Current Urban Studies, 2014, 2, 83-87
Published Online June 2014 in SciRes. http://www.scirp.org/journal/cus
http://dx.doi.org/10.4236/cus.2014.22009

Urban Water Management: Best Practice Cases

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Received 5 March 2014; revised 25 April 2014; accepted 20 May 2014

Abstract

Current water resources management practices in most developing countries result in unnecessarily high economic and environmental costs. The magnitude and consequences of such costs have spurred the emergence of a global consensus on principles for improving water resource management. India will face an acute scarcity of water by 2025, more than most nations in the developing world. There is compelling evidence that improved water resources policies can have major impacts. In a number of cases in developed and developing countries pricing and tariff combined with regulations have produced savings of 20% to 30% and more. Improving water management will require that developing countries address the major constraints that currently undermine the allocation and efficient use of their water resources. Experiences in both developing and developed countries, as presented in this article, showed that improved policies for conservation and reallocation can have major benefits. The concerned authorities should look for various alternatives such as rainwater harvesting, recycling of wastewater, reducing un-accounted water and other options. Rainwater harvesting should be made compulsory; wastewater reuse has to be made with dual water supply system for new layouts. As the suburbs in the city are increasing day by day, rainwater harvesting would be able to serve the city for much longer time.

Keywords

Modified Balanced Winnow, Sentiment Analysis, Twitter, Online Social Networks, Feature Selection, Data Stream

1. Introduction

India will face an acute scarcity of water by 2025, more than most nations in the developing world (3rd World

Water Forum at Kyoto, Japan). Delhi, which is already facing shortage of water, is going to face worse period by 2015. According to recent reports every year Delhi ground water is depleting by 4 to 5 ft. By 2015 Delhi ground water will completely go down and 50% of Delhi people will have no water if the same trend continues (Ramakrishnaiah, 2002). In Karnataka, India, the numbers of districts susceptible to draught are in the range of 20 - 27. The number of districts which receives less than state average rainfall is 21 (Groundwater water resources status of Karnataka, India, 1994). It has experienced an unprecedented growth of 76% in population in the decade 1971-1981, and 39.4% during 1981-1991, 34.8% during 1991-2001, 48% during 2001-2011. The Bangalore development authority (BDA) has projected the population of Bangalore as 10.5 million by the year 2021. Bangalore, the capital city of Karnataka state, India, is one of the few big cities in the world which is too far from a perennial source of water and is located at such an elevation that every drop of water has to be pumped over high heads and over long distance. The water is pumped and transported over a distance of 100 km, from the Krishna Raja Sagar dam in Mysore. The power required to pump this water to the city is 50 mega watts which is enormous and it is citizen's tax money Rs 300 crores that finances this. Because of this, any augmentation scheme will be costly and hence delayed due to financial constraints. Currently for the reused water, it is not given much importance, as there will be a huge investment involved in treating the wastewater. The quantity of wastewater generated in the Bangalore City is around 800 MLD. Out of this, approximately around 200 MLD-300 MLD enters the Treatment plants due to the lack of adequate sewerage system and it has been observed that only 50% of the Bangalore City is sewered. Remaining wastewater is being let into the streams thereby contaminating it.

The water demand management is therefore become important for a city like Bangalore. The city is facing an acute water scarcity problem which is witnessed by the increase in gap between supply and demand. **Table 1** shows the projected population and water gap up to 2051 in Bangalore city. In the coming days, providing water would be a gigantic task, as there is no perennial river. There are also limitations for drawing the Cauvery water beyond 600 cusecs (Thippeswamy, 2004).

There will be a gap between the demand for water and supply level. Hence there is a need for harnessing ground water, cleaning all the lakes in Bangalore city and storing the water in the lakes which will recharge the groundwater table and enhance the groundwater as a dependable alternative source of water supply to the Bangalore city.

Considering an area of 800 square kilometers of Bangalore, the amount of fresh water received by way of rainfall precipitation is estimated as follows. For this purpose, the average yearly rainfall precipitation of 978mm is considered.

[(800 sq km × 1000 × 1000) × 0.978] cu m × 1000/10 = 782,400 ML

Considering daily supply of 900 ML for 365 days, the total yearly water supplied works to 328,500 ML. Considering full capacity of 1460 MLD, the yearly water supplied will be 532,900 ML in the year 2021. Considering the water demand of 2095 MLD in the year 2021 and the supply of 1460 MLD available from Cauvery, the short fall in demand will be 635 MLD. The water demand to be met from the water received by way of rainfall will be 231,775 ML which is less than the total water received by the way of rainfall over an area of 800 sq.km *i.e.*, 764,675 ML.

Total runoff from the new area of 800 sq km will be;

119,805 ML + 59,902 + 271,395 = 451,102 ML

The water demand to be met from the water received by way of rainfall in the year 2021 will be 231,775 ML which is 51% of the total runoff available from a land area of 800 km^2. In the year 2031, the water demand to

Table 1. Projected population and water demand up to 2051 in Bangalore city.

Year	Population in lakhs	Water demand in MLD	Present supply in MLD	Shortfall in demand	
				MLD	TMC
2011	84.99	1683	900	723	9.33
2021	105.81	2095	1460	635	8.19
2031	142.96	2831	1460	1371	17.69
2041	170.85	3383	1460	1923	24.81
2051	205.61	4071	1460	2611	33.69

(Thippeswamy, 2004).

be met from the water received by way of rainfall will be 500,415 ML which is 10% more than the total runoff available from a land area of 800 km^2.

2. The Need for Conservation

There is compelling evidence that improved water resources policies can have major impacts. In a number of cases in developed and developing countries pricing and tariff combined with regulations have produced savings of 20% to 30% and more.

3. Water Conservation: Best Practice Cases

3.1. Effects of Increased Tariffs on Household Demand in Bogor, Indonesia

Table 2 shows the raw water requirements for 2000 and 2010 in Bogor, Indonesia. In order to balance demand and supply, Bogor water supply enterprise, introduced both price and non-price policy instruments.

3.1.1. Price Policy Instrument

After a new water surface treatment plant began to operate, Bogor water supply enterprise adjusted the water rates. They started charging lower rate to the one who have lower income and consume less water. They increased the price also. The price increase was significant, from 100 percent to 280 percent.

3.1.2. Non-Price Policy Instrument

In spite of tariff increase, 51% of the customers were still using more than 30 m^3 per month. Therefore they initiated a campaign to reduce water use especially for customers with a monthly consumption above 100 m^3. The campaign was organized in three steps.

1) Local government water supply agency sent every customer pamphlets and brochures describing ways to reduce water use within house and instructions for reading water meters.

2) Local government water supply agency sent customers with monthly consumption greater than 100 m^3additional information on possible reasons for high consumption. Home visits by PDAM employees were offered through the Consumption Level Evaluation Program (CLEP).

3) When customers joined the program, Local government water supply agency employees visited their homes to look for leaks. If leaks were found, an estimate of repair costs and projected savings were provided. During the visit, employees carried out a survey of the household's water use habits and made recommendations for improving water use.

3.1.3. Effectiveness of Price Policy Instruments

As a result of the substantial water rate increase, domestic and commercial water use decreased by 30%. In the case of domestic customers with yard connections and house connections, average monthly consumption decreased from 39 m^3 and 37 m^3 to 28 m^3 and 26 m^3, respectively which represents a 28 percent and a 30 percent reduction in water use. Commercial customers also responded to the price increase by decreasing their consumption by 29% on average.

3.1.4. Effectiveness of Non-Price Policy Instrument

Three months after the campaign for reducing water consumption started, average monthly water use decreased

Table 2. Raw water requirements for 2000 and 2010 in Bogor, Indonesia.

Year	1984	2000	2010
Total population	251390	956871	1356701
coverage	49%	82%	87%
Per capita consumption	169	130	132
Water requirement (l/s)	483	2267	3454
Available supply (l/s)	420	540	540
Additional raw water (l/s)	63	1727	2914

(Bhatia, Cestti, & Inpenny, 1995).

by 29%, from 159 m^3 to 113 m^3.

3.2. Water Demand Management in Melbourne, Australia

In Melbourne, water demand management measures were initially introduced to cope with droughts. Later they are extensively used for deferring future water supply investments by curbing demand growth. Water demand management measures adopted during dry years have resulted in temporary reduction of consumption by as much as 30% during drought.

3.2.1. Adopted Measures

- They created task force on demand management in 1983. The main responsibility was to implement measures that would reduce domestic water use by 20%.
- Advertising.
- When water restrictions were imposed, water demand fell to 27% below normal level.
- Fig Water demand trends in Melbourne, Australia.

This reduction was originated by changes in consumers' behavior and attitudes towards water. These changes were induced by advertising campaign on water conservation via Television, Radio, local news paper, posters, stickers, calendars and brochures.

3.2.2. Public Education

The second measures adopted by Melbourne and Metropolitan Board of Works (MMBW) to reduce water consumption were a comprehensive educational program aimed at school children. The purpose of the program was to develop "an appreciation of the value of water in everyday life" that would eventually influence the whole house hold's attitude towards the use of water. The education program caused a drop of about 15%.

3.2.3. Introduction of Water-Saving Services

The third measure adopted was the redesign and promotion of water saving device, for example, dual-flush cisterns that require only 9 and 6 liters per flush replaced those that require 11 liters; shower heads that deliver 9 liters per minute instead of the usual 12 liters/minute.

3.2.4. Water Pricing Reform

The price reform established two components for the water bill: one based on the domestic property value, and the second one based on the volume of water used. It was estimated that after this price reform domestic consumption dropped 2% in the first year.

Increased water conservation efforts in the future could provide lead-time for new water supply augmentation projects by 10 yrs up to 2014.

3.3. Effects of Restriction, Quotas, and License in Israel

In view of the scarcity of water, in 1952 the Govt of Israel began formulating comprehensive water legislation. In 1959 it enacted the water law which adopted the following principles.

- Public property.
- Water rationing.

3.3.1. Adopted Measures

- License of water supply.
- Surcharges.
- Promotion and dissemination.
- Water saving technologies.

3.3.2. License of Water Supply

Water is allocated to each industrial firm according to a licensing provision. The total volume is determined by norms that consider the nature of the end product, the production process, the existing equipment, raw materials, the technology available for efficient use of water, and the quality of effluent. The norms are updated from time to time as new technologies become available.

In the dairy industry, for example, the approved norm was 3.5 liters of water per liters of milk in 1964, but in 1973 the norm was reduced to 1.7 liters by 1977 the norm was reduced to 1.45 liters. The annual water allocation to each industrial unit is then calculated by multiplying the planned volume of production by the appropriate norm.

3.3.3. Surcharges

In order to keep consumption within the volume allocated to the industrial unit, a special surcharge of about 200 percent is levied on the volume used beyond its quota.

3.3.4. Promotion and Dissemination

The water commission provides technical advisory services to disseminate information about water saving technologies. The commission also participates with the private sector in research and development activities.

Subsidized financing for investment. The government has established a fund to provide low-cost financing to construct projects that can reduce water consumption.

To encourage industries to invest in water conservation, the government offers low-interest loans for up to 80 percent of the related investment.

3.3.5. Water Saving Technologies

The licensing system forces industries to adopt water saving measures. The government, in turn, supports research and development of technologies to reduce industrial water consumption and pollution. Recycling of cooling water through cooling towers has become a standard practice, and other improvements include recycling of blow down water, automatic and semiautomatic valves, reuse of rinsing water; and use of low grade water.

4. Conclusion

Evidence from countries at different stages of development suggests that water conservation and reallocation solutions are widely applicable with local variants and adaptations. Still, the chances for success will be greatest when there is public support for and understanding of the policies to be adopted and if the policies are compatible with overall economic efficiency, environmental quality and equity objectives. The concerned authorities should look for various alternatives such as rainwater harvesting, recycling of wastewater, reducing unaccounted water and other options. Rainwater harvesting should be made compulsory; wastewater reuse has to be made with dual water supply system for new layouts. As the suburbs in the city are increasing day by day, rainwater harvesting would be able to serve the city for much longer time.

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