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Sustainable water demand management in the face of rapid urbanization and ground water depletion for social–ecological resilience building

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ABSTRACT

Necessity of Sustainable water demand management (SWDM) is immensely higher in the rapidly urbanized mega cities of the world where groundwater depletion and water deficit are taking place perilously. This paper focuses on the present condition of water demand, supply, system loss, pricing strategy, groundwater level, and per capita water consumption of Dhaka city, Bangladesh. The study founds population growth has a large influence on water demand to rise and demand of water is not responsive to the existing pricing rule adopted by DWASA. It emerges that, water demand is increasing at 4% rate an average in the Dhaka city since 1990 and groundwater table goes more than 70 m down in central capital due to extensive withdrawal of water. The study suggests an integrated SWDM approach, which incorporates optimum pricing, ground and surface water regulation, water conservation, sustainable water consumption and less water foot print to ease groundwater depletion. In order to attain sustainability in water demand management (WDM) the study recommends certain criteria under economic, social and environmental segment to administer the increasing water demand of growing population and conserve the fresh water resources of the world's mega cities for social–ecological resilience building.

1. Introduction

Water demand management, ensuring minimum water for daily consumption, water resource planning, and ground water depletion are the common concern in the rapidly urbanized mega cities around the world and the challenge is much higher in the developing countries to address and mitigate such primary water problems. In 2014, closely 3.9 billion people, or 54% of the global population lived in cities, and by 2050, two-thirds of the global population will be living in cities, which will generate 55% additional water demand in the world (OECD, 2012; UNDESA, 2012). The future water condition will be impossible to manage unless the world cities are able to address the present water challenges including water security, demand management, conservation, equity, water efficiency and sustainable consumption. In household water security index Central and West Asia, East Asia, South Asia, the Pacific and the advanced economies obtained 2.3, 3, 1, 1.5 and 5 respectively. Besides, in urban water security index Central and West Asia, East Asia, South Asia, the Pacific and the advanced economies received 1.6, 2, 1.9, 1 and 2.9 correspondingly (ADB, 2013). It appears that, the situation of urban water security index is comparatively worse than the household water security index for all the regions and the condition of South Asia is relatively lower in both categories. The existing index suggest that, all the regions specially the developing

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world have good room to improve the water condition in urban and household level for ensuring the long term well being of the nations, which can be done through properly implementing SWDM approach. Broadly, sustainable WDM addresses how the countries are ensuring the efficient use of water to sustain their economic growth, food production, household consumption, industry, and energy (WWAP, 2015; ADB, 2013). The study focuses the case of Dhaka city of Bangladesh to investigate such problem and provide a systematic framework of sustainable water demand management for enabling social–ecological resilience, which may useful to the other countries with similar context. Here, resilience refers to the capacity of a social–ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions (Holling, 1973; Gunderson and Holling, 2002; Walker et al., 2004).

Nevertheless to say, Dhaka is one of the highly populated mega cities in the world. Unplanned urbanization, rapid industrialization and immense migration inflows are putting pressure to the principal public utility services system including electricity, energy, and water. Further, policy lacks for the decentralization of Dhaka city is responsible to create deadlock for reducing population pressure from its frontier, which uplift the population size closely 16 million from the 3.03 million in 1980. In this backdrop, it is a challenging task to provide quality public utility services to the city dwellers. Presently, 87% of the supplied water comes from the ground water resources and only 13% water comes from the surface water (SW) treatment plants to meet the growing demand of this huge population of Metropolitan Dhaka. Dhaka is bordered by a good number of rivers such as Turag, Buriganga, Balu, and Lakhya, which are perilously polluted by the resident and commercial waste disposal, industrial effluent, and other anthropogenic activities (Islam et al., 2010a,b). The biological oxygen demand and the ecosystem of these rivers are no more exists at this moment (BBS, MICS and UNICEF, 2011). Besides, river filling, illegal housing are dangerously squeezing the river basin areas and swiftly eliminating the canal, ponds and wetlands from the Dhaka city (Biswas et al., 2010). In this backdrop DWASA is not getting sufficient source of fresh surface water, and facing technical and economic infeasibility to decontaminate the over polluted river water to the level of safe drinking water. Thus, extreme stress falls in the ground water resources, which forces to deplete the ground water table comprehensively. If the existing trend of ground water extraction continues the stock may no longer available in the future for withdrawal, which will make the society and ecology in irreversible condition (Uddin and Baten, 2011). Presently, the ground water level of Dhaka city dropped to more than 52 m below mean sea level (MSL) from the 34.18 m in 2000 and 26.6 in 1996 which is triggered by the excessive withdrawal and least ground water recharge. As a result environmental degradation takes place around the city and the risk of intrusion of the southern saline water into the ground water reservoir is also appearing. In this context, a sustainable water demand management (SWDM) policy becomes mandatory, which will incorporate the sustainable consumption, water extraction and distribution, optimum pricing, taxing for private deep wells, water conservation and water pollution.

Zahid and Ahmed (2009) strives to suggest an appropriate sustainability criterion in WDM for the fast urbanized mega cities around the globe, where water demand is relatively higher and increasing day by day along with depleting the ground water level. In their words groundwater management must adopt an integrated approach taking into account a wide range of ecological, socio-economic and hydrological factors because country's GDP is highly dependent on the development of water resources in general. Uddin and Baten (2011) projected that if the existing trend of ground water extraction takes place, by 2050 groundwater level will go down 120 m in the Dhaka city and the present groundwater recharge of the city is counted only 1.33 m/y against 2.81 m/y of depletion rate. Furthermore, the study has attempted to draw three scenarios considering existing water supply situation, future roadmap, unaccounted for water, downtime or production loss to project water demand and supply up to 2050. All of the three scenarios showed a large gap in water demand and supply situation. The study suggests that, in order to meet the growing water demand effective and demand driven water supply management in essential for Dhaka city. Change in tariff often use to change the water demand but water tariff alone does not influence the demand for water always. Worthington and Hoffmann (2008) demonstrated that, price elasticity of water varied between −0.25 and −0.75 because water tariff represent a small proportion of income and has no substitute for basic uses. Statzu and Strazzera (2009); and Schleich and Hillenbrand (2009) found that along with tariff and income level some other driving forces such as population characteristics, population density, immigration, household feature and economic growth are responsible to affect the water demand of urban areas. Jamal and Rahman (2012) examined how the crisis of water and gas causing problem in the daily life of middle income locality of Dhaka and found local people are taking different adoptive measures, even compromising their daily life cycle to make and adjustment with these problems. Kumar and Singh (2001) defined certain market based instrument for demand management in the face of water scarcity and over use of water in the agriculture of Western India. The paper suggests the use of water market as the institutional arrangement for promoting economically efficient use along with rational pricing of canal water and electricity for encouraging conservation. MAPC (2006) endeavors to produce a guideline for summer water demand management for Massachusetts and revealed that in many Massachusetts communities water consumption rises 50% or more during summer time, but water supplies are hampered as very city's river is discharging very low water during summer months. This mismatch between supply and demand is partly due to local water policies that tend to promise abundance and promote consumption. The study recommends public education, voluntary conservation, conservation pricing, irrigation controls, and direct water use regulation are indispensable for the long term WDM along with compulsory investment, and political commitment. Available studies are based on WDM and ground water depletion, but no paper has been found related to SWDM to conserve water resource and prevent ground water depletion from multidisciplinary perspective in the rapidly urbanized cities of the developing world. In this backdrop, this study suggests a comprehensive approach and tools