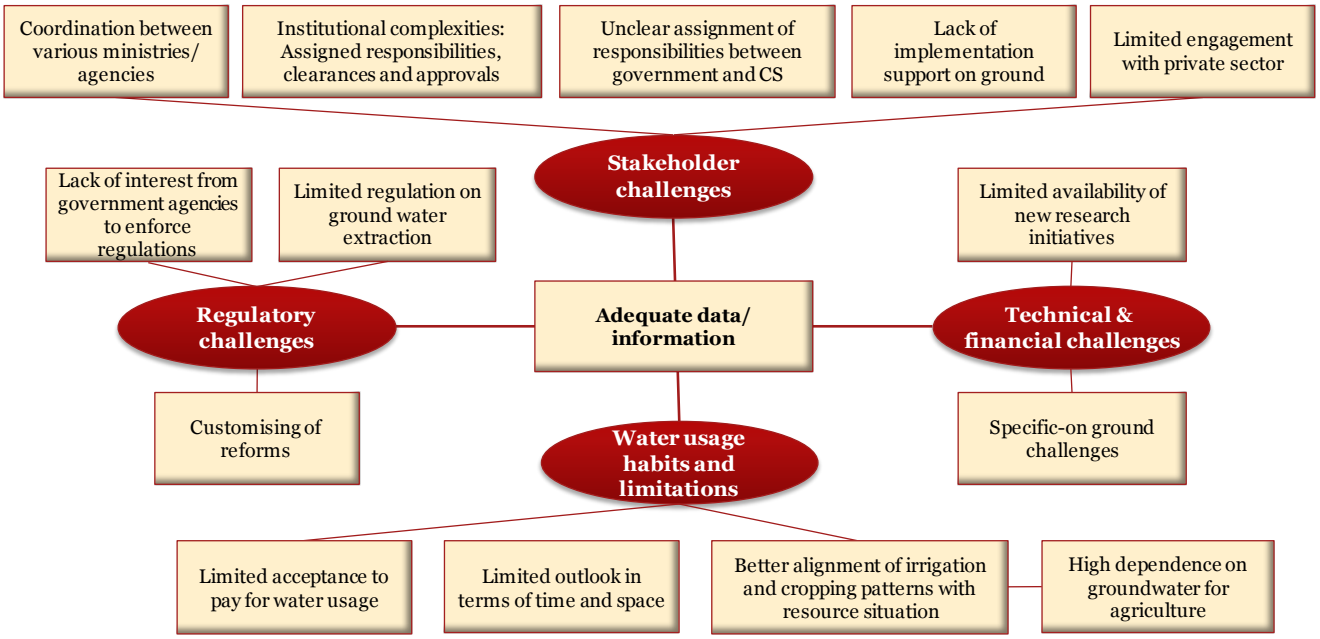
Water Supply	32	6.30			
Water Demand (2011)			1.1925	0.0435	30.26872964
Water Demand (2030)			2.0825	0.091	44.21069255

B.10. Mapping the main challenges of stakeholder groups

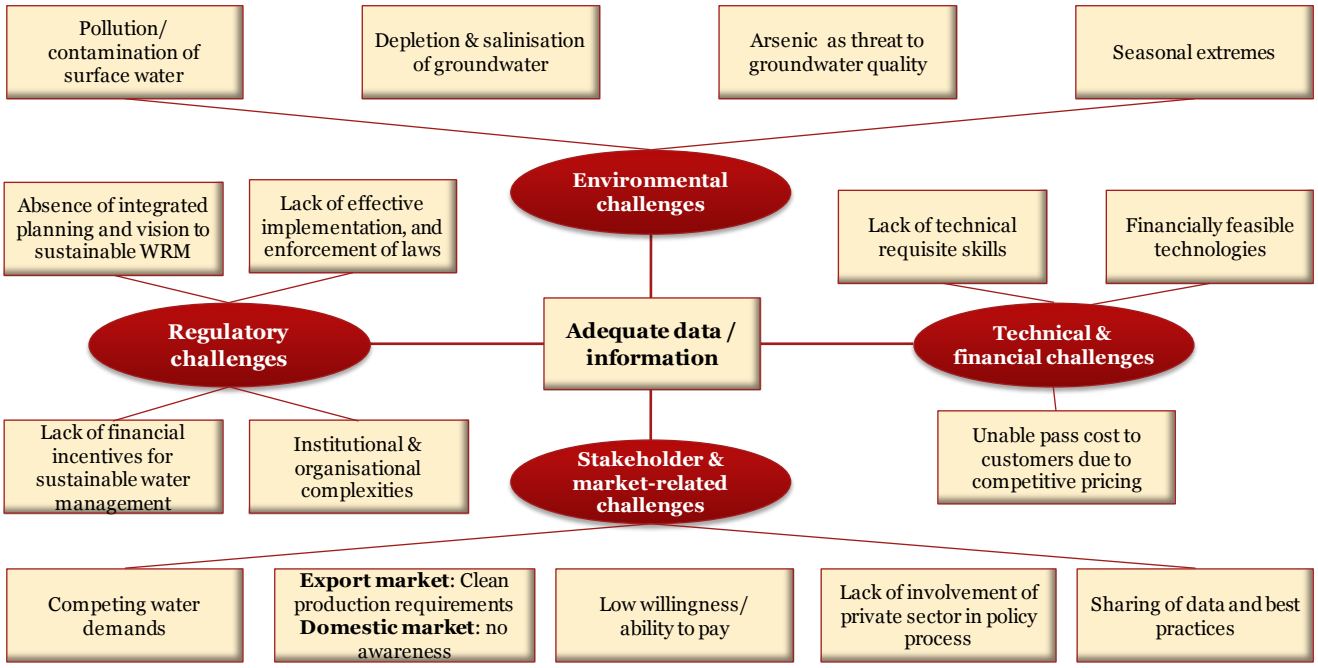
B.10.1. Public Sector



B.10.2. NGOs, IDA and IO



B.10.3. Private sector



Appendix C. - Deep Dive on exploring the potential for sustainable sewage treatment in Dhaka and its satellite towns

Background – The issue of untreated sewage

Dhaka is surrounded by a river and has a canal system consisting of the Buriganga, Turag, Shitalakhya, Balu and Bangshi. The Buriganga River, flowing past the southwest outskirts of Dhaka, has been the city's lifeline - as a source of livelihood and transportation. However, its water quality has been deteriorating rapidly leaving,particularly in the dry season,- some stretches entirely void of any aquatic life. Thus, the Buriganga is, in the dry seasons, more comparable to an open sewer rather than the city's lifeline it was in the past. However, while Buriganga is worst affected, the recent River Water Quality Report from the Department of Environment (2013) shows that most of Dhaka's surrounding rivers show dissolved oxygen levels (DO) of zero or close to zero during most of the dry season, i.e. not allowing aquatic life to prevail. The graphical representation in Figure 18 illustrates the severity of the situation, with the best water quality of assessed river stretches being categorized as "critically polluted".

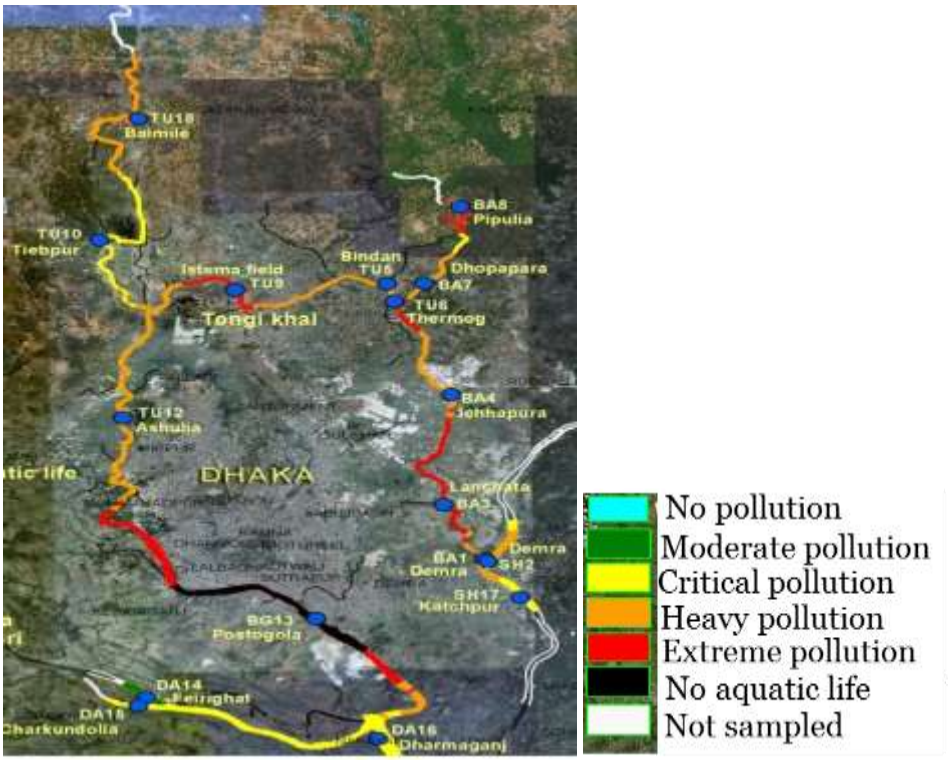


Figure 18 Water Quality Map of Dhaka

The polluted rivers cause negative health and environmental impacts. In addition, given the impact on aquatic life, almost the entire fishermen community has been affected adversely in the Dhaka region, reducing economic productivity and food security (Interview DoF). The water treatment plant operating at Shitalakhya river has to shut down in the dry season due to the bad water quality

(Interview DWASA). Further, groundwater-surface water interactions cause pollutants to enter the precious groundwater with pollutant levels in groundwater increasing (LGED, 2010). Given Dhaka's dependence on groundwater and impending water gap in 2030, the opportunity costs related to the potential use of surface water and potential pollution of groundwater are very high. In addition, the current situation bears equity issues, as the sweepers clean (septic) tanks manually and dump the sludge in areas where predominantly the poor are residing (SNV, 2014).

The water pollution is mainly being caused by untreated effluents entering the surface water bodies. Depending on the estimates, around 50% of untreated effluents comes from untreated sewage, 30% from tanneries, 10% from other industries, while 10% of the pollution comes from dumping solid wastes (Interview DoE).

Sewage treatment gap assessment

In Bangladesh's on-site sanitation systems, such as septic tanks, improved and unimproved pit latrines, the predominant methods are used by about 94% of Bangladesh's population (SNV, 2014). In 2012, open defecation is currently being practiced by about 3% of the population (19% in 2000). A water-borne sewage system only exists in Dhaka, to which 30% of the population is connected (2.5% of Bangladesh's population). Dhaka's only sewage treatment plant at Pagla, has a design capacity of 120,000 m^3/ day, however, currently it only operates at 40% capacity. Thus, in practice only 12% of Dhaka's sewage is treated. The low capacity utilization at Pagla Sewage Treatment Plant is caused mainly by blockages in the sewerage system, which also results in raw sewage overflowing into streets and water bodies, such as Gulshan Lake, without reaching the sewage treatment plant (Interview DWASA). In addition, BOD levels of incoming sewage is four times higher than the design capacity, resulting in the treated sewage far exceeding the environmental requirement for outgoing sewage (requirement 40 BOD (mg/l), outgoing 200 BOD (mg/l)). **Thus, the quality of the outgoing, treated, sewage** (as per BOD level) **is equal to the quality required for incoming sewage to allow for optimal treatment.** The high BOD levels are mainly said to be caused by effluents from the food industries which are also connected to Pagla STP (Interview DWASA).

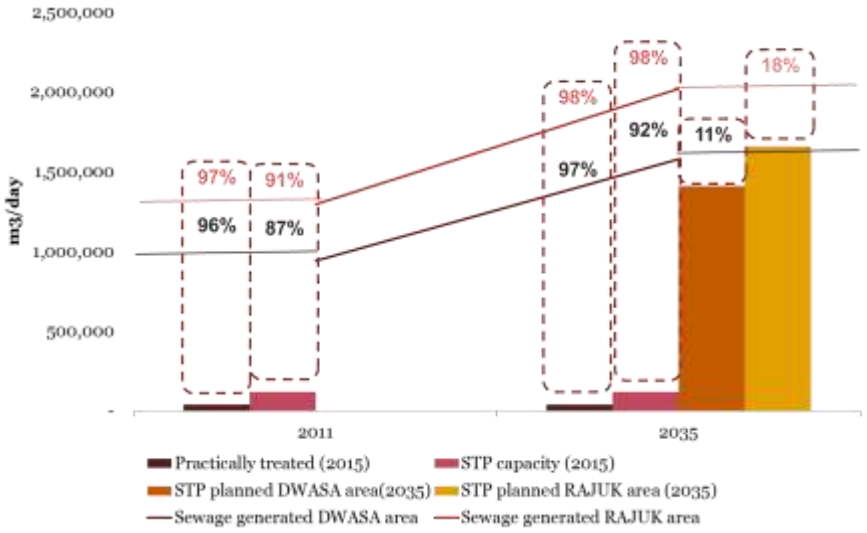
Dhaka's population, which is not connected to the water-borne sewage system, is dependent on the network of drainage pipes and underground canals for sewage disposal (Interview DWASA). As the drainage system is not designed for sewage disposal, methane emissions from the sewage have caused bursts in closed drainage canals with occasional fire. While it is estimated that 30% of households do have septic tanks for sewage treatment, these are assumed to be inoperational (Interview DoE). Due to a thick clay layer of soil, percolation of water is slow in and around Dhaka. This leads to ineffective use of soak pits of sceptic tanks. Further, owners of septic tanks are not incentivised to pay for the O&M costs, given the "cost-free" option of discharging the sewage straight into the drainage system (Interview DWASA, DOE).

Given Dhaka's size, it can be divided into different zones. The area of Dhaka Metropolitan Development Plan (DMDP) of RAJUK covers *approx.* 1425km^2. Within the DMDP RAJUK area, the DWASA service area will encompass *approx.* 401 km^2 by 2035, which is divided into 11 DWASA Maintenance, Operation, Distribution and Service (MODS) Zones. To accommodate for Dhaka's growing population and industrial activities, a number of satellite towns have been developed. These are either located within the city of Dhaka or at its outskirts.

Dhaka is expected to be one of the fastest growing mega cities in the world – and with it, its (untreated) sewage. Currently, an **estimated 96% and 97% of sewage remains untreated** in DWASA and RAJUK areas respectively.[46] By 2035, **a 67% and 56% increase in sewage generated** can be estimated for DWASA and RAJUK areas respectively, resulting in approximately 1.6 mn m³ (DWASA) and 2 mn m³ (RAJUK) sewage generated per day. The **Dhaka Sewerage Master Plan 2035** is just being completed (see section on Pavin the Way for Solutions). If the target of connecting 65% of Dhaka's population to a water-borne sewerage system is reached, 11% and 18% of sewage generated in DWASA and RAJUK areas respectively, is expected to remain untreated. In case business as usual continues, the gap will amount to 97% and 98% for DWASA and RAJUK areas respectively.

Focusing on Dhaka's key satellite towns and city districts, it becomes apparent that Narayanganj, Savar, Tongi, Mirpur and Gazipur show the highest total sewage generated and highest increase between 2011 and 2035.[47] The Dhaka Sewerage Master Plan 2035 plans to cover the satellite towns of Gazipur, Uttara, Mirpur, Tongi, Narayanganj, Savar, Rupganj, Keraniganj, Demra and Karangir Char.[48]

Figure 19 Estimated gap of untreated sewage in DWASA and RAJUK areas (2011, 2035)



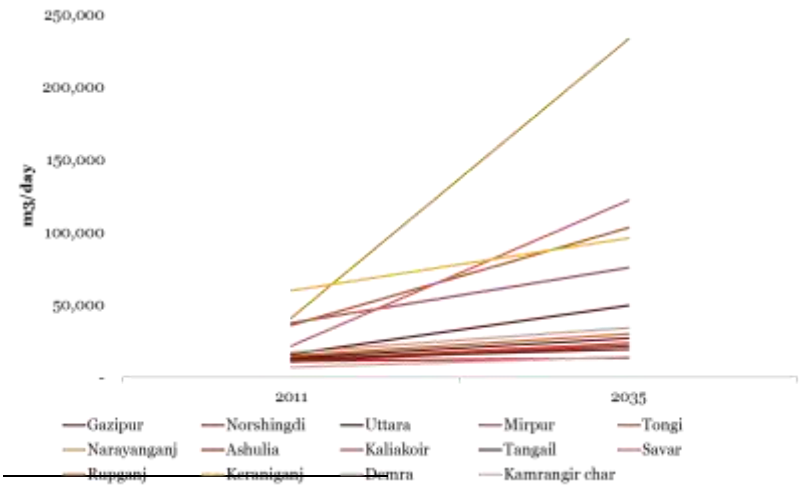


Figure 20 Estimated sewage generated in satellite towns (2011, 2035)

[46] Considering Pagla Treatment Plant is operating at 40% capacity.
[47] Annual estimated growth rates: 8.3% Narayanganj; 8.3% Savar,; 5.3% Tongi; 3.7% Mirpur and 5.6.% Gazipur
[48] Currently not more information on planned treatment capacity in each satellite town etc is available.

Note: Sewage generated is based on the assumptive norm of 30 l/cap/day sewage being generated in low income areas and 100 l/cap/day in remaining areas. In 2011 35% of population in RAJUK area is estimated to live in LIC areas (RAJUK Detailed Area Plan); in 2035 53% of the population is estimated to live in LIC areas (DWASA, 2011). The Sewage Master Plan 2035 is based on targeted connection coverage of 65% of the RAJUK area, assuming 100 l/ cap/ day of sewage generated. Estimates assuming 100 l/ cap/ day for the entire population can be found in Annex C.3

Policy and national level thinking on sewage management and solutions

The **National Policy for Safe Water Supply and Sanitation (1998)** is the key policy document governing the water supply and sanitation sector. It sets the objective "to ensure that all the people have access to water and sanitation services at an affordable price". For the urban sector, this translates into the goal to ensure a sanitary latrine within easy access for every urban household ranging from pit latrines to water borne sewage systems. Community latrines shall be installed in densely populated poor communities as well as in public places, such as schools, bus stops, etc. The **National Water Management Plan (2004)** had envisaged appropriate sanitation for all by 2010 and made provisions for waterborne sanitation and drainage in major cities. The **National Sanitation Strategy (2005)** builds on the aforementioned documents and "delineates ways and means of achieving the national target through providing a uniform guideline for all concerned". It further states that "appropriate desludging of septic tanks and pit latrines must be enforced". All aforementioned documents, however, only focus on unhygienic defecation and not on the actual solid waste management, ways of disposal of household waste water or storm water. While Bangladesh has made impressive progress on improving sanitation, e.g. open defecation was reduced from 19% in 2000 to 3% in 2014, the neglect and consequent absence of sewage and fecal sludge treatment results in significant public health and environmental risks. As a reaction to this, the draft final on the **National Strategy for Water Supply and Sanitation (2014)** includes a strategy for the establishment of fecal sludge management.

Regarding the responsibilities for sewage treatment, the **Water Supply and Sewerage Act (1996)** outlines the construction, improvement, expansion and maintenance of water, sewerage and sanitary works. This Act specifies WASA's responsibilities to water supply and water-borne sewerage systems, i.e. not any alternative technologies for sewage and sludge treatment. The **Bangladesh National Building Code (1993-2006)** sets minimum requirements for sanitation and sewage disposal in buildings.

The **Bangladesh Water Supply and Sanitation Regulatory Commission Bill** (2013), aiming to establish an independent and impartial regulatory commission for the water supply and sanitation sector, as well as the **Regulatory Framework for Water Supply and Sanitation Sector in Bangladesh,** are currently being drafted. Further, DSK and ITN-BUET, funded by Bill & Melinda Gates Foundation, are currently working on drafting **Regulations for Fecal Sludge Management** in Bangladesh.

Paving the way for solutions

Water-borne sewerage systems

In the light of the challenges that Dhaka is facing with respect to untreated sewage, The Government of the People's Republic of Bangladesh and Dhaka WASA with World Bank/ International

Development Association support, developed the recently completed **Dhaka Sewerage Master Plan 2035 (DSMP 2035)**. Its primary goal is to "reduce significantly, and, in the long-term, to eliminate the pollution arising from unhygienic disposal of wastewater, of all industrial, commercial and domestic origin, up to the planning horizon (2035)".

Box 1: Salient features of the Dhaka Sewerage Master Plan (DSMP 2035), prepared for DWASA

- DSMP 2035 is prepared based on the sewage treatment requirements of the Dhaka Metropolitan Development Plan (DMDP) of RAJUK (covering approx. 1425km²) by 11 new sewage treatment projects, serving a total population of 16.6 million.
- The plan requires a capital investment of USD 722 million. In addition, the total O&M costs (including wastewater treatment plants as well as the sewerage operation) are expected to be USD 33.68 Mn/ year.
- The plan focuses on a phase wise approach to address two key priorities, (i) installation of septic tanks and latrines in low to medium density and in rural areas with preference to on-site disposal – targeting expansion of services, and (ii) Installation of sewerage and wastewater treatment system in densely populated urban centres, targeting improvement and augmentation of current level of services.
- In Phase I (2011-2015) focus was on revamp and augmentation of existing infrastructure including sewerage system, pump stations, wastewater treatment facilities, and rehabilitation of systems in Dasherkandi catchment (including rehabilitation of Hatirjheel lake).
- In Phase II (2015-2025), emphasis is on reconstruction/replacement of secondary trunk mains (laterals) and associated sub-catchments, further development of Dasherkandi catchment, development of the Baridhara sub-catchment and construction of sewage collection systems, transmission mains and wastewater treatment plants with extension of systems to the Pagla catchment.
- Under Phase 3 (2025-2035), construction of sewage collection systems, transmission mains and wastewater treatment plants within the urban centres will be prioritized.

More specifically, by 2035 "all households and public/private facilities are planned to have either access to the public sewerage system or improved on-site (or hybrid) facilities". The DSMP 2035 targets the entire area of the Dhaka Metropolitan Development Plan (DMDP) of RAJUK (approx. 1425km2). Reflecting technical, socio-economic and financial realities, the DSMP 2035 introduces a phased approach categorizing areas into core area for sewerage service, transitional area from on-site treatment and/or hybrid systems to sewerage service, and on-site treatment area. The DSMP 2035 is based on a zonal sewerage system, in which each of Dhaka WASA's 11 Maintenance, Operation, Distribution and Service Zones will be served by a separate treatment plant. An estimated 65% of all households are expected to be connected to the water borne sewerage system.

The total costs for 11 STPs incl. sewerage systems amount to **1.69 bn USD (CAPEX) and 33.7 mn USD/ year (O&M expenditures)** and are split as follows:

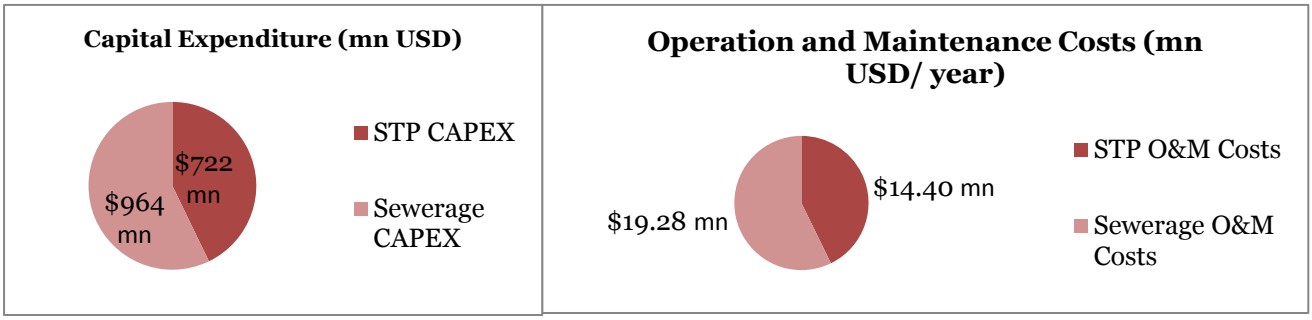


Table 6 illustrates the break-down of OPEX and CAPEX for each of the 11 planned sewerage systems under the DSMP 2035.

The capital cost for the construction of new sewage treatment plants are expected to be 50 USD/ capita while the rehabilitation of Pagla Sewage Treatment Plant is expected to be 24 USD/ capita. O&M costs amount to 10 USD/ capita/ year for new constructions and 4.8 USD/ capita/ year for Pagla Sewage Treatment Plant. The costs for the sewerage system depend on location specific determinants such as required length and depth of the sewerage pipes. The capital costs range between 30 USD/ capita to 215 USD/ capita, while the O&M costs range between 0.60 USD/ capita/ year and 3.45 USD/ capita/ year.

Further, a first estimate on cost recovery from the sewage tariffs was made. The sewage revenue for 2035 was calculated based on the current sewage charges while considering an annual 5% increase in tariffs as accounted for the WASA Act. The OPEX for 2035 was calculated considering an average annual increase in O&M costs of 14.5 % (DWASA Audit report 2013-2014). Overall, sewage revenues are not expected to be sufficient to cover OPEX in 2035, resulting in an annual OPEX finance gap of 146 Mn USD. With the exception of Pagla sewerage system, all sewage systems are expected to run at an operational loss in 2035. Capital costs are not expected to be covered by current sewage revenues.

Table 6 CAPEX, OPEX and expected Sewage Revenue per Sewage Treatment Plant

Catchment Served	Estimated Pop. Served 2035	Capital Costs (Mn USD)	Total O&M costs 2015 (Mn USD/year)	Estimated total O&M costs 2035 (Mn USD/ year)	Estimated Sewer Revenue 2035 (Mn USD/ year)	Estimated OPEX Finance Gap 2035 (Mn USD/ year)
DWASA Service Area						
Dhaka North	1600000	137	2.74	41.83	35.48	6.35
Dhaka West	2800000	226	4.52	69.00	62.09	6.91
Dhaka East	1600000	202	4.04	61.67	35.48	26.19
Kamrangirchar	1600000	147	2.94	44.88	35.48	9.40
Pagla	4200000	228	4.52	69.00	93.13	(24.14)
Demra	900000	115	2.30	35.11	19.96	15.15
Narayanganj	1400000	186	3.72	56.79	31.04	25.74
Greater Dhaka						
Savar	400000	89	1.78	27.17	8.87	18.30
Tongi/Gazipur	1200000	180	3.6	54.95	26.61	28.34
Rupganj	500000	97	1.94	29.61	11.09	18.53
Keraniganj	400000	79	1.58	24.12	8.87	15.25
Sum Totals	**16,600,000**	**1,686**	**33.68**	**514.12**	**368.10**	**146.02**

Sources: PwC Calculations, DSMP 2035, DWASA Audit Report 2013/2014, DWASA MIS Report February 2014, Interviews with DWASA

Note: Please note that these are preliminary calculations. For investment decisions etc. more detailed calculations are required.

Alternative sewage treatment technologies

The remaining 35% of Dhaka's population, which is not planned to be connected to the water-borne systems by 2035, will be required to install individual on-site treatment facilities or to develop cluster-wise community sewerage system for combined treatment of night soil/septic tank sludge and sullage.

Given Dhaka's high population densities – averaging 45,716 inhabitants/ km² with a maximum density of 168,151 inhabitants/ km² in Lalbagh –available space for sewage collection, transport and treatment technologies is a key concern. Dhaka's traffic situation simultaneously calls for closely located treatment facilities.

Bangladesh's National Building Code (2011) specifies that each building is required to either be connected to a sewerage system or to use septic tanks or Imhoff tanks (the latter in buildings with more than 300 residents). It further states that "effluent from septic tanks shall not be discharged into open water courses". While this regulation appears to be a solid basis to address the untreated sewage situation, the continued discharge of untreated sewage into drainage systems and lack of installed septic/ Imhoff tanks illustrates the lack of enforcement of this regulation. Further, the BNBC limits sewage treatment to the two mentioned technologies. Due to a thick clay layer of soil, percolation of water is slow in and around Dhaka. This leads to ineffective use of soak pits of sceptic tanks – thus resulting in a sub-optimal solution. The installation of alternative technologies, which may be more suitable, would result in a violation of the BNBC (relevant once enforced).

Further, to date there is no policy or regulatory framework on Fecal Sludge Management (FSM) in Bangladesh, nor are the relevant issues of fecal sludge collection, transportation and treatment covered in the BNBC. However, its importance is being realized and the recent National Strategy for Water Supply and Sanitation (2014) includes a strategy for the establishment of fecal sludge management. Further, ITN-BUET and DSK, as part of the K-Hub activities, are currently developing a regulatory framework for FSM to pave the way towards its successful implementation, highlighting the importance to focus on the entire sanitation value chain – from capture to reuse – rather than only on toilets. However, a wide distribution of responsibilities causes further challenges to a streamlined approach: RAJUK is responsible for housing; WASA for water and sanitation; DOE for regulation; MoI for ETPs/CETPs etc.

To address the situation, a number of noteworthy initiatives have taken place. For example, DSK and Water Aid started a pilot project on creating awareness about sewage management and providing collection service in the North Dhaka City Corporation Area (including Ashulia, Mirpur and Savar). Mobile vacuum-tug machines are deployed to collect sewage from sceptic tanks, which is then, as per a Memorandum of Understanding (MoU) with DWASA, disposed at a collection center in Mohammadpur for subsequent treatment at Pagla Treatment Plant. While the technologies were financed by donor agencies, charges for emptying the tanks cover the O&M costs. [49] Key challenges are a lack of awareness of the importance of sewage management and a low willingness to pay for related services given the option of "free" discharge to the drainage system (Interview DSK).

[49] Tariff structure for collecting sewage from septic tanks: Slum Areas: 1,000 tk (12 USD)/2,000 lts tank; Residential Areas: 1,200 tk (15 USD)/2,000 lts; Commercial Areas: 1,500 tk (19 USD)/ 2,000 lts.

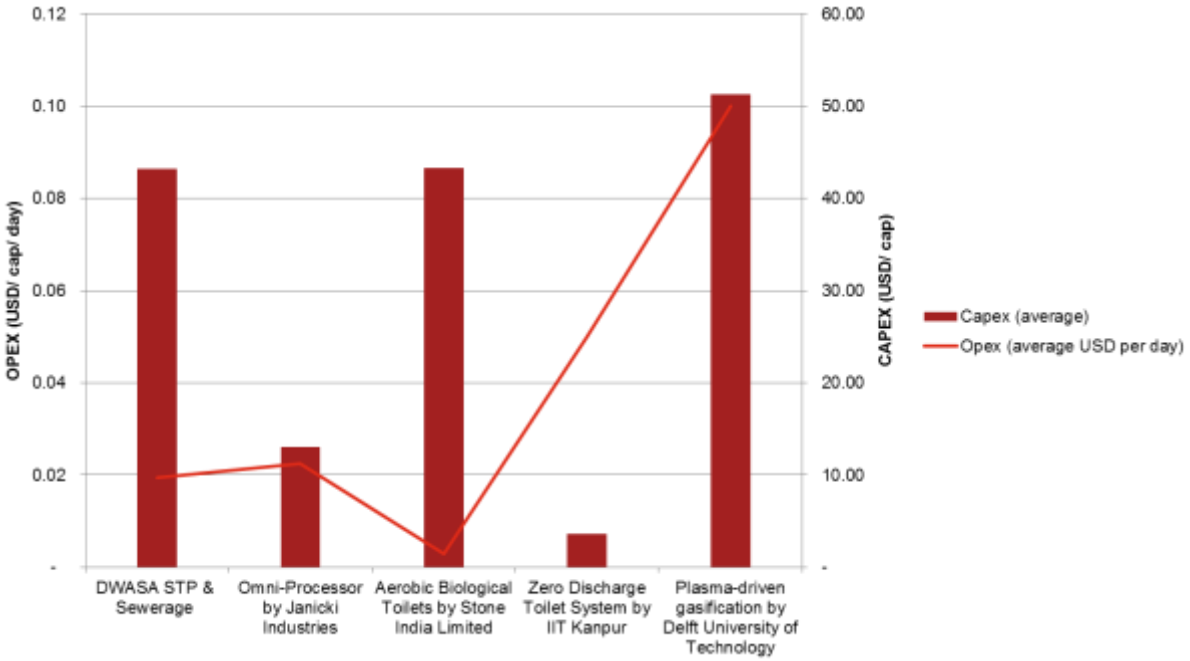
In a further initiative, DSK, Water Aid and INT-BUET installed a wastewater treatment plant in two slum areas in Dhaka, namely, Bhashantek and Bhownath. DSK took the initiative to create awareness among the slum population, and convinced them to provide land for the project. Wastewater is collected from houses through a pipe network system, which is discharged into a canal after treatment. The beneficiaries pay a fixed price (flat rate) for this service which covers O&M costs. The technology was designed by INT-BUET and financed by donor agencies. The key challenge of replicating this project is the availability of land.

SNV is currently working on pro-poor market based solutions for faecal sludge management in urban centres in Bangladesh. The objectives include the creation of demand for FSM, the development of a business model for the collection of faecal sludge, as well as the identification of suitable technologies for faecal sludge treatment which allow for resource recovery and consequent business models around FSM. While the pilot project is located in Khulna City Corporation area and two small towns of Khushtia and Jhenaidah in Khulna division, the models can be replicated in Dhaka, as these locations also feature high population densities.

ADB-designed a project related to sludge management in sub urban areas, funded by the Government of Bangladesh and executed by DPHE. The project designed and operationalised a mechanical and mobile sludge management system for 11 towns in Bangladesh, in which an automatic sludge collector vehicles to provide door-to-door service to clear sceptic tanks. The sludge is then treated to a secondary level outside the cities, while solid wastes are composted for future usage. The treatment plant is locally designed and costs around 3,800 USD/ plant serving 80,000 residents. The vehicles for sludge collection are locally made and cost between 1,540 USD (700 l capacity) and 2,300 USD (2 m^3 capacity). While these vehicles are not suitable for densely populated areas, adjustments, such as longer pipes, can be made to avoid road damages.. The tariffs for this service are decided by the local authorities and differ from place to place. For instance, it is 3000tk (38 USD)/ septic tank in Lakshmi and 3000tk-6000tk (38-77 USD)/ septic tank in Jessore.

R&D on sustainable sanitation solutions is progressing rapidly. The concept of valuing end products from sewage treatment as a potential revenue stream and thus moving towards a circular economy is gaining prominence. According to SNV (2014), on-site sewage treatment with FSM can be five times cheaper than conventional water-based sewerage systems. Considering financial constraints, the below listed technologies which consider the reuse of outputs in some cases, require lower capital and operational expenditures than the above mentioned water-borne sewerage systems (see Figure 21 and Table in Annex C.5).

Figure 21 Capex and Opex for alternative sanitation technologies



Source: Reinvent toilet fair (2014), DWASA Sewage Master Plan 2035, PwC Calculations
Note: Depreciation and expected lifetime of assets are not considered. To increase comparability for sewage treated from toilet usage 25% of the estimated daily sewage generated in the water-borne sewage system is assumed to come from toilet usage (5l per flush with Asian style toilet).

The bottleneck of access to finance

Based on stakeholder consultations with the public and private sector as well as civil society, the key challenge for sustainable sewage treatment – besides the regulatory and institutional framework, technology and awareness, is access to finance.

While various sewage master plans for the city of Dhaka have been undertaken, the most recent and relevant one being prepared in 1998 by JICA, but the lack of finance prevented their implementation (Interview DWASA). DWASA has a good track record of loan repayments and thus a good reputation among donors for funding (Interview WB). While financing for the rehabilitation of the Pagla Sewage Treatment Plant, the construction of Uttara and Daasherkandi sewage treatment plants is secured and financing for Mirpur sewage treatment plant is likely, finance for the remaining seven sewage treatment plants still needs to be arranged for and could pose a potential bottleneck to the implementation of the SMP 2035. [50] Likewise, finances need to be arranged for the alternative sewage treatment technologies.

Given the large amount of finance required to achieve sustainable sewage treatment in Dhaka, alternative financing models to government and donor financing should be considered.

[50] The World Bank agreed to finance the rehabilitation of Pagla STP and the construction of Uttara STP. Mirpur STP will potentially be financed by the World Bank. For Daasherkandi STP an EPC contract was signed with the Chinese Government.

Re-financing investments via tariffs

Currently, sewage tariffs for households connected to the water-borne sewage system are equal to the water tariffs, i.e. Tk. 7.33/ m^3 for metered connections and Tk. 47.21 / month for non-metered connections. According to DWASA, these tariffs are sufficient to cover O&M costs, but not capital costs. Given the political nature of water and sewage tariffs, it became clear during stakeholder consultations that in the given political climate, the scope to increase tariffs seems limited and thus limits financing of capital investments in the close future.

Considering alternative sewage treatment solutions (see section above), the tariffs are (not yet fully or independently) regulated by the government (to reflect e.g., cost recovery) and thus can be designed according to the willingness to pay of its beneficiaries. Considering the rapid technological development of treatment technologies and the reuse potential of sewage treatment outputs, concrete business models can be developed. For this, the regulatory structures, e.g. on reuse, needs to be put in place and awareness and demand need to be created to allow for the execution of these business models.

Green Finance Fund

Green finance has the goal to promote investments in green technologies to support the transition of Bangladesh's economy to a resource-efficient and low-carbon economy. In the light of this goal, the Bangladesh Bank has issued Policy Guidelines for Green Banking on 27th February, 2011. Key sectoral focus areas under green banking includes solar based irrigation, solar based power generation, bio-gas based power generation and industrial effluent treatment plants. To incentivize sustainable investments, funds are allocated at an interest rate of 5% to the commercial banks which lend it to the investor at 9%. This is comparatively lower than the average market interest rate (about 11%). The green finance initiative is divided into three budgets: 1) Green Finance (Tk. 11.35 bn / 145 mn USD), 2) Climate Change Risk Fund (Tk. 1.70 bn/ 21 mn USD) and 3) Marketing and Capacity Building (Tk. 231 mn/ 3 mn USD). [51]

While the Green Finance Fund offers interest rates below the market interest rates, this source of funding is not attractive to stakeholders for who have access to alternate donor funding. For example, the GoB currently receives funds from the World Bank at 0.75% interest rate and lends these at 2% to DWASA. Contrasting the 2% interest rate to the available 9% interest rate from the GFF, this source of funding is not attractive to DWASA to finance all or parts of the Sewage Master Plan 2035 (not taking into account the forex risk that is retained by GoB). Further, the size of the fund is not able to cover the amount of investments required (1.69 bn USD (CAPEX) and 33.7 mn USD/ year (O&M expenditures)).

Thus, the GFF is more attractive to private investors seeking smaller amounts of finance. However, during stakeholder consultations, it became apparent that stakeholders investing in private STPs were not aware of the GFF. Guidelines for STP financing options were perceived to be useful to consider this option.

Public Private Partnerships (PPPs)

The programme promoting PPPs is part of the Governments Vision 2021 to "ensure a more rapid, inclusive growth trajectory, and to better meet the need for enhanced, high quality public services in a

[51] Bangladesh Bank (2012) "Green Banking Activities" http://www.bangladesh-bank.org/recentupcoming/news/oct022012newse_1.pdf (last accessed 27 March 2015). Budget figures refer to 2012.

fiscally sustainable manner" (PPPO, 2015). [52] The promotion of PPPs started in 1996 with the *Private Sector Power Generation Policy (PSPGP), which marked the first launch of PPPs in the power sector*. In 2010, the Policy and Strategy for Public Private Partnership was introduced, which aims at facilitating the development of core sector public infrastructure and services vital for the people of Bangladesh, including water supply and distribution and wastewater management. The PPP Office, a separate, autonomous office under the Prime Minister's Office, supports sector line ministries to facilitate identification, development and tendering of PPP projects to international standards. Further, a PPP Unit under the Ministry of Finance was established to foster an environment of fiscal responsibility and sustainability in PPP projects.

Since its introduction, there has been an acceleration of PPPs in Bangladesh. PPPs predominantly occurred in the power (BOO), transport (BOOT/BOT), port (BOOT/BOT), tele-communications and information technology sectors. Further, there are PPPs in the health and education sector. These projects were predominantly BOO, BOT and BOOT.

In the water and sanitation sector, however, the uptake of PPPs has been somewhat slower and less advanced. While selected projects exist, these mostly focus on water supply in rural areas. In the mid 90's an attempt was made to privatize DWASA. Facing high resistance from the DWASA employees and trade unions, a compromise was made to engage in an experimental privatization on water billing and collection. One revenue zone was contracted out to a private enterprise, while another revenue zone was managed by the specially formed DWASA Employee Co-operative. The achievements were assessed based on the performance improvement indicator on billing and collection and system loss reduction. The DWASA Employee Co-operative performed better and thus continued its services (Hoque, 2003). Till date, no PPP in sewage treatment has been implemented. However, DWASA has recently signed an EPC contract for Daasherkandi Sewage Treatment Plant with the Chinese Government.

Box 2: Alandur Sewerage Project, India

The sewage system in Alandur town (India) was dependent on individual septic tanks. According to the reports, 98% of 19,800 households used septic/ holding tanks to collect sewage, which was periodically disposed in the low-lying areas outside municipal boundaries. Due to absence of an underground sewerage system, unregulated disposal of sewage was a major environmental and health concern.

In 1996, the Alandur Municipality undertook a plan for construction of an underground sewerage system and waste water treatment facility in the town on Public-Private-Partnership basis. Being first-of-its kind in India, the construction of network infrastructure (such as pipe, pumping station, etc.), sewage treatment plant (STP), and operation and maintenance of the same for five years on a fixed fee basis was undertaken by the private sector. The responsibility for collection of tariff and provision of new connections was undertaken by the public sector (municipality). The sewerage system was designed to meet requirements till 2027 for an estimated population of 300,000. The initial plan was to treat 12 million litres per day (MLD) of sewage; however, the ultimate capacity of the plant was revised to 24 MLD. One of the key success factors of this project was active public participation to finance implementation of this project. The task to build consensus, address public concerns and explain benefits, costs, and tariff system of the project was undertaken by the Alandur Municipality through extensive

[52] Source: PPP Office Website: http://www.pppo.gov.bd/what_we_do.php (last accessed 27 March 2015).

Box 3: Metropolitan Waterworks and Sewerage Systems, Manila, Philippines

Metropolitan Waterworks and Sewerage Systems (MWSS), Manila faced the dual challenge of inadequate service and poor financial performance. Due to long-term underinvestment in infrastructure the utility was unable to provide services to large portions of the service area. MWSS entered into two 25-year concessions contracts with private sector entities for providing water and sewage management services for two zones – the East Zone and the West Zone. Under the contract, the concessionaires would utilize existing systems to provide water service and collect and own revenues from tariffs. At the same time, the concessionaires were responsible for operational costs and investments to improve the services. At the end of the agreement, the utility with all of its assets would be handed over to the government. This is considered as typical case of corporatizing a public sector utility.
There has been significant improvement in the state of water services for Manila. For instance, population coverage for providing drinking water by Manila Water has almost tripled from 2 million in 1997 to more than 6 million in 2012. Further, access to 24/7 water has increased from 26% of the network in 1997 to an all-time high of 99.6% in 2012. On the other hand, NRW has decreased to 11% in 2012 from 63% in 1997. One of the major outcomes of this project was the shift to performance-oriented functioning by the utility. It focused on drivers of efficiency, transparency, accountability and measurement of results. On the other hand, leadership empowerment was encouraged and supported at all levels allowing subject matter expertise at mid-level staff and managers to plan and implement changes.

Source: Tap Secrets, The Manila Water Story, Asian Development Bank (http://www.gwp.org/Global/ToolBox/Case%20Studies/Asia%20and%20Caucasus/CS_450_TAP_%20Manila.pdf)

While the general PPP framework is in place and functioning (within given constraints), PPPs in the water and sanitation sector face additional challenges related to uncertainties about regulation, limited independence of the water supply and sanitation operations, low tariffs and difficulties with revenue collection and limited coverage. In addition, there is a potential risk of resistance from communities. When compared to water supply, investments in sewage treatment plants bear a greater risk to additional complexities of the technologies and construction. This limits the willingness of investors to engage in PPPs with much capital at risk.

Box 4: New Cairo City, Egypt

With rapid expansion of the Greater Cairo city, it is expected that the population of New Cairo City will grow to approximately 3 million by 2029, which will strain the already inadequate water service infrastructure of the city. Considering this, the government focused on the improvement of the city's water and sewage management service infrastructure. In this direction, it decided to implement the New Cairo Wastewater Treatment Plant Project on Public-Private-Partnership basis. Under the 20-year agreement, the private sector was designated the responsibility to design, finance, construct, operate, and maintain the plant with a capacity of 250,000 cubic meters a day. On the other hand, government would pay a sewage treatment charge including a fixed portion to cover the investor's fixed costs and a variable portion based which would be based on the actual volume of treated sewage. In addition, Egypt's New Urban Communities Authority would buy services of the plant and pay its electricity costs as per agreement. The deal was successful to mobilize $150 million to $200 million in private investment in Egypt and attracted regional and international investors to its PPP market. The project is expected to act as a role-model to encourage future undertakings in water sector through PPPs in the country.

Source: New Cairo Wastewater Treatment Plant is Egypt's First Public-Private Partnership, Stories of Impact, IFC Advisory Services

Further, as the private sector has to obtain financing once the PPP is awarded, access to long term finance (10-25 years) is essential. The local financial market does not have the capacity to cater for these financial needs, except for a few select funds, such as the IDCOL and BIFFL, and supplementary the Viability Gap Fund.[53] The international financial markets do have the capacity, however, to account for the country risks where the cost of finance is considerably higher (ADB, 2014).

Thus, to incentivize PPPs related to sewage treatment, attractive business models for the private sector needs to be determined and promoted. Interviewed stakeholders mentioned that low tariffs and concerns on revenue collection, in addition to lack of access to finance were key constraints.

Overview of options for finance

Finance Options	Water-based Sewerage Systems (Sewage Master Plan)	Alternative Sewage Treatment Technologies
Donor Finance	Limited funds	Limited funds
Green Finance Fund	High interest rates	Potential
PPPs	Potential	Potential
Tariffs	Politically sensitive	Potential

Recommendations for Cleaning Dhaka's Waters

In the last decades, the focus was clearly on enabling access to clean drinking water and improved sanitation. With having made good progress in meeting these objectives, the attention of key stakeholders – the government, donor agencies, NGOs and the private sector – is now shifting to addressing the increasingly troublesome issue of untreated sewage and effluents.

While past initiatives related to sewage treatment had difficulties in gaining momentum in the past, the time for action has arrived. The country is experiencing an increased interest in sewage treatment and in faecal sludge management, as is demonstrated by the development of the Dhaka Sewage Master Plan 2035 and its (partially) secured finance, the inclusion of a FSM strategy in the National Strategy for Water Supply and Sanitation (2014), as well as the country's participation in the ADB K-Hub on FSM and increasing activities from NGOs and academia in these fields.

To gain momentum, attract stakeholder's interest and acknowledge sewage treatment being part of a wider challenge, we suggest launching an overarching initiative on **Cleaning Dhaka's Waters** of which sewage treatment will form part of the solution. India's **Clean Ganga** initiative may allow benefiting from lessons learnt to adapt such an initiative to Dhaka's circumstances.

[53] Please see overview of funds in Annex C.4.

Box 1: India's Clean Ganga Initiatives

At present, the Ganga basin receives approximately 12,000 million litres per day (mld) sewage, with treatment capacity of around 4,000 mld. Out of this volume-wise contribution of toxic and non- biodegradable industrial pollution is about 20 per cent. With the endurance to clean river Ganga, Ganga Action Pan I (GAP I) was initiated in 1985 based on a comprehensive survey of river Ganga by Central Pollution Control Board (CPCB). In 1995, GAP was renamed the National River Conservation Plan (NRCP). The scope of activities for NRCP was to tackle pollution levels in other identified polluted stretches of major rivers to improve their water quality. In 2011, NRCP covered 35 stretches of polluted rivers spread across 164 towns in 20 states. In 2014, strong political will of the new government, has provided initiatives to clean Ganga a renewed strength and support. The present government aims to achieve strong visible impact to clean Ganga during its tenure.

To improve Dhaka's sewage management, we suggest four key recommendations, which can form part of the wider "Clean Dhaka's Waters" Initiatives.

To create synergies across existing initiatives, we suggest close cooperation with the project on 'Eco restoration of four rivers around Dhaka' which is currently being approved by the Ministry of Environment and Forests (no official documents available yet) as well as with the ADB Knowledge Hub.

Develop a value proposition for sewage management

Moving away from the concept of a linear economy, i.e. using resources and disposing these afterwards, it is time to realise the economic potential of the outputs from sewage treatment. These outputs, such as treated wastewater to different water quality levels and bio-solids, can be re-introduced to the economy for a profit. Identifying marketable outputs can lead the way to make sewage and faecal sludge management a profitable enterprise, as compared to a service for which even cost recovery of O&M costs can be a challenge. This would further pave the way to incentivise private or community-based investments for non-water based sewage treatment solutions, mobilizing the funds currently required and may – in addition - attract further interest in investments for the Sewage Master Plan 2035.

Suggested steps include the following:

- **Explore potential to use bio-solids as fertilizers for agriculture and to nurture soil productivity**. As part of the BRAC WASH II programme (2013-2014), research was undertaken on the production of sludge-based fertilisers that meet WHO guidelines for commercially viable faecal sludge reuse in agriculture. A proposal to allow sludge based compost to be marketed as fertiliser is currently being reviewed by Bangladesh Agriculture Research Council (BARC) under the Ministry of Agriculture. Further, amendments of the Bangladesh Fertiliser Management Law are required. It is suggested to join forces with this initiative, particularly to launch and spread this idea across all stakeholder groups.

- **Explore potential to use bio-solids for fish production.** Fish is the key protein source for 60% of the population, for which demand is expected to increase by 300% by 2030. In many Asian countries fish production in ponds, which is fertilised by faecal sludge, is widespread. The high demand for fish production in DWASA's facultative lagoons (see Box 2) provides an initial insight on potential market demand. Measures need to be taken to take precautions for food safety concerns. Cooperation with DWASA, the Department of Fisheries is suggested to identify marketable solutions.

- **Explore potential to reuse treated wastewater.** Currently, DWASA has few formal plans to reuse the treated wastewater. Given that agricultural land in the proximity of Dhaka is scarce due to high land prices, alternative water reuse options can be explored, such as reusing treated water for greeneries, cleaning and toilet flushing, or meeting industrial water demand of varying qualities.

- **Develop business models which are easy to replicate.** Once the potential for marketable solutions for outputs are identified, business models need to be developed and piloted to facilitate replications. These business models can cover the entire sanitation chain, or parts of it, such as sewage collection, treatment, etc. Awareness building will aim at creating demand and can build on past success of community-led sanitation program. Cooperation with stakeholders already working on the identification of these is suggested, including SNV, DSK, WaterAID, WSUP, DWASA and INT-BUET.

Box 2: Attempting the circular economy approach at Dhaka WASA

Realizing the value of the outputs of Pagla sewage treatment – the treated sewage water and sludge – attempts were made by Dhaka WASA to utilize these in the early 90s. These attempts, however, faced challenges and thus could not be executed at this stage:

- The potential to reuse the treated effluent for (non-food) crops was explored. However, even after the treatment, the heavy metal content was too high and thus could not be executed.
- During the sewage treatment process, waters in the facultative lagoon were found to be ideal breeding grounds for fish, due to the remaining nutrients. This potential was quickly recognized by the locals who started growing fish in these facultative lagoons. Following health concerns, the fish was tested in the BCSIR lab, and due to the high heavy metal content of the effluent, was found unfit for human consumption. Locals unwilling to forego their fish production necessitated Dhaka WASA to request military support to kill all fish

The challenges DWASA faced in the early 90s emphasize the importance of a holistic approach towards cleaning Dhaka's waters. Reducing harmful industrial effluents containing heavy metals and other toxins will be conducive for moving towards a circular economy approach.

Determine optimal sewage/ faecal sludge treatment technologies for Dhaka's circumstances

R&D on sustainable sanitation solutions is progressing rapidly. The concept of valuing end products from sewage treatment as a potential revenue stream and thus moving towards a circular economy is gaining prominence. According to SNV (2014), on-site sewage treatment with FSM can be five times cheaper than conventional water-based sewerage systems, thus necessitating stakeholders to broaden their understanding of technological solutions and moving beyond status quo.

Suggested steps include:

- Connecting with key stakeholders active in R&D on sanitary solutions, such as the ADB Knowledge Hub/ INT-BUET, Bill & Melinda Gates Foundation, Mirpur Agricultural Workshop and Training School, Center for Study of Science, Technology and Policy (CSTEP) India, etc. to identify solutions adequate for Dhaka's circumstances and potential to be produced locally

- Undertaking a cost-benefit / marginal cost curve/ cost effectiveness analysis on identified solutions to prioritize technologies

- Combining identified technologies with the development of business models as proposed above

Enable access to finance

To enable infrastructure investments, access to a long term finance (10-25 years) is essential. The local financial market does not have the capacity to cater for these financial needs, except for a few select funds. The international financial markets do have the capacity, however, to account for the country risks, where the costs of finance is considerably increased.

Suggested steps include:

- Explore opportunities to reduce the interest rates for strategic investments in sewage treatment beyond those offered by the Green Finance Fund and explore options to removing current regulatory constraints related to financing

- Explore the potential of the VGF to compensate low tariffs from sewage treatment to make PPPs in sewage treatment attractive to the private sector. To increase attractiveness, the overall budget of the VGF needs to be increased, the eligibility extended to PPPs besides BOT and the selectin criteria needs to go beyond the highest economic rate of return for projects (as sewage treatment projects are expected to have lower ERRs than "competing" PPP projects.)

- Explore opportunities to raise more capital by introducing green finance bonds for water, in cooperation with Bangladesh Bank. Further, for local and small scale solutions, the potential of designing sewage treatment projects into attractive investments for micro-savings from communities can be explored, e.g. in cooperation with SNV.

- Explore options for providing political risk insurance products and options for foreign currency risk mitigation to facilitate access to international finance

- Successful case studies on investments around sewage treatment need to be made public to attract national and international investor's interests. Further, guidelines on successful project models, such as PPP guidelines on sewage treatment or blueprints of successful projects ("package projects"), have the potential to reduce investment uncertainties and costs involved in upfront investigations increasing project's attractiveness.

Key stakeholders for potential cooperation include: Bangladesh Bank, PPPO, PPP Unit, DWASA, SNV, key commercial banks etc.

Support improvements in institutional and regulatory frameworks and capacity

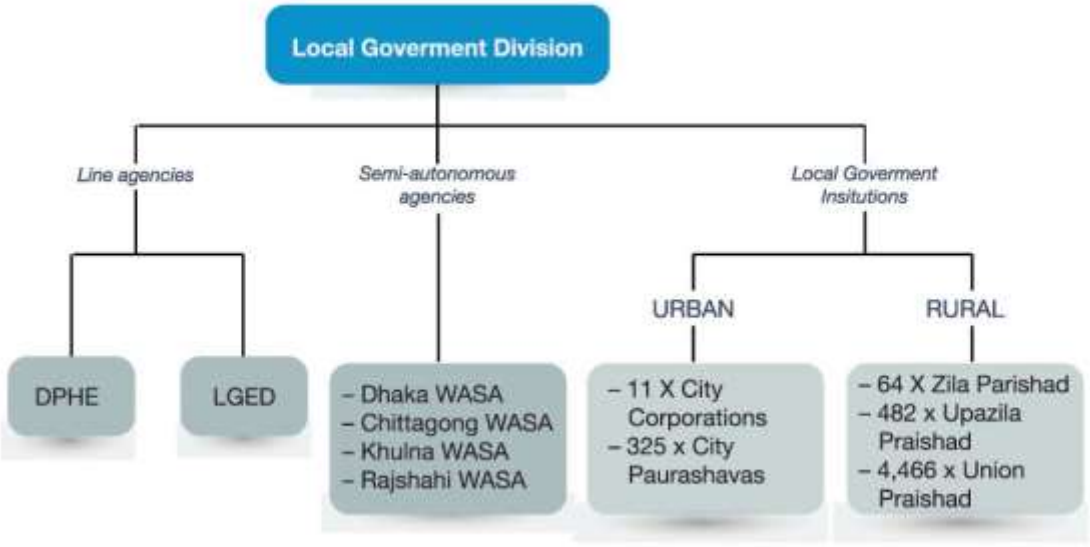
To enable sustainable sewage management, the enabling environment, i.e. the institutional and regulatory frameworks, need to be in place and enforced. Currently, the enforcement of the requirement to be either connected to the water-borne sewage system, or have an onsite sewage treatment as stated in the BNBC, is not enforced, nor is the prohibition of discharging untreated sewage. Further, regulatory frameworks, which are required to introduce business models along the lines of circular economy, do not exist.

Suggested steps include:

- Identifying mechanisms to support the Department of Environment in its mandate to regulate untreated discharges to the environment
- Working towards including additional technologies for sewage treatment management to the Bangladesh National Building Code, to allow for more efficient sewage treatment and greater flexibility in the light of dynamic technological developments. In addition, include regulations on collection and treatment of faecal sludge, e.g. in cooperation with SNV
- Joining forces in the development of guidelines on faecal sludge management with DPHE, PSU and NGOs to include private sector perspective and circular economy considerations. Further, support efforts of stakeholders, such as BRAC WASH, to introduce required regulations related to the use of bio-solids for agricultural activities and reuse of wastewater. In addition, regulations for the transport of faecal sludge are required.
- Strengthening overall capacity of employees at PPPO to identify attractive business models and offer support to the private sector as required.

C.1. Institutional overview on sewage and faecal sludge management in Bangladesh

Table 1: Roles and responsibilities of organisations related to urban water supply and sanitation



Source: SNV (2014) Review of Legal and other Governing Factors related to faecal sludge management in Bangladesh

Ministry of Planning Under this ministry, the Planning Commission reviews, appraises and approves sector plans, programmes and projects received from the line agencies through the MLGRD&C and includes those in five-year plans and annual development programmes.	
Ministry of Finance Mobilizes, allocates and releases funds for WSS sector plans, programmes and projects appraised and approved by the Planning Commission.	
Ministry of Local Government, Rural Development and Co-operatives • Responsible for the overall governance and development of the WSS sector. • Focuses on the development of policies, strategies, plans and legal instruments, • Its mandate also includes identification of investment projects, and coordination and monitoring of sector activities.	
Local Government Division	Provides overall guidance to the WSS sector. Performs a wide range of functions, including policy-making, strategic planning, financial mobilization and allocations, supervision, monitoring and evaluation. The PSU, under the LGD, assists in formulation and implementation of policies and strategies. The PSU is implementing the recent sector development plan and with ADB assistance, has initiated the formulation of a regulatory

	framework for the WSS sector.
Department of Public Health Engineering	Provides advisory services to government in framing policy and action plans for WSS. Provides water and sanitation services in rural and urban areas not served by WASAs. Provides technical assistance to local bodies responsible for water and sanitation. Prepares WSS development projects and implements them in consultation with WATSAN Committees
Water Supply and Sewerage Authorities	Dhaka WASA's mandate covers water supply, subsurface drainage and sewerage. Chittagong WASA only deals with water supply. WASAs have been recently established for Khulna (2008) and Rajshahi (2010) cities.
City Corporations	DCC's mandate covers solid waste management, surface drainage and implementation of OSS. The other CCs are responsible for surface drains, solid waste management and maintenance of water supply implemented by DPHE and LGED. CCs are required to establish a Sanitation Division to plan, implement and monitor sanitation programmes in cities
Paurashavas	Responsible for FSM in urban areas based on the Local Government (CC and Paurashava) Act 2009, including amendments and the National Sanitation Strategy 2005. Paurashavas in small and medium-sized towns must establish sanitation units for planning, implementing and monitoring sanitation programmes
Upazila Development Coordination Committees	Responsible for planning, implementation and evaluation and development of programmes at Upazila (sub-district) level. Water and sanitation provisions of the Upazila centers are the responsibility of Upazila WATSAN (Water Supply and Sanitation) committees.
Local Government Engineering Department	Responsible for rural infrastructure and assists municipalities in implementing infrastructure, including water and sanitation in development partner-supported urban projects. Its function overlaps with DPHE.

Source: Adapted from SNV (2014) Review of Legal and other Governing Factors related to faecal sludge management in Bangladesh

C.2. Excerpt from Draft Final - National Strategy for Water Supply and Sanitation (2014)

Strategy 5: Establish fecal sludge management

1. Give priority to the management of fecal sludge from septic tanks and pit latrines such that all sludge are collected, transported, treated and disposed safely in an environmentally friendly manner.
2. Develop innovative technologies appropriate to local conditions for collection, treatment and safe disposal of fecal sludge.
3. Allocate land at suitable locations (by LGIs) for fecal sludge treatment and disposal for all urban areas and upazilla headquarters.
4. Build fecal sludge management and regulation capacities of LGIs.
5. Emphasis on action research and demonstration projects for recycling fecal sludge, such as composting for use as fertilizer thus recycling nutrients back to nature, and generation of biogas.
6. Encourage use of double pit latrines to enable proper in-situ composting of sludge and for its safe disposal or to be used as fertilizer.
7. Make arrangements including bylaws for regular emptying of septic tanks and pit latrines.
8. Establish fecal sludge management in trains, launches and boats.
9. Provide technical and business support to private sector in sludge management, recycling, and sale of compost or other products.

C.3. Estimated gap of untreated sewage and sewage generation of satellite towns (scenario 2)

Figure 22 Estimated gap of untreated sewage in DWASA and RAJUK areas assuming sewage generation of 100 l/ cap/ day irrespective of income level (2011, 2035)

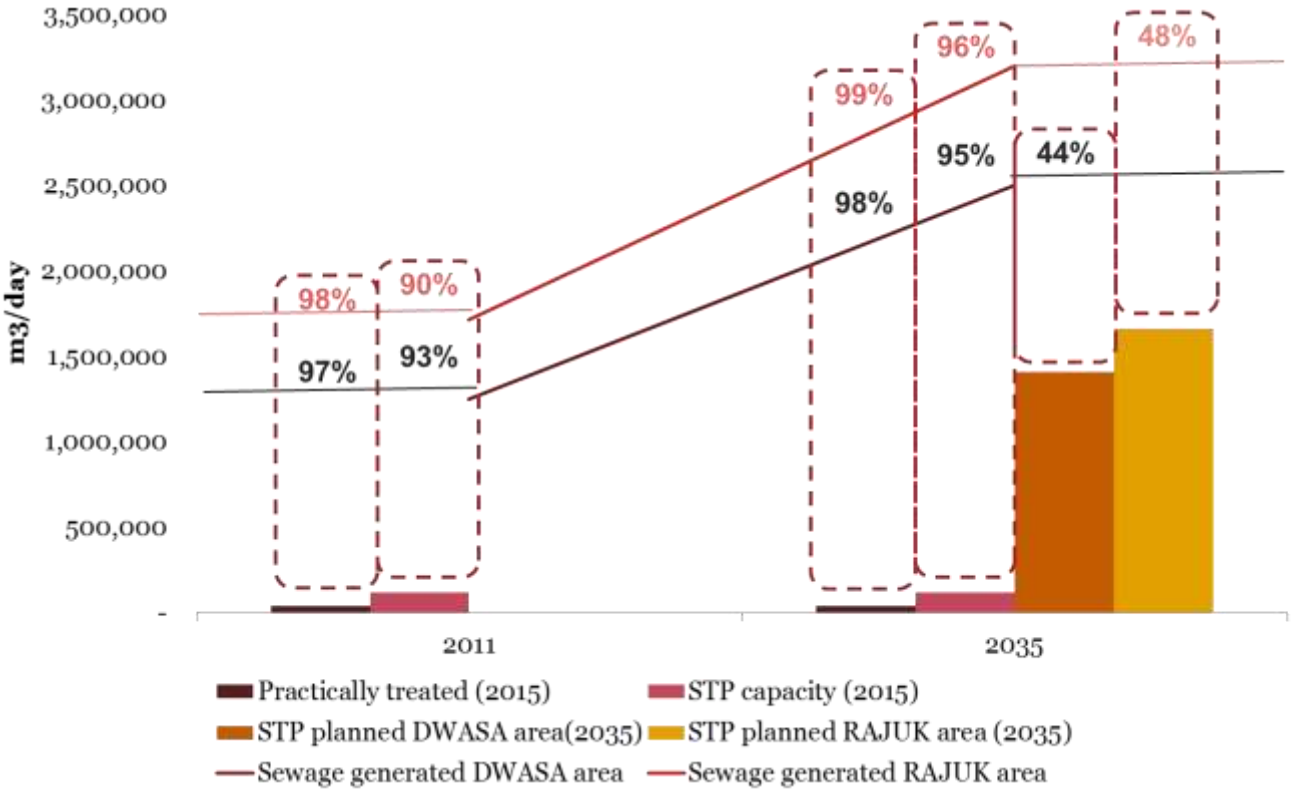
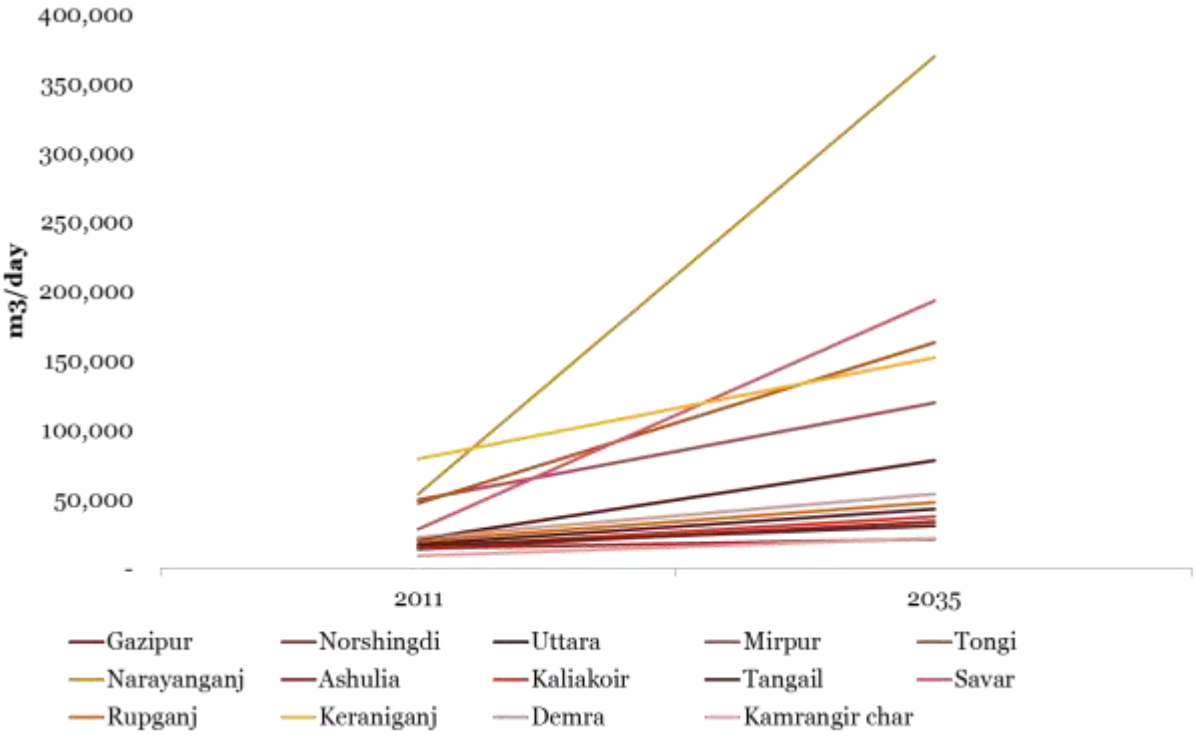


Figure 23 Estimated sewage generated in satellite towns assuming sewage generation of 100 l/ cap/ day irrespective of income level (2011, 2035)



C.4. Overview of available PPP funds

To ensure financing for PPP projects, a number of funds are available. The **PPP Technical Assistance Fund**[54] (Tk. 1 bn as one-time grant by GoB) was established to provide early stage project development funding support to sanctioned PPP projects (such as project identification, pre-feasibility studies, procurement procedures and documentation & evaluation). The **Viability Gap Fund (VGF)**[55] (Tk. 3 bn as a one-time grant by GoB) will provide supplementary government financing to projects that the PPP Unit deems economically vital to the public interest but that may not be fully financially viable on a commercial basis, e.g. as they are restrained from charging required service charges. VGF monies can be used to share the up-front cost of a project (maximum 30%) or provided on an annual basis to effectively subsidize PPP project costs. VGF is only applicable or Build-Operate-Transfer (BOT) projects. If more than one project is competing for VGF, the project with highest Economic Rate of Return (ERR) will be chosen, increasing the difficulty of making STP project eligible for this finance. **Bangladesh Infrastructure Finance Fund Limited (BIFFL)**[56] was incorporated by the Ministry of Finance in 2011 to provide long-term financing in local currency to infrastructure projects that meet BIFFL's investment criteria. The Government of the People's Republic of Bangladesh had provided BDT 16 Billion (USD 220 mn) to this company as initial equity capital and had taken 100% ownership of the company. In addition, a Tk 30 billion fund for project development and co-investment exists.

[54] 2009_ Invigorating Investment Initiative through PPP(http://www.mof.gov.bd/en/budget/09_10/ppp/ppp_09_10_en.pdf)
[55] 2009_ Invigorating Investment Initiative through PPP(http://www.mof.gov.bd/en/budget/09_10/ppp/ppp_09_10_en.pdf)
[56] ADB Report, Page 1 (http://www.adb.org/sites/default/files/project-document/81555/44316-012-tacr-01.pdf)

USD/ per capita	Description	Reuse Potential	CAPEX (min)	CAPEX (max)	OPEX (min/ day)	OPEX (max/ day)
STP & Sewerage	See Sewage Master Plan 2035	No reuse planned	80.71	265.00	0.03	0.04
Omni-Processor by Janicki Industries	It is a 300-kW combined heat and power plant that uses fecal sludge – ranging anywhere from 5%-50% solids – as the fuel source for electricity generation. The heat from combustion is utilized to generate high pressure steam that is used for producing electricity.	$0.07/user/day. The OP is designed to generate excess electricity for sale, in addition to revenue created by processing of sludge.	11.00	15.00	0.015	0.03
Aerobic Biological Toilets by Stone India Limited	The primary function of the biological toilets is to completely eliminate open defecation. The biological toilet consists of a purpose built multi chambered bio digester tank in which the wastes are stored.	Water: All the usable water may be treated as irrigation nutrient or recycled after treatment as flush water. Fertilizer: The total volume of the waste that enters the Bio digester tank per day is fully converted into water which can be used as a fertilizer	21.67	65.00	0.003	
Zero Discharge Toilet System by Indian Institute of Technology, Kanpur	The system is based on the wisdom of isolating the water bodies from human excreta. The toilets are identical to those in conventional water borne system and known to be hygienically safe. The solid and liquid matters are separated underneath the toilet seat itself by using a solid-liquid separator.	Water: 70% - 80% of the used water Fertilizers: > 90 % of nutrients and > 40 % organic matter	3.61	3.61	0.05	
Upgrading human waste with plasma-driven gasification by Delft University of Technology	The processing facility consists of a Microwave Plasma Gasification process to generate electricity out of dried feces which is fed into the gasifier. It will produce enough electricity and heat to make the system self-supporting	Water for reuse: 2,000L per day Fertilizer: 91 tons of ash/fertilizer per year Energy generated: 0.06 kWh/user/day	N/A	N/A	0.08	0.12

Source: Reinvent toilet fair (2014), DWASA Sewage Master Plan 2035, PwC Calculations

Note: ***To increase comparability for sewage treated from toilet usage, 25% of the estimated daily sewage generated in the water-borne sewage system is assumed to***

come from toilet usage (5l per flush with Asian style toilet).

C.5. Overview of alternative sewage/ faecal sludge treatment technologies

C.6. Suggested Work Stream Members

Public Sector

- Ministry of Water Resources
- DWASA
- Dhaka City Corporation North & South
- Department of Environment
- Planning Commission
- Rajuk
- Bangladesh Bank
- Policy Support Unit
- Department of Public Health Engineering

Civil Society

- INT-BUET
- SNV
- DSK
- Water Aid

Private Sector

- Sigma Pumps
- Commercial Banks, such as IDLC
- Mirpur Agricultural Workshop and Training School (export of locally produced manufacturing trucks, vacutugs)
- Selected (local) technology provider

Acknowledgement

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