Chapter 26
Water Supply of Dhaka City: Present Context and Future Scenarios

Mohammed Abdul Baten, Kazi Sunzida Lisa, and Ahmed Shahnewaz Chowdhury

Abstract Dhaka, the capital of Bangladesh, has been expanding both horizontally and vertically since last three decades with an estimated annual growth of six percent. Over the past several decades, concerns have been raised regarding the amount of water used in Dhaka as with higher rates of personal water use, which mostly collected from ground water resulting in declined aquifers across the area. This study investigated household consumption and management behaviour, more specifically household water management of different income groups of Dhaka city. Based on the present water demand and supply data of Dhaka city, this study attempted to build three scenarios for the year 2050. The study finds that despite Dhaka Water and Sewerage Authority's (DWASA) existing capacity of supplying required water to its population, quality-water scarcity has been increasing at household level mostly due to management inefficiency. Under a business-as-usual scenario, the situation signals for a worrying future where 12.37 million people may be deprived of basic water requirement by 2050. In addition to existing inequality, unplanned rapid urbanization and over extraction of groundwater make the inhabitants more vulnerable to access to safe water. This research predicts that unless substantive actions are taken to increase surface water supply as well as reducing Unaccounted for Water (UfW) in response to increased demand, a considerable number of Dhaka's population will be deprived of access to minimum water with increased inequality even under ambitious future roadmap .

Keywords Access to water · Dhaka city · DWASA · Groundwater depletion · Water demand and supply

M. A. Baten (✉) · K. S. Lisa · A. S. Chowdhury
Independent University (IUB), Dhaka, Bangladesh
e-mail: a.baten@iub.edu.bd

M. A. Baten
University of Maine, Orono, USA

M. Babel et al. (eds.), *Water Security in Asia*, Springer Water,
https://doi.org/10.1007/978-3-319-54612-4_26

26.1 Introduction

Urban public services provision has been struggling to keep pace with population growth in developing countries, where access to safe water is a debateable issue (Bakker 2010). An estimate suggests that globally 142 million urban dwellers are lacking improved drinking water sources (UN-Habitat 2008). However, the situation is worse in low-income urban areas due to their poor infrastructure and inefficient management. Kjellén and McGranahan (1997) predict that two-thirds of the world's population will experience water stress condition by 2025 and some countries may experience high water stress condition where water withdrawal against available resources will exceed 40%. The alarming news is that the withdrawal rate against available resources is 48% in South Asia (Ariyabandu 1999). Bangladesh, being a riverine country, confronts dual challenges from water: firstly, unlimited flood water during wet season, and secondly, increasing scarcity during dry season. Bangladesh also faces tremendous challenges in providing safe and adequate water to its large population, most importantly its' rapidly growing urban population.

Water is a cross cutting resource due to its social and ecological importance. But in many cases, water resource experiences mismatch in management, where the scale, at which decisions are made, does not match the scale, at which it functions (Cash et al. 2006). The urban water management involves complicated and systematic process that includes planning, research, design, engineering, regulation, and administration. Mismatches among these processes may give rise to inadequate water supply. Such situation creates spaces for private sector to intervene in the water supply, either in the form of large corporation or small vendor based on micro treatment plants, whose overwhelming focus on profit may exert additional price pressure to the consumers (Bakker 2010). Those, who cannot afford costly private water supply or out of public water supply network coverage, are often found collecting water through illegal tapping or compelled to use polluted water from urban lake or other common water bodies (Singh 2004).

Water right, inherently linked to other fundamental human rights, is not merely a right issue rather it is a highly political and policy issue (Watkins 2006). The constitution of Bangladesh reserves the rights of its citizen and acknowledges country's obligation to provide the basic necessities of life such as food, clothing, shelter, education and medical care [Constitution B (1972) Article 15, clause (a)]. It seems that the water right is considered under food, but no article or clause deduces the water right issue conspicuously.

In Bangladesh, the National Policy for Safe Water Supply and Sanitation (GoB 1998) declares state ownership to water. Even though the policy acknowledges that access to safe water is essential for socio-economic development of the country, but no special provision was made to ensure citizen's right to water. Rather, article 4.3 (paragraph f) addresses water as an 'economic good' by keeping provision of conferring water right to private or community bodies to provide secure, defensible and enforceable ownership/usufructuary rights for attracting private investment. Moreover, the Bangladesh Water Act (2013) in its preamble defines 'right to water' as acquired access and use rights. The act does not acknowledge ‘citizen right to water’ and state’s obligation to supply safe water; rather it encourages privatization of water through a general authorization or license. These provisions defy the spirit of constitution’s deceleration on rights to the basic necessities. On the other hand, the Government of Bangladesh (GoB 2011) kept provision of developing and to managing water resources efficiently in its Sixth Five Year Plan (2011–2015), but ‘right to water’ issue remained overlooked there as well.

Since Independence in 1971, Bangladesh has been maintaining an upward economic growth with non-linear GDP figures. Economic opportunities attract more people in rural areas to urban growth centres and, therefore, country’s urban population is growing on an average six percent per annum (Islam 2015). Rasheed (2000) predicted that the urban population growth would continue to be higher than the rural population in this decade, although it might decrease somewhat from the present level. Based on current growth trend, Rasheed (2000) estimated that in the next decade the relative proportions of the urban population would be 47% by 2020, and 53% by 2025 in Bangladesh. Dhaka, capital of Bangladesh, has been experiencing a tremendous growth in last few decades both horizontally and vertically, but the earlier rate has slowed down in current decade, albeit maintaining an annual rate of 3.5% without following any systematic plan (Islam et al. 2010). The percentage of urban population in Dhaka district was 21.9% in 1981, which has reached to 27.8% in 2011 (BBS 2011).

Despite being recognized as a megacity based on population number, Dhaka’s urban basic services provision is well behind the required standard (Moinuddin 2013). Specially, in the last five/six years the situation has reached an alarming state due to unregulated urban sprawl that dispenses immense pressure on the infrastructures of the city resulting in deprivation of basic amenities to a large population, where water supply has appeared as the most critical service. Nishat et al. (2008) estimate that 25% population of Dhaka city has no direct access to potable water.

Dhaka Metropolitan Area (DMA) constitutes 27% (360 km^2) of Dhaka Statistical Metropolitan Area (DSMA), which covers an area of 1353 km^2. Until 1989, Dhaka Water Supply and Sewerage Authority’s (DWASA) operation was limited to DMA, but since 1990 it has extended operating area to adjacent Narayanganj metropolitan area (DWASA 2011). Even though this paper will focus on DMA, but it would consider demand and supply of DWASA as a whole. Based on the DWASA demand and supply data, this research has empirically examined Dhaka city’s (Fig. 26.1) present water demand and supply context, built future scenarios both at spatial and temporal scale, and finally identified challenges that need to be addressed for an efficient water supply system.

26.1.1 Dhaka City’s Water Supply System

History of piped water supply in Dhaka city is dated back in 1874, when a small water treatment plant was built on the bank of the Buriganga River to provide water to some rich households of old Dhaka through roadside hydrants (DWASA 1991).

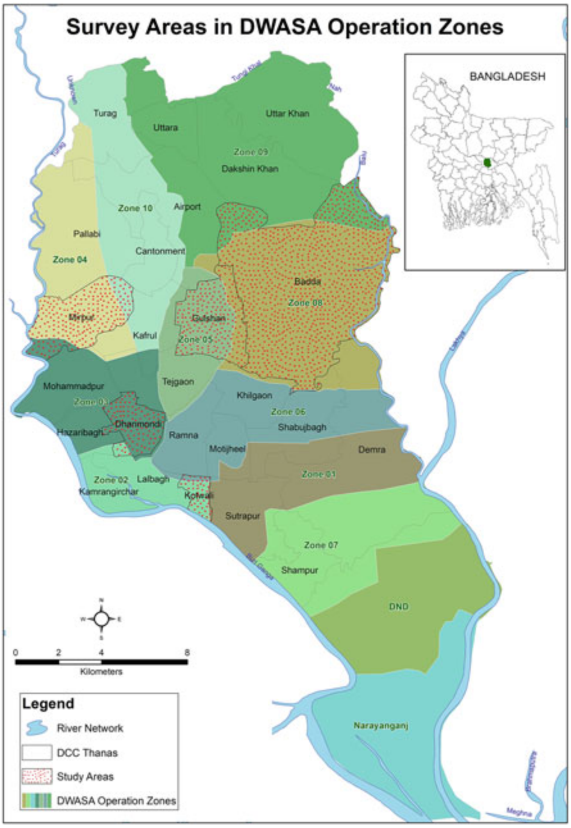

Fig. 26.1 Map of Dhaka Water and Sewerage Authority (DWASA) operation area and survey area

Before establishing DWASA in 1963, the responsibility for supplying water to Dhaka city residents was laid to Dhaka Municipal Corporation (DMC). Later DWASA was created in 1963 under the Ordinance No 19 to provide water and to manage sewerage of Dhaka city. On the other hand, DMC was renamed as Dhaka City Corporation (DCC) in 1990, which has been mandated to regulate private sources of water supply. However, the DCC became inactive in water, sewerage and drainage services after establishment of DWASA, although DCC is yet shown active performing these functions in the stature book (Siddiqui et al. 2000).

The DWASA ordinance was amended in 1996, and a vision plan was prepared to ensure 100% water supply coverage by 2005 and 80% sanitation coverage by 2020 (Haq 2006). At present, both Dhaka city and Narayanganj city are under the service coverage of the DWASA, and they have a plan to further extend services to adjacent suburb of Gazipur and Savar in the near future (Siddiqui et al. 2000). For management purposes, the DWASA service area is divided into 8 zones, of which 7 are located in Dhaka city and only one is in Narayanganj city (Siddiqui et al. 2000).

Since establishment, the DWASA has expanded both in coverage area and water supply capacity, yet its' standard of service is under critical scrutiny. World Bank (1999) conducted a survey and found that over the years, water supply situation in Dhaka did not improve much compared to the minimum requirement of the city dwellers. Although DWASA estimates water demand considering 150 L per Person per Day (lpd), but about one-third of the total city dwellers even do not get minimum water requirement of 100 lpd as set by WHO (2010). During dry season, when groundwater level goes down and water demand increases, water supply situation in some parts of the city becomes unbearable. Varis et al. (2006) estimated that DWASA could supply 0.51 km^3 of water per year against the demand of 0.73 km^3, serving around 72% of the city dwellers. The quality of the supplied water is very much in question. More than 1,300 private wells abstract another 0.40 km^3 of groundwater annually, mainly for industrial purposes (DWASA 2014).

Like many other urban areas of developing countries, getting water is becoming more difficult and often more expensive for the poorest people in Dhaka city. Women and children of poor households in urban settings spend hours - in extreme cases up to six to eight hours - each day to collect water from different sources (World Bank 2013). In most cases, the poor do not have piped water supply in their property. Instead, they have to buy or take water from other sources. People, who buy water from other sources, may have to pay three to ten times higher than the price of DWASA supplied piped water (World Bank 2013). In the slums of Dhaka city, the average user to water-point ratio is 1,000:1 and only 20% of the people have some form of sanitary latrine (Ahmed 2004). Lack of sanitation, long queuing times for water collection, and unhygienic surroundings are the appalling concerns in the slums of Dhaka city. Other than these squatters, permanent residents of Dhaka city have also been experiencing a year-round water scarcity, more acutely in dry season (Khan 2013). In response to water scarcity, many affluent residents and small water-vendors have installed private deep tube wells, and pump groundwater illegally that results in lowering the groundwater table further. Water quality is another major concern for dwellers of Dhaka city. Even though DWASA claims to maintain the quality of water according to WHO requirements, but the consumers are apprehensive regarding the quality. Consequently, the urban citizens seldom drink untreated piped water, rather boil the supplied water to kill dangerous bacteria making it potable.

Over the years, surface water sources have been considered as unreliable for drinking water that requires more capital investment to serve the citizens' demand. Accordingly, emphasis was given to groundwater extraction (Crow and Sultana 2002). Water supply in Bangladesh is overwhelmingly dependant on groundwater. In rural areas, more than 90% of the population extracts groundwater to meet drinking water demands (World Bank 2008), whereas 87.60% of the Dhaka city's water supply is coming from groundwater sources (DWASA 2014). Moreover, rapid urbanization and resultant increased built area has been contibuting to the increased surface run-off retarding infiltration. Thus, groundwater recharge rate is decreasing day by day. Due to unregulated abstraction and lower recharge of the aquifers, the water table in Dhaka has been lowering down at the rate of more than two meter per year (Akther et al. 2010; UNEP 2005).

26.2 Materials and Methods

This study has examined performance of the DWASA for the present and future. Data on water demand and supply were obtained from DWASA annual report 2012–13, 2013–14 and DWASA Monthly Information Report (MIR) June 2014. To gain understanding on the dynamics and management context of water supply at Dhaka city, and to build possible future scenarios, three experts from DWASA, Bangladesh University of Engineering and Technology (BUET) and Dhaka University were interviewed by both face-to-face and telephone calls.

To investigate household water consumption and management behaviour, 300 households were surveyed based on income groups from five different areas of Dhaka city (Fig. 26.1). Study areas were primarily selected using cluster sampling based on the Household Income and Expenditure Survey (HIES 2010) income range and RAJUK[1] (*Rajdhani Unnayan Kortipokkho*) recognized settlement areas based on income groups. For instance, *Gulshan* and *Dhanmondi* areas were selected for high-income residences, *Banasri* and *Wari* (Old City) were selected for middle-income, and *Mirpur* was selected for lower middle income and low-income groups. From each study area, 60 households were then surveyed using systematic random sampling.

Residential water use for the DWASA was calculated using the number of households on public water supply and the average per-household water use per day. Per-household water use is a function of demographic, socioeconomic, or climatic variables (Arbues et al. 2003). DWASA estimates its demand as 150 lpd (DWASA 2014).

Residential water use for the years 2020, 2030, 2040, and 2050 was projected by a linear-predictive model using an estimated model intercept (inelastic demand) and linear coefficients for demographic growth. For water demand projection, the average population growth of Dhaka city was estimated as 3.5% for the years 2010, 2020, 2030, 2040 and 2050.

Total residential water use for the years 2020, 2030, 2040, and 2050 is determined as follows:

$$Qy = (qy * hy)/10^6 \tag{26.1}$$

where,

Q_y is the total residential water use in year (y), in million liter per day;
q_y is the per-household water use in year (y), as determined; and
h_y is the number of persons served by public supply in year (y).

[1]RAJUK is a statuary body authorized for Dhaka city's settlement planning and implementation.

26.3 Results and Discussions

26.3.1 Current Water Demand and Supply in Dhaka City

Water supply in Dhaka city is predominantly groundwater based. Although four rivers surround Dhaka city (namely, Buriganga, Balu, Turag and Tongi *Khal*), only 12.40% of supplied water is coming from these rivers (ADB 2004). Surface water sources from surrounding rivers and lakes have already exceeded the standard limits of many water quality parameters because of the discharge of huge amount of untreated and municipal wastes. Treatment of this water has become so expensive that water supply authorities have to depend on groundwater aquifer for drinking water production (Biswas et al. 2010). Other than these four over-polluted rivers, the nearest water body is the Padma River and the Meghna River, which have acceptable water quality and ability to meet the demand; however, those rivers are located within a distance of 17 km and 50 km respectively from Dhaka.

Since 1990, DWASA had been projecting total water demand considering 160 lpd. But from the year 2010, it has started projecting demand as 150 lpd, and accordingly supplies water to the city dwellers. Total water demand in Dhaka city varies from 2,100 to 2,300 Million Liter per Day (MLD) with seasonal variation. Arguably, since 2014 DWASA total production capacity is 2,420 MLD (both groundwater and surface water) (DWASA 2014). Apparently, DWASA is able to fulfil current water demand through their capacity. However, DWASA has never been able to reach its production target. If we account 31.68% unaccounted for water (UfW)[2] or system loss between production and end-user level then end-user water availability would be 1,653.34 MLD. The statistics implies that approximately 25% of the population in Dhaka city are deprived of getting DWASA projected standard water requirement of 150 lpd. To supply water in Dhaka city, DWASA runs 702 Deep Tube Wells (DTWs) and four Surface Water Treatment Plants (SWTPs) (DWASA 2014) (Table 26.1).

[2]Unaccounted-for-water, expressed as a percentage, is calculated as the amount of water produced by the DWASA minus the metered customer use divided by the amount of water produced multiplied by 100. They collect water from the mainline without permission or in contract with corrupted person of the supply authority. During the financial year 2002–2003, almost 52% system loss was accounted that indicates very poor management scenario. The situation has been fluctuating but never came to an admissible limit. Present Government has taken a few initiatives to lessen system loss in water supply. With this and by the increasing effort of the DWASA officials, the system loss is gradually decreasing. During the FY 2009–2010, the system loss was accounted for 35.7% while in FY 2010–2011 the UfW goes down to 31.7%. It is an indication that if Government and authority show their willingness to improve management, the situation becomes well off. In addition, awareness campaign regarding misuse of water also contributes to the lowering down of the system loss (DWASA 2011).

Table 26.1 Current water supply information of DWASA (*Source* DWASA 2014)

	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015
Deep tube well	586	615	644	672	702
Water treatment plant	4	4	4	4	4
Water production/day (MLD)	2,150	2,180	2,420	2,420	2,420 (+)
Water demand (MLD)	2,180	2,240	2,250	2,280	2,300
Ground water (MLD)					2,120
Surface water (MLD)					300
Water line (km)	2,800	3,040	3,040	3,040	3,461.56
Public hydrant (active)	38	38	38	38	38
Roadside tap	1,643	1,643	1,643	1,643	1,643
Connection to religious organizations	1,898	1,898	1,898	1,898	1,898
Residential consumer	–	–	–	–	89.59%
Total consumer	–	–	–	–	3,50,772 connections

26.3.2 *Future Water Demand and Supply Scenarios of Dhaka City*

Providing safe and adequate water to city dwellers are challenges to the DWASA. Considering population growth and expansion of the city areas, DAWSA plans to adjust its infrastructure and management practices accordingly. Rasheed (2000) projected that Dhaka city's water demand would reach to 3,200 MLD by the year 2025 (the author estimated water demand as 160 lpd). The author warned that unless undertaking more comprehensive and long-term schemes by the DWASA, the city would experience greater shortage of domestic water supply by 2025 compared to the present condition.

In this study, based on the existing water supply data and DWASA (2014) projected future road map, three scenarios on future water demand and supply status in Dhaka city are constructed for the years 2020, 2030, 2040 and 2050. For these projections, the average population growth of Dhaka city is estimated as 3.5% and water demand is calculated as 150 lpd. The first scenario is based on the current production status of DWASA (2014) under a business-as-usual situation; but second and third scenario considered UfW and Downtime Loss or Machine Loss (Cs) anchored on the ambitious future road map.

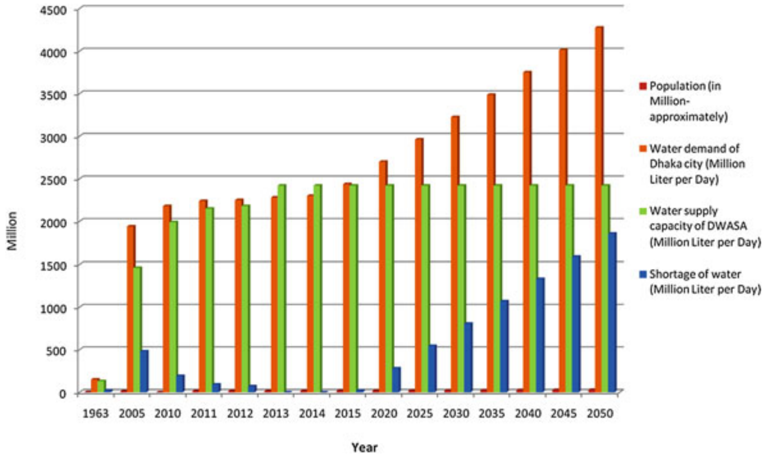

Fig. 26.2 Demand and supply of water supplied by DWASA in 2050 (*Source* DWASA 2014)

26.3.3 Scenario 1 (Obscure)

Based on demand and supply data as collected from the official document of DWASA (2014), considering 2014 as *status quo* in water production, a projection is constructed, which illustrates that by the year 2050 the demand and supply gap would be 1,855 MLD. The supply gap implies that 12.37 million people of Dhaka city may suffer from acute water crisis in 2050, unless the production increases comprehensively (Fig. 26.2).

26.3.4 Scenario 2 (Enigma)

DWASA has undertaken a number of initiatives to address increasing trend of present and future water demand. Many of those initiatives are still at the planning stage. The second phase of the Saidabad Surface Water Treatment Plant (SWTP) came under operation in 2012 with a supplying capacity of 225 MLD along with previous First Phase of 225 MLD. Moreover, several other projects are under consideration to lessen the dependency on groundwater and enhance the surface water extraction.

The current study has made another projection for 2050 based on DWASA's future roadmap. Taking into account the UfW or system loss as 30% from production to end-user level, the projection shows that despite huge investment plan in water production, DWASA will not be able to meet future demands without reducing UfW to 10% or less from the current percentage of 31.68% (Table 26.2).

Table 26.2 Water supply scenario based on future water production road map

Year	2012	2015	2020	2025	2030	2035	2040	2045	2050
Total user-end demand (MLD)	2,250	2,437.5	2,700	2,962.5	3,225	3,487.5	3,750	4,012.5	4,275
UfW (%)	30%	30%	30%	30%	30%	30%	30%	30%	30%
Ground water (MLD)	1,880	2,120	2,120	2,120	2,120	2,120	2,120	2,120	2,120
Sayedabad SWTP I (MLD)	225	225	225	225	225	225	225	225	225
Sayedabad SWTP II (MLD)	225	225	225	225	225	225	225	225	225
SWTP III (Khilkhet) (MLD)			500	500	500	500	500	500	500
SWTP IV (Padma) (MLD)			500	500	500	500	500	500	500
SWTP V (Sayedabad) (MLD)				500	500	500	500	500	500
SWTP VI (MLD)					500	500	500	500	500
SWTP VII (MLD)					500	500	500	500	500
Total production capacity (MLD)	2,330	2,570	3,570	4,070	5,070	5,070	5,070	5,070	5,070
Total user-end gap (30% UfW)	699	771	1,071	1,221	1,521	1,521	1,521	1,521	1,521
Shortage (Total production-(30% UfW + Total user-end demand) MLD	−619	−638.5	−201	−113.5	324	61.5	−201	−463.5	−726

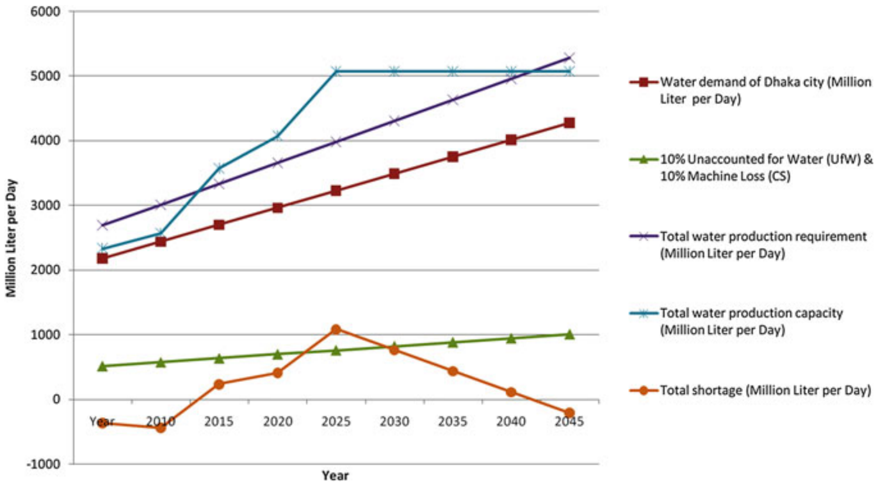

Fig. 26.3 Water demand and supply scenario considering 10% production loss (Cs) and 10% Unaccounted for Water (UfW)

26.3.5 Scenario 3 (Utopia)

The third scenario is a combination of ambition and reality. This scenario is based upon DWASA's future production roadmap and perceives that DWASA will have improved their management system so that they would have been able to reduce UfW up to 10% from current 31.68%. Nevertheless, the pump cannot operate to its full capacity due to power shortage, depleted ground water table, and pump-overhauling time. The scenario, therefore, considered 10% machine loss (Cs). The groundwater table is declining at a rate of 2.81 m/yr (UNEP 2005), the upper Dupi Tila aquifer has reached its limit, and it is likely that 223 numbers of DTW will need to be replaced as the existing ones would go out of service by 2013 because of depletion of groundwater table (DWASA 2011). Under this scenario, it is assumed that the DWASA would be able to fulfil Dhaka city's water demand by 2018. Moreover, DWASA supply would supersede the demand in 2020 through maintaining increased trend of production status and improved management system. However, unless new treatment plants are coming into operation in response to increased demand starting at 2045, DWASA will experience 209.63 MLD supply deficit by 2050 even in this highly ambitious scenario (Fig. 26.3).

26.3.6 Challenges of Water Supply in Dhaka City

Taking into account DWASA's incapacity of supplying required water, sewerage and drainage facilities to the growing population, Siddiqui et al. (2000) identified two incongruities. First, they showed their reservation in extending service area of DWASA without improving existing service quality. Second, they have noticed that DWASA has a strong preference to the higher income groups than lower income groups in case of service delivery. Their study found that about 98 to 100% of the households in *Banani*, *Baridhara,Gulshan* and *Dhanmondi* residential areas have water and sewerage connections, whereas only 50 to 75% households have these facilities in lower middle-income areas such as *Rayer Bazar*, *Bashabo*, *Jurain* and *Mirpur*. However, this current study has found a slightly different scenario for water connection. Almost 100% of the household in *Mirpur*, *Banashri* and Old Dhaka, considered as middle and low income residence, are connected to DWASA. But, in case of residence of *Gulshan* and *Dhanmondi,* the percentage is 67 and 87, respectively, though DAWSA has pipeline in those places (Table 26.3). This is because of DWASA's poor service quality that provokes high income residents of *Gulshan* and *Dhanmondi* areas to install private DTWs, and develop their own supply system. This study also finds that almost 90% of the people, who are dependent on DWASA as a primary source of household water, take any of the precautionary measures, either boiling or using filter or combination of both, to make the supplied water drinkable. It implies that most of the city dwellers do not rely on DAWSA water for drinking, but in *Gulshan* and *Dhanmondi* areas one third of the respondents were found drinking water directly collecting from their own source other than DWASA's supply system (see Table 26.3 for full results). World Bank (1996) found that only 42% have access to reasonably safe drinking water sources in urban areas of Bangladesh, and the rest others have to depend on contaminated sources.

Challenges regarding access to water vary from area to area and with the changing socio-economic status. Social wellbeing, economic development, and environmental quality are dependent on water resources, and a little change in water supply can largely affect the development process (Forslund et al. 2009). Siddiqui et al. (2000) surveyed over 3000 slums and squatter settlements, and found that access to the DWASA service was restricted to less than 2% of the population. The same study also interviewed 175 journalists on their experience of services provided by the DWASA including DMP, RAJUK, and DESA. The study found that almost 80% of the respondents were dissatisfied with the performance of the DWASA in terms of transparency, accountability, corruption, and people's participation. In an interview, DWASA's the then Managing Director also admitted that corruption was rampant in DAWSA, and sometime they fall short to reach the standard quality in water supply (The Daily Janaknatha July 7 1997).

Haq (2006), Khan and Siddique (2000), Rasheed (2000), and Siddiqui et al. (2000) have identified serious lack of coordination among DWASA, RAJUK, Titas Gas, DCC, and DESA, who are responsible for providing different services to Dhaka city dwellers. Such mismatches result in poor services and sufferings for the city dwellers. Haq (2006) and Siddiqui et al. (2000) also noticed DWASA's lack of comprehensive planning on tapping rainwater including enhancing ground water recharging. Both the authors identified system loss and faulty revenue collection as the most important governance challenges. Siddiqui et al. (2000) have noticed 74% revenue collection against the billed amount.

Table 26.3 Household water management behavior of Dhaka city residents of different income groups (expressed as percentage of population)

		High income groups		Middle income groups		Lower middle and low income groups
Study area		Dhanmondi	Gulshan	Rampura-Banashri	Old Dhaka (Wari)	Mirpur
Source of water at household	DWASA (%)	87	67	98	100	100
	Private well (%)	12	33	2	0	0
Primary source of drinking water	Piped water	98	60	95	87	95
	Bottled water	2	2	0	7	0
	Both piped and bottled water	0	12	2	0	2
Drinking water treatment	Filter attached to water tap	0	27	12	2	22
	Filter after collection	8	0	2	0	8
	Boiled water	5	0	15	42	15
	Use purification tablet	0	0	0	2	0
	Use carbon filter	20	0	10	2	0
	Boiled and Filter	32	53	52	47	38
	Direct use of tap water	35	20	10	7	17

The DWASA projects water demand taking into account the water consumption at a rate of 150 lpd, compared to the internationally accepted standard of 110 lpd (DWASA 2011). DWASA produced few scenarios to meet future demands considering water demand as 140 lpd for residential consumers in 2010, with a vision of reducing water demand to 110 lpd by 2025 through increasing water use efficiency (DWASA 2010). On the other hand, for slum dwellers, current water demand has been projected as 35 lpd (DWASA 2010) against basic water demand of 50 lpd[3] (Gleick 1996). However, under a long-term vision, DWASA plans to increase water supply to slum dwellers to 50 lpd by 2050 (DWASA 2011). The current scenario on water access implies that poor people are, mostly living in slum areas, neglected both at the demand and supply side, more deprived of having access to potable water, thus suffering from health hazards.

26.3.7 Groundwater Depletion of Dhaka City

With rapid urbanization, the paved area of Dhaka city has been increasing without following any regulated and structured trend (Aziz et al. 2012) that affects percolation of water. Moreover, paved area increases total surface run-off, which also affects the drainage system (UNEP 2005). In many parts of the city, the main aquifer has changed from a confined to an unconfined condition. Such changes in the hydrodynamic condition can make the aquifer vulnerable to possible groundwater contamination.

Dhaka city's water supply is overwhelmingly dependent on ground water that results in depletion of water table. Akther et al. (2010) estimated that DWASA withdrew 1.6 Million Cubic Meters per Day (MCM/d) of groundwater in 2005 against city's total water demand of 2.1 MCM/d. UNEP (2005) reported a 20 m decline of ground water table between 1997 and 2005 at a rate 2.81 m/yr. However, the depletion rate is uneven and the worst case recorded at the central part of the city due to high population pressure and increased commercial activities. Water table also depletes due to the overlying hard clay and increased urbanization that retards vertical recharge to aquifer. For instance, the groundwater table at *Tejgaon* area, located in the central part of Dhaka city, is about 65.7 m below the ground surface, at *Mirpur* about 55.4 m below the ground surface, but in *Mohammadpur, Dhanmandi* and *Sutrapur* areas, which are close to the river periphery, 20 to 34 m below the ground surface (Zahid et al. 2009).

In addition to the 702 DTWs (average capacity 3,000 L per month) operated by the DWASA, there are more than 1,300 wells of various capacities are under operation by the private Sector (DWASA 2014). Haq (2006), with reference to Sir McDonald and Partners (1991) and BUET (2000) studies, warned that such groundwater abstraction may result in land subsidence in Dhaka city, similar to the incidence that happened in Bangkok and Mexico City. Therefore, the study suggested reducing the contribution of groundwater to maximum 50% in the total water supply. However, the

[3]Water requirement (e.g. drinking, removing or diluting waste materials, producing manufactured goods, growing food, producing and using energy) varies with weather, lifestyle, culture, tradition, diet, technology, and wealth. The type of access to water is an important determinant in gross water use where use of water is the commutation of withdrawal (intake), recirculation, and reuse (Gleick 1996). Using a minimum level of 15 lpd for bathing and 10 lpd for cooking, the international organisations and water providers recommended adopting an overall Basic Water Requirement (BWR) of 50 lpd for meeting domestic basic needs, irrespective of climate, technology, and culture (Gleick 1996).

author was aware that building a treatment plant for surface water has a much longer gestation period and high initial cost, which may present challenge to water supply system. Moreover, lack of locally available manpower and equipment along with highly polluted surface water sources of the city (rivers and wetlands around Dhaka city) make it difficult to shift to surface water sources quickly from current higher dependency on ground water.

26.4 Conclusions

Access to safe water is critical to economics as well as to the ecosystems; and a scarcity of safe water can directly affect the long-term prospects for sustainable development (Forslund et al. 2009). Without an adequate water supply, living organisms may die, factories depending on water may have to close temporarily, crop yields may decline, workers may be unproductive, and fisheries may destroy. The present water supply of Dhaka city is heavily dependent on groundwater, which signals for a murky future with acute water crisis. Though the DWASA has already started to shift its present groundwater based production system to surface water production, but the shift demands huge investment and time. Moreover, the status of peripheral rivers of Dhaka city is so degraded and a major portion is under illegal encroachment that it is highly unlikely to fulfil the future demand just only relying on these sources. Considering the present crisis and future demand, it is high time to seek additional sources and improve present management system through reducing system loss and using water efficient appliances.

Acknowledgements This research received a financial grant from Christian Aid under "Addressing Inequality" project implemented by the Unnayan Onneshan and another grant from the Independent University Bangladesh (IUB) to conduct a survey on water management behaviour of residents of Dhaka city. This paper is a part of a larger report titled 'Water Supply of Dhaka City: Murky Future'. A part of the report titled "Diagnosing water supply of Dhaka city: present and future" paper was presented in the IWA World Congress on Water, Climate and Energy 2012, 13–18 May - Dublin, Ireland. However, this version of paper is a completely reworked and revised version. The authors would like to thank Mr. Rashed Al Mahmud Titumir, Chairperson of Unnayan Onneshan for his constant support, careful supervision, and continuous encouragement to carry out this research.

References

ADB (2004) Technical assistance consultant's report; Dhaka water supply project. Asian Development Bank

Ahmed M (2004) Development and management challenges of integrated planning for sustainable productivity of water resources. Proc Bangladesh J Polit Ecol 21(2):105–142

Akther H, Ahmed MS, Rasheed KBS (2010) Spatial and temporal analysis of groundwater level fluctuation in Dhaka City, Bangladesh. Asian J Earth Sci 3(4):222–230

Ariyabandu RDS (1999) Development of rainwater harvesting for domestic water use in Rural Sri Lanka. Asia-Pac J Rural Dev 9(1):1–14
Arbués F, Garcıa-Valiñas MÁ, Martınez-Espiñeira R (2003) Estimation of residential water demand: a state-of-the-art review. J Socio-Econ 32(1):81–102
Aziz SS, Ferdosh J, Khalid M (2012) Governance of urban services in Dhaka city. In: State of cities: urban governance in Dhaka. Institute of Governance Studies, Brac University
Bakker K (2010) Privatizing water: governance failure and the world's urban water crisis. Cornell University Press, Ithaca
BBS (2011) Population & Housing Census 2011. Bangladesh Bureau of Statistics, Dhaka
Biswas SK, Mahtab SB, Rahman MM (2010) Integrated water resources management options for Dhaka city. In: Proceedings of international conference on environmental aspects of Bangladesh (ICEAB10), Japan
Cash DW, Adger WN, Berkes F, Garden P, Lebel L, Olsson P, Young O (2006) Scale and cross-scale dynamics: governance and information in a multilevel world. Ecol Soc 11(2):8
Crow B, Sultana F (2002) Gender, class, and access to water: three cases in a poor and crowded delta. Soc Nat Resour 15(8):709–724
DWASA (1991) Annual Report 1990–1991. Dhaka Water and Sewage Authority, Dhaka
DWASA (2010) Annual Report 2009–2010. Dhaka Water and Sewage Authority, Dhaka
DWASA (2011) Existing situation & service delivery gap report. Dhaka Sewerage Master Plan Project (Package DS-1A), Dhaka Water and Sewage Authority, Dhaka
DWASA (2013) Annual Report 2012–2013. Dhaka Water and Sewage Authority, Dhaka
DWASA (2014) Annual Report 2013–2014. Dhaka Water and Sewage Authority, Dhaka
DWASA (2014) MIR June 2014 (management information report). Dhaka Water and Sewage Authority, Dhaka
Forslund A, Renöfält BM, Barchiesi S, Cross K, Davidson S, Farrell T, Smith M (2009) Securing water for ecosystems and human well-being: the importance of environmental flows. Swedish Water House Report, vol 24
Gleick PH (1996) Basic water requirements for human activities: meeting basic needs. Water Int 21(2):83–92
GoB (2011) Accelerating growth and reducing poverty. Sixth Five Year Plan FY2011-FY2015, General economics division, planning commission, Ministry of Planning, Government of Bangladesh, Dhaka
GoB (1998) National policy for safe water supply & sanitation. Ministry of local government, rural development and cooperatives, Government of the People's Republic of Bangladesh, Dhaka
Haq KA (2006) Water management in Dhaka. Int J Water Resour Dev 22(2):291–311
HIES (2011) Household income and expenditure survey 2010. Bangladesh Bureau of Statistics, Dhaka
Islam MS, Rahman MR, Shahabuddin AKM, Ahmed R (2010) Changes in wetlands in Dhaka city: trends and physico-environmental consequences. J Life Earth Sci 5:37–42
Islam N (2015) Urbanization in Bangladesh: challenges and opportunities. In: Conference towards sustained eradication of extreme poverty in Bangladesh, Dhaka
Khan A (2013) Conserve water, save life. The daily star. https://archive.thedailystar.net/beta2/tag/water-shortage/. Accessed 05 Oct 2013
Khan HR, Siddique QI (2000) Urban water management problems in developing countries with particular reference to Bangladesh. Int J Water Resour Dev 16(1):21–33
Kjellén, M, McGranahan G (1997) Urban Water-towards Health and Sustainability. Comprehensive Assessment of the Freshwater Resources of the World, SEI
Moinuddin G (2013) Metropolitan government and improvement potentials of urban basic services governance in Dhaka City, Bangladesh: rhetoric or reality? Theor Empir Res Urban Manag 8(4):85–106
Nishat B, Rahman SMM, Kamal MM (2008) Environmental assessment of the surface water sources of Dhaka City. In: Proceedings of international conference on sustainable urban environmental practices, Southeast Asia urban environment applications (SEA-UEMA), Chiang Mai, pp 13–37

Rasheed KBS (2000) Bangladesh towards 2025. In: Ahmad QK (ed) Bangladesh water vision 2025: towards a sustainable water world. Bangladesh Water Partnership, Dhaka
Siddiqui K, Ahmed J, Awal A, Ahmed M (2000) Overcoming the governance crisis in Dhaka City. University Press Limited, Dhaka
Singh R (2004) Water for all: is privatisation the only solution? Combat Law 3:2
The Daily Janaknatha (1999) Interview of DWASA managing director. Accessed 07 July 1997
UNEP (2015) Dhaka City - State of Environment (SOE). United Nations Environment Programme, Dhaka (2005). Accessed 10 Dec 2015
Un-Habitat (2008) State of the world's cities 2008–2009: Harmonious Cities, Earthscan
WHO (2010) The right to water, fact sheet no. 35. WHO, OHCHR, UN-Habitat, UN, Geneva
Varis O, Biswas AK, Tortajada C, Lundqvist J (2006) Megacities and water management. Int J Water Resour Dev 22(2):377–394
Watkins K (2006) Human development report 2006-beyond scarcity: power, poverty and the global water crisis. UNDP Human Development Reports, UNDP
World Bank (1996) Fourth Dhaka water supply project. Staff Appraisal Report, Washington DC
World Bank (1999) Toward an urban strategy for Bangladesh: infrastructure unit. South Asia Region, Washington DC
World Bank (2008) Bangladesh - water supply program project: restructuring. Washington, DC (2008). https://documents.worldbank.org/curated/en/2008/09/9880147/bangladesh-water-supply-program-project-restructuring. Accessed 22 Dec 2015
World Bank (2013) Access to safe water. Washington DC (2013). https://www.worldbank.org/depweb/english/modules/environm/water/. Accessed 09 Oct 2015
Zahid A, Hassan MQ, Karim MA, Islam MA (2009) Excessive withdrawal of groundwater for urban demand of Dhaka city: emergency measures needs to be implemented to protect the aquifer. In: Proceeding of the international symposium on efficient groundwater resources management, Bangkok, pp 219–222