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Domestic Water Demands: Issues and Sustainability

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ABSTRACT

Water is the most essential natural resources for life next to air and is likely to become a critical scarce resource in many regions of the world in coming decades. The total fresh and sea water content of earth is essentially fixed. Growing demand due to increase in population across competitive sectors, increasing droughts, declining water quality, and unabated flooding, inter-state river disputes, growing financial crunch, inadequate institutional reforms and enforcement are some of the crucial problems faced by the country's water sector. The provision of clean drinking water has been given priority in the Constitution of India, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the state. Water is basic to survival and well-being and, therefore, adequate quantity of water of potable quality must be provided to all. Domestic water demand and main issues related to domestic water requirement are discussed in the present study. Water demand management would be required for its sustainability. The study also demonstrates that conventional and non-conventional programmes are to be equipped for reducing water requirement. Water pricing, water efficiency, water reuse ad recycling of water, technological advancement, and increased water tariffs will also be helpful to fulfill the domestic water demand. When sustainability will come in water management scenario then water demand would be reduced definitely without compromising the quality of life.

Keywords: domestic water demand, sustainable development, water management

1. INTRODUCTION

Water is basis to survival and well-being and, therefore, adequate quantity of water of potable quality must be provided to all. According to UN estimates, the total amount of water on earthis around 1,400 million cubic km which is enough to cover the earth with a water layer of a depth of 300 meters. However oceans cover about 3/4th of earth's surface and contain nearly 98% of earth's water. Fresh water constitutes only 2.7% of the total quantity of water available on earth i.e. 37.8 million cubic kmout of which 75.2 % lies frozen in polar region and further 22.1 is present as ground water.The total fresh and sea water content of earth is essentially fixed. Although man has been able to modify to a certain extent, the pattern of availability of the fresh water supplies with respect to space and time but the total availability basically has remained the same possibly over millions of years but the water demand has increased manifolds.

Growing demand due to increase in population across competitive sectors, increasing droughts, declining water quality, and unabated flooding, inter-state river disputes, growing financial crunch, inadequate institutional reforms and enforcement are some of the crucial problems faced by the country's water sector.The World Bank (2003) water resources sector strategy argues for both better management of water resources and more investment in infrastructure to make these resources available for multiple uses of water-irrigation, energy, fisheries, urban, rural, industrial, livestock and mining supply.

The provision of clean drinking water has been given priority in the Constitution of India, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the state.Agenda 21 and the Dublin principles (Summit 1992) put the concept of water as an economic good on the global agenda, and they have received wide acceptance by the world's water professionals.

While accessing drinking water continues to be a problem, assuring that it is safe is a challenge by itself.At present, the more pressing water problem of the region is the efficient and timely delivery of water rather than limited supply. Unfavorable policies, such as high government subsidies, lack of infrastructure, and inadequate institutional capacity to deliver have impacted negatively on the water sector in some countries in the region. As a result, many existing water distribution systems for domestic use and other sectores are inefficient and fast deteriorating.

Domestic water demand and main issues related to this e.g. water pricing, water efficiency, reuse and recycling of water, technological advancement, and increased water tariffs to fulfill the domestic water requirement are discussed in the present study. Various standards for estimating water requirements for human use,water demand management and sustainable development of water are also discussed in the present study.

2. ISSUES RELATED TO DOMESTIC WATER SECTOR

India, being a developing country, is facing several economic, political and water crisis challenges. The population of India continues to increase at an alarming rate and current population is about 1.21 billion (General 2010).India requires proper design and effective execution of suitable strategic options. The National Water Policy (MoWR 2002) encourages private sector participation in planning, development and management of water resources project for diverse uses, which might help in generating financial resources and introducing corporate management and improving service efficiency and accountability to users. The policy also recommends some incentives to promote public private partnership. Also, competition in provision of public services could improve efficiency in water supply services.Some issues related to domestc water sectors as as follows:

2.1. Pricing Aspects

Water pricing has four principal effects: (i) reduction of demand (ii) increased supply (because marginal projects become affordable) (iii) facilitation of reallocation among sectors, (iv) increased managerial efficiency leading to improved service, maintenance, etc (Serageldin 1995).

Based on a literature search, Gehrels (1985) found that demand in water sector is responsive to price changes. It was concluded that by modifying rate structures and manipulating price, water use in Southern Alberta would be reduced, thus extending existing water supplies. Chourasia (1987) studied the effect of metering on consumption of water through household connection in three villages of UP, India. The average consumption of water in metered connection was about 50 lpcd and that of unmetered connection was 125 lpcd. Kolvalli and Chicoine (1989) cited the cases of groundwater market, its benefits and implications and constraints to water markets, in Gujarat in India. The willingness to buy high-priced water often, even if less costly alternative sources are available, may be attributed to the greater reliability of private well water supply compared to canal supply.

Water pricing could affect: water allocation between competing uses; water conservation; generation of additional revenue which could be used to operate and maintain water systems, and even repay part or all investment costs; income distribution; Efficiency of water management; Overall environmental impacts. The overwhelming thrust of the hypothesis was that if the right water prices could be charged to water users, they would become rational optimizers (Biswas 1991). Water pricing can improve economic efficiency and improve social equity, and by using less of the resource more efficiently lead to environmental enhancement. Hence, water pricing helps to address all three of Agenda 21's concerns about sustainability of the resource(Rogers et al. 2002).

2.2. Water Efficiencies

Water supply in India continues to be inadequate and unreliable, despite longstanding efforts by various levels of government to improve coverage. The sector suffers from chronic operational inefficiencies, unreliable quality and poor coverage. Problems include suboptimal resource allocation, poor operations and maintenance (O&M) practices, uneconomic tariff structures, low collection efficiency and high levels of leakage. Rapid urbanization coupled with unplanned growth of cities and towns is only adding to the problem.

For water resources planners, managers, and operators, efficiency is an issue of ever growing importance: increasing demand and increasing constraints require more efficient tools. The Unaccounted for Water (UFW) in India is about 30 percent and in certain studies this may even go up to 70 percent. It indicates wasting almost 1/3rd of the treated water produced at high cost. The wastage of treated water in terms of cost may touch up Rs 300 crore a year. As per the detailed investigations carried out by NEERI, 17 to 44 percent of the total flow in the distribution system is lost as unaccounted through leakage in mains, communication and service pipes and leaking valves. The major portion of the leakage (about 82%) occurs in the house service connection, through service pipes and taps. The remaining 18% is due to leakage in pipelines (Suresh 1998).Water supply system in urban India suffers from a number of problems. There exists serious mismanagement in water supply system in urban India (Kundu and Thakur 2006).

2.3. Reuse and recycling

A rapidly expanding area of water supplies, specifically water reclamation and reuse was examined, and provided a comprehensive planning methodology for developing and evaluating water reuse alternatives by Mohorjy (1989). The methodology used five phases: goal setting, identification of reuse opportunities, development and evaluation of planning alternatives, assessment of water reuse linkages, and making decisions and recommendations. A tool called 'input-output modeling' was used in the third phase to present numerical data and choices. The methodology sought to integrate the hydrologic and socio-economic aspects of water resources planning in the area of study. The potential for water reclamation and reuse in developing countries by considering the relationships among the pertinent technical, social, economic, and environmental parameters were assessed (Mohorjy 1989).

Reuse of treated domestic wastewater has three beneficial impacts mainly in arid zones: the availability of more water, positive economic aspect and a decrease in environmental pollution hazard. It also satisfies nutrient requirements. Al-Zubari (1998) reported that GCC countries consider domestic wastewater as an integral part of their water resources. Major plans for water recycling exist in most of these countries. The main handicaps for reuse expansion are both social (psychological repugnance and religion) and technical (microbiological pollutants, potential heavy metals accumulation in irrigated soil, and industrial waste mixing).

A growing awareness is taking shape that it is more important to manage and administrate water demand in order to assure water security, than to meet the growing demands at any cost. Two goals will be achieved: first, from the economic point of view, a reduction of the costs and investments, and second the protection and conservation of the environment. In this respect, conservation, recycling and reuse of water play a key role (Beekman 1998).

2.4. Water Quality

Unregulated growth of urban areas, particularly over the last two decades, without infrastructural services for proper collection, transportation, treatment and disposal of domestic waste water led to increased pollution and health hazards. Fast urbanisation followed by increase in prosperity resulting in steep increase in waste generation. The municipalities and such other civic authorities are responsible for management of the waste that have not been able to cope up with this massive task and could be attributed to various reasons including erosion of authority, inability to raise revenues and inadequate managerial capabilities. That is why; it became necessary to launch the Ganga Action Plan and subsequently the National River Conservation Plan, which are essentially addressed to the task of trapping, diversion and treatment of municipal wastewater.

Since comprehensive water quality monitoring programmes in nearly all developing countries are either in their infancy or even non-existent, a clear picture of the status of water pollution and the extent to which water quality has been impaired for different potential uses is simply not available at present. With the available information it is reported that 70 percent of surface waters are polluted in India.As per the estimate of Central Pollution Control Board, about 29,000 million litre/day of wastewater generated. A large part of un-collected, un-treated wastewater finds its way to either nearby surface water body or accumulated in the city itself forming cesspools. In almost all urban centers cesspools exist. These cesspools are good breeding ground for mosquitoes and also source of groundwater pollution. The wastewater accumulated in these cesspools gets percolated in the ground and pollute the groundwater. Also in many cities/towns conventional septic tanks and other low cost sanitation facilities exists. Due to non-existence of proper maintenance these septic tank become major source of groundwater pollution. In many urban areas groundwater is only source of drinking. Thus, a large population is at risk of exposed to water borne diseases of infectious (bacterial, viral or animal infections) or chemical nature (due to fluoride or arsenic). Water born diseases are still a great concern in India.

Central Pollution Control Board (CPCB 2000) while assessing the water quality classification of River Yamuna, used three water quality variables namely BOD (biochemical oxygen demand), DO (dissolved oxygen) and F. Coli (faecal coliforms). Four water quality classes are distinguished. The range of BOD for class A is < 3mg/l, for class B (3-6 mg/l), for class C (6-10 mg/l) and for class D (10-30 mg/l). In order to reduce quality parameters for the large scale study at national level, the single variable, BOD is considered to give classification (Board 1995).

3. ESTIMATION OF WATER REQUIREMENTS FOR DOMESTIC USE

Water demand forecasting is a crucial component in the successful operation of any water distribution system. Accurate water demand forecasting across short-, medium-, and long-term time horizons can be used for capacity planning, scheduling maintenance, financial planning, rates adjustment and optimization of the operations of a water distribution organization. Most urban water demand forecasting studies have reported on short-, medium-, or long-term forecasting, but not across all time horizons. A research paper by Ghiassi et al. (2008) presents the development of dynamic artificial neural network model (DAN2) for the comprehensive urban water demand forecasting. Accurate short-, medium-, and long-term demand forecasting provides water distribution companies with information for capacity planning, maintenance activities, system improvements, pumping operations optimization, and the development of purchasing strategies. They examine the effects of including weather information in the forecasting models and shows that such inclusion can improve accuracy.

A stochastic end-use model for the simulation of residential water demand has been developed by Blokker et al. (2009). The end-use model is based on statistical information of water-using appliances and residential users instead of water demand measurements. The frequency of water use is mainly determined by a Poisson distribution; a negative binomial distribution is applicable to the frequency of use for the kitchen tap. The intensity of water use depends on the type of end-use and was described by a constant or a uniform probability distribution. The duration of water use is either determined by the user and can be described by a lognormal distribution or by a water-using appliance and can then be described by a constant. The diurnal water use was estimated by using statistical information of users' activities, such as their time of going to bed and getting up, leaving the house and returning home. With limited input information, a pattern was predicted for a fraction of the costs involved in the conventional measuring approach. The result shows that the simulation results are in good agreement with measured water demand patterns (Blokker et al. 2009).

There are overall two basic forecasting techniques used by water demand analysis. The first is trend based or extrapolative forecasting, where projections of future water consumption are based on past consumption data. The second is the so called component or analytical technique, in which water consumption is disaggregated into major components. Future changes in each component are predicted separately and aggregated.

4. WATER DEMAND MANAGEMENT

Water management has typically been approached as an engineering problem, rather than an economic one. Water supply managers are often reluctant to use price increase as water conservation tools, instead relying on non-price demand management techniques. These include requirements for the adoption of specific technologies (such as low-flow fixtures) and restrictions on particular uses (such as lawn watering). However, The economists (Olmstead and Stavins 2007) emphasize the strong empirical evidence that using prices to manage water demand is more cost-effective than implementing non-price conservation programs.

As in any policy context, political considerations are also important. Price and non-price conservation programs also differ in terms of their political feasibility. Water demand management through non-price techniques is the overwhelmingly dominant paradigm in India. Raising prices, particularly for what people perceive to be a "public service" can be politically very difficult.Key factors for water management in domestic water sector are given below.

4.1. Effect of Price on DomesticWater Demand

If policymakers are to use prices to manage demand, the key variable of interest is the price elasticity of water demand, the percent decrease in demand that can be expected to occur when price is raised by one percent.In shorthand, we can think of price elasticity as represented by the reciprocal of the steepness of the slope of a demand curve. Because price and demand are inversely correlated (an increase in the price of water means that consumers will want less of it, all else equal), price elasticity is a negative number. An important benchmark in elasticity estimation is –1.0; this figure divides demand curves into the categories of elastic and inelastic. Elastic demand is demand for which a one percent increase in price leads to a greater than one percent decrease in demand (represented by an elasticity "more negative than" –1.0). If demand is inelastic, a one percent increase in price leads to less than a one percent decrease in demand; in this case, elasticity lies between zero and –1.0. There is a critical distinction between the technical term "inelastic demand" and the phrase "unresponsive to price". If demand is truly unresponsive to price, price elasticity is equal to zero, and the demand curve is a vertical line – the same quantity of water will be demanded at any price. This may be true in theory for a subsistence quantity of drinking water, but it has not been observed for water demand in general in fifty years of empirical economic analysis.

Water demand in the residential sector is sensitive to price, but the magnitude of the sensitivity is small (i.e., demand is inelastic) at current prices. The price elasticity of residential demand varies substantially across place and time, but on average, in the United States, a ten percent increase in the marginal price of water in the urban residential sector can be expected to diminish demand by about three to four percent. However, no such estimate of demand curve is available in India.

The city norms in India are based on the water needs of the city and on the availability of water there. As per the individual cities, the norms for metropolitan cities vary from 65 lpcd in Vishakhapatnam to 250 lpcd in Lucknow as per (NIUA et al. 1999), based on a comprehensive study of 300 cities and towns in India. To what extent should the public water supply system meet these requirements? Since potable water is required for drinking, cooking and washing utensils, the formal water supply system should, at the least, meet these requirements. Using the norms recommended by the CPHEEO, which takes into account the needs of sewerage system, the results of NIUA et al. 1999 indicated that the water supply situation in urban India was distressing with almost 46 per cent of the sampled urban centers were not getting adequate water supply, that is, getting a per capita supply below the recommended norm. The average coverage of population by formal water supply in the sampled urban areas was reasonably high with 94 per cent of the population being covered by the service. However, the term coverage has to be read with caution for India as it only indicates the reach of the public water supply system but does not indicate the quantity, quality, and duration of supply or the mode of provision to the covered population.

4.2. Technological reduction factor - conservation programs and non-price conservation programs

Pricing policies are also constrained by law and by politics. As a result, water suppliers tend to rely on non-price conservation programs. It often includes: (1) required or voluntary adoption of water-conserving technologies; (2) mandatory water use restrictions; and (3) mixed non-price conservation programs.It is very difficult to estimate the impact of technology and of price conservation programs on water demands. As the water availability is reducing and water scarcity is increasing due to population growth and economic activity in India, the people will eventually forced to adopt the water-conserving technologies within affordable costs. (Postel 1997) gives a number of successful cases of water conservation in cities and mentions savings between 10 and 30 percent. It was also stated that cities could cut their water demand by a third with technologies available today, without sacrificing quality of life. Therefore, it will be fair to assume a 20% reduction in the domestic unit water demand by 2050 by the use of water-conserving technologies and mandatory water use restrictions in India. NCIWRDP (1999) assumed that the adoption of water saving technologies for different water sector can reduce the present rate of use of water up to 20% by the year 2050. Technological advancement refers to the use of technology at the user end, which reduces the wastage of water and thus helps in reducing the unit water demand at the user end.

5. SUSTAINABLE DEVELOPMENT OF WATER

The first global conference, especially on water to deliberate the water development issues and to draw attention to the coming water crisis was the United Nations Water Conference held in Mar del Plata, Argentina in 1977 (UN, 1977). Mar del Plata Action Plan stimulated a number of activities including the International Drinking Water Supply and Sanitation Decade (IDWSSD) 1981-1990, the global Consultation on Safe Water and Sanitation for the 1990s, held in New Delhi in 1990.

The concept of sustainable development (SD) was first launched in World Conservation Strategy, a joint report by the IUCN, UNEP, and WWF. Though there was little political commitment, strategy received wide attention. The concept really entered the political arena a few years later, when at the end of 1983 the General Assembly of the United Nations decided to form a World Commission on Environment and Development with the task of formulating 'a global agenda for change'. In 1987, the commission published its well-known report- Our Common Future also known Brundtland report, which set out the global challenge of sustainable development, 'to meet not only our current needs but also those of future generations'. The aim of SD strategy outlined by Our Common Future is 'promote harmony among human beings and between humanity and nature'. In Our Common Future the definition of SD (development that meets the needs of the present without compromising the ability of future generations to meet their own needs) is based on two concepts- basic needs and environmental limits. Critical objectives for environment and development policies that follow from the concept of SD are: (1) reviving growth, (2) enhancing the quality of growth, (3) meeting essential needs for jobs, food, energy, water and sanitation, (4) ensuring a sustainable level of population, (5) conservation and enhancing the resource base, (6) reorienting technology and managing risk, and (7) merging environment and economics in decision making.

The most important political event since then has been the United Nations Conference on Environment and Development (UNCED) in June 1992 in Rio de Janeiro, Brazil, which produced Agenda 21, an action plan for 21st century. As a preparation for UNCED, the International Conference on Water and Environment (ICWE) was held in Dublin, Ireland, in January of the same year. ICWE was the most comprehensive water conference since the one in Mar del Plata, produced a Report of the Conference and a Dublin Statement, the latter containing four 'guiding principles' which should give direction to future water policies at local, national and international level.

5.1. Key principles of sustainable development

Regarding water management, sustainable development has generated attention on four principles. First, fresh water should be regarded as a finite and vulnerable resource. Effective management links both land and water across the whole of a catchment or groundwater aquifer, and therefore effective management requires a holistic approach in which social and economic development is linked to protection of natural ecosystems.

Second, water development and management should be based on a participatory approach, involving users, planners, and policymakers at all levels. This also means that decisions should be taken at the lowest (most basic) appropriate level via open public consultation with, and involvement of, users.

The concept of sustainable development applies not only to water itself, but also to the living resources it supports. Shown here are Japanese supporters of commercial whaling standing in front of an anti-whaling banner at an annual meeting of the International Whaling Commission.

Third, because women play a central role globally in the provision, management, and safeguarding of water, they should have more opportunity to participate in planning and managing of water resources.

Fourth, water has significant economic value, and thus should be recognized as an economic good. However, it also is essential to recognize the basic right of all humans to have access to safe, drinkable water and sanitation. Pricing water as an economic good will discourage wasteful and environmentally damaging uses of water by encouraging conservation and protection of water.

6. CONCLUSION

- The study clearly indicates that water pricing is a complex issue because water is merit good. Water pricing policy is intended to serve many objectives such as equity, efficiency financial sustainability, and full cost recovery often inconsistent to each other. The need to fix an appropriate charge of price for water has been strongly advocated in recent years. Several reasons have been put forward in support of appropriate price policy. Although pricing is an important policy measure to improve the efficiency and conservation but the 'hydraulic law of subsidies' always pertains - water flows towards influence and power, which the poor never have.
- There is a necessity to improve the water use efficiencies in various water use sectors as the water saved is equivalent to augmenting the water supply for other users. As the water is already becoming scarce resource, no society can afford the inefficient use of this limiting resource.
- Reuse and recycling can play a key role in reducing freshwater demand and needs to be considered as viable option to reduce the demands for sustainable water resources development.
- Most of the studies on the water demand projections are either trend based (past consumption data) or component based (water consumption is disaggregated into major components).
- Water quality is an important issue and must be integrated in related models for a sustainable development of water resources.
- Management of water resources is still fragmented that is most practitioners in the water resources area have probably studied different components separately. It is difficult to predict the long-term water supply and demand but it is inevitable. There is a need of integrated water resources development studies that includes projection of water demand encompassing population and economic development, technological awareness, economic aspects of water, and water resources availability in a sustainable manner for better understanding and development of water system.

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