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STATE OF CITIES 2018

WATER GOVERNANCE IN DHAKA

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Brac Institute of Governance and Development (BIGD)
Brac University

Overall Guidance and Supervision

Imran Matin, Executive Director
Brac Institute of Governance and Development (BIGD)
Brac University

Study Team

Mohammad Sirajul Islam (Lead)
Zia Mohammad
Zeeshan Ashraf
Md. Mahan Ul Hoque
Montajima Tasnim
Raihan Ahamed
Tanvir Ahmed Mozumder
Sumaiya Kabir Talukder
Maria Matin

Reviewers

Sally F Cawood
Nusrat Jahan
Md. Shanawez Hossain

Cover Design and Layout

Md. Abdur Razzaque

Acknowledgement for input and advice from

Dr. Sultan Hafeez Rahman, Dr. M. Anwar Hossen, Mr. A.K.M. Shahid Uddin, Serena Cocciolo, Dr. Md. Akramul Islam, Dr. Khairul Islam, Dr. Sajjad Zohir, Dr. Muhammad Shahadat Hossain Siddiquee, Ms. Syeda Salina Aziz, and respondents of qualitative interviews and household survey.

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Introduction

Since 2011, Brac Institute of Governance and Development (BIGD), Brac University had begun studying the 'State of Cities' on the most pressing issues of urbanization in Bangladesh to provide research-based insights for innovative, practical solutions to urban challenges. The first three reports focused on understanding the urban governance dimensions—historical, economic, and political—of service delivery, transport provisions, and environmental challenges in three cities: Dhaka, Narayanganj, and Chattogram. Since 2015, we are focusing on liveability and related governance issues of Dhaka, considering its political and economic importance and the magnitude of the problems. Previous three studies dealt with solid waste management, traffic congestions, and housing issues in Dhaka; the current study focuses on 'water'.

Global demand for water is growing by one percent per year along with population and economic growth (UNESCO, 2018). But climate change, unsustainable extraction, and pollution are dwindling our freshwater sources. Nearly half the global population (i.e. 3.6 billion) already live in water-scarce areas and this could increase to 5.7 billion by 2050 (UNESCO, 2018); at least 1.8 billion people use faecally-contaminated drinking water (Eid, 2015).

Meeting the water demand of the urban population is becoming a key concern. Urban population and per capita income are continuously growing, lifestyle and household consumption patterns are changing, all of which can result in higher water usage (Lee, Tansel & Balbin, 2011). As our cities are becoming increasingly concentrated, the resultant 'urban heat island' impact—the observed temperature difference between urban environments and the surrounding rural areas (Voogt, 2002)—is likely to add to the already rising temperature because of climate change. Higher temperature means higher water demand—increased consumption of drinking water, greater number of showers taken, etc. (Jain & Sarkar, 2017). Globally, urban water demand is predicted to rise by 80% by 2050 (Florke, Schneider & McDonald, 2018).

With over 42 million urban residents, Bangladesh has one of the largest urban[1] populations in the world (Mansour, Islam & Akhtaruzzaman, 2017). Dhaka is the largest and fastest-growing urban centre in Bangladesh with a population density of 44,500/km^2 (UN Habitat, 2017). One-tenth of the country's population and a third of its urban population (36%) live in Dhaka (Bird et al., 2018). It is the 9th largest city in the world and projected to become the 4th largest by 2030 (United Nations, Department of Economic and Social Affairs, Population Division, 2018). Ensuring equitable and affordable access to safe water to the ever-growing population of Dhaka is going to be a monumental challenge. That is why, we have chosen water as the topic of our 'State of Cities 2018'.

[1] According to the Pourashava Act, an area is considered urban when three-quarters of its adult male population are engaged in non-farm activities; has at least 15,000 inhabitants; and the average density is at least 2,000 inhabitants per square mile.

The Conceptual Framework and Study Objectives

The framework for analyzing water governance in this study is constructed on three elements—accountability, efficiency, and sustainability—which work in a cycle. In this cycle 'sustainability' is the outcome of 'accountability' and 'efficiency'; conversely, emphasizing on 'sustainability' motivates further strengthening of accountability and efficiency of water governance. How to ensure equitable and affordable access to safe water to the citizens of Dhaka sustainably, efficiently, and with accountability is the central question of our study.

Specifically, the study aims

- To assess the present water usage and factors that may increase water demand in the future;
- To analyse the capacity of water supply system to meet the current and future water demand;
- To test the water quality and evaluate the institutional arrangements to ensure the water quality;
- To examine the management of surface water sources (i.e. canals, lakes, rivers) to reduce the dependency on groundwater extraction;

Study Methodology

It is a mixed-method study: we employed desk research as well as qualitative and quantitative methods. Along with reviewing relevant literature, we conducted qualitative interviews with relevant government officials and experts.

We also conducted a quantitative survey of the households in Dhaka on their water consumption and other issues related to water. Dhaka Water Supply and Sewerage Authority (DWASA) is the sole legal entity to develop and maintain the water supply system for Dhaka metropolitan and its surrounding areas, including Narayanganj and 89% of DWASA water is supplied to the households for domestic consumption (DWASA, 2019). So, we focused on household water consumption in Dhaka.

> Sustainable Development Goal 6 (SDG 6) pledges to ensure the availability and sustainable management of water and sanitation for all (UNDP, 2019). SDG 6 is also a priority for Bangladesh. Prime Minister Shaikh Hasina envisions transforming Bangladesh into a model of SDG 6 by ensuring universal access to safe water and sanitation ('PM Seeks to Showcase Bangladesh as SDG 6 Model', Dhaka Tribune, 20 November 2016). As half the people in Bangladesh will live in cities by 2050, achieving SDG 6 will crucially depend on meeting the water demand in the cities.

DWASA has divided Dhaka into 11 Management, Operations, Distribution, and Services (MODS) Zones that includes Narayanganj. This study focused on 9 Zones which fall within Dhaka city. The number of households surveyed in each Zone was proportional to the number of official DWASA connections within the Zone and the households were randomly selected—both from formal and informal settlements. In total, we surveyed 768 households. (Detailed methodology in Annexe 1.)

Water Demand and Supply in Dhaka

Dhaka is the largest and fastest-growing city in Bangladesh. According to Dhaka Structural Plan 2016-2035, the population of Dhaka will be 22.79 million by 2035. Is DWASA ready to meet the demand of such a large population?

Estimates of Per Capita Water Demand

We did not find an official estimation of per capita water demand in Dhaka. But in our interview, relevant DWASA officials confirmed that the agency estimates that per capita water demand in Dhaka is 150 litres per day.

This estimation is consistent with other reliable estimations. For example, the World Health Organization (WHO) states that between 50 and 100 litres of water per person are needed every day to ensure that the most basic needs, including drinking, personal sanitation, washing of clothes, food preparation, personal and household hygiene are met (UN, 2010; UN, 2018). This estimation corroborates to the one provided by the Bureau of Indian Standards (BIS), which considers a minimum of 70-100 litres per capita per day for urban communities, excluding flushing requirements—including which per capita demand rises to 115-145 litres (Udmale et al., 2016).

Per Capita Water Usage in Our Survey

How did we calculate per capita water usage?

In our household survey, we asked about the water bill paid by the household last month, which we then used to calculate per capita water usage in litres per day.

In the case of households in the formal settlements, one holding or building has a single water meter which is used to calculate the water used by the entire building/holding. In the case of slums with formal DWASA connection, a single metered DWASA connection is managed by a Community-based Organization (CBO) and shared by 10-20 households. In both cases, the total bill, calculated from the meter reading, is equally divided among the individual households.

The water bill paid by an individual household is used to calculate the household's total water usage at the rate of BDT 11.02 per 1000 litres—the DWASA tariff effective since 1 July 2018. We excluded the added value of 15% tax from the average bill in the calculation. Average per capita water usage is calculated by dividing the household's total water usage by the number of household members.

Along with households in the formal settlements, in the analysis of per capita water usage, we only included households in the informal settlements that have access to metered DWASA water through Community-based Organizations (CBOs). We excluded the households in the informal settlements on private land in this analysis as their water bill does not correspond to their water usage.

Per capita water usage

We find that on average, per capita water usage is 310 litres per day among the households in the formal settlements. Among the households in the informal settlements receiving water through metered DWASA connection, per capita usage is just 85 litres per day (Figure 1). However, we see that the average per capita usage by the households in the formal settlements is more than twice as high as the DWASA estimation and other recommendations.

We could not find the average usage by households in the informal settlements by Zone because of the small sample size—as the majority of the informal settlements do not have access to metered DWASA connection, the number of households that had metered connection in our sample was small. But as we can see from Figure 2, the average per capita usage in the formal settlements exceeds the DWASA estimated per capita demand of 150 litres in all of the Zones by a wide margin, though there are considerable variations across the Zones:

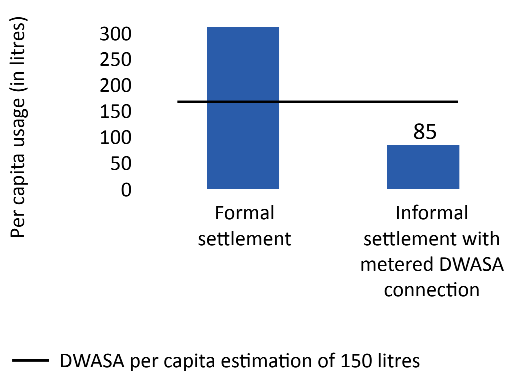

Figure 1.
Average per capita water usage in the formal and informal settlements with metred DWASA connecton

Zone 1.	East side: Nababpur Road, Bashabo-Gandaria; West side: Jatrabari, Saydabad, and Maniknagar
Zone 2.	West side: Nababpur Road, Hazaribag, Nababganj, and Khilket-Azimpur to Buriganga
Zone 3.	East side: Kazi Nazrul Islam Avenue; North side: Agargaon Road and Shyamoli; South side: Nilkhet and Beribadh
Zone 4.	East side: Rokeya Sarani and Pallabi Main Road; West side: Gabtali; North side: Beribadh and Pallabi; South side: Agargaon
Zone 5.	Gulshan, Banani, Kawranbazar, Tejgaon, Kazi Nazrul Islam Avenue, and Airport Road
Zone 6.	East side: Nandipara; West side: Paribag and Banglamotor; North side: Banglamotor, Mogbazar, Rampura, and Banasree; South side: Stadium
Zone 8.	East side: Badda; West side: Baridhara; North side: Joar Sahara, Kurl, and Kuratali; South side: Rampura Bridge
Zone 9.	Uttarkhan, Dakkhin Khan, Nikunja, Khilkhet, and Uttara Model Town
Zone 10.	East side: Kuchukhet, Cantonment; West side of Rokeya Sarani and Pallabi Main Road; North side: Mirpur Ceramic; South side: Bijoy Sarani

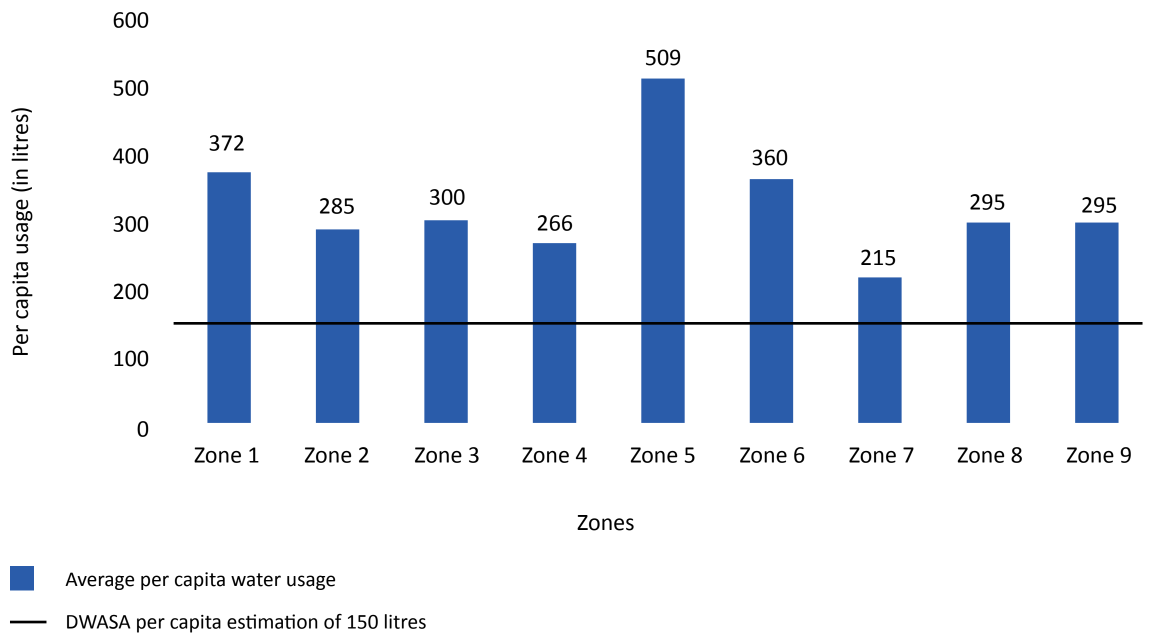

Figure 2.
Average per capita water usage in the formal settlements compared to the estimated demand of 150 litres per day

Zone 5, which includes some of the most affluent parts of Dhaka, including Gulshan and Banani, has by far the highest per capita usage—509 litres. Zone 8 has the lowest per capita usage of 215 litres. Even though Zone 8 includes Baridhara, which is an affluent area, most of the Zone comprises of middle and lower-middle income areas such as Joar Sahara, Kuril, Rampura, and Badda. This indicates that per capita water usage is higher in affluent areas.

As we see, even in Zone 8, which has the lowest per capita usage across the 9 Zones, on average, every person uses 215 litres of water per day, much higher than DWASA estimates and other recommended usage.

Factors That May Further Increase Water Usage

Income and standard of living

We find a strong connection between income and water usage in our survey—per capita income and water usage go up simultaneously (Figure 3). In households with

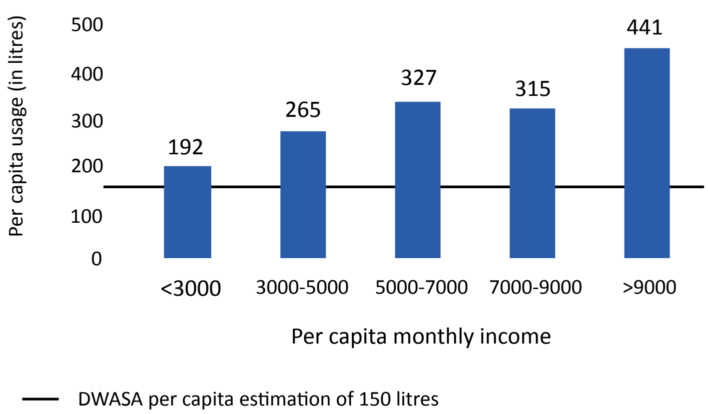

Figure 3.
Per capita income vs water usage in households in the formal settlements

per capita income less than BDT 3,000, per capita usage is less than 200 litres, whereas with per capita income of 9,000 and above, usage is 441 litres.

In our survey, we asked the respondents whether they used different types of water-dependent facilities, as these can increase the use of water. The most common types of facilities mentioned were flushing toilets and showers. As we can see from Figure 4, the use of these two facilities sharply increases with per capita income. Almost no household with per capita income less than BDT 3,000 has showers and flushing toilets, while more than 60% of the households with per capita income higher than BDT 9,000 have these facilities. We find that among households with flushing toilets and showers, per capita usage is almost 100 litres higher than those without—356 litres vs 264 litres.

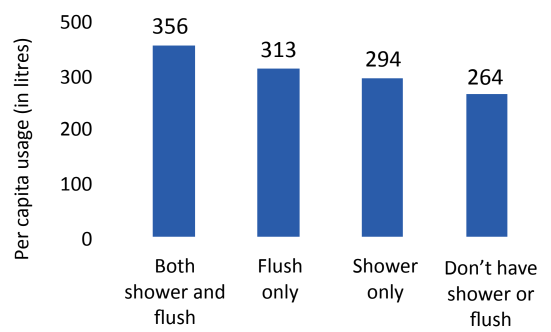

Figure 4.
Per capita usage and the use of showers and flushing toilets among households in the formal settlements

These findings are consistent with Lins et al. (2010), who assert that water demand bear a significant association with income. The same study finds that income and education are associated with lifestyle and access to assets, which in turn affects water demand.

Bangladesh is experiencing steady economic growth since the 1990s and we aspire to become a high-income country by 2041. Dhaka is already the powerhouse of the country's economic growth, contributing 20% to the country's GDP and 44% of the formal employment (Bird et al., 2018). Thus, we expect the average income of the citizens of Dhaka to increase continuously and given the current trend, their per capita water usage will also increase substantially.

Changing weather patterns and water usage

Eighty-five percent of the household respondents reported 'summer' (March, April, May, and June) as the period with the highest water usage. There is a clear link between temperature, season, and water demand, with higher demand during hotter summer months. For example, the average monthly temperature remains close to 30 degree Celsius from March to October in Dhaka (Khatun et al., 2016). The duration of summer has also increased globally due to the incidence of global warming (Magnuson et al., 2000). Bangladesh is highly vulnerable to the effects of global warming (Elahi & Khan, 2015) and 'most climate models predict that the temperature in Bangladesh will rise sharply because of climate change' (Shourav et al., 2018), meaning that the duration of summer in Dhaka is likely to increase, leading to an increase in water demand.

Additionally, the 'urban heat island' phenomenon, as discussed before, will continue to increase the temperature of Dhaka. Increasing population density and highly-concentrated vertical growth of the city will trap more heat, adding to the increasing temperature because of climate change and consequently, further increasing water demand.

How does the current billing system incentivize water overuse?

As mentioned before, individual households do not have a separate water meter. There is one water meter for an entire building/ holding, which is used to calculate the water used by all the households within that biulding/holding. The total bill is then equally divided among the households, which means that the bill paid by an individual household may not represent the actual amount of water used by that household.

A household with more members is most likely to use more water than a household with fewer members. As a result, households with fewer members have to share a portion of the cost of usage by the households with more members. As we can see in our survey, households with two members or less pay BDT 229 per capita per month (Figure 5). As the number of household members increases, per capita cost of water continues to go down; a household with 6 or more members pay just BDT 79 per capita.

This type of billing system is inequitable to start with. But more importantly, it encourages unsustainable use or waste of water resources as in this system, neither the households with fewer members nor those with more members have an incentive to reduce water consumption. Even if the smaller households reduce their water consumption substantially, their water bill will not reduce much if other households in the building continue using more water. Similarly, larger households do not have an incentive to reduce consumption as their cost of higher consumption is shared by others.

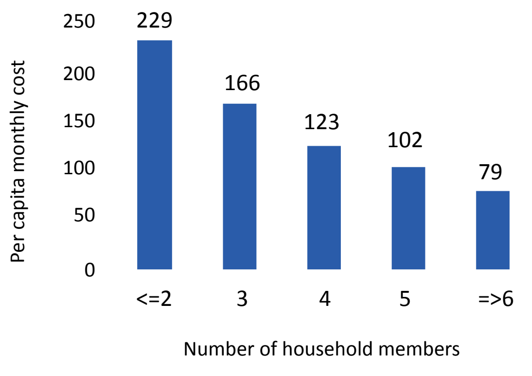

Figure 5.
Family size and the average per capita cost of water

The media also report that consumers waste water, for example, by running taps during household work (Prothom Alo, 2014). Moreover, according to our survey, around 23% of the households get water during a scheduled time—specific times in a day, once a day, once in two days, etc. However, often when the freshwater flows from the tap, the households release the unused stored water to store freshwater (Prothom Alo, 2014).

Poverty and Water Inequity

Water crisis in the slums of Dhaka is a frequent topic of public discussion. Studies also highlight the challenges of getting sufficient water in the informal settlements, as supply can be intermittent, shared among multiple households, and of low quality (Sultana et al., 2013; Mahmud & Mbuya, 2015; Cawood, 2017). Furthermore, studies show that the frequency of inadequate pressure is higher in the informal, compared to the formal settlements (Cawood, 2017). Another study on how to promote hygiene in shared toilets in Dhaka slums found inadequacy of water as the number one reason why slum-dwellers fail to maintain the basic hygiene of their shared toilets (Saxton et al., 2017).

DWASA provides holding-wise water connection. Land-ownership-led water connection excluded households in the informal settlements from formal access to DWASA's water until 2005. This exclusion created business opportunities for water supply in the informal settlements, often based on illegal water collections from adjacent DWASA pipelines and/or pumps. Due to illegal water connections, DWASA lost revenues, leading to high system loss. Moreover, in the absence of a formal supply system, households in the informal settlements purchased water at highly inflated rates. A recent study in three Dhaka slums has found that slums-dwellers pay 7 to 14 times higher rate than the households with formal access (Rahaman & Ahmed, 2016). Another study estimates that often slum-dwellers spend a quarter of their income on water (Haque, 2019).

DWASA's community programme and consumer relation (CPCR) department serving Low-Income Communities (LICs) in the informal settlements

In response to the popular demand for water supply to Low-Income Communities (LICs) and to address system loss, DWASA established a Community Programme and Consumer Relation (CPCR) department in 2010, popularly known as the 'LIC Unit'. The CPCR department, in coordination with the Zonal Engineering and Revenue Collection department, has provided 4,881 legal water connections in 435 informal settlements (DWASA, 2018a).

In this system, a single water point is managed by a Community-based Organization (CBO) and shared by 10-20 households on an equal cost-sharing principle. Each water point installation costs BDT 13,350 (Prothom Alo, 2016). Legal connection receivers usually pay this money in three installments. In addition, every household equally shares the monthly water bill as per the rate fixed by DWASA.

As we saw, per capita usage is just 85 litres per day by households in the informal settlements with metered DWASA connection, which is more than 3.5 times lower than the per capita usage in households in the formal settlements (Figure 1). Whereas per capita usage in the formal settlements is more than two times higher than the DWASA estimated demand of 150 litres, usage is much lower in the informal settlements. Water inequality between households in the formal and informal settlements, in other words, between the well-off and the poor is readily evident.

Even though the number of households in the informal settlements with legal DWASA connection is small, at least they get water at the DWASA rate of BDT 11.02 per 1000 litres. Previously, no households in the informal settlements received formal DWASA water supply. Before the legal water supply in LICs, the households would pay a large amount of money for water connections and pay as high as BDT 300-400 per month to illegal water vendors (Prothom Alo, 2016; Cawood, 2017).

In our survey, we found that households in the informal settlements with metered DWASA supply pay BDT 117 per month on average whereas with households without metred DWASA water supply pay almost double—BDT 209 and as high as BDT 600 per month (Figure 6).

As we discussed earlier, households in the informal settlements without metered connection pay a very high rate for their water. So, even though these households are paying about twice as much as their

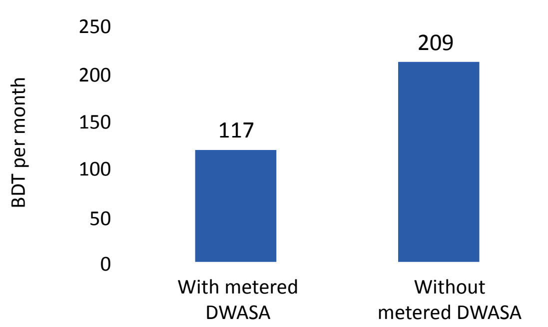

Figure 6.
Average cost of water per household in the informal settlements—those with metered DWASA access and those without

counterpart with formal access, most likely they have access to less than 85 litres of water per capita. A previous study indicates that slum households often pay BDT 500 for as little as 30 litres of water per capita (Uddin & Baten, 2011).

Progress and challenges of the CPCR initiative

Despite a commendable initiative of DWASA to formalize water supply in low-income communities, the majority of the households in the informal settlements still remain outside formal coverage. At present, through CPCR, DWASA supplies water to approximately 640,000 low-income people (DWASA, 2018b). But the number of low-income people in Dhaka is estimated to be between 4 (Asian Development Bank, 2017) and 5.6 million (Water Aid, 2016). So, approximately only 11-16% of the low-income households are covered by the CPCR initiative. The majority are still getting too little water for too high a price.

DWASA's initial target was to bring all informal settlements under its coverage by December 2017 (DWASA, n.d.). However, this target has been moved several times and the current targeted completion date is December 2019. Given that only a fraction of the low-income communities is currently covered, it is unlikely that the target will be met. We explored the constrains of implementation through KIIs, and two main constraints emerged.

First, the CPCR department is severely understaffed. It started with three permanent and one contractual staff in December 2010. The number remains unchanged to this day, as we found from our interview with CPCR officials.

Second, inadequate human resources have led to a dependency of the CPCR on the Non-Government Organizations (NGOs). But NGO-dependencey is unsustainable, as one CPCR department official explains: "NGOs are working with DWASA as a project partner and after the completion of the project period, the CPCR department loses the NGO's support which have immediate effects on the CPCR department's work and ultimately on water supplies in the informal settlements."

Current Water Supply Situation

DWASA has drastically increased water supply from the 1990s, as seen from Figure 7. Between 1990 and 2018, supply has increased from 510 to 2,500 Million Litres per Day (MlD)—almost a five-fold increase. And, according to a recent DWASA report (2018b), the agency has produced surplus water of 150-170 MLD over city dwellers' demand during FY 2013/14–FY 2017/18.

Availability of water

But in our survey, we found that there is a scarcity in water supply.

Adequacy in the water supply can be assessed based on the duration and amount of water accessed by the

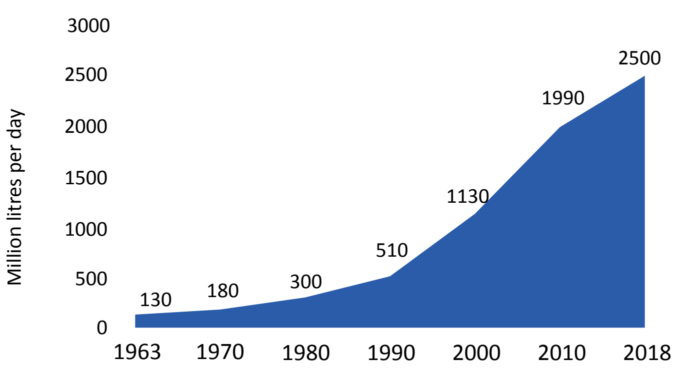

Figure 7.
Supply capacity (million litres per day)

water users. Twenty-four-hour piped supply to the households is the best measure of good water supply service in a city (ADB, 2003). Around 15 years ago, Dhaka was one of the most poorly performing cities, along with Delhi, Karachi, and Kathmandu, serving less than 10% of the population with 24-hour water availability (ADB, 2003).

We asked the respondents whether the amount of water that they get is sufficient. We find that approximately 22% of the surveyed households do not get water according to their demand. In some Zones, this rate is above 40%.

We also found that not all households have 24-hour access to water. According to our survey, around 23% of the households have to wait for specific water supply schedules. For example, they get water during a scheduled time—specific times in a day, once a day, once in two days, etc.

But when we combine the two measures of water availability—sufficiency and regularity (24-hour access), we see that two-thirds of the respondents (68%) have sufficient and regular water supply, a fifth have either insufficient or irregular supply and 13% have both insufficient and irregular supply (Figure 8).

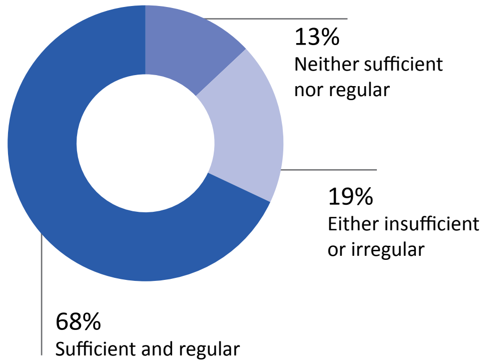

Figure 8.
Sufficiency and regularity of water in the households

Insufficient water supply pushed the households to undertake private initiatives. For instance, of those who mentioned not getting sufficient water according to their demand, approximately 67% store water for later use, around 45% complete water-dependent activities (such as bathing, cooking, washing clothes, and so on) within the period of water availability. In addition, around 42% of the households reduce water usage and around 16% buy water to manage insufficient water supply (Figure 9).

Pressure in supplied water

Our survey also found that approximately 37% of the households did not have access

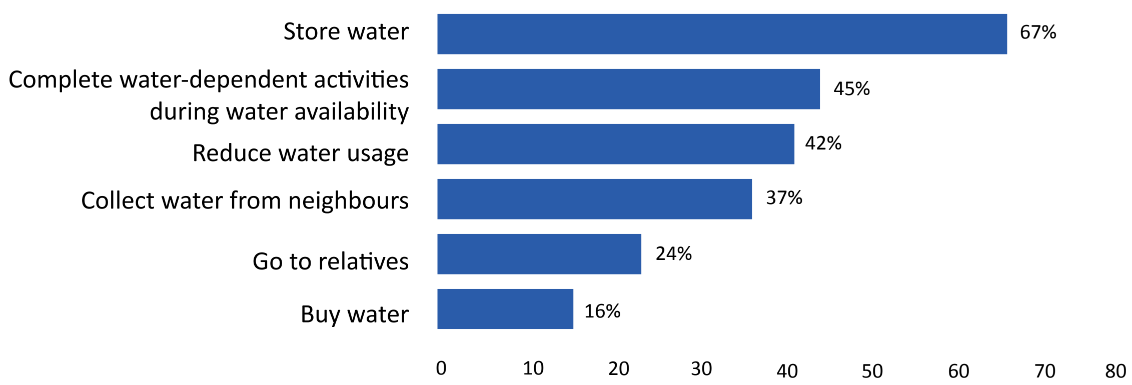

Figure 9.
Household mechanisms to cope with the water supply situation

to adequate water pressure for 24 hours. A number of media reports such as Prothom Alo (2018a) also state the inadequate water pressure in DWASA pipeline for Dhaka city dwellers. To deal with the low pressure of supplied water, households often resort to using suction pumps below the underground reservoir to pull water. In our survey, a quarter of the respondents reported that their DWASA connection is attached to a suction pump.

To develop and enhance the distribution system which would increase water pressure and reduce system loss, DWASA introduced the District Meter Area (DMA) approach in 2006. DWASA's officials in interviews argue that the introduction of DMA reduced illegal water connections from 40% to 5%. Moreover, uninterrupted pressurized water supply to residents led to a decrease in the usage of suction pumps by the land owners (ADB, 2017).

Our study examined water pressure when it comes out of tap based on the respondents' feedback of a complete DMA (that is, Zone 5) and a complete non-DMA (which is Zone 2). Among households in the formal settlements, 86% always experience sufficient water pressure in the DMA Zone while 42% reported the same in the non-DMA Zone. However, we did not find any difference in the reported water pressure between the informal settlements in DMA and non-DMA Zones.

Implications of Our Findings on Water Supply and Demand

We find diverging scenarios in water usage between the formal and informal settlements. On one hand, households in the formal settlements, on average, use more than double the water demand estimated by DWASA. Our data also suggest that the current billing system, which is largely unrelated to individual-level usage, is likely to encourage inefficient water use. On the other hand, households in the informal settlements, on average, are most likely using far less water than required for a decent living and paying a much higher price for their water. So first, it is a question of equitable access to water.

We also see that demand for water is likely to soar for a number of reasons: increase in population and per capita income, the commensurate increase in the usage of water-based amenities (e.g. flushing toilets and showers), climate change, and increasing concentration of people and infrastructure.

But we also find that there is already a scarcity in DWASA water supply. So, the question is, how will DWASA meet the scarcity, ensure access to adequate water to the large number of households in the informal settlements who are without legel DWASA connection, and keep pace with the ever-increasing demand. We now turn to explore the question of the source of water supply.

> “
> On one hand, we need to increase water-use efficiency by discouraging wastage in the formal sector. On the other, we need to ensure consistent, adequate water supply, particularly in the informal settlements at an equitable rate. This is particularly relevant to SDG Target 6.4, which aims to substantially increase water-use efficiency across all sectors … and substantially reduce the number of people suffering from water scarcity by 2030.

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Water Source

The ability of DWASA to supply sufficient water to the urban dwellers depends on water availability at the source. DWASA relies on two primary sources: groundwater and surface water. Groundwater is extracted through deep tube-wells and surface water from rivers is treated through water treatment plants.

Groundwater

As we have discussed earlier, DWASA has consistently increased the supply of water since 1963 to meet the demand of Dhaka's ever-increasing population—from 150 million litres to 2,500 million litres in 2018 (DWASA n.d.; Ali, 2018)—a 19-fold growth. However, this increase in water supply has come at a cost. During the same period, DWASA increased the number of deep tube-wells from 30 to 771—a staggering 26-fold increase.

Not surprisingly, DWASA is heavily dependent on groundwater—78% of DWASA water comes from underground (Alam, 2018). DWASA's dependency on groundwater is evident from Figure 10 bellow. Since 1997, water supply and the number of deep tube-wells grew at a very similar rate.

DWASA had set a target in 2010 to reduce the dependency on groundwater from 78% to 22% by 2021 (DWASA, n.d.; Ali, 2018). Installation of deep tube-wells, however, increased by 38% while the supply capacity

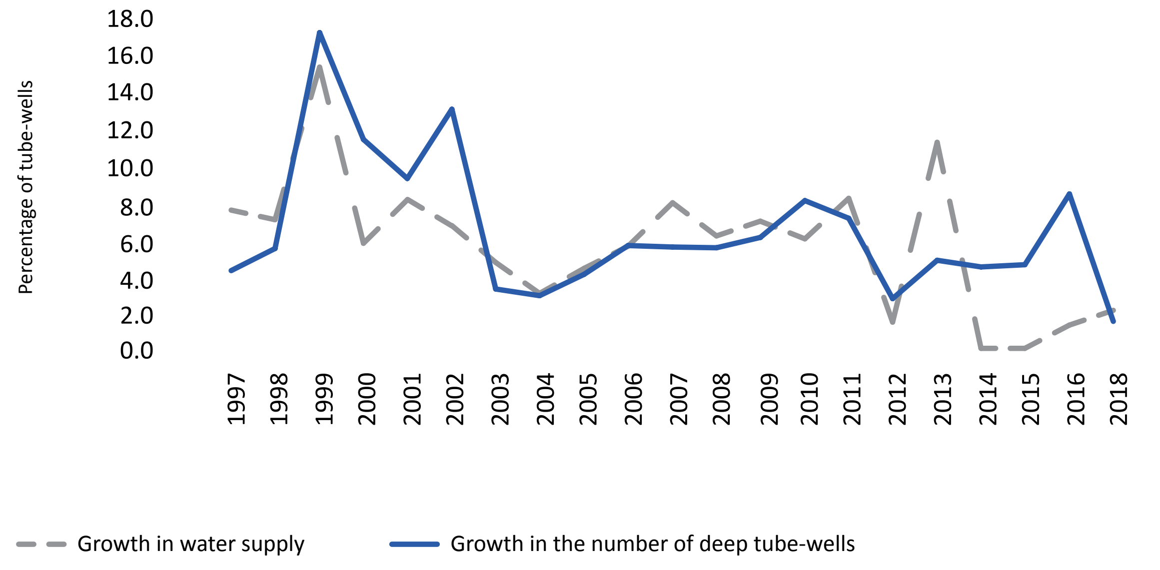


Figure 10.
Comparison of the growth rate of water supply and the number of deep tube-wells (1997-2018)

increased by 26% during 2010-2018, while the number and capacity of water treatment plants did not change. Hence, the dependency on groundwater did not decrease; most likely it increased.

The soaring number of deep tube-wells for supplying water has already proven to be unsustainable, as described below:

Plummeting groundwater levels

Increasing water demand is contributing to greater pressure on groundwater sources and causing incremental depletion of groundwater (Islam & Islam 2017; Akter, Kurisu & Hanaki, 2017). Because of over-extraction, Dhaka's groundwater level is declining by 2-3 meters every year (Islam and Islam, 2017; Khan et al., 2016). In the last 50 years, groundwater level dropped by more than 60 meters on average in Dhaka (Khan et al., 2016). If the present depletion rate continues and any preventive measure is not taken, groundwater level will plummet to around 110 to 115 meters by 2050 (Khan et al., 2016).

To restrict excess extraction of groundwater, Section 19 of the Water Act, 2013 stipulated the formation of a high-level executive committee to fix the lowest level of aquifers. According to an expert, the government has taken several initiatives regarding safe extraction of groundwater (e.g. recent enactment of Bangladesh Water Rules, 2018). However, these rules and regulations are yet to be implemented.

The following two figures (Figure 11 and Figure 12) demonstrate a clear correlation between the number of deep tube-wells established by DWASA and the lowering of groundwater level in Dhaka.

In some areas of Dhaka such as Gulshan, Khilgaon, Tejgaon, Mirpur, Mohammadpur, Dhanmondi, and Mirpur, continuous extraction and drying up of wetlands caused a drastic drop in the water level (Hossain et al., 2018). The rate of depletion in Mirpur is particularly alarming, as 13% of DWASA's tube-wells are established there (The Daily Star, 2014). Another seriously affected area in Dhaka was Hazaribaag, where the over-extraction of groundwater for tanneries has made it difficult to get water for household usage, as we learned from our interview with an expert.

Due to difficulty in underground water availability, DWASA has installed deep-tube wells at the city's outskirts (for example, Well Field Construction Project at Ttululjhora-Bhakurta and Singair, Savar Phase 1 & 2). Our interview with a former high official of DWASA reveals that such installations can cause water scarcity for the locals.

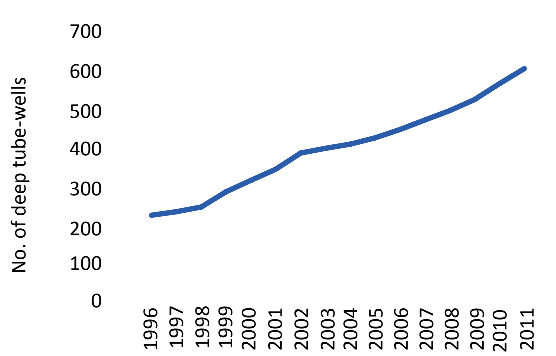


Figure 11.
No. of deep tube-wells

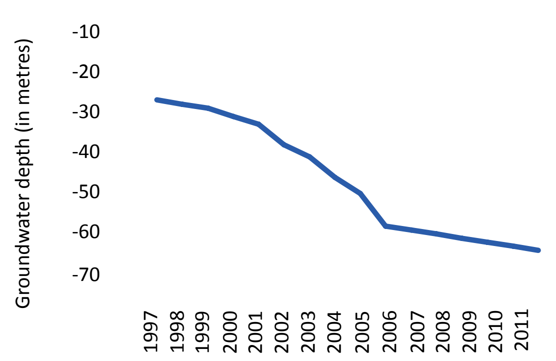


Figure 12.
Groundwater depth (in metres) (Rahman et al., 2014)

Increasing cost of deep tube-well installation and maintenance

As we see, DWASA has been continuously increasing water supply. But interviews with former DWASA officials and experts reveal that this surplus water supply comes at a high financial cost. For instance, DWASA spent BDT 17.6 million on average to set up a deep tube-well and associated pump station in 2016-17. This cost is nearly double compared to FY 2010-11, in which each deep tube-well and pump station cost BDT 10 million (Prothom Alo, 2017). As one DWASA official argued, the cost of deep tube-well installation is rising because of the gradual decrease in underground water level. It is also reducing the operational life of existing pumps, which often go out of order within 2-3 years after installation. Thus, DWASA needs to replace around 40 to 60 deep tube-wells each year, according to the DWASA officials interviewed. Frequent pump failure also increases the recurring maintenance cost of pumps. In addition, around 15 to 20 deep tube-wells remain out of operation daily due to mechanical and electrical failures (Prothom Alo, 2017).

Pumps unable to extract water as per capacity

Because of the lowering level of groundwater, the pumps have to work harder and harder to pull water. Often the pumps are unable to produce the amount of water per day as per capacity. The case of Baldha Garden is a glaring example. (See Box 1).

Environmental impact of groundwater depletion

Heavy groundwater extraction has already proven to have detrimental effects on the environment (Uddin & Baten, 2011). Over-extraction of groundwater is one of the major causes of land subsidence in megacities around the world (Haque, Onodera & Shimizu, 2013). A study published by DWASA predicted that the land will subside by 6.4 cm in Dhaka between 2010 and 2020 (DWASA & IWM, 2008). Land subsistence can increase the intensity of environmental disasters such as flooding (Phien-wej, Giao & Nutalaya, 2006).

BOX 1.

Plummeted Groundwater Level and Insufficient Water Availability: The Case of Baldha Garden

In 1981 Baldha Garden authority provided 1,200 square feet land to DWASA to establish a pump and in exchange, DWASA was due to supply 38,000 litres of water to Baldha Garden per day. Presently, DWASA cannot supply water as per the contract. In response, Baldha Garden authority wrote two complaint letters to DWASA. According to the DWASA officials of the concerned Zone, at best, the pump can supply 600 litres of water per minute to Baldha Garden and adjacent households even though it had the capacity of extracting 3,000 litres per minute. This was due to the plummeted groundwater level triggered by continuous extraction of groundwater for a long period of time.

Source: Prothom Alo, 2019

Trees and plants may not get proper nutrition if the groundwater level keeps depleting (Alam, 2018), leading to an increase in carbon emissions and other major environmental damages. Thus, in Dhaka, unsustainable management of underground water is not only creating uncertainty in the water supply but also causing a negative impact on the environment.

Surface Water

Groundwater in Dhaka is understood to be more reliable in terms of quality (Khan et al., 2016) whereas the highly-polluted surface water bodies in Dhaka need to be treated to make it usable for citizens (Sabit & Ali, 2015). But given the worrying condition of groundwater levels, it is absolutely necessary to move away from groundwater extraction to surface water harvesting. As mentioned earlier, DWASA wants to drastically reduce groundwater dependency. So, what are the prospects of depending on surface water as a predominant source for meeting the water demand of Dhaka?

Water treatment plant projects are lagging behind

Currently, DWASA has only four surface water treatment plants (DWASA Annual Report, 2015-2016), through which it supplies only about 22% of the water (Alam, 2018). To reduce the dependency on groundwater, the agency has undertaken four new water treatment plant projects, with a budget of BDT 1,700 billion, intending to add 1,400 Million Litres per Day (MLD) to the distribution network through treating the water from the Padma and Meghna by 2021.

Until now, the construction work of these projects is going at a snail speed. Construction work of Gandharbpur Water Treatment Plant, for example, started in 2014 and is due to be completed by 2022; however, only 20% of the physical work was completed until July 2018 (Prothom Alo, 2018b). If the construction work continues at this pace, 41% of the physical work will be accomplished by the scheduled project completion date. Sayedabad Water Treatment Plant-III began in July 2015 and was planned to be completed by June 2020. During the last three years only 2% of the physical work has been completed. (Prothom Alo, 2018).

Disappearing surface water sources

Dhaka is blessed with an average of annual rainfall of about 2,148 mm (Wetherbase, 2019). One study estimates that proper rainwater harvesting systems could potentially supply more than 15% of Dhaka's requirements (Sumon & Abul Kalam, 2014). Dhaka city has five rivers—Turag, Buriganga, Dhaleshwori, Balu, and Shitalakhya—and approximately 43 canals which can potentially serve the purpose of retaining rainwater. But these retention bodies are fast disappearing. Mahmud (2017) reports that Dhaka used to have 65 canals, over 50 of which had regular flow even as recently as the early 1980s; but now it has 43, of which DWASA manages 26. Most of these canals have either disappeared or are in environmentally 'critical' conditions because of solid waste dumping and land-filling (Bird et al., 2018).

The Dhaka Detailed Area Plan (DAP) 2010 identified 5,523 acres of water retention areas, 20,093 acres of canals and rivers, and 74,598 acres of flood flow Zones for preservation by the government. However, a RAJUK study in 2017, found the existence of only 1,744 acres of water retention areas around the capital, which is why the DAP is being revised (Ahamad, 2018).

Encroachment is one of the key reasons for dwindling water retention areas. Study

> The dwindling of surface water retention bodies is at odds with SDG target 6.6 which states that by 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

shows that around 43% of the floodplain of Dhaka city has been filled in between 2003-2017 (Kamol, 2019). These illegal encroachments are done mainly by local politically powerful elites (Nishat, 2016). This is intensified due to rapid urbanization and the phenomenal increase in land price, giving rise to huge rents and payoffs to be realized through land transactions.

Thirty-two percent of our respondents live near a water body. Of them, around 67% identified the construction of commercial housing as the primary purpose for which encroached land is used, followed by individual housing construction (56%) and communication infrastructures (38%) (Figure 13). Furthermore, approximately 87% of the respondents believe local influential people are responsible for grabbing water bodies and nearly 51% of the households blame the government for encroachment (Figure 14).

Encroachment on the water bodies for housing demonstrates the growing demand for housing in Dhaka. BIGD study (BIGD, 2017) highlights the necessity of building 25,000 new houses every year to cater to the demand for housing.

Apart from commercial housing projects, building illegal low-income housing on wetlands was found to be another big reason for encroachment. During our survey, respondents identified 22 cases of land-filling, the majority of which were filled to establish slums by local elites or businesses. Low-income households are unable to afford formal houses, therefore, they rent substandard rooms built over wetlands.

Pollution of existing water sources

Ever-dwindling water retention bodies in and around Dhaka are also facing alarming levels of water pollution. The industries around Dhaka are one of the main polluters. The government instructed industrialists to set up 'Effluent Treatment Plans (ETPs)' at respective industries by 31 October 2007 to reduce river pollution, (The Daily Star, 2009). But compliance with this directive needed strict surveillance by government agencies, specifically the Department of Environment (DOE). Most of the industries in this country

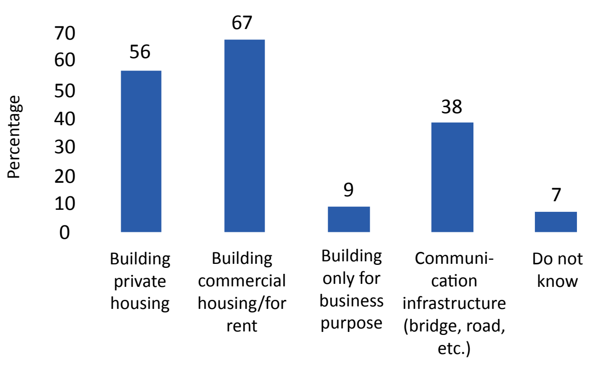


Figure 13.
Purpose of land encroachment (as per respondents living near water bodies)

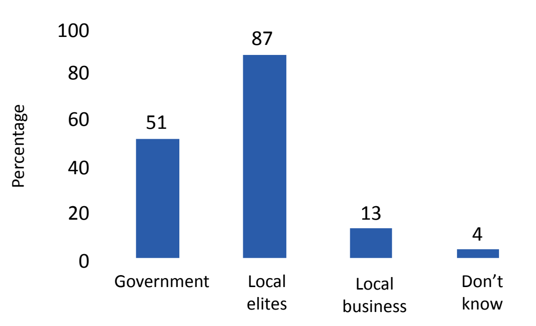


Figure 14.
Water body-grabbers (as per respondents living near water bodies)

do not have ETPs though the operation of such ETPs has been made mandatory by the law (Nishat, 2016).

The main polluting industries in and around Dhaka, as identified by DOE, are tanneries, textiles, engineering, pharmaceuticals, and chemical industries (Karn & Harada, 2001).

The case of tanneries is particularly a telling example of how difficult it is to control industrial pollution. Because the tanneries in Hazaribagh were creating extreme land and water pollution in Dhaka, in 2001, the Supreme Court of Bangladesh ordered the industry to relocate to Savar, where government allotted 155 plots to the tanneries in 2003. This was not executed by the industry or the relevant ministries. In 2003, Bangladesh Environmental Lawyers Association (BELA) filed a case against the tannery industry and relevant ministries as these parties failed to perform their statutory duties—relocating tanneries in Hazaribagh area to address the pollution of Buriganga. Supreme Court gave the verdict for BELA and again ordered relocating. Nonetheless, it took 15 years to negotiate the transition and the industry was finally relocated in 2018. But since the establishment of the industry in 1965, it polluted Buriganga for 50 years and it seems that tannery pollution merely shifted to the Dhaleswari river in Savar (New Age, 2018). Most of the relocated tanneries either do not have or do not use ETPs (Nishat, 2016).

As for domestic waste management, at present there is only one sewerage treatment plant in Pagla and the sewerage network coverage in Dhaka has declined from 30% to 20% due to city expansion (The Financial Express, 2018). Consequently, the faecal and solid waste ends up in the rivers and water bodies in the city. World Water Development Report 2017 reports that Bangladesh has the second-lowest level of wastewater treatment in the Asia-Pacific region after Vietnam.

> With the current state of affairs, achieving the SDG Target 6.3 will be impossible, which aims to improve water quality by reducing pollution, eliminating dumping and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally by 2030.

As a result, surface water sources are becoming untreatable. A 2016 study by DWASA, funded by the World Bank, found that the water pollution of all the rivers in and around Dhaka—Buriganga, Shitalakkhya, Dhaleshwari, Turag, Bongshi, and Balu—has reached such a level that it has become almost impossible to treat the water from these rivers for human use (The Dhaka Tribune, 2016). In fact, a recent LGRD commissioned study has found that the treated water from two plants—Saidabad and Chadnighat water treatment plants—has harmful bacteria including coliform (The Daily Star, 2019a).

Management of water resources

Management of water resource is grounded in the constitutional obligation (Article 18A) (GoB, 2011) of the government and accordingly, the government has formulated a number of Acts and Rules such as the Environment Conservation Act, 1995; Bangladesh Water Act, 2013; National River Protection Commission Act, 2013; etc.

Also, different government agencies took some initiatives against encroachment; for example, the shipping ministry evicted 4,740 illegal institutions from the banks of Balu, Turag, and Buriganga rivers since 2015 (Mamun, 2015).

However, according to Chan et al. (2016), the recent Water Act, 2013 does not explain how the government would address land-grabbing, river encroachment, or treatment plant establishment related issues. It also discounts the power of citizens: without written complaint from the Director General of the Water Resource Planning Organisation—the apex organisation under the Ministry of Water Resources, dealing with nationwide water resources planning—courts cannot accept lawsuits related to enforcing the provisions of the Act.

Additionally, our expert interview suggests that the environment court is non-functional, and therefore, the Supreme Court has been disposing a number of cases related to the protection of the water bodies. In 2009, the Supreme Court provided judgment on the four rivers of Dhaka—Buriganga, Turag, Balu, and Shitalakkha—which outlined the steps to be taken and timeframe for actions to save the rivers. On that basis, the government established demarcation pillars and planned to build 220 kilometres long walkways alongside the banks of these rivers to stop encroachment at an estimated cost of BDT 8 billion (The Independent, 2018). However, the demarcation pillars were established along the riverbanks based on the lean flow of the dry season, excluding around 2,500 acres of river foreshores and wetlands; this goes against the provision of the Water Act, 2013. This distortion was publicly acknowledged by then Shipping Minister during his visit to the Buriganga and the Turag. He said, out of 6,000 boundary pillars, 2,000 were installed wrongly (The Daily Star, 2016).

In January 2019, the Supreme Court passed another judgment declaring the rivers as legal entities (Khalequzzaman, 2019). The judgment indicates a mechanism to implement the rights of rivers by providing detailed directions to several government agencies to take the following steps:

- Enlist the land-grabbers and publish the names of perpetrators;
- Reject loans and candidacy for these perpetrators to run for public offices;
- Treat river-grabbing as a crime;
- Remove illegal structures from the rivers;
- Amend the laws to punish criminals responsible for the deterioration of the natural flow of rivers;

Implementation of this judgement will need an amendment of laws and strong political commitment. However, overall resource allocation for water resource management presents a bleak scenario as expenditure on water resources management was around 4% of the total development spending in 2012, but this is reduced to around 3% in 2017 (provisional) (BBS, 2017).

Effect of water pollution on survey households

We find that households face various nuisances linked to poorly-managed water bodies. Among those who live near water bodies, only 7% of the respondents mentioned that their nearby water bodies are in a good condition. An overwhelming 78% mentioned that the nearby water bodies are in bad or very bad condition.

Around 94% of households in the informal settlements are either highly effected or affected by the bad odour from water bodies, this rate is 75% among households in the formal settlements (Figure 15).

Mosquito annoyance affected approximately 97% of the households in the informal settlements and among them, 75% are highly affected. Even in households in the formal settlements, 81% are affected by the mosquito problem.

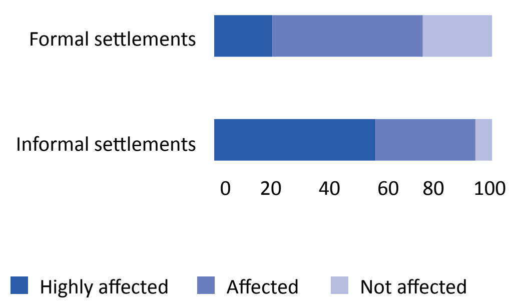


Figure 15.
Households affected by bad odour from water bodies (among those living near water bodies)

Are households concerned about the deteriorating sources of water?

In our survey, around 36% of the respondents expressed that they are concerned about the contamination of surface water sources. Only 21% expressing the same about the depletion of groundwater levels in Dhaka. This reveals a general lack of awareness about the grave situation of our water sources, particularly the groundwater source.

Implications of Our Findings on Water Source

To meet the ever-increasing water demand of the citizens of Dhaka, DWASA needs to increase its supply continuously. But we see that DWASA's overdependency on groundwater has already become unsustainable. In fact, to restore the environment and avert possible environmental disasters, DWASA needs to deeply cut down on groundwater extraction.

That means, harvesting of surface water must accelerate. But the path towards transitioning from groundwater to surface water is not clear. First, DWASA's surface water treatment projects are not on track. On the other hand, we see that the surface water retention bodies are fast disappearing as well as becoming contaminated. There are also severe governance and management challenges to surface water. This means, DWASA will have increasingly limited options for using surface water with continuously rising cost of water treatment because of the increasing pollution.

Quality of Supplied Water

The majority of the citizens of Dhaka have access to water. But what about the quality of the water they get? Water quality is a major concern for public health; around 80% of all diseases and two-thirds of deaths in developing countries are attributed to consumption of poor-quality water and on average, 10% of an individual's productive time is lost due to water-borne diseases (Hoque et al., 2012). World Bank (2018[b]) observes that while 98% of the population of Bangladesh have access to water, 80% of the household tap water is contaminated by E. Coli bacteria. It indicates that access to safe water is a fundamental issue of public health across the country, including Dhaka.

> SDG Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

Household Satisfaction with Water Quality

Overall, around 30% of the respondents expressed their dissatisfaction with the water quality (Figure 16). Dissatisfaction is higher among the households in the informal settlements compared to those in the formal, as can be seen from the figure.

Furthermore, satisfaction with the quality of water varies across DWASA Zones. In some Zones, (e.g. Zone 3 and Zone 2) almost half of the respondents were found to be dissatisfied.

According to WHO (2004), "Microbial, chemical and physical water constituents

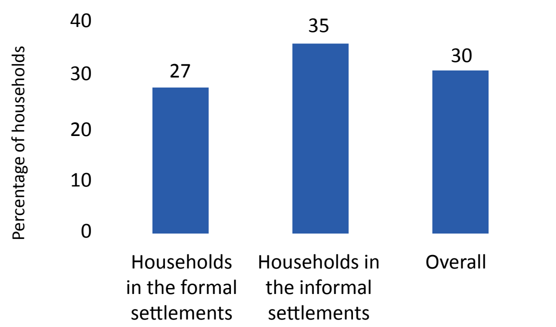


Figure 16.
Percentage of the households dissatisfied with the quality of supplied water

may affect the appearance, odour or taste of the water, and the consumer will evaluate the quality and acceptability of the water on the basis of these criteria." The study captured households' assessment about the quality of supplied water based on three parameters: colour, taste, and smell (Figure 17).

Approximately 27% of the surveyed households reported that they did not get clear water; nearly half of the respondents (49%) received partly muddy water; and one-third of the households reported occasionally or regularly getting brownish water.

Good quality water does not have any particular taste; however, around 56% of the households experienced a particular taste; 49% of the respondents felt the presence

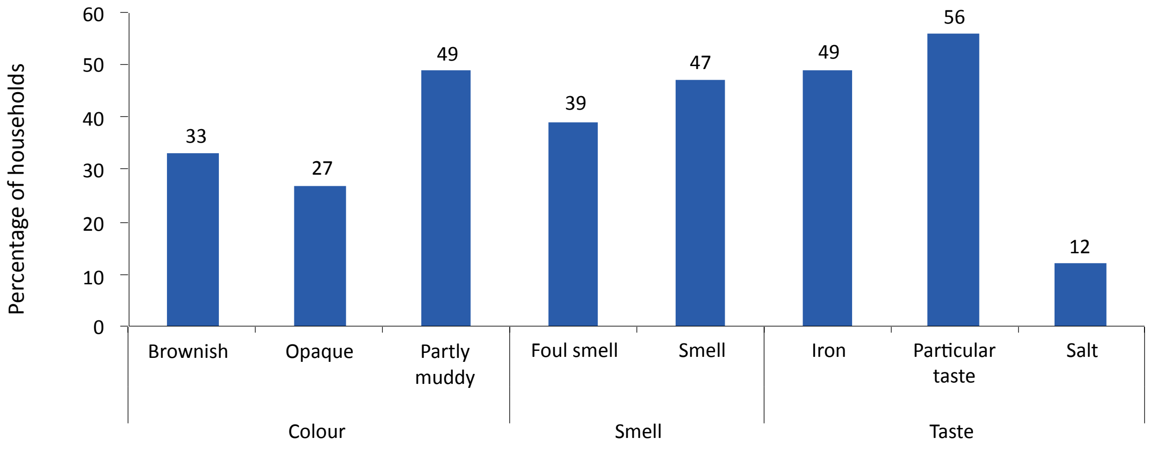


Figure 17.
Percentage of the households reporiting they always/sometimes get water of undesirable colour, smell or taste

of iron in water; and 12% of the households even reported getting salty water.

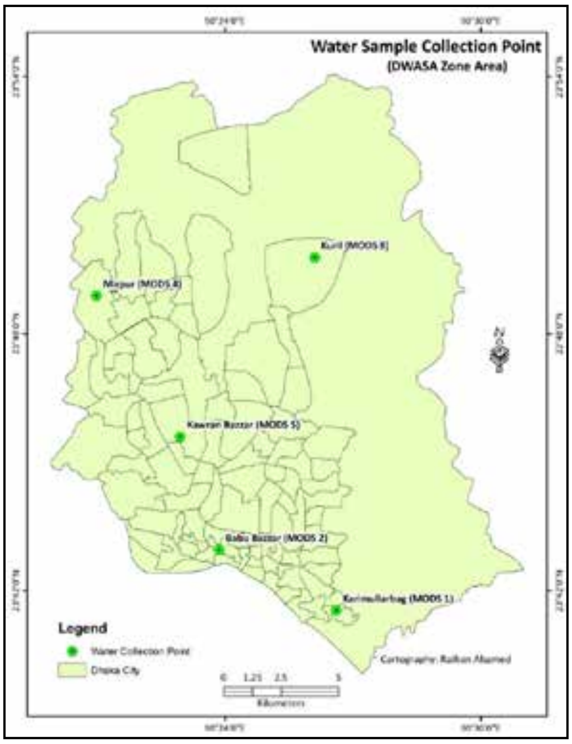
Similar to taste, there should not be any sort of smell in the supplied water. In reality, approximately 47% of the respondents reported getting some kind of smell and around 39% found foul odour in their supplied water.

Laboratory Test Results

Apart from getting feedback on the physical properties of the supplied water, we also wanted to check DWASA water quality through proper laboratory testing. We collected water samples from five different DWASA MODS Zones, as indicated in Figure 18. From each Zone, we collected water samples from DWASA pump stations, household underground reservoirs and rooftop reservoirs (tap water) for laboratory testing of chemical (pH, TDS, nitrate), bacteriological (FC and TC), and heavy metal (iron, lead, manganese) substances. In total, we had 15 samples—five pump stations, five underground reservoirs, and five rooftop reservoirs.

The test results reveal that water samples contained alarming levels of bacteriological

Figure 18.
Water Sample Collection Points



substances (Figure 19). More specifically, the presence of faecal coliforms and total coliforms crossed the acceptable standards, set by the Government of Bangladesh and WHO, in 9 out of 15 water samples.

Noticeably, both types of coliform contamination were found only in one out

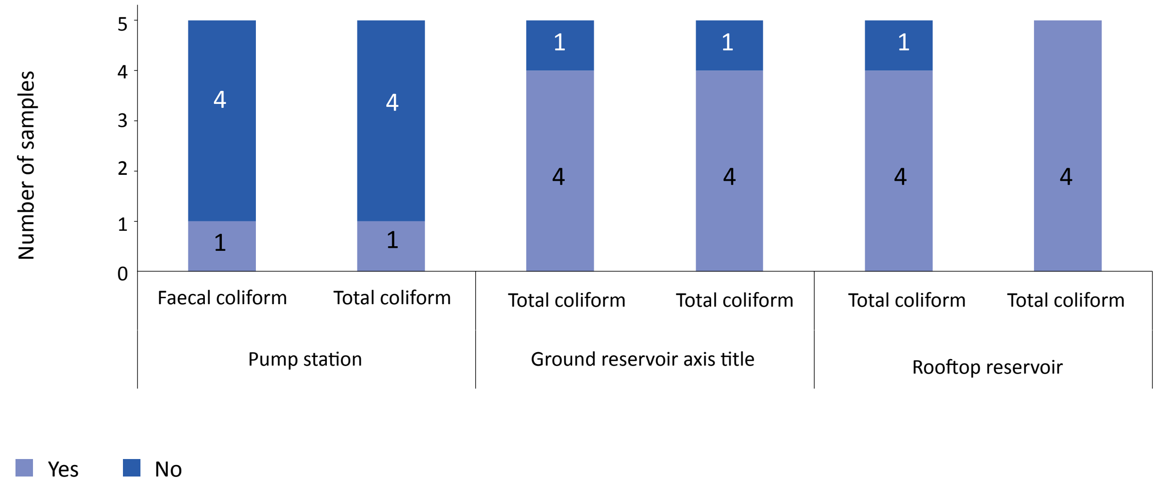


Figure 19.
Faecal and total coliform beyond acceptable standard (Yes/No)

of the five samples collected from pump stations; in case of ground reservoirs, four out of five or 80% samples had unacceptable levels of faecal and total coliform contamination. All the rooftop reservoirs had some sort of coliform contamination and four out of five had faecal coliform contamination. The highest bacteriological ingredients were found in underground reservoirs (6000/100ml) and tap water (2000/100ml) in Babu Bazar of Old Dhaka.

A study conducted in four slums of Dhaka based on 480 water samples from the last delivery point of DWASA and after the households collected water revealed that almost 100% of the water was faecally contaminated (The Daily Star, 2019b).

Drinking or using contaminated water affects public health. For instance, bacteria-infected water causes diarrheal diseases, typhoid, Hepatitis A, urinary tract infection, cholangitis, and pneumonia (Lenntech, 2019). A fifth of the family members of the interviewed households, both in formal and informal settlements, were affected by diarrhoea in the last year. Water users may not understand the symptoms of water-borne diseases immediately; but long exposure to contaminated water harms various parts of the human body.

Quality Monitoring Facility

DWASA has a central laboratory in Asad Gate to check the water quality. Sample collectors, who are based in the central laboratory collect water samples from the field and share the results with internal departments as well as the Zone offices. Including the sample collectors, DWASA has 23 staff for water quality monitoring and running the laboratory under the Microbiology and Chemical department. It is less than one percent of DWASA's total human resource (DWASA, n.d.). In its annual reports, DWASA publishes the number of samples tested in its laboratory; however, it does not disclose the test results to the consumers. As a result, consumers have limited confidence in DWASA and take personal measures to purify their drinking water, as discussed later.

Quality Management at the Water Distribution Level

While lifting groundwater, DWASA maintains a chlorination system to kill or inactivate waterborne pathogens. In the case of surface water supply, chlorine is mixed with treated water before it is transferred to the pipelines. Water samples are tested by DWASA's central laboratory prior to deep tube-well installation and chlorination system before transferring to pipelines usually result in safe water at the source. This is also confirmed in our laboratory results. As the majority of the houses are getting contaminated water, something must be happening in between. This fall in water quality indicates to a poor water distribution system and the lack of cleanliness of water reservoirs at holdings.

DWASA pipelines have been vulnerable to leakage for a number of reasons: old age of the pipelines, holes created for illegal water connections and construction work of different authorities, as described by DWASA officials and experts in the interviews.

But DWASA does not have an active surveillance to check the condition of the pipelines. In fact, our interview with a former high-level DWASA official reveals that the agency does not even have a comprehensive and systematic mapping of the distribution network extended over the period. DWASA also does not have a proactive quality monitoring system. Once DWASA gets a complaint such as bad quality of water, leakage in the pipeline, etc. from a customer, only then it takes an initiative to check the pipelines.

During interviews, DWASA officials argued that the City Corporations, RAJUK, Titas, and other service providing agencies undertake development activities without prior consultation with DWASA in most cases. Currently, these agencies coordinate with the City Corporations for excavation as the latter owns most of the roads within the city area. However, there is no similar bilateral communication with DWASA, putting DWASA's water supply lines at the risk of damage during excavation. Lack of coordination between and among service providing agencies along with differences in the agencies' modes of operation and accountability structure act as barriers to progressive and efficient working relationships (Panday & Jamil, 2011).

Furthermore, depriving the majority of the low-income people of formal water connections, as stated earlier, provides room for illegal water connections, which increases the risk of damaging DWASA pipelines. There are illegal connections alongside the legal ones in the city's high-income areas to wash vehicles, for gardening, and bathing animals, as described by an expert in an interview.

DWASA has started implementing the DMA that includes installation of High-Density Polyethylene (HDP) geothermal pipelines, which have a longer lifetime and are more resistant to leakage and drilling for illegal connection. But the entire DWASA area, specifically the Old Dhaka and the peripheries are not yet within DMA. The agency has planned to divide its MODS Zones into 141 DMAs; of which 47 DMAs have been completed (TIB, 2019).

As mentioned earlier, one-fourth of the holding-owners use suction pumps when they do not have adequate water pressure. Suction pumps are installed below the underground tanks. While extracting water from the pipelines, suction pumps add soil and micro-organisms to the water, contaminating the supplied water with bacteria, as we found from our interview with a high-level DWASA official.

Quality Management at the Household Level

Water quality further declines due to irregular cleanliness of water reservoirs by the holding owners. We can see, only a quarter of the respondents said that their underground reservoir is cleaned at least every three months (Figure 20). A third mentioned that it is cleaned yearly and a fifth have no idea if it is cleaned at all.

We can also see that the rooftop reservoirs are cleaned more frequently than the underground ones. The high cost of cleaning underground reservoirs leads the households to clean them less frequently.

Through qualitative interviews, we found that the cost of cleaning an underground reservoir is BDT 1,500-5,000, while it costs BDT 900-3,000 for cleaning a rooftop reservoir. We further found that the reservoirs are cleaned with detergents (such as Surf Excel, Jet, Vim, Wheel, and so on), although disinfecting the water tanks requires chlorination (WHO, 2013).

Our expert interview also finds that cleanliness of the water storage facilities such as buckets and jars can also be a source of contamination.

Burning Natural Gas to Purify Water

Approximately, 62% of the households apply various traditional and modern techniques, such as boiling, filtering, and purification tablets to make DWASA's supplied water drinkable (Figure 21). Households in the formal settlements are more than twice as likely to purify water than households in the informal settlements, as can be seen from the figure.

Boiling is the predominant method of purifying. Of all the households, 42% boil water and an additional 12% filter the water after boiling.

We find that, on average, a household takes 49 minutes to purify 18 litres of water daily. According to the experts interviewed

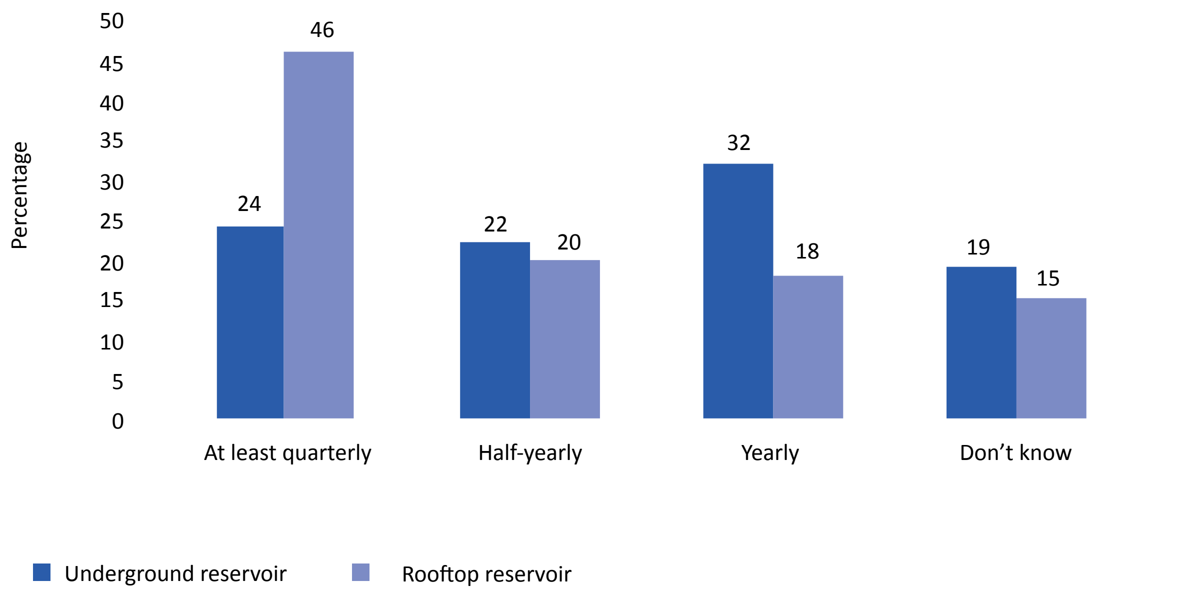


Figure 20.
Frequency of cleaning underground and rooftop reservoirs

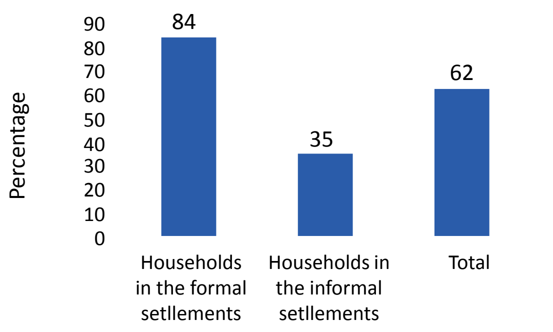


Figure 21.
Percentage of the households who purify their drinking water

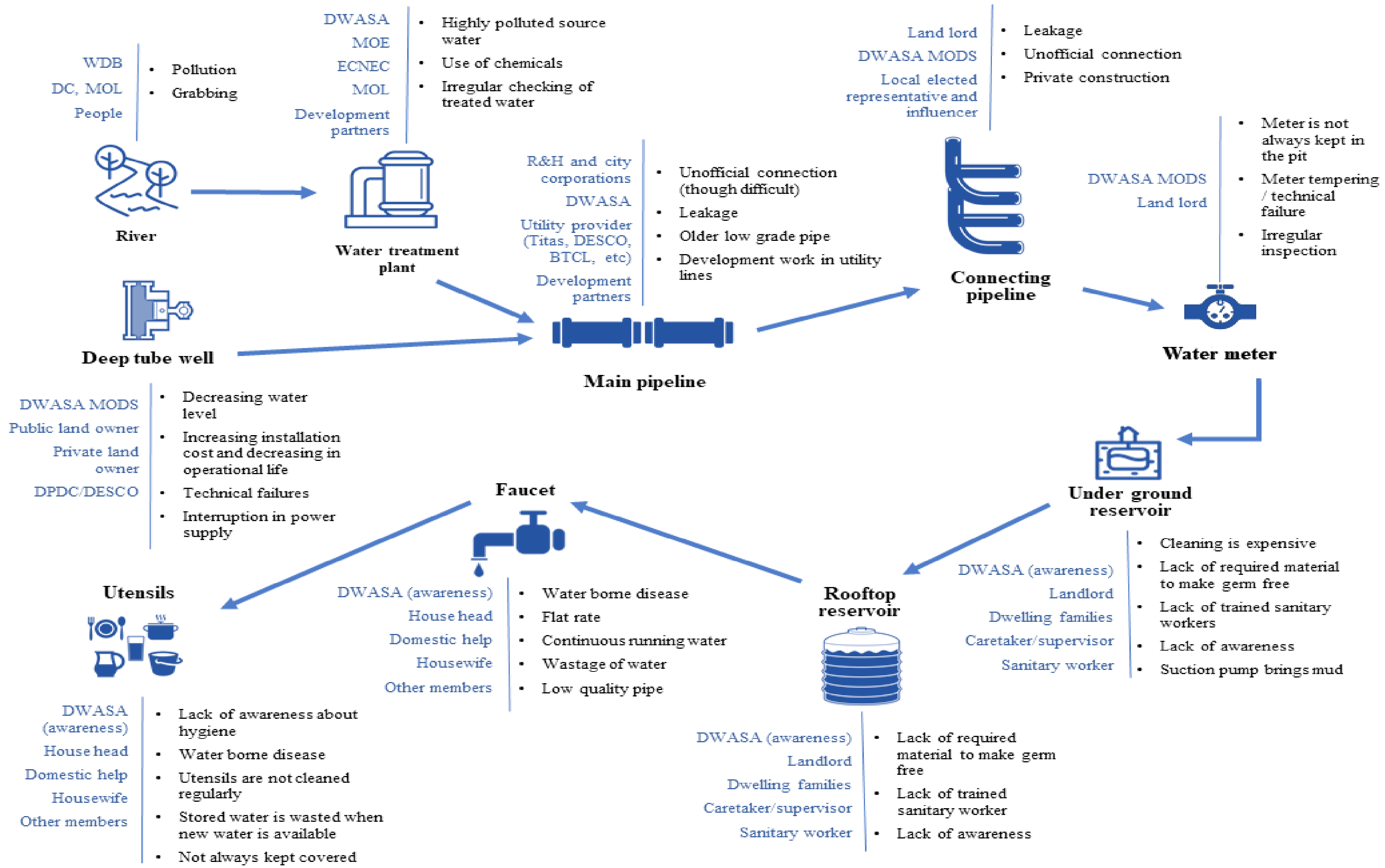
from Titas, the process burns 0.151 cubic meters of gas. On average, a household boils approximately 6,486 litres of drinking water per year spending 54.99 cubic meters of gas, which costs BDT 615.89 a year. As 54% of the households in Dhaka currently boil water, we estimated that in Dhaka, approximately 152 million cubic metres of precious natural gas is burned worth BDT 1.7 billion for boiling water. If 100% of the boiling were done using LPG, the cost would be BDT 26.63 billion.

Implications of Our Findings on Water Quality

Our survey findings reveal that the quality of water that the citizens get is not up to the mark. More than a third of the citizens complained getting water that does not have the desired colour, smell, or taste. Through laboratory test, we also find that the water that ultimately reaches the households is mostly contaminated by coliform bacteria.

But our laboratory test also finds that the water at the source is largely uncontaminated. So, it must become contaminated in the transfer process or at the holding/household level. While there are indications that water may become contaminated because of leakage in the pipelines, the study also indicates that the households have responsibilities too as the use of suction pumps and infrequent and improper cleaning of water reservoirs can deteriorate the quality of water.

Water: Multiple Actors, Complex Governance Challenges



Conclusion

From the schema above, we can clearly see that ensuring sustainable and equitable access to safe, quality water to the citizens of Dhaka is an extremely complex enterprise involving a range of stakeholders including public agencies, private entities as well as the citizens or water users. While DWASA is mandated to supply water, it has to depend on multiple stakeholders including public authorities and private entities, particularly for preserving the surface water sources and management of its distribution lines.

But we also see that the citizens or water users have several important responsibilities. For example, they must use water responsibly and efficiently. They should also take the responsibility of ensuring the quality of water as it reaches their territory. They must also refrain from illegal activities such as the use of suction pumps. But the citizens must be made aware and incentivized to play their part.

So DWASA needs to work in close collaboration with the water users. But in our survey, we find that approximately 84% of the respondents did not have any interaction or communication with DWASA. But increasing communication and interaction between DWASA and its users will be crucial in achieving the SDG 6 for the citizens of Dhaka: ensuring the availability and sustainable management of water and sanitation for all.

Water Demand Management: A Combination of Monetary and Non-monetary Measures

On one hand, the ever-growing population combined with factors such as economic growth and climate change will continue to increase the demand for water in Dhaka. Our study indicates that already there is a scarcity of water in the city. On the other hand, available water sources are becoming increasingly scarce because of groundwater depletion, disappearance and pollution of surface water sources.

But we also find that there may be inefficient use or waste of water in the formal settlements while a large number of households in the informal settlements are not getting enough water for a decent living. Through proper demand management, DWASA can reduce the existing inefficiencies in water use and attempt to bring further efficiency. This efficiency gain will enable DWASA to better serve the underserved low-income communities and close the ever-widening gap between future water demand and supply.

1. Setting a standard recommendation for water usage

From our interviews with DWASA officials, we found that DWASA estimates per capita demand to be 150 litres. But we did not find any recommended standard about how much water a city-dweller should use or need for a decent living.

- A standard usage recommendation can be used to track the extent of overuse and deprivation among the different segments of the citizens.
- A standard can be used to make the citizens aware of their own water usage.
- But most importantly, a standard can indicate our goal of increasing water-use efficiency

2. Need for a multi-pronged programme for water conservation

Awareness campaign

Despite the dire situation of our groundwater sources, we find that very few (only 21%) are concerned about the issue. We also find that households in the formal settlements are using, on average, more than double the amount of DWASA and other demand estimations. At the same time, households have no idea about how much water they are using because of the current billing system. So first, the citizens must be aware of our current and future water crisis and its relation to their water use habit.

Through decades-long series of campaigns such as 'Let's Not Waste Precious Water' and 'Safe Water Campaign', Singapore took diverse initiatives at national and community levels to inform citizens about the need for water conservation and inculcate water-saving habits. School children were specifically targeted for communication; a water conservation course was introduced in the high-school. To directly influence water use, free thimbles were distributed to reduce excessive pressure and flow by fitting them on taps and hoses. (Tortajada & Joshi, 2013).

Along with price measures, these campaigns have substantially reduced Singapore's domestic water usage over time—from 165 litres per day in 2003 to 143 litres in 2017, with a target to further lower it to 130 litres by 2030 (Singapore's National Water Agency (PUB) n.d.).

Currently, there is no long-term, well-planned campaign effort for motivating the citizens of Dhaka to conserve water. Based on good examples such as the one from Singapore, thorough and long-term campaigns should be designed and implemented, highlighting the critical situation of our water sources, future sustainability and providing specific guidance about how much water should be used and exactly how water can be conserved.

Creating a monetary incentive for water conservation

We found that in the current billing system, there is a weak correlation between water usage and the cost of water at the individual household level as the water bill of a holding/building is equally shared among the households irrespective of household size or usage. It has two consequences. First, even if an aware household wants to conserve, it has no way to monitor how much it is conserving. Second, individual households have no monetary incentive to reduce consumption, as discussed earlier. So, household-level water metering could provide financial incentive to conserve and also serve as a tracking tool for households that want to conserve.

Progressive tariff—water pricing as per usage—is a popular and successful measure used in many countries to manage water demand (Rogers, De Silva & Bhatia, 2002). A refined form of progressive tariff is Increasing Block Tariff (IBT), which specifies the rate charged for each additional block (volume) of water used—higher rate for higher block. Potential benefits of IBT includes: 1) It can ensure equity as poorer household tend to use less water, so they will get water at a reasonable rate (Rogers, De Silva, & Bhatia, 2002), 2) Progressive water tariff will further work as a monetary incentive for the household to conserve water, and 3) DWASA can get higher revenue. Good news is, around 61% of the surveyed households were found to be willing to pay for water as per usage.

Water Source Management: Implementation of Laws and Public Awareness

DWASA alone cannot maintain the sustainability of the sources of water. While DWASA needs to expedite the construction of the water treatment plants, it needs to work with other government agencies as well as the private entities for ensuring that usable freshwater sources are available.

3. Strong implementation of existing laws and coordination among agencies

A single coordinating agency should be established with overriding authority for Dhaka's water management system to oversee the compliance with legal norms and implementation of the Supreme Court's instructions. All concerned ministries and agencies (including land, planning, transport, DWASA, City Corporations) should sit together and discuss their roles to reduce overlap and fragmentation. The land -grabbers should be accountable through enforcing the High Court rule. The two City Mayors, as the elected representatives, should take the leading role in recovering grabbed water bodies.

The Hatir Jheel project is an example of how a strong political will and coordination can work in saving a critical water body from encroachment.

Water Quality Management: A Public, Community, and People Partnership

From the schema, we see that DWASA has a greater responsibility at the level of source and distribution line but as it gets closer to the water users, individual responsibility becomes more and more important. It is true that citizens or water users need to be made aware of their role but they also should take their share of responsibility.

4. Regular, pro-active, accountable monitoring of quality throughout the distribution channel

DWASA can take a number of measures to ensure a safe water supply. First, the entire distribution system should be brought within the DMA system, which will increase the durability and reduce the possibility of leakage and illegal connections.

DWASA should test the quality of water randomly from all vulnerable points in the distribution system at regular intervals and make the results available to the public. This will not only help DWASA to take targeted actions to fix the problems at source or the pipelines but will also help water users make informed choices about their action.

We can also explore the possibility of citizen engagement in the monitoring process of water quality within their community. The government is already testing how citizens can be proactively involved in monitoring the quality of public work, for example, through the DIMAPPP project (BIGD Inception report, 2018).

5. Water users also have a responsibility in maintaining water quality

In the survey, we find that the underground and rooftop reservoirs are cleaned in variable frequencies. A large percentage of respondents said that their reservoirs are cleaned less than twice a year or they do not even know whether their reservoirs are cleaned. We also found that, in most cases, the proper cleaning method is not followed. A quarter of our respondents also mentioned that their connection has a suction pump, which pulls mud and other pollutants along with water. All these indicate that there is a lack of awareness among the water users about their role in maintaining water quality. So, along with the efficiency campaign, DWASA also needs to campaign on creating awareness among the users on how they can play an active role in maintaining the quality of water. For example, DWASA should come up with a standard procedure and frequencies of cleaning reservoirs and create mass awareness for compliance.

It is evident that water users have a crucial responsibility in maintaining the quality of water. If they do not clean their reservoirs properly and regularly and do not store the water in a hygienic condition, they will never get good quality water even if the water quality is good at source or pipelines. Taking these initiatives needs time and money; but considering the potential health benefits, the cost is not very high. According to our estimate, it costs a maximum of BDT 8,000 to clean both the reservoirs on each occasion.

We conclude that in order to meet the challenges, we need a multi-stakeholder partnership that brings together the public and the private sector with community and people. We need to go beyond a single actor model to a multi-actor model and explore more effective innovations in both water supply and demand management.

Annexe 1.
Study Methodology

The geographical location for this study is the Dhaka WASA service excluding Narayanganj and Dhaka-Narayanganj-Demra (DND) area. This area is selected as it covers the main city area and also contains the most urban population and DWASA operations. Approximately 96% of DWASA's water, around 2,352 Million Liters per Day (MLD), is supplied to the consumers in Dhaka and the remaining 4% (98 MLD) goes to Narayanganj (DWASA, 2019a).

The study utilized both quantitative and qualitative methods. We used multiple data sources to fill data gaps and triangulate the findings. For instance, anecdotal evidence received from interviews have been cross-examined with published official documents and other literature. The research tools included:

Secondary data collection

Desk review of previous water studies, journal articles, and reports, particularly focused on urban context;

Collection of official statistics related to water demand-supply, the current state of surface water sources and institutional arrangements to manage water demand, supply, source, and quality

Household questionnaire survey

The perspectives of water users have been captured from randomly selected 768 households–both from formal and informal settlements. A structured questionnaire was used to collect information on water access, source, pricing, supply disruption, grievance handling, interactions with DWASA, satisfaction, awareness about water governance, and surface water management.

Sample size and respondent selection

The household population is the total number of households in the formal and informal settlements who have active DWASA connections over nine DWASA Zones. The sample size has been determined using the statistical formula as s=Z 2 (p) (1-p)/d 2 [s=sample size, Z=z score, p=estimated proportion of the population, d=margin of error]. This study took a confidence interval of 95% with a 5% margin of error, which brought the sample size to 384. Considering time and cost the study, we used cluster sampling to select two particular areas from each Zone—formal and informal. The study used a design effect (DEFF) of 2 (as a rule of thumb) as the variance is expected to be twice as large due to cluster sampling. This brings the total sample size to 768. Two-thirds of the respondents from each DWASA Zone were randomly selected from the formal settlements and one-third were selected from informal settlements.

Interviews and consultation with experts

Approximately, 32 relevant public officials, experts, civil society members, and academics were interviewed to obtain their views about legal, functional, and overall water governance in Dhaka. In addition, eight holding/flat owners were interviewed about various aspects of the cleanliness of underground and rooftop reservoirs. Also, an advisory group consisting of eight national and international academics, representatives from government (DWASA) and non-government organizations (Water Aid, Brac), and economists was formed to guide this study.

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BIGD, Brac University
SK Centre, GP, JA/4, Mohakhali, Dhaka 1212

+88 02 5881 0306, 5881 0326 info@bigd.bracu.ac.bd bigd.bracu.ac.bd