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High Population Growth and Climate Change: Challenges in Safe Water Supply of Dhaka City

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ABSTRACT

Dhaka, the capital of Bangladesh, is one of Asia's fastest growing cities, with a population currently around 20 million. Safe water supply is a major challenge from the very beginning of the city. Much of Dhaka's water problem centers on its over-dependence on ground water, and water specialists say the city needs to increase its usage of surface water sources like ponds, rivers and canals. Excessive use of ground water put pressure on water resources, stresses that are likely to be exacerbated by climate change. Power outages and a drop in the water table during the annual dry season from March to May mean water supply authority is unable to extract enough water to meet demand. High population growth and climate change is likely to increase water demand while shrinking water supplies. This shifting balance would challenge water managers to simultaneously meet the needs of fastest growing communities, sensitive ecosystems, energy producers and manufacturers. Changes in the amount of rain falling during storms provide evidence that the water cycle is already changing. But water needs are increasing day by day in not only Dhaka city but in all over the world. Due to climate change temperatures rise, as a result people and animals need more water to maintain their health and thrive. In this study high population growth, climate change and sustainability of safe water supplies of Dhaka city analyzed broadly.

KEYWORDS

Climate change, water supply, population growth; Dhaka; Bangladesh

INTRODUCTION

Bangladesh is undergoing one of the fastest urbanization processes in Asia. By 2017, the country's urban population is expected to hit 50 million, representing almost one third of the total population (UNICEF, 2015). In a high density city of Bangladesh like Dhaka, the effects of climate change on the surface and ground water resources will be very severe and alarming. Changes to water resources and hydrology will have a significant impact on the water supply where most of the city dwellers depend on the surface water and groundwater for fresh water supply. Access to water is a basic human right and it is a crosscutting issue for sustainable development. Water resources have unlimited importance including human survival, socio-economic stability and environmental sustainability. Dhaka city dwellers, following an unsystematic urban sprawl, are deprived of basic urban amenities where water supply has appeared as the most critical issue. The theoretical propagation on access to pure water has received momentum with the accelerated pace of water pollution and resultant freshwater scarcity. Water management in Dhaka, the capital of Bangladesh and a city with 20 million inhabitants, faces numerous challenges such as flooding, poor service quality, groundwater depletion, inadequate sanitation, polluted river water, unplanned urban development, and the existence of large slums where more than one third of its population lives (Wikipedia,2015)

Water supply of Dhaka city is heavily dependent on groundwater extraction where more than 75 percent of the supplied water is being extracted from this source. Such extensive dependency enhances a very high depletion rate of groundwater table. Dhaka city has been experiencing a sharp declination in groundwater table with more than 20 meters lower down during the last seven years at a rate of 2.81 meter per year (m/y). Considering the existing depletion rate, several studies predict that the groundwater table will go down to 120 meters by 2050. A different finding shows that the potential groundwater recharge of Dhaka city is only 1.33 m/y in contrast to 2.81 m/y of groundwater depletion rate. Such finding implies that despite sufficient amount of rainfall, Dhaka city is experiencing 1.48 m/y groundwater recharge deficit every year. Moreover, increased rate of urbanization, illegal occupation, and encroachment reduce the amount and volume of surface water bodies around the city that deteriorate the present situation (Uddin & Baten, 2011). In Dhaka, extensive pumping of groundwater has depleted some water sources, calling into question the sustainability of the city's groundwater supply. Surface water as a viable water source is also problematic as it is often polluted by untreated sewage and industrial waste.

In this study, Particular attention has been given to elucidate adequate amount of water in Dhaka city with respect to high population density and climatic change.

DATA COLLECTION

Secondary data have been collected from books, journal articles, and reports of different government and non-government organizations for this purpose.

WATER SUPPLY SCENARIO OF DHAKA CITY

At present, more than 15 million people are living in Dhaka city while 35 percent of them are living in slums. In the slums of Dhaka city, the average user to water-point ratio is 1,000:1 and only 20 percent people have some form of sanitary latrine (Akhter, Ahmed & Rashed, 2009). In response to water scarcity, many affluent residents and water-vendors have established illegal private deep tube wells and pump groundwater that contribute to the downward groundwater table. Another major concern

of Dhaka water supply system is its quality. Even though DWASA (Annual Report, 2014-2015) claims of maintaining the quality, according to WHO (Guideline of Drinking Water, 2006) requirements the consumers are doubtful regarding the quality and seldom drink untreated piped water. The city dwellers usually boil supplied water to kill dangerous bacteria to make it potable. For this purpose, they use gas and in some cases wood or charcoal. The fuel they burn may cause severe indoor air pollution. Moreover, in the case of wood or charcoal usage, destruction of forests will take place that will be causing additional environmental problems including erosion and loss of top soil. This also has a severe negative impact on human health.

Surface Water Resources of Dhaka

Surface water sources have been considered as unreliable for drinking water that requires more capital input to serve the population demand and hence emphasis is given to groundwater extraction. Through enormous authorized and unauthorized deep tube wells, the groundwater table is going below the extraction level. Moreover, recharge rate is decreasing and surface run-off is increasing which make the situation more vulnerable due to rapid urbanization.

About 10-15 percent of Dhaka city's land areas are comprised of surface water area including a number of rivers, canals, lakes (Islam, Rahman & Ahmed, 2010). Major surface water bodies of Dhaka city are the Buriganga, Turag, Balu, Tongi Khal, Dhanmondi Lake, Ramna Lake, Gulshan Lake and Cresent Lake. There were more than 35 canals within Dhaka city area (Khan, 2001) even though most of them are now fully encroached or polluted to a level that cannot be used even for washing purposes.

Groundwater Resources of Dhaka

Dhaka is dependent primarily on groundwater for the urban water supply; about 78% of the present municipal water supply comes from groundwater and 22% is from surface water (DWASA, 2016). The dependence on ground water for domestic, industrial, and commercial water supply in the city area was more than 95% prior to the commissioning of a large surface water treatment plant (Sayedabad Surface Water Treatment Plant) in 2002. Systematic groundwater development began in the Dhaka city in 1949 and available records show that groundwater extraction in the city has increased drastically in recent decades (Ahmed, Dottidge & Wonderen 1999). With the increased trend of urbanization and irregular rainfall behavior, surface run-off has increased in recent times, which reduces groundwater recharge considerably.

WATER DEMAND AND SUPPLY OF DHAKA CITY

Even though Dhaka city is surrounded by the four rivers namely Buriganga, Balu, Turag and Tongi Khal but only 22 percent of supplied water is obtained from these rivers. Dhaka city faces two major problems in supplying water to its residents: i) gradual decrease of raw water sources and ii) discharge of large quantities of polluted water (USGS, 2016). 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 waste materials. Treatment of this water has become so expensive that water supply agencies have to depend on groundwater aquifer for drinking water production. Other than these four over-polluted rivers, the nearest water body is the river Padma

and the Meghna that have acceptable water quality and ability to fulfill the demand. However, those rivers are located within a distance of 17 km and 50 km respectively from Dhaka.

DWASA projects total water demand considering per person per day water demand as 150 liter and accordingly supplies water to the city dwellers. Total water demand in Dhaka city varies from 2250 to 2300 Million Liter per Day (MLD) with seasonal variation. However, total production capacity of DWASA is 2420 MLD. Apparently, DWASA is able to fulfill current water demand through their capacity. However, DWASA has never reached its production target and actual production for groundwater and surface water is 1820.2MLD and 432.4 MLD respectively (Table 1) with a demand-supply gap of 167.4 MLD.

Table 1: Water Production Capacity of Dhaka WASA

Source	Production Capacity (MLD)	Actual Production		Source wise % of production	No. of DTWs and SWTPs in operation
		MLD	% of Capacity		
Groundwater	1887.6	1820.2	96.4	78	702
Surface Water	532.4	432.4	81.12	22	4

Moreover, if we account 22 percent unaccounted for Water (UFW) or system loss between production and end-user level Dhaka city are deprived of getting DWASA projected standard water requirement (150 l/p/d). To supply water in Dhaka city, DWASA runs 702 deep tube wells (DTWs) and four surface water treatment plants (SWTPs). The total length of the water line across the Dhaka city is 3461.56 km (Table 2) including 350772 household connections and 1643 standpipes. Moreover, there are also 1620 and 1500 DTWs that are under operation by private agencies and other unrecognized sources respectively.

Table 2: Water Production Details of DWASA

Description	**Amount**
Water Line	3461.56 km
Daily Water Production	2252.6 MLD
DTW in Operation	702 no.
DTW of other agencies	1620 no.
Overhead Tank	38 no.
Water Treatment Plant	4 no.

GROUND WATER LEVEL DEPLETION OF DHAKA CITY

In Bangladesh, the depth of water tables varies from less than a meter to more than 30m. The shallowest water table occurs in the coastal region whereas the deepest water table occurs in the Barind Tract and Dhaka City (more than 30m from the ground surface) (Banglapedia, 2015). The

depth to the water table moves seasonally with annual recharge and discharge conditions. The amount of seasonal fluctuation varies from less than a meter to more than 10m depending on the local hydrogeological conditions, amount of groundwater abstraction and natural discharge of groundwater. In recent years, there is a declining trend in the water table due to larger amount of groundwater withdrawal.

Geologically, Dhaka city is under the category of the Pleistocene terraces mostly composed of the Madhupur clay deposits. There is little variation in the surface elevation of the city. The thickness of the Madhupur clay ranges from 8 m to about 45 m with an average thickness of 10 m in this city.

The underlying layer is known as "Dupi Tila" composed of sand particles that are considered as the main aquifer of Dhaka city. The impermeable clay layer of variable thickness overlies the sandy layer that makes the groundwater aquifer mostly confined in nature. The total thickness of the Dupi Tila aquifer varies from 100 m to about 200 m with an average thickness of 140 m. Some scientific studies on the groundwater of the city revealed that the aquifer piezometric level which is the natural water level of a confined aquifer of the city main aquifer, has gone down significantly in last few years due to over-withdrawal of groundwater (Akhter, Ahmed & Rasheed, 2009).

In Dhaka city, groundwater extraction started from a depth of 100 meters and in some extreme condition the well goes up to 300 meters to reach the main aquifer. The depletion rate varies from area to area as in Mirpur the groundwater level dropped 53.75 meters between 1991 and 2015 at a rate of 3.5 meter per year. While the decline was 1.11 m/y in Mohammadpur, 2.3 m/y in Sabujbagh, 0.6 m/y in Sutrapur, and 0.9 m/y in Dhaka Cantonment during the same period (The Daily Star, 2015). The city's groundwater level has dropped about 20 meters over the last seven years at a rate of 2.95 meter per year, and from the year 2010 the rate is increasingly high.

SUSTAINABLILITY IN WATER SUPPLY

Sustainable water planning understands the interdependence among water infrastructure, ecological systems, and the built environment. Plans should simultaneously address and integrate habitat conservation; water storage, treatment, and conveyance methods; and water uses (Sustainability Principle, 2013).

To cope with current insufficient water supply and increasing demand, the Dhaka Water Supply and Sewerage Authority (DWASA) plans to provide improved access to a more reliable and sustainable water supply to Dhaka city dwellers, with assistance from the Asian Development Bank (ADB). Dhaka Environmentally Sustainable Water Supply Project (DESWSP) will provide more reliable and sustainable water supply for Dhaka City dwellers by developing a new surface water supply scheme for supply augmentation, which includes development of a water intake at Meghna River, one raw water transmission pipeline, a water treatment plant (WTP) at Gandharbpur with capacity of 500 million liters per day (MLD), a treated water transmission pipeline to the existing water supply network, and distribution reinforcements (fig-1). The project also includes distribution network improvements to reduce non-revenue water (NRW), and will promote household and community access to safe water, including support to low-income communities (LICs). Dhaka Water Supply and Sewerage Authority (DWASA) is the executing and implementing agency of the project (DESWSP, 2013).

In total, 316.7 acres (128 hectares) of land are needed to implement the project. Out of the total 316.7 acres (128 ha) of land (and canal areas) required for the project, 135.4 acres (54.8 ha) (42.8%) are owned by different agencies of the government, including Dhaka WASA, and 181.3 acres (73.4 ha) (57.3%) are private land in different locations that have to be acquired by DWASA (ADB, 2016).

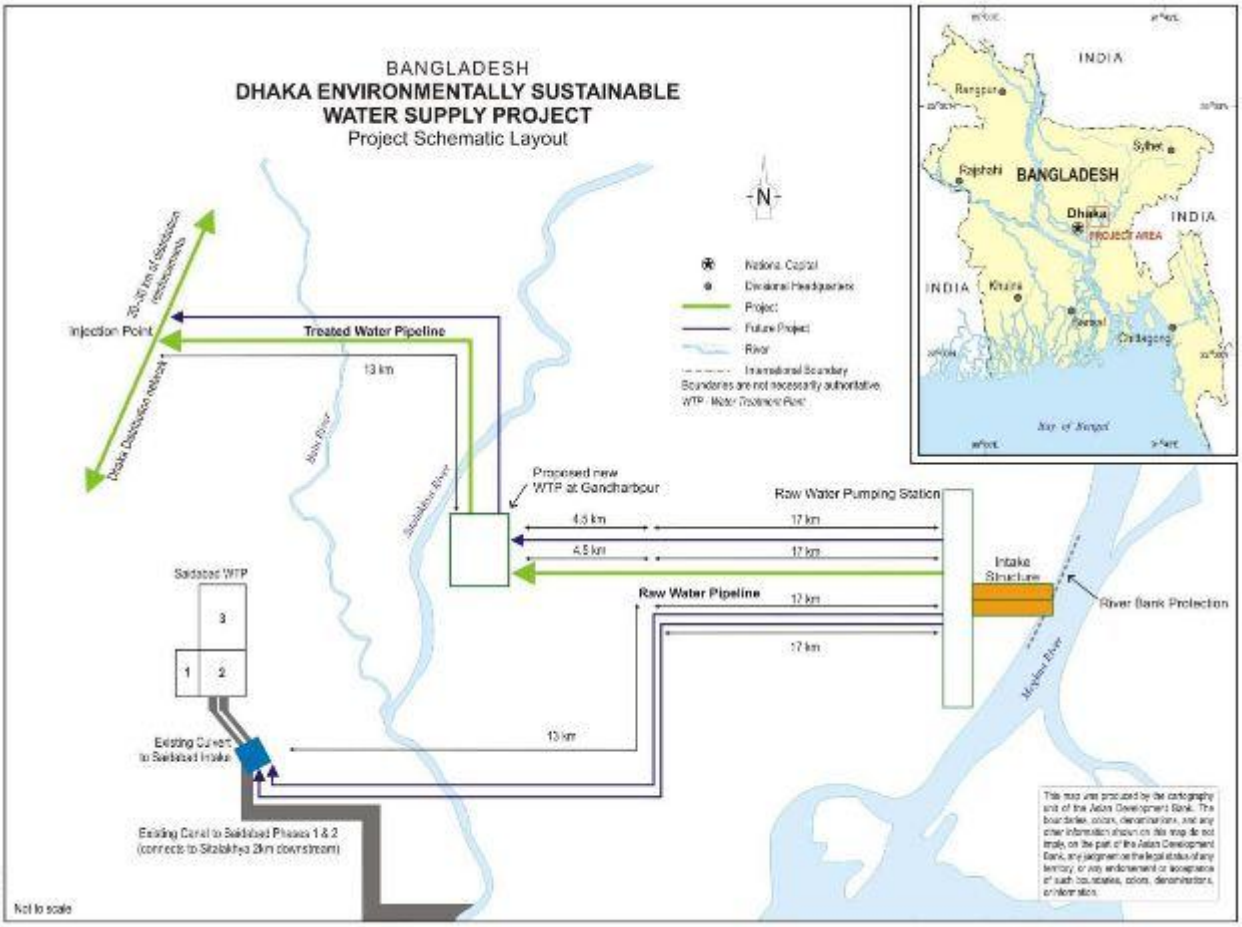

Figure 1: Schematic Layout of DESWSP

POWER SUPPLY IN WATER DISTRIBUTION

Power supply is an important issue in water distribution system. Sudden power drop could worsen the water supply system.

Dhaka WASA has 420 diesel driven generators including 42 mobile generators which help maintaining the abstraction of water from underground during the interruption of power supplies. Particularly during the summer season water demand as well as the electricity crisis becomes worst. At that period water supply system in Dhaka city is kept under normal condition by abstracting water with the help of these generators. Besides, over 200 tube wells have dual-electricity connections for uninterrupted water supply during load-shedding. Meanwhile, Dhaka WASA instantly supplies water through using 31 water carriers and 44trolleys (DWASA, 2015). Uninterrupted water supply is a major challenge for Dhaka water distribution authority. Continuous power supply could strengthen the water distribution system of Dhaka in many ways.

CLIMATE CHANGE IMPACTS ON WATER SUPPLY

The relationship between climate change and cities is complex. City-based activities contribute significant amounts of greenhouse gases and, simultaneously, are often more vulnerable to the impacts of climate change. Dhaka is now the world's eighth largest city and a significant proportion of Bangladesh's greenhouse gases are generated there although, relative to total emissions world-wide, the contribution is negligible. But this contribution is likely to increase rapidly with the continuing growth of the city's population, water supply and electricity consumption, as well as increased motor vehicle use. At the same time, Dhaka is prone to damaging and costly flooding, both from the rivers that bound it and from rainfall that generates runoff that is beyond the capacity of the drains (Alam & Rabbani, 2007).

Water supply in growing cities like Dhaka is also suffering from climate change through disrupting hydrological cycle in the form of increased flood in wet season and drought in dry season. Climate change has two-fold impacts: supply-side and demand-side pressure. The supply-side pressures include reducing or increasing the amount of water associated with environmental degradation. On the other hand, demand-side pressures include urbanization leading to increased water demand for domestic, industrial, agricultural (irrigation), and environmental demands (Amel, 1999)

With rapid urbanization, the paved area of Dhaka city is increasing without following any regulated and structured trend, affecting the percolation of run-off into the subsurface water. In addition, paved area increases the total run-off, which also affects the drainage system. In many parts of the city, the condition of the main aquifer has changed from confined to an unconfined condition. Such change in the hydrodynamic condition can make the aquifer vulnerable to possible groundwater contamination. Moreover, groundwater reserve will decrease that results into production loss and contribute to the increasing gap between demand and supply.

Climate change will result in a slight increase in the savings from water conservation programs targeting outdoor use. This would partly offset the increase in water demand due to climate change. It is difficult to quantify this effect since there is no data available to establish the relationship between the savings and key climate variables. However, as the increase is very small it should be interpreted that climate change impacts would not significantly affect the savings achieved by demand management programs.

CONCLUSIONS

The amount of water available in the Dhaka city area is already limited, and demand will continue to rise as population grows. Though the government has already started to shift its present groundwater based production system to surface water production, the shift demands huge investment and time. Moreover, the status of peripheral rivers of Dhaka city is highly degraded and a major portion is under illegal encroachment. That is why it is highly unlikely to fulfill the future demand just by relying on these sources. Considering the present crisis and future demand, it is high time to seek additional sources like rainwater harvesting system, waste water recycling etc.

Dhaka has already undertaken a number of measures to improve it water supply system like Dhaka Environmentally Sustainable Water Supply project. Proper implementation of this project could be able tackle the water supply challenges.

Proper groundwater recharge could help in keeping balance in groundwater table. Dependency on groundwater must be shift towards surface water. In this regards, the pollution of this adjacent rivers should be mitigate in a certain stage.

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