Urban Water Demand Management

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ABSTRACT

Population growth and rapid urbanization led to considerable stress on already depleting water resources .In most of developing countries water scarcity and high demands led the water authorities to resort to intermittent supplies. So large no of household in cities do not have access to one of the most basic of human needs- A safe and reliable supply for drinking water .So access to sufficient amount of water is still one of the main challenges facing the world. Now a days it is becoming clear that developing new water resource will not be enough to meet these challenges, it must be coupled with wiser use of existing stock of water through water demand management measures, water reuse and maintenance of water quality .

In most of the cities water demand exceeds water supply, therefore water deficit is continually increasing .Based on this fact institution need to adopt water demand for efficient use of water, water supply managers are often reluctant to use price increase as water conservation tools, instead relaying on non price demand management practice this include requirement for adoption of specific technologies (such as low flow mixture and restriction on particular uses (such as lawn watering)

The purpose of this paper is to present a proposal for formulating a specific water demand management .The objective is to stimulate discussion on development and adoption of a formal policy document Identify the main tools that influenced the water demand management which can be implemented to control the demand.

1. INTRODUCTION

The rapid growing of urban populations is increasingly becoming a problem for stakeholders and water sector institutions throughout the world, and it creates a difficult provision for them to ensure an adequate water supply and sanitation. Therefore alternative and complementary approaches to managing water resources are needed to balance the supply and the demand for water .The WDM offers one such powerful approach to positively influence water use and contribute effective water governance context. WDM is seen as the preferred alternative to meet increasing water demand and can be defined as any practice or policy implemented which results in water being used in a more efficient, equitable and sustainable way[1]. It addresses technical, institutional, financial and social aspects to provide multi- sectoral and integrative effort to motivate and support water users to regulate the amount, quality and timeliness in which freshwater is accessible, consumed and disposed. With regard to the domestic consumers, water demand management is active tools to satisfy the water needs of urban growing populations . Dedicated source of supply to cities is essential to meet the water demand. Demand is the major uncertainty in the WDS, which varies daily, in different seasons and for different types of consumers etc . It is difficult to investigate probable nature of demand in the WDS. Urban WDS demand management involves two measures - supply side management and consumer demand management. The supply side management involves infrastructure optimization, preventative maintenance, minimization of UFW and other water losses, metering of all connections, pressure management and energy efficient system. The consumer demand management involves social awareness and effective usage of water supplied, pricing, billing and minimization of losses due to overflow of tanks. A good relationship should be maintained between supply and demand for an efficient system where the quality can be maintained by reducing the residence time of water in the storage structures [2]. Water pricing is often recommended to reduce demand . If there is shortage of water, the solution should not be limited to supply options alone (an alternate source of water), but also consider demand-side options, such as minimizing water losses, and influencing demand to more desirable levels through structural modifications, retro fitting of water appliances, recycling and re-use, leak detection and repair, conducting educational and awareness campaigns.

2. WATER DEMAND

The demand of water is the amount required for a given purpose, for example liter per person per day or mm per crop. The demand can be present or future, and it can be actual (i.e. related to an available infrastructure) or potential (assuming full infrastructural development and no raw water shortage). The serviceable (part of the) demand is limited both by infrastructure and raw water availability. A distinction can be made between consumptive demand (for households, industries and agriculture), and non-consumptive demand (for habitat preservation, fisheries, navigation, and salinity control at the river mouth). A similar but flighty different distinction can be made between in stream demand and off stream demand. In this connection, storage reservoirs are somewhere in between- they 'consume' water (by storing it) in part of the year, and release it in a different part of the year. Run-of-river hydropower schemes are basically non-consumptive .Note that availability and demand are largely independent. Estimates of (future) water demand are normally much more uncertain than estimates of the water availability [1-4].

Use of water

The use (or consumption, or utilization) of water is the part of the demand that is actually served at a given time. Many uses generate a return flow, (for example sewage, or irrigation tail water). The return flow can occur at a different time or place than the withdrawal (for example a storage reservoir retaining water for release in a different part of the year)[2]. The use of water can be increased by infrastructural development and reduced by demand management.

Demand management

Demand management is intervention in order to reduce the consumption of water. Demand management is applied in order to meet a water shortage, or a shortage of money for infrastructural development, or to improve the water efficiency.

Supply enhancement

Supply enhancement is to make more water available to households, industries, farmers, and other consumers. This can be done by infrastructural development (of waterworks, distribution systems and irrigation systems), and/or by storage (in reservoirs), and/or by using new raw water sources. Supply enhancement requires raw water and money.

Efficiency improvement

In general, efficiency is the ratio between outputs and inputs. The over-all water efficiency is the production per unit of water. The distribution efficiency is the ration between water supplied and raw water withdrawn. Improvement of water efficiency comprises reduction of any unnecessary losses and waste (during storage, distribution or consumption)[3]. This can be achieved (for example) by appropriate operation and maintenance (and rehabilitation if required), and/or by introduction of new technology in agriculture and industry.

Factors affecting residential water demand

. These variables are in five major categories:

Utility management policy variables: water rates

Household economic variables: consumer income or wealth

Household physical features and technological variables: infrastructure of water-using and water-saving devices/ lot size/ metered and unmetered

Environmental factors: temperature and precipitation

Demographic variables: number of household residents/ attitudinal and cultural variables.

Different researchers usually derive the specific variables from the above exhaustive summary which they believe to be significant according to their respective level of analysis or the problems addressed [1-4].

Demand management tools

The demand of water for domestic consumption can be controlled by measures [1-4] such as

- Installation of water meters (if not done already), and charging a water fee;
- Applying different tariffs for different housing areas;
- Generation of awareness about prudent use of water;
- Rationing of water (normally in case of critical shortage only).
- The demand of water for irrigation can be controlled by measures such as
- Charging a water fee that depends on the volume of water used (rather than the irrigated area);
- Applying different tariffs for different seasons;
- Generation of awareness about prudent use of water;
- Promotion of good operation and maintenance;
- Promotion of new, water-efficient technology (crops and cultivation routines).
- Rationing of water, possibly by de-central administration (water user groups).

3. SOLUTIONS

3.1. Spatial distribution

The reviewed cases reveal that a variety of solutions to increased water self-sufficiency in urban areas are widely used around the world. Examples are found on every continent. A bias towards the industrialized parts of the world is intentional since the main focus is on solutions in industrialized urban areas [5].

3.2. Drivers

Five main drivers for increasing the self-sufficiency are discussed in the following: 1) direct and 2) indirect lack of water, 3) constrained infrastructure, 4) high quality water demands and 5) the sectoral system.

3.2.1. Direct lack of water

We define direct lack of water as occurring when the supply cannot meet the anthropogenic demand needed for households and irrigation. The deficit may occur as a result of decreased supply (drought), for example caused by climate change, or as a result of increased demand (population growth)[5]. Drought and population growth are common arguments for implementing alternative water strategies.

3.2.2. Indirect lack of water

Indirect lack of water can be defined as the case where water resources are sufficient to meet anthropogenic demands, but available water resources may be allocated for other uses or the resources can be undesirable for political reasons [6]. An indirect water deficit can therefore originate in a wish to allocate water to the environment or through a wish to avoid political conflict.

3.2.3. Constrained infrastructure

The driver constrained infrastructure is defined as the situation where bottlenecks in the water supply occur due to limited capacity of the infrastructure. Pipe systems designed decades earlier may be expensive to upgrade and restrain amounts of water to supply or remove from an area after use [7].

3.2.4. Demand for high quality water

A fourth driver is defined as a demand for high quality water. Membrane processes employed in water reclamation schemes can produce water that is even purer than required for potable supply [8] and industrial applications can create an additional demand for intensively treated wastewater. The electronics industry requires ultra pure water [9] .

3.2.5. The sectoral system

Innovation and development occur within a sectoral or innovation system as a result of the knowledge base and interactions that exist among the system agents, i.e. firms, universities, authorities etc. Although not being a direct driver for specific self-sufficiency trends, the sectoral system defines the framework for the development [10]. Commercial and institutional pressures are locally influenced by the technological paradigms employed by the commercial and non-commercial bodies and institutions in the area. Paradigms are reflected in regulations, standards, labor markets etc. It is possible, when firms, authorities, universities and related organizations build up knowledge and experience within e.g. desalination, that they develop biases, intentionally or otherwise, towards their own commercial or institutional interests [11]. It is difficult to measure how much such paradigms drive the development, but examples suggest an impact.

3.3. Techniques and concepts for self-sufficiency

Increased self-sufficiency is linked to rapid developments of three main solutions to water supply, namely wastewater reclamation, desalination and rainwater collection. Other solutions, for example local groundwater abstraction, are not included since contribution to self-sufficiency is believed to be very limited or highly dependent on water fluxes from neighboring areas.

3.3.1. Wastewater reclamation

Wastewater reclamation as a source for irrigation and groundwater recharge for both urban and non-urban uses is increasing in all parts of the world. Thousands of water reclamation projects are running throughout USA, Japan and Australia and their number is increasing rapidly (European Commission, 2006). The EU has relatively few wastewater reclamation projects, but has a great potential for development of water reclamation facilities [6]. For urban wastewater reclamation applications we distinguish between non-potable reclamation, indirect potable reclamation and direct potable reclamation [12].

3.3.2. Non-potable reclamation

Non-potable urban reclamation covers use of water for irrigation, nature restoration (environmental flows), household toilet flushing, and industrial process water. In Japan's megacities there are now thousands of on-site reclamation plants connected to public and commercial buildings. These plants typically replace 30% of the water used in such buildings, mainly for toilet flushing (Yamagata et al., 2003) [13]. On a larger scale, water is reclaimed for irrigation and to reestablish environmental flows where water is withdrawn for water supply.

3.3.3. Indirect planned potable reclamation

Indirect reclamation recirculates wastewater to drinking water after blending with natural sources. For example, in Orange County, California, reclaimed municipal wastewater is pumped back to replace 30% of the water withdrawn from the aquifer. These reclamation systems use several barriers to prevent pollutants from entering the drinking water supply. For example, in several Countries, conventional wastewater treatment is improved by microfiltration combined with reverse osmosis and UV and hydrogen peroxide disinfection before filtration through the groundwater zone [14] .

3.3.4. Indirect unplanned potable reclamation

Indirect potable reclamation occurs in an unplanned manner, where supply is based on water discharged by upstream users. For example, Berlin, Germany, has a water-supply system entirely based on local groundwater abstraction. However 70% of groundwater withdrawal is recharged to the aquifer via recharge of river water through the river banks and the volume of treated wastewater returned to local surface water is more than the volume recharging aquifers via bank infiltration (Massmann et al., 2004). Berlin's water supply has a self-sufficiency ratio of 70%. The ratio is high because groundwater abstraction is replaced by river water, which in turn is sourced from treated wastewater [15].

3.3.5. Direct planned reclamation

The wastewater from households is kept separate from the industrial wastewater, treated by a series of processes, including flocculation, sand filtration, ozonation, activated carbon filter, and ultrafiltration, before re-entering the city's water supply [16] .

3.3.6. Desalination

Membrane technologies are currently developing very rapidly with the number of membrane-based treatment plants increasing and treatment costs decreasing. In addition, to facilitate advanced treatment of wastewater for reclamation, the technology is also increasingly used for desalination of saline waters (Service, 2006). Desalination has been used for decades and the global installed desalination capacity now exceeds 60 millionm3/d (Pankratz, 2010).[18] The currently largest desalination plants in the world are based on thermal desalination of seawater and are found in the Middle East, where single plant capacities exceed 800000m3/d (Pankratz, 2010). The world's largest reverse osmosis desalination plant is situated in Israel (>270 000 m3/d) (Tal, 2006). In the countries of the Gulf Cooperation Council, 2/3 of domestic water is supplied by desalination (Dawoud, 2005). Researchers are working to improve desalination performance and a vast range of technologies are being investigated on lab and pilot scale. These include improved membrane materials that prevent fouling, while enhancing water flux and salt rejection, with the goal of lowering pressure needs and hence energy requirements. For cities with excess and waste heat sources, alternative technologies like forward osmosis and membrane distillation may become commercially attractive [19].

3.3.7. Rainwater collection

Rainwater collection is another important contributor to urban water self-sufficiency. For example, Singapore plans by the end of 2007 to collect storm water from 2/3 of the island's area, store it in reservoirs like the new Marina Barrage, and membrane filter it before sending it to drinking water supply (Public Utilities Board of Singapore, 2007). Our analysis revealed s many cities are now legislating collection of rainwater from roof tops with requirements depending on construction date, type and size of buildings. In these places, rooftop collected rainwater is used for toilet flushing, washing of clothes and garden irrigation and typically supplies 25% of the domestic drinking water use. These cases confirm earlier studies which also show that rainwater collection has a limited capacity to supply domestic water [20]. Domestic rainwater collection typically substitutes less than 1/3 of the household water consumption with the major limitation being 1 H.

4. DEMAND MANAGEMENT

Advantages:

- Low investment required (except for repair of distribution network, which can be very expensive)
- Public income can be generated by water fees.
- Incentive to industries and agriculture to improve their efficiency (and thereby their competitiveness in an open market).
- Raw water is preserved for alternative uses downstream, including fisheries.
- Less sewage treatment capacity required.

Disadvantages:

- Excessive demand management can affect general economic development.
- Risk of adverse social impact to the poor part of the population.

The negative effects of demand management will be less if regulation is introduced gradually, by small steps, and in a transparent and predictable way

5. CONCLUSION

it is concluded that:

Water self-sufficiency is a predictable response to urbanization and increasing water stress, and several cities are already taking advantage of low grade water resources within the city boundaries. Many cities reclaim wastewater and collect rainwater, and desalination is becoming increasingly common worldwide.

Self-sufficient water supplies are driven by direct (physical) and indirect (political) water deficits, concerns of water quality, and constrained water infrastructure. The inter disciplinary nature of the drivers emphasizes that water management is not just an engineering challenge. Calculating the degree of water self-sufficiency .

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