OPTIMUM WATER SOLUTION IN MEGA CITY DHAKA

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ABSTRACT

In the urban areas (10622 ha) and suburban areas (17874 ha) of the mega city Dhaka present total population is about 7.5 million (excluding slum and floating population). The Dhaka Water Supply and Sewerage Authority (DWASA) cannot provide the recent requirement of 1900 MLD. Moreover, with a population growth rate of 5.5%, in near future there will be increased pressure on the existing system. This paper will focus on the causes of water shortage and the technologies that can mitigate the water requirement.

Before 1997, almost 96% of water was extracted from groundwater sources. Due to this intense extraction piezometric levels in some densely populated areas have gone to depth of 40 m. Hence, with the existing 385 deep tube wells (DTWs) it is possible to produce only 1350 MLD with a shortage of 550 MLD. Moreover, it is estimated that in recent time Unaccounted For Water (UFW) is about 48%. Although Dhaka is surrounded by four rivers Balu, Turag, Buriganga and Sitalakhya (pH of raw water ranging from 6.6 to 9.8 and BOD ranging from 1.0 to 6.6 mg/l), the obstruction and pollution of these rivers make it difficult to use.

DWASA report shows that a surface water treatment project reduces the contribution of ground water from 96% to 85%. Hence Padma and Meghna rivers which are far away from Dhaka city are also considered as alternative water sources beyond the conveyance cost.

In the edges of the city piezometric level ranges from 8 to 12m. It is easy to construct and operate some DTWs in this region.

The average rainfall in rainy season is 1650 mm. To meet scarcity in the dry season, it is an alternative source. At places where supply of water is scarce Pond Sand Filter (PSF) or Infiltration Gallery will be alternative source of water.

Considering cost-benefit analysis, public acceptance, water quality and seasonal variations, a combined water supply system will be adopted and there will be provisions so that failure in one source can be compensated by others.

1. INTRODUCTION

Dhaka mega city (DMC) includes Dhaka City Corporation, the entire Narayanganj Sadar, Bandar, Keraniganj, Uttara, Savar, Gazipur Sadar Thana. Its current population is about 11 million and area is about 290 sq. km. Since 1963 Dhaka water supply and sewerage authority (DWASA) is responsible for water supply in this region. For reasons of convenience DWASA has divided the whole area into seven distinct zones. Except for zone 5 there are deficits in water production in other zones. With limiting water sources the increasing demand with time makes it a serious threat to the city dwellers.

2. DEMAND VS. PRODUCTION

Present demand of water is about 1900 MLD and in the year 2015 it will be around 3500 MLD assuming a water consumption of 180 liter per capita per day (lpcd). There are 197760 connections of DWASA where 187899 are domestic connections with a demand of 1700 MLD. Besides domestic water demand, industrial and commercial institutions exert a significant demand on DWASA water. Table 1 shows the projected gross water demand for industrial, commercial, hospital and other sectors in Dhaka city for the year 2000:

Table 1: Assessment of industrial and commercial demand for year 2000

Category	Demand per day (in liters)	Gross demand (MLD)
Industrial	2000/worker	28.2
Commercial	38.5/person	8.6
School	27.2/student	44
Hospital	1258.9/bed	14.1
Offices	33.9/day	63.1
Religious institution	1.5/person	9.5
Average		167.5

Source: DWASA (1997)

Supply of water to the consumers is provided mainly by DWASA. In addition some private agencies contribute in small amount. Table 2 shows water production systems in DMC:

Table 2: Water production system in DMC

1.Deep tube wells operated by DWASA:	Nos. 392
2.Over head tanks in operation	Nos. 38
3. .Deep tube wells of other agencies:	Nos. 1096
4. Water Treatment Plants:	Nos. 3

Source: Management Information Report (DWASA) January 2003.

So far DWASA has a production capacity of 1526.09 MLD. Figure 1 indicates production of water from different sources:

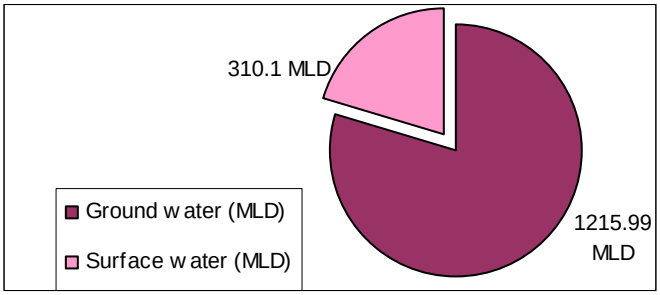

Fig. 1: Source wise water production capacity.

It is here clear that most of the production comes from ground water by extracting with deep tube wells. This water can be easily distributed within the zones of the operating DTWs and in most cases not possible to distribute in other zones. Zone 1 has a highest water demand of 400 MLD against a supply of 230 MLD with a deficit of 170 MLD. But highest deficit is observed in zone 2 as 190 MLD. Figure 2 shows a comparison of demand vs. supply in different zones.

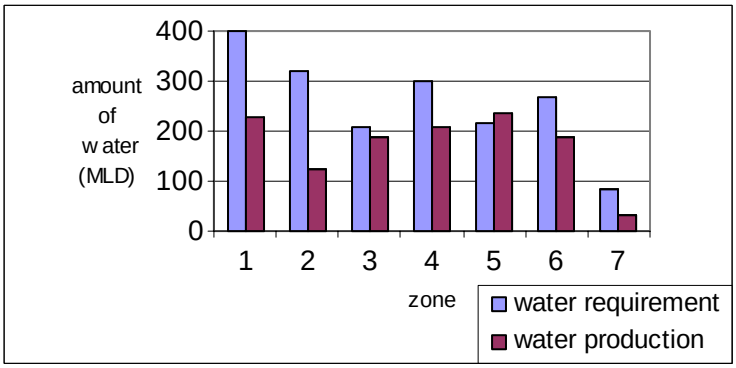

Fig. 2: Demand vs. production in different zones.

In the year 2002 Saidabad Water Treatment Plant added 225 MLD capacities to DWASA. Hence a total 310.1 MLD from surface water is contributed to capacity of DWASA with capacity of Dhaka water works (Chandnighat) 18.5 MLD and Narayanganj water works 18.81 MLD. To cope up with the future water demand DWASA is searching for new water sources and some projects are undertaken by DWASA. Table 3 shows proposed future water supply in the city:

Table 3: Proposed Projects to Meet Future Water Demand

Proposed projects	Project period	Capacity (MLD)
Fourth water supply project phase-II	2002-2005	225
Fourth water supply project phase-III	2005-2010	450
Pagla Water Treatment Plant	2002-2005	450
Water System Expansion and Rehabilitation	2002-2007	225

Hence at the end of the year 2010 there will be a capacity of 2700 MLD. Figure 3 shows the overall condition of water demand and water capacity of DWASA in the future.

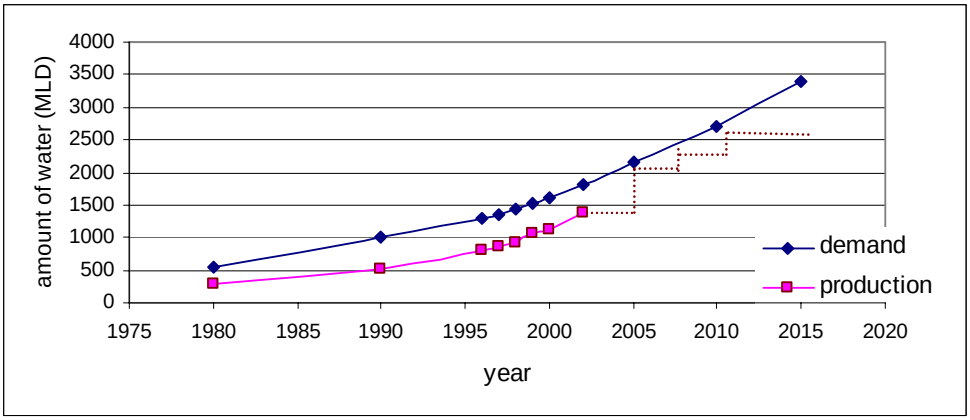

Fig. 3: Demand vs. supply for the Dhaka city.

3. PROBLEMS FACED BY DWASA

DMC is suffering from acute water supply problem due to the following causes:

Increase in population due to rapid urbanization is a major reason. Large working opportunities provided by the city causes immigration rural to urban 51.80% and urban to urban 4.36% with a total immigration of 56.16%. Moreover current growth rate is 5.5% per year and recent population is about 11 million. If this growth rate continues at the end of the year 2015 the population will be around 18.7 million.

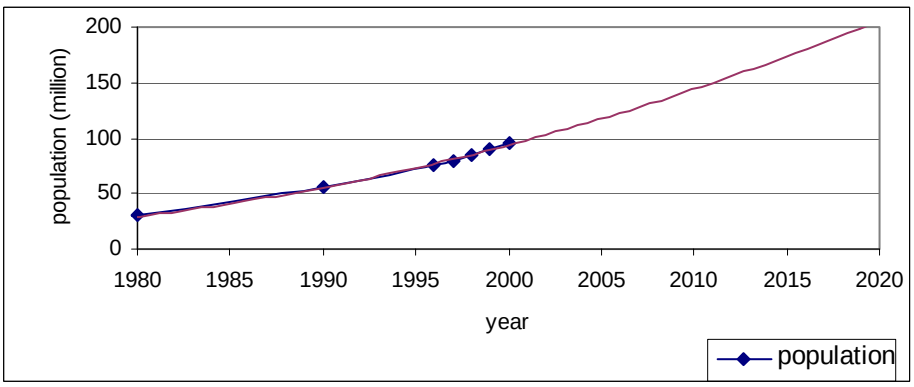

Fig. 4: Population trend in Dhaka city.

Apart from ground water, no suitable water sources exist within the city area. Surface water source can supply only 310 MLD against the total demand of 1750 MLD. Four perennial rivers in and around the DMC are Buriganga, Turag, Balu and Sitalakhya. Quantity, quality, future availability of water and distance between source and service area are the basic concerns for choosing a source. For example water from Siadabad Water Treatment Plant in the south east zone cannot be reached to the north zone.

Incremental dumping of organic, inorganic biodegradable matter, priority pollutants, nutrients, toxic matters etc of the domestic and industrial wastes confines the use of river water. Turag and Balu are not suitable for treatment by conventional methods.

Most of the water supply comes from ground water. There are 392 Deep Tube Wells (DTW) operated by Dhaka WASA (DWASA) and 1096 DTWs by other private agencies. This causes a tremendous pressure on the aquifer and the piezometric level is declining day by day. The rate of lowering of piezometric level was found to be 0.5m per year in the eighties. At present it stands up to 1.0m per year while in some areas it may be greater than 1.5m per year. Constant extraction of water by the DTWs has lowered down the water level to 40m in the central part of the city which makes it more difficult for the pumps in that zone to extract water.

The DTWs are brought into a network of 100mm to 800mm diameter pipe lines. It is found that the total length of 100mm diameter water line is 954.44 km which is about 42% of the total length the entire supply network. With this small diameter pipelines it is possible to transport water to the close vicinity of the operating zone but not feasible to transport sufficient amount of water from one zone to another zone.

Table 4: Water line (up to Dec'2001)

Size (mm)	100-200	250-450	500-800	others	Total
Length (km)	1868	280.6	9	100.7	2258.3

Variations in water supply from the DTWs are also observed throughout the year. During the dry period water production from the existing DTWs is somewhere around 1125 MLD whereas during the monsoon and post monsoon it is about 1250 MLD. This variation is mainly due to intense rainfall in the monsoon period and the consequent ground water recharge in the post monsoon period. Again in the dry period electrical energy supply is not adequate. Hence sometimes generators come into act when the DTWs cannot be operated to the scheduled quota of 20 hours. The full demand cannot be met with these generators.

Groundwater samples from DTWs are tested by DWASA for arsenic every three months and river water samples for chromium and aluminium every six months. According to DWASA the quality of the water it supplies is, in most cases, within the acceptable limits set by WHO (DWASA 2000a). Against this claims in old and central Dhaka (encompassing areas from Bangshal to Lakshmibazar and Mugdapara to Shantinagar respectively) water samples were found to be contaminated with numerous total coliforms and faecal coliforms. Water samples from new Dhaka areas were found to be least polluted with coliforms. It indicates that DWASA supply water is being contaminated with faecal matter along with other contaminants during distribution.

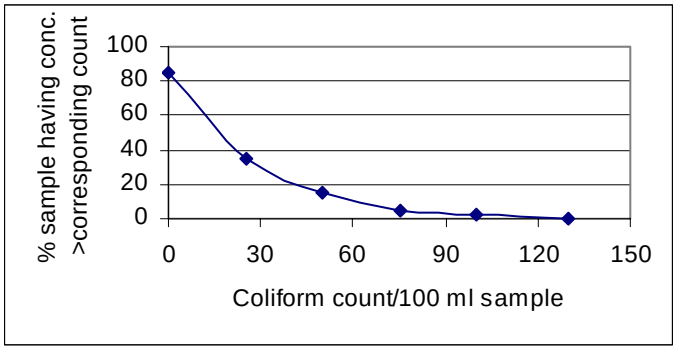

Fig. 5: Presence of coliform in sample water

Leakage in DWASA distribution system is primarily responsible for such contamination. At the same time, intermittent pumping of water, which often creates a negative pressure in the supply line, makes it easier for outside water to get into the supply line. Groundwater is also under a great threat of heavy metal contamination. Dumping of solid waste without protective lining, tannery waste disposal at the western periphery of the city are the main sources of increasing levels of lead and chromium in water supply.

As mentioned earlier, surface water treated from Buriganga River at the Chandnighat treatment plant also accounts for a small part of the DWASA water supply. However, indiscriminate disposal of domestic wastewater and industrial effluents in the river system is threatening the surface water supply source. The quality of Sitalakhya River has deteriorated to such an extent during last 5 years that the ability of the Saidabad Treatment Plant to produce water of acceptable quality as per drinking water standards is being questioned.

Table 5: Non physical and physical losses of the supplied water of DWASA:

Non physical losses:	
1. Non-metered connection:	7.48%
2. Illegal connection:	2.80%
3. Defective meters:	6.81%
4. Inaccurate meters:	0.37%
5. Faulty reading/billing:	13.20%
6. Miscellaneous:	0.04%
Total:	31.06%

Physical losses:	
1. Pipe leaks:	7.48%
2. Service connection:	8.54%
3. Miscellaneous:	8.92%
Total:	24.94%

Source: DWASA Leak Detention and Waste Prevention Programme.

Unaccounted for water (UFW) accounts for both physical and non-physical losses. Table 5 shows various physical and non-physical losses of water. UFW is a major concern for DWASA. Although it is in decreasing rate its present value is about 48% where as it is only 5% in Netherlands.

The average difference between water production and revenue earned is about 195 million cubic meters over the years. Figure 6 indicates a relation among water production, bill and revenue income:

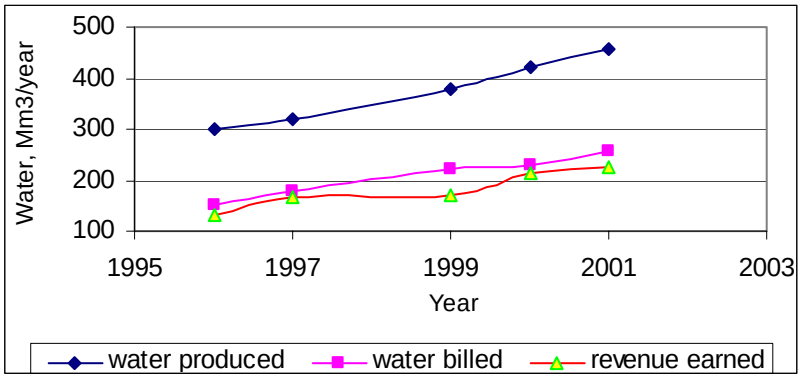

Fig. 6: water produced, billed, revenue earned

4. POSSIBLE SOLUTIONS

It is possible to have capacity approximately equals to the demand by existing systems of DWASA and its future four projects up to 2010. But as 48% of water produced is lost by some means, it won't be possible to reach the demand. Zones should be responsible with stricter administrations intervention for the difference in the water consumed and the revenue earned. Apart from leakage and blockade all the losses can be reduced to zero by maintaining an ideal network which certainly pushes the actual supply line close to demand line.

As mentioned earlier piezometric level is monotonically lowering and this makes it difficult to install further DTWs in central and west part of the city. So the only future water source is the surface water which is also deteriorating. Long term planning should be considered right now regarding this and necessary treatments should be adopted prior to damping of all the wastes into the up streams of the rivers. DWASA is now in search of surface water of better quality away from the city. The possible options are Meghna and Padma rivers. The Government of Bangladesh has signed a MOU with the Chinese Government to implement a surface water treatment plant at Pagla bringing water from Padma.

Due to insufficient chlorination in some samples faecal coliforms was found. But to ensure potable water, it is necessary to adjust the dosing factor and perform tests of coliform count after every 2 or 3 months. In addition there should be provisions for similar leak detention program.

180 lpcd is taken as the gross demand for a person. All this water need not be potable in nature. Apart from drinking and few cases with aesthetic considerations about half of the required water do not need all costly treatment. Again there are also some industries, commercial places where water is used only for cooling or washing purposes or may be used in

boilers that require specific treatment for the purpose not all treatment as performed by DWASA. So it will be handy to have a second supply line in each zone where preliminary treatment of water will be done and in some cases specific treatment if necessary. The cost of this new network can be recovered from the respected industries.

Rainwater offers advantages in water quality for domestic use. Rainwater is naturally soft (unlike well water), contains almost no dissolved minerals or salts, is free of chemical treatment, and is a relatively reliable source of water for households. Rainwater collected and used on site can supplement or replace other sources of household water.

Rainwater can be used directly for household use and for artificial groundwater recharge. Figure 7 shows the month wise rainfall pattern in Dhaka city.

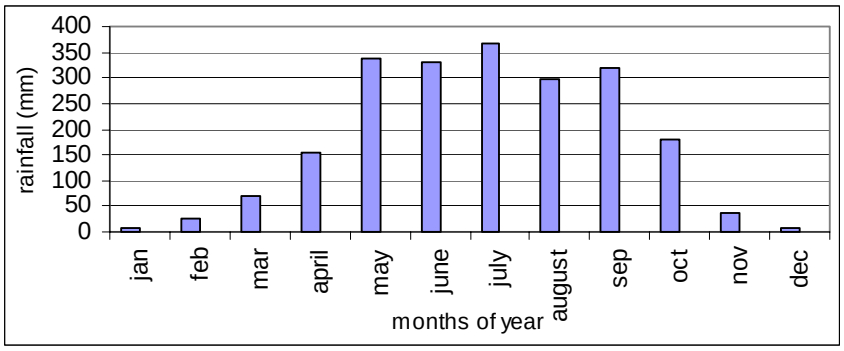

Fig. 7: Rainfall variation during a year in the city.

From the Fig.6 it can be concluded that rainwater collected from the May to September can reduce the pressure of the deep tube wells.

Water quality can also be improved by using a Pond Sand Filter (PSF) which uses a hand pump to deliver pond water into a small sand filter unit. PSF can be used for domestic, industrial, commercial purpose where potable water is not required.

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