# RW07
# Integrated Water Resources Management Options for Dhaka City

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***Abstract*—Intensive use of water with mounting population is raising unmet demand along with increased water conflicts in Dhaka city. Poor surface water quality, lack of alternate resources and financial limitation constrained water supply agencies to ground water withdrawal leading to rapid fall of ground water level. Inadequate drainage system on the other hand causes water logging every year. Therefore an integrated approach like integrated water resource management (IWRM) system is required that responds to problems that are all interrelated. Alternate supply and demand management tools such as ground water recharge, rainwater harvesting, effective water pricing, reclaimed water use are suggested to meet the deficit of current supply system through the efficient use of the scarce resources available. Institutional reform and improved water planning are required to facilitate economic growth and social development. Finally, human resource development is identified as key factor for the sustainable effective management of this valuable resource.**

## INTRODUCTION

IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems [1]. Dhaka is located in central Bangladesh on the lower reaches of the Ganges Delta. The city is surrounded by the distributaries of the two major rivers, the Brahmaputra and the Meghna. The city covers a total area of 153.84 $km^2$ [2]. The city population is growing with an estimated rate of 4.2% per annum [3], one of the highest amongst Asian cities. Considering present birth rate and rural-urban population migration, it is estimated that with a growth rate of over 5.6 %, Dhaka will be the 2nd largest city of the world by the year of 2015. The giant population exerts enormous pressure on water supply system and causes huge amount of deficit every year. Various sectors such as urban households, industries, agriculture and ecosystem are experiencing competition for their share of water. Unplanned urbanization, economic development as well as gigantic population have caused increased interaction among different water uses**,** changed the water environment of Dhaka, polluted the river bodies and ecosystem, lowered ground water table and altered water and sediment regime.

## STATE OF WATER AVAILABLE IN DHAKA CITY

Dhaka Water Supply and Sewerage Authority (DWASA) is primarily responsible for providing water to about 90% of the Dhaka metropolitan area (DMPA). Remaining 10% depends on private wells. It is required to mention that the coverage of 90% DMPA does not mean that all people in this area get continuous DWASA supplied water. About 91% of the total water served by DWASA is utilized to meet the domestic water demand and about 9% is supplied to industrial and commercial sectors. Everyday around 1794.44 million liter (ML) water is produced by DWASA as per May 2008. More details are given in Figure 1. About 1540 MLD of this supply is abstracted from 471 deep tube wells (DTW) situated in Dhaka City and 14 DTWs in Narayanganj. The rest 254.44 MLD is produced through two surface water treatment plants (SWTP) in Dhaka (Saidabad & Chandighat) and one SWTP in Narayanganj (Godnail). About 223.1 MLD is solely produced by the Saidabad SWTP. In addition to this around 1179 DTWs are currently operated by the private agencies to meet the present water demand of the city. About 585 private DTWs supply water for domestic use and 562 DTWs for industrial and commercial use.

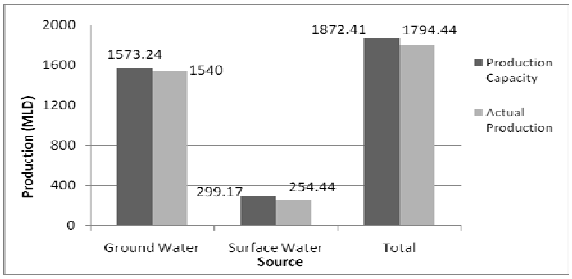


Fig 1: Water production per day in Dhaka city [4]

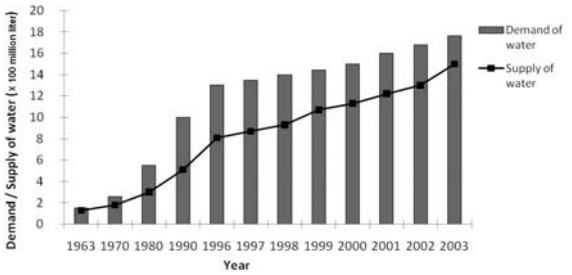


Fig. 2: Demand, supply and deficit of water in Dhaka city [4]

Figure 2 shows the demand supply and deficit trend for Dhaka city since 1963 [5]. The total water demand for Dhaka city was increased from 150 million liter (ML) in 1963 to 1760 ML in 2003. In 1963 the total deficit for water supply in Dhaka city was 30 ML which substantially increased to 260 ML in 2003. Figure 3 shows the present and future water demand scenario in Dhaka city.

Though the city is surrounded by four rivers Buriganga, Balu, Turag and Tongi Khal, only about 14.18% of supplied water, as showed in Figure 4 is obtained from these rivers. Water of the surrounding rivers and lakes has 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 agencies are almost entirely dependent on ground water aquifer for their

potential alternate source of supply. It is observed that the annual abstraction in public sector has increased from 177 million cubic meters (MCM) in 1990 [6] to 562 MCM in 2008 [4]. The number of private wells has increased from 130 in 1990 to 289 in 1999 [6]. This number significantly increased to 1179 in 2008 [4]. As an outcome upper parts of the aquifer became dewatered throughout the area except the northeast and southeast corner of the city

Dhaka experiences a hot, wet and humid tropical climate. The city is within the monsoon climate zone, with an annual average temperature of 25 °C. Nearly 80% of the annual average rainfall of 1,854 mm (73 in) occurs between May and September. The aquifer of this city is primarily recharged by direct rainfall, river water, and floods through direct infiltration and percolation. But due to unplanned urbanization, the recharge area of the city is decreasing significantly with time. It is observed that the water level is declining at the rate of about 2 to 3 m per year depending on the locations. The vulnerable conditions of the aquifer may result in drying of existing wells, land subsidence, and intrusion of contaminated water from adjacent polluted rivers. Covering the vertical recharge inlets with pavement materials or other construction materials causes water logging for even small duration heavy rainfall in most areas of Dhaka city. Inadequate storm water sewer infrastructure and improper maintenance of storm sewer system further aggravate the scale of this problem.

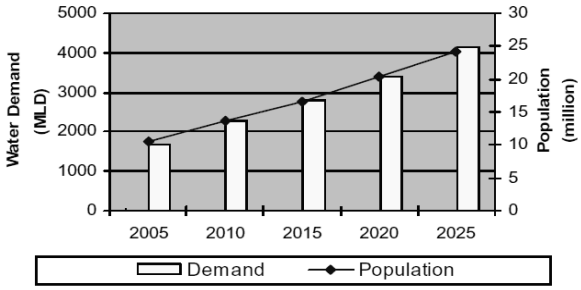


Fig. 3: Present and future water demand scenario in Dhaka city

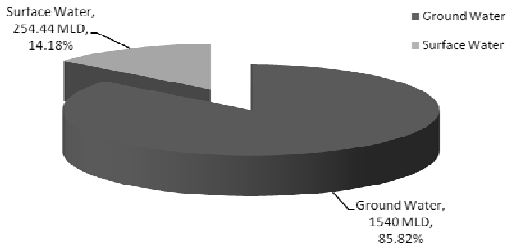


Fig. 4: Source-wise water production per day in Dhaka city [4]

## OPTIONS OF WATER RESOURCES MANAGEMENT IN DHAKA CITY

*Issues to be considered*

In order to manage this complicated situation it has become necessary to integrate four major issues; these are socio-economical issues, biophysical issues, institutional issues and water quality issues. Making wise decisions about water resources management requires knowledge and wisdom from different disciplines to identify alternatives for action and to assess their effects. Engineering knowledge might focus on physical infrastructure systems, whereas sociology or psychology might focus on human impacts. Large capital investments, willingness to pay, people's participation and religious view have been identified as key aspects of socio-economic issues.

*Measures to be taken*

Water management is already very challenging because of its temporal and spatial distribution. Moreover the present supply system of Dhaka city is having difficulties to manage the enormous increased demand of the growing population and fulfill the huge deficit caused by the economic development. All of these problems are related with each other. Hence principles of IWRM are required to solve these problems considering the system as a whole. Key principles of IWRM are:

- Water should be treated as an economic, social and environmental good
- Water policies should focus on both the management of water (demand) and the provision of water (supply)
- Regulatory frameworks are critical in fostering the sustainable development of water resources
- Water resources should be managed at the lowest appropriate level
- Participation of target peoples for management and safeguarding of water

Thus the aim is to provide a water and resource management system to meet the rising demand economically and to facilitate growth and development by using scarce resources as efficiently as possible. Water supply and demand management through groundwater replenishment, rainwater harvesting, reclamation, recycling and reuse, waste reduction and new source development plans can give increased security to domestic water supplies and resolve the current water deficit problem. Revised domestic and industrial water pricing and reallocation can reduce the misuse and unnecessary loss of water. Institutional reform and effective water resource planning are necessary to increase revenue collection. Selection of target population and people's participation are vital for the potential application of IWRM**.** Resource development is further essential for the sustainable management of this valuable resource.

*Rainwater Harvesting*

Rainwater harvesting provides inexpensive drinking water. This is a multipurpose way of not only recharging the ground water but also reducing the runoff and water logging during the season of heavy rainfall. The traditional knowledge, skills and materials can be used for this system. During rainy season individual can collect water on his rooftop and manage it on his own. Reserved rain water on rooftops can be used for self purposes or domestic use. If needed, a chemical treatment such as chlorination can be used to purify the water. Water from different rooftops of a lane can also be collected though a piped network and stored for some time. This water can be then channeled to deep wells to recharge ground water directly or to ponds to replenish groundwater slowly or to reservoirs to dilute reclaimed water for non-potable use.

*Waster Water Reclamation and Reuse*

Decentralized waste water treatment can be practiced by an individual, or by a community consisting of several buildings or by an industrial entity. Membrane bioreactor or

membrane filter can be used for industrial and urban waste water treatment. Reclaimed water may be pumped into reservoir where it will mix with and be diluted by storm water. This mixture of storm water and reclaimed water could then be treated again. The treated water is suitable for reuse for non-potable purposes, in dust control, soil compaction, in non-potable industrial processes, cooling water etc. In a home system, treated grey water from sinks, baths, showers, or washing machines may be used to flush toilets or for gardening or car washing. This saves potable water for drinking and reduces water demand.

*Effective Water Pricing*

In order to resolve present water crisis issues, it is necessary to make DWASA a financially self-sustaining commercial entity. Computerized billing system, 100% system metering and involvement of private sector and civil society in revenue collection will further help to improve the current scenario. Revenue collection can significantly be increased by revised water pricing system. Rates of piped water should be amended to avoid waste of water.

## POTENTIAL APPLICATION OF IWRM

Potential application of IWRM includes planning phases of the proposed program, institutional reform, water resource planning and human resource development. Questionnaire survey needs to be carried out to address information and data acquisition, preliminary market assessment for potential users, economic considerations, environmental and social analysis, possible complementation plan, willingness to pay, scale of decentralization, level of people's participation, religious view required to be carried. Users should be categorized based on produced water quality and quantity, water capacity to meet future demand, current water supply, demand and deficit, current and future rates and fees, aspects of water use legislation, attitude of agencies, organization and users toward produced water use.

## INSTITUTIONAL REFORM

Lack of proper institutional legislation and policy is the central problem. Existing institutions should be reformed with comprehensive water code addressing legal issues. Legislation for groundwater right should be introduced. Some of the agencies, responsibilities and jurisdiction can be consolidated. National water resource planning agency might be powered with more authority and political control. Decentralization of water service provision can be effectively used in this regard. A central repository of water and other resources data with advanced GIS facilities can be built.

## WATER RESOURCE PLANNING

Water plan should contain the integrated planning and management principles, pricing and decentralization policy, consideration of social and environmental impacts in the evaluation of water projects, public participation, accomplishments and goals and projection of water supply, demand and subsequent measures to balance them.

## HUMAN RESOURCE DEVELOPMENT

Education program to increase public awareness should be introduced. Existence of government staff with necessary skill and training are required. Local consultants with appropriate understanding of local conditions are likely to be more successful in this context. Building the capacity of higher educational system in environmental science, engineering and management will play a vital role in future management of water resources.

## CONCLUSION

Water crisis is one of the critical challenges in Dhaka city. This problem is not a new one and it cannot be solved overnight. There was a good option to use the water of the peripheral river, but extreme pollutant loading leads it beyond the treatment level. Although there exists tremendous pressure on ground water aquifer, installation of more DTW by DWASA to meet the public demand makes it more acute. Thus there is no other alternative but to undertake the IWRM to save the city from social, economical and environmental disaster. Socio-economical, biophysical, institutional and water quality issues must be considered in area-wise service provision, process optimization and policymaking. Alternate water supply and ground water recharge system should be implemented on the basis of priority and feasibility analysis. Simultaneously change in water consumption behavior, modification of pricing, taxing, reduction of system loss, development of human resource, institutional reform and sustainable planning considering impacts of climate change should be brought under common goal to get the best outcomes.

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