Science, Technology and Private Sector Division

Demand Management (water conservation)

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Summary

The prevailing scarcity of water and capital to cope with the growing demand in the urban sector of the developing countries enhances the significance and potential of water demand management.*

Implementation of a step-by-step strategy (Annex 1) would lead to a comprehensive programme promoting substantial water savings thus enabling governments to extend and expand urban water supplies at low marginal costs. Demand management programmes may include a variety of instruments in order to achieve the decrease of water wastage and irrational use at home, and at the commercial and industrial sub-sectors, as well as saving of irrigation water in the gardens, parks and urban-related agricultural activities near or within the city limits.

Demand management deals with the emerging problems of water utilities having 40-60%—and even higher—levels of unaccounted-for-water. This problem undermines management and utility functioning efforts. Case studies in the world (Annex 2) clearly show the ability to decrease unaccounted-for-water toward the 15-20% levels and reduce wastage in the domestic and commercial sub-sectors by 20-25% through leak repair and retrofitting by the private sector or the utility staff (Box 1).

Irrigation efficiency increases through the application of appropriate techniques. This leads to substantial increases in yield and income per unit of water, thus releasing large quantities of water from the agricultural sector for urban usage (Box 2).

Industrial demand management efforts promote water savings, lowering of water pollution levels, encouraging energy and raw material savings and as well as reuse of sewage effluents (Box 3).

Interestingly, recent developments have shown that exchange of fresh water for treated sewerage effluents have become a feasible option to deliver—additional—water quantities to the cities at much lower costs than those associated with the execution of the next water project, in many cases from remote and polluted resources (Box 4).

A comprehensive demand management strategy calls for the use of policy, legal, economic/financial and technological means. However, governments should not wait for the establishment of adequate institutional structures. Implementation of a stage-by-stage demand management strategy can assist and trigger the proper functioning of the utilities, thus creating the necessary enabling environment.

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* Optimization of water use through consumption reduction strategies and methods as complements to and substitutes for supply augmentation projects

1. Concerns related to current water development and management

Today's major concerns regarding water resources development and management may be grouped into three categories (Table 1). Clearly, they do not present isolated concerns, but are, indeed linked.

The environmental and economical implications of current water development strategies are intricately linked with the strong bias towards supply augmentation schemes. The very concept of supply augmentation is to continuously meet demand, which is, indeed, unsustainable. Firstly, because demands appear to be insatiable if they are not managed carefully. Moreover, the reservoirs filled with water create the illusion of plenty, thus not encouraging efficient use.

Secondly, the ever increasing demand of water forces water developers to reach out to more distant resources. As a result costs for new projects double or even triple in certain cases.

Thirdly, undervaluing water by making it seemingly plentiful and at the same time not achieving sufficient cost-recovery make existing supply schemes a heavy financial burden to governments. Indeed, many water supply schemes are in disrepair and thus not able to supply the amounts of water they were designed for.

1. **Environmental concerns** *associated with degrading water resources*	2. **Economical concerns** *associated with present water development and management*	3. **Social concerns** *associated with environmental degradation and poor access to water supply and sanitation*
• Degradation of ecosystems regulated by groundwater and surface water regimes (wetlands, forests, etc.) • Irreversible degradation of aquifer systems • Reduced soil fertility through pollution, salination, waterlogging, and erosion	• Insufficient cost-recovery • Inadequate supplies for future domestic and industrial uses • Increasing cost of new water supply schemes	• Conflict over water and land use • Reduced food security • Water related disease • Reduced standards of living

Table 1. Three major concerns related to current water development and management

2. Supply augmentation vs. demand management

Summarizing, the **supply augmentation** approach is a

- short-term solution,
- it involves high investment - and is thus not suitable for low-value uses such as irrigation,
- furthermore, it exacerbates environmental degradation, including resource depletion.

Whereas **demand management**

- averts high infrastructural investments - by bringing down current consumption as well as projected demands.
- It reduces degradation of resources
- and it reduces pollution, salination, waterlogging, and erosion both through efficient use of water.

- Moreover, it prevents conflict through inter-sectoral reallocation of water, particularly through freeing up of water in the irrigation sector.

3. Tools[1]

A. Conserving in cities

Water deliveries to households, schools, businesses, and other municipal activities account for less than a tenth of global water use today. Nonetheless, meeting these needs is no easy task. Drinking water must be treated to a high level of quality and supplied with a high degree of reliability, which makes it expensive. As cities expand, planners reach out to capture ever more distant and costly resources (Figure 1). By the end of this century, some 22 cities worldwide will have populations of 10 million or more, and 18 of them will be in the Third World. Serving these dense population centers will in many cases take more water, capital, and energy than is available or affordable. Already today, there remains a large unmet demand for household water. Nearly one out of every three people in the developing world —some 1.6 billion people[2] in all— do not have access to a safe and reliable supply for their daily needs. As a result, water borne diseases account for an estimated 80 percent of all illnesses in developing countries. And women and children walk several kilometers to collect enough water for drinking, cooking, and cleaning, a drudgery that saps time and energy from more productive activities.

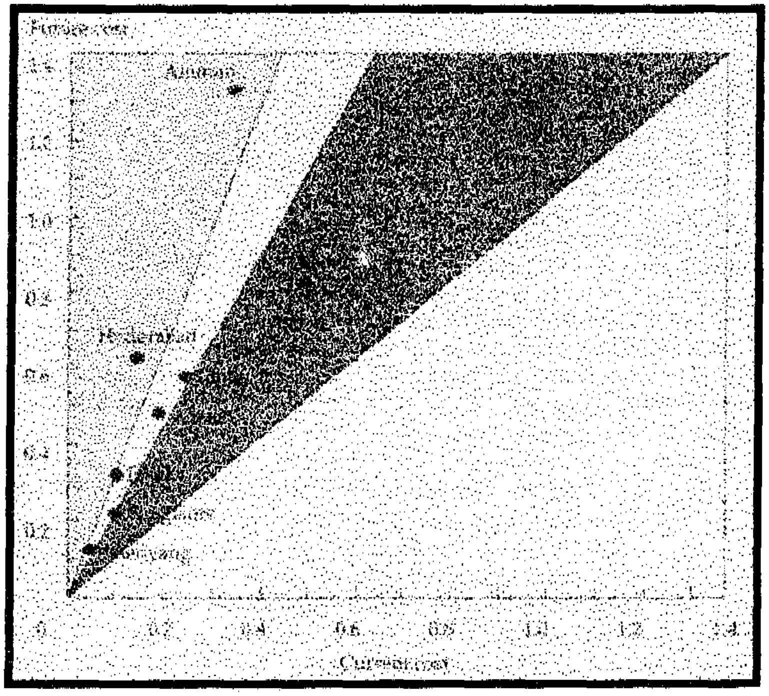

Figure 1. How the cost of supplying water is increasing[3]

Therefore, conservation, once viewed as just an emergency response to drought, has been transformed in recent years into a sophisticated package of measures that offers one of the most cost-effective and

1 From Sandra Postel. 1992. Last Oasis: Facing water scarcity. Worldwatch Institute. Washington, DC.

2 From the 1995 draft report to ECOSOC of the ACC Subcommittee on Water Resources, Energy and Natural Resources.

3 From Ismail Serageldin. 1994. Water Supply, Sanitation, and Environmental Sustainability: The Financial Challenge. The World Bank, Washington, DC.

environmentally sound ways of balancing urban water budgets. Water planners are realizing that an assortment of water efficiency measures can yield permanent water savings and thereby delay or avert the need for expensive new dams and reservoirs, groundwaterwells, and treatment plants (See Box 1). Slowly the idea is spreading that managing demand rather than continuously striving to meet it is a surer path to water security—while saving money and protecting the environment at the same time.

B. *Efficient irrigation*

Of all the water taken from rivers, lakes, and aquifers, agriculture claims the largest share accounting for an estimated 65% of global water use. As opportunities to extend cropland area have dwindled, augmenting food production has come to depend more on coaxing higher yields from existing farmland, which often requires irrigation. Over the course of this century, as the number of people to feed swelled from 1.6 billion in 1950 to more than 5.4 billion at present—a threefold increase—, agriculture's water use increased fivefold. The really rapid rise began around mid-century, when water development entered its hey-day, and continued as the Green Revolution took hold and spread. However, due to poor management, operation and maintenance, and insufficient cost-recovery to pay for O&M as well as new investments, irrigation is a very inefficient and low-value water user, especially in the developing world. Dryland regions, such as Israel, Texas and California have proven that with appropriate technologies—such as use of drip, surge and sprinkler techniques—and the right economic incentives, water use efficiency in irrigation can increase substantially (See Box 2).

C. *Industrial recycling*

Industries make the second largest claim on the world's water bodies, accounting for a fourth of global water use. Generating electricity in thermal power plants (nuclear and fossil fuel) takes copious amounts of water, as does making the paper, steel, plastics, and other materials we use every day. Spurred by droughts, strict pollution control requirements and appropriate pricing, industries in countries like USA, India and China have shown that they can reduce their water use dramatically by recycling and reusing their supplies (See Box 3). Yet these technologies remain greatly underused, particularly in the developing world, where industry's water use is now rising rapidly.

D. *Waste water reuse*

The greatest gains in domestic water use lie in redirecting water used in cities and towns for a second use on farms. Though typically viewed as pollutants, most wastewater constituents are nutrients that belong on the land, where they originated. Farmers worldwide spend heavily on chemical fertilizers to give their crops the nitrogen, phosphorus, and potassium that domestic wastewater contains in large amounts. According to one calculation, it takes the equivalent of 53 million barrels of oil—worth more than $1 billion—to replace with fuel-based fertilizers the amount of nutrients yearly discarded in US sewerage.

Israel has the most ambitious wastewater reuse effort underway in the world today. Already some 70 % of the nation's sewage get treated and reused to irrigate 19,000 hectares of agricultural land. Globally, at least 500,000 hectares of cropland in some 15 countries are now being irrigated with municipal wastewater. Although this amounts to two tenths of one percent of the world's irrigated area, in dry regions wastewater can make up an important share of agriculture's water supply (See Box 4).

In fact, by not making wastewater reuse a part of water planning and management, developing countries put their urban and rural populations at risk, since reuse will almost surely take place in dry climates out of economic necessity, but without adequate sanitary controls.

4. Constraints

As illustrated by a few examples mentioned above—and further illustrated by case studies in the Boxes indicated—, the many ways of conserving, recycling, and reusing water constitute the making of an efficiency revolution. With tools and technologies readily available, enormous water savings are possible in agriculture, industries, and cities. Yet we are stuck at the brink of this transformation because of policies and laws that encourage wastefulness and misuse rather than efficiency and conservation.

Governments often build, maintain, and operate irrigation systems with public funds, and then charge farmers next to nothing for these expensive services. Irrigators in Mexico, for instance, pay on average just 11% of their water's full cost, and those in Indonesia and Pakistan, about 13%. In Egypt, a land of extreme scarcity, farmers are not charged directly for their irrigation water at all. And in India, the world's third largest food producer, government spending to operate and maintain medium and large canal projects exceeds the total revenue collected from farmers by 23.5 billion rupees (US$ 816 million). These are but a few examples. It must however be realized that[4]:

- Most countries provide subsidized or free water for irrigation
- Most countries subsidize water supply infrastructure
- Few countries accomplish significant cost-recovery
- Few countries have well defined demand management techniques

Thus appropriate pricing, the creation of markets for buying and selling water, and other economic inducements for wise water use hardly exist in most places. These measures, however, have an important role to play in an era where water becomes increasingly scarce.

5. Demand management: institutional and management options

A. Water pricing

Many of the water shortages cropping up around the world stem form the widespread failure to value water at anything close to its true worth. To the contrary, grossly underpricing water perpetuates the illusion that it is plentiful, and that nothing is sacrificed by wasteful practices. Correcting these perverse situations is easier said than done. It requires

- Challenging political interest;
- raising awareness and building a strong commitment from civil society, governments, and the private sector to make protection of water ecosystems a central goal in all that we do;
- creating an enabling environment; and
- decentralizing water management and encouraging user participation so that local water suppliers and users have more responsibility and accountability for the performance of their operations

Additionally, it requires that waterusers in developing countries at least pay for the operation and maintenance of their supply system. This is often frustrated by the notion that they cannot afford the prices. Yet those benefiting from irrigation commonly earn far more than those cultivating rainfed lands do. And slum dwellers typically pay 5-10 times the price of the municipal water to the water vendor. Moreover, Third World water users have shown time and again that they are willing and able to pay more for water that is reliable and

[4] From EDI/UNDDSMS. 1993. *Proceedings of the Workshop on Water Resources Management in Southern Africa, Victoria Falls.*

over which they can exercise control, in the case of irrigation. Therefore, incentives and structures for improving fee collection have to be put in place.

Setting prices closer to the real cost of supplying water is a key component of agricultural, urban and industrial conservation. As revenue collection based on volumetric pricing can be difficult, as it usually is in the irrigation sub-sector using open canal systems, governments —and donors— frequently attempt to organise water users to take ownership of and responsibility for operating water systems. In such cases markets in tradable water rights can also provide the right incentives for conservation.

B. Water allocation

With the pace of water development slowing and supplies no longer expanding in places, meeting new demands will increasingly require shifting water among the different users —irrigators, industries, cities, and the natural environment. In many parts of the world, such competition is already evident, and in most cases it is agriculture that will lose water —sometimes out of choice, and sometimes not. In fact small percentage reductions—in the order of 5-7%—of water use in irrigation would free up vast quantities of water for industry and municipal usage.

In the western United States, competition for scarce supplies has spawned an active market that is fostering transfers of water from farms to cities. If an irrigator can earn more by selling water to a nearby city than by spreading it on alfalfa, cotton, or wheat, transferring that water from farm to city use is economically beneficial. If it prevents the city from damming another river to increase its supplies, the transfer can also benefit the environment. In this way, marketing can be an effective means of reallocating a finite pool of water.

Farmers can free up supplies for sale in three ways:

- by irrigating more efficiently and selling the conserved water,
- by switching to less thirsty crops and selling the water they no longer need, or
- by taking land out of irrigation entirely and either producing dryland crops or retiring the land from agriculture.

Irrigators may also choose among several different types of transactions:

- they can sell their water rights directly, which permanently transfers control to the buyer,
- they can lease some or all of their water for an agreed-upon period, while keeping the rights, or
- they can swap supplies with another water user.

To the extent that agricultural supplies are freed up by increasing irrigation efficiency or by switching crops, land need not come out of production, however, agriculture could lose more water —and land— than is socially desirable, given the challenge that lies ahead of feeding a much larger world population.

In parts of Bangladesh, India, and Pakistan, water markets of groundwater have emerged as an effective way of distributing water. Often poorer villagers cannot afford the pumps and other machinery to extract underground water for their crops. But if they are able to buy supplies from wealthier farmers, they can still receive some of irrigation's benefits.

However, where electricity is subsidized and priced according to a flat fee geared to the horsepower of the pump, as is common in many areas, a farmer has an extra incentive to sell the water, since there is no real cost to the extra pumping. Although water marketing makes relatively inexpensive water available to poorer farmers, it also creates a strong inducement to overpump the resource, especially because tubewell owners often have de facto ownership rights to as much groundwater as they can extract. As a consequence, groundwater levels decline, resulting in drying up of the shallow wells forcing the poorer farmers to buy water from the tubewell owners, creating a downward spiral of social inequity and environmental degradation.

To serve the goals of efficiency, equity, and sustainable resource use simultaneously, water marketing would need to be accompanied by limits on groundwater pumping, the reduction of energy subsidies, and assurances that markets do not further concentrate water rights in the hands of the rich. Additionally, protecting the many other functions water performs that a marketplace does not adequately value —such as habitat protection, species preservation, and aesthetic benefits— requires limiting the amount of water that cities, industries, and agriculture collectively claim.

6. Concluding remarks

Falling freely from the sky, water has deluded us into believing it is abundant, inexhaustible, and immune to harm. The challenge is now to put as much human ingenuity into learning to live in balance with water as we have put into controlling and manipulating it.

From an institutional and management point of view, establishing demand management as the future strategy of water development requires primarily:

- Raising awareness and building a strong commitment from civil society, governments, and the private sector we have to make protection of water ecosystems a central goal in all that we do.

  Building on this commitment, the following instruments and approaches can be applied:

- an efficient regulatory and legal framework;
- appropriate water pricing practices; and
- increased emphasis on decentralization and small scale projects to enhance user participation

  will have to be put in place.

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Step-by-step demand management (water conservation) strategy for urban areas, including any of the following important components:

I. Water conservation

A. Retrofitting to reduce flow in commercial and public buildings as well as at home

- Reducing volume of flush in toilets
- Installation of low-pressure flow regulators on taps, faucets and showers

B. Efficient urban-related irrigation using drip, surge and low-pressure sprinkler techniques

- Parks and gardens
- Farmers within the city's jurisdiction or within a feasible distance from the city

C. Industrial conservation

- Reduction of flow rates
- Switching from continuous to intermittent flows
- Sequential reuse of process water or water of lower quality

II. Reducing unaccounted-for-water

A. Reducing water thefts

B. Reducing leaks

III. Water pricing and pollution control

A. Comprehensive metering system and its routine repair and calibration

- Industries—gradual installation starting with large users
- Commercial and public buildings—Government and private offices, schools, army & police camps, etc.
- Domestic metering following a prioritization of districts: 1) Rich, 2) middle-income, and 3) low-income groups

B. Pricing

- Progressive block rate—essential for succesful achievment of objectives
- Flat rate

C. Pollution control

- Enforced effluent charges promoting industrial in-house treatment and reuse

IV. Minimizing unaccounted-for-water

A. Complete loss inspection (including leaks and theft) and leak repair programme

B. *Complete billing and collection of fees, enforcement*

V. Institutional and management changes to promote demand management

A. Institutional changes

- Creation of department responsible for reducing unaccounted-for-water
- Creation of department responsible for fee collection
- Creation of unit responsible for promotion of retrofitting—use of private sector is highly recommended

B. Water transfers from farms to cities

- Farmers can irrigate more efficiently and sell the conserved water
- Farmers can switch to less water consuming crops and sell the water they no longer need
- Farmers can take land out of irrigation entirely either by producing dryland crops or retiring the land from agriculture
- Farmers can use treated effluent and sell water to the cities

VI. Comprehensive demand management for urban areas, including reuse of effluents

A. Waste water reuse options

- Installation/completion of sewerage system
- Full biological/conventional treatment of sewerage
- Redistribution for second use on city parks and gardens, as well as farms
- Installation of double water supply system (drinking water and sanitation)
- Redistribution for sanitary reuse
- Supply of treated effluents for use by the industry, industrial zones could install and opertate their own sewage treatment plants

B. Setting appropriate standards for water fitting and appliances

To deal with local manufacturesrts and/or imports

C. Enlisting the private sector (contractors, management frims) to assist utilities in

- Leak detection and repair
- Retrofitting at households, offices and commercial buildings
- Design of dryer water cycles in the industrial subsector

Box 1. Conserving in cities

Mexico - Efficiency standards, pricing, and education

Faced with an enormous water shortage, the Mexican government and city officials are orchestrating an agressive water conservation initiative. In 1989, the federal government took a bold step and adopted a strict set of nationwide efficiency standards for household plumbing fixtures an appliances. They require toilets—the biggest water guzzler in the home—to use no more than 6 liters (1.6 gallons) per flush, and they set maximum limits for showers, faucets, dishwashers, and washing machines as well.

Mexico City has launched an ambitious program to replace conventional toilets (using about 16 liters) with the 6-liter models in public places, commercial buildings, and private residences. By late 1991, more than 350,000 toilets had already been upgraded, which will save nearly 28 million cubic meters of water per year—enough to meet the household needs of more than 250,000 residents.

Officials hiked the city's water rates in 1990, encouraging residents to install the package of home water-saving devices made available and to be more thrifty overall.

And to bolster the whole effort, a large scale public information campaign—including educating schoolchildren and airing radio and television spots— is under way to raise awareness about the city's water plight and to let people know how they can conserve.

Indonesia - Pricing

Pricing was the main tool of a conservation strategy adopted by the water utility serving Bogor, Indonesia. With a proposed new water project estimated to cost twice as much per unitof water as existing supplies, the utility opted to try to reduce demand through more effective pricing. It tripled or quadrupled water prices, depending on the amount used, to encourage households to conserve. Between June 1988 and April 1989, average monthly residential water use dropped nearly 30 percent, which should allow the utility to connect more households to the urban water systme at a lower cost.

Source: Sandra Postel, *Last Oasis: Facing water scarcity,* Worldwatch Institute, 1992

Singapore - Leak repair

Measures to curb wastage in the transmission and distribution systems in Singapore include inspection for leakage along pipeline routes for transmission mains of 700 mm diameter and above and implementation of a yearly leakage detection programme for all distribution mains of 500 mm and below. The objective of the programme is to check the soundness of the entire distribution network at least once a year. Leakage detection tests are carried out for the entire distribution network within eleven months, leaving one month to re-test the leak prone areas. Any leaks detected will be repaired immediately.

In 1991, 1,010 leaks were detected. Had the 1,010 leaks not been detected and repaired up to the end of the year, the total cumulative wastage could have amounted to 165,829 cubic meters per month.

Source: *Urban water reources management*, ESCAP Water Resources Series, No. 72, 1993

Box 2. Efficient irrigation

Israel - drip irrigation

Following its establishment as an independant nation in 1948, Israel faced the challenge of growing crops in a dry environment with extremel limited supplies of water that often contained high levels of salt. In response, Israeli researchers developed a new concept in agricultural water use known as drip irrigation—and they have been perfecting it ever since. Under this method, water is deliverd through a network of porous or perforated piping, installed on or below the soil surface, directly to the crops' roots. This keeps evaporation and seepage losses extremely low. Because water is applied frequently at low doses, optimal moisture conditons are maintained for the crop, which boosts yields, and salt is prevented from accumulating in the root zone. Modern Israeli farmers often have highly automated drip systmes, with computers and monitors sensing when and how much water to apply and determine the precise amount of nutrients to add.

Drip systems often achieve efficiencies in the range of 95 percent. Because it is relatively expensive, with the initial outlay typically running $1,500-$3,000 per hectare, drip irrigation is mostly used on higher valued fruit and vegetable crops, though more than 130,000 hectares of cotton, sugar, sweet corn, and other field crops are now watered by drip as well.

Texas - surge irrigation

Farmers in Texas are turning to a technique called "surge" irrigation, which can greatly improve traditional gravity methods. Instead of releasing water in a continuous stram sown the field channels, irrigation under the surge method alternates between two rows at specific time intervals. The initial wetting somewhat seals the soil, allowing the next aplication to advance more quickly down the furrow. This surging effect reduces percolation losses at the head of the field and distributes water more uniformly, especially if the furrows are somewhat shortened.

Farmers who adapt their old-fashioned furrow systme to the new surge technique have reduced their water use by 15-50 percent, while cutting their pumping cost at the same time. For those in Texas Plains, wher savings have averaged 25 percent, the initial investment of about $30 per hectare is typivcally recouped within the first year.

Texas - LEPA sprinkler irrigation

Between the 1989 and 1990 growing season, tow farmers sold the conventional side-roll sprinkler that had been watering their alfalfa farm east of Lubbock, Texas, and bought a "low-energy precision application" (LEPA) system. In addition, they buried gypsum blocks in the soil to monitor soil mosture, which allowd them to irrigate only when thier crops really needed it. The detailed records they kept for those two years showed that water use dropped by 47 percent, electricity use fell by 32 percent, while crop yield—owing mainly to better-timed irrigations—rose to nearly a third. As a result, their overall water productivity climbed 150 percent.

Adapting an existing sprinkler for LEPA costs Texas farmers in the range of $60-$160 per hectare, and the water, energy, and yield gains typically make it a cost-effective investment. The payback for such a retrofit is two to four years, while converting to a LEPA sprinkler from an entirely different systme would typically have a payback period of three to seven years.

Source: Sandra Postel, *Last Oasis: Facing water scarcity*, Worldwatch Institute, 1992

Box 3. Industrial recycling

Massachusetts - drought

Spalding Sports Worldwide, a sporting goods manufacturer, has a Massachusetts plant that draws upon the Quabbin Reservoir, the main source of supply for the greater Boston area. When the region's brush with drought in 1988 and 1989 further squeezed an already tight water supply outlook, the company decided to take a hard look at its entire production process with an eye toward expanding the conservation affors it had begun earlier in the decade. Through a number of measures—especially recycling the cooling water for its machinery—Spalding cut its water use from 1.5 billion cubic meters in 1989 to 64,000 cubic meters in 1992, a 96 percent drop in just three years.

California - regulations

As part of a city-wide conservation effort during the mid-eighties, industries in San Jose, California, made impressive progress in water conservation. A detailed look at 15 companies in the area—including several computer makers, a food processer, and a metal finisher—showed that by adopting a diverse set of conservation measures these firms collectively reduced their annual water use by 5.7 million cubic meters, enough to supply about 9,200 San Jose households. Water savings ranged from 27 to 90 pwercent, and in most cases, the payback period on the conservation investments was less than 12 months.

Besides the typical inducements of strict federal and state water quality regulations, Californian industries have faced the possibility of large cubacks in water supply because of the ongoing drought. As a result, many are investing in water conservation well beyonf what is financially justified at the present itme as an insurance policy against future rationing, which could threaten production.

India - pricing and regulations

In the town of Goa, India, a fertilizer plant owned by Zoari Agro-Chemical Limited cut its water use by half over six years in response to high water prices and government pressure to reduce effluent discharges to the sea. The Goa plant now produces a ton of nutrients using only 40 percent as much water as a fertilizer plant at Kanpur in Uttar Pradesh.

Source: Sandra Postel, *Last Oasis: Facing water scarcity,* Worldwatch Institute, 1992

China - administrative and legilative measures

In Tianjin, China, economic, administrative and legilative measures resulted in a decrease of indusrial water use from 360 cubic meters per 10,000 Yuan of gross production value in 1981 to 145 cubic meters in 1988, which represents a reduction of 60 percent of industrial water consumption per unit of industrial output value. In Beijing also, between 1978 and 1984, th decrease was from 880 cubic meters per 10,000 Yuan of production value to 335 cubic meters.

Source: *Water conservation and pollution control in Indian industries,*
Water & Sanitation Currents, UNDP/World Bank Water and Sanitation Program, 1994

Box 4. Waste water reuse

Israel

Isreal has the most ambitious wastewater reuse effort under way in the world today. Already, some 70 percent of the nation's sewage gets treated and reused to irrigate 19,000 hectares of agricultural land. With no new sources to tap, Israel plans to expand the use of reclaimed wastewater by the end of the decade. Virtually all of it will go to agriculture, which is projected to lose as much as 38 percent of its allocation of fresh water to spredaing urban areas. If the nation meets its targets, reclaimed wastewater will supply more than 16 percent of Israel's water needs by the end of the nineties.

About half of Israel's reclaimed water comes from the greater Tel Aviv metropolitan area, where it undergoes treatment, is recharged to an underlying groundwater basin, is detained there for further treatment, and then is pumped back up and piped to farms in the western Negev desert.

Another strategy is the "agro-sanitary approach used in parts of the western Galilee. The key to this low-tech strategy is a series of ponds and reservoirs that biologically treat sewage and remove its harmful constituents, making it safe for watering crops that will not be eaten raw. Organic matter is reuced so as not to overload the land, but a share is retained to add usefull nutrients and other elements to the soil.

Typically, engineers achieve the required treatment through a sequence of physical, biological, and chemical processes that collectively can bring wastewater up to a very high quality. Depending on the size and type of operation, the advanced treatment needed to meet the strictest standards for reuse cost 15-42 cents per cubic meter ($180-520 per acre foot), including conventional primary and secondary treatment.

Florida

St. Petersburg, Florida, is the only major U.S. city to have closed its cycle completely by reusing all its wastewater and discharging none to surrounding lakes and streams. The city has two water distribution systmes—one that delivers fresh water for drinking and most household uses, and another that distributes treated wastewater for irrigaing parks, road medians, and residential lawns, and for other functions that do not require drinking water quality. For residents hooked up to the dual system, the recalimed water costs only about 30 percent as much as the drinkable supply, and, because of the nutrients it contains, cuts down on their lawn fertilizer as well.

Source: Sandra postel, *Last Oasis: Facing water scarcity*, Worldwatch Institute, 1992

4.15 Revenue Enhancement, a Neglected Procedure of Public Waterworks, Malaysia

by Mr. Kam U Tee, waterworks management consultant

Abstract: Although demand management has been achieved in Malaysia, nevertheless, waterworks are run less efficiently due to lack of attention to the commercial aspects of a supply organization. This paper argues that revenue enhancement procedures, hitherto neglected aspect of operations has to be made into a main business priority.

Introduction

Demand Management: an Attained Objective

All waterworks in Malaysia have adopted a full regime of meter reading and billing, some of them as long as 50 years ago. As a result, per capita domestic consumption has been stabilized between 200 to 230 liters per capita per day (lcd). In contrast, some waterworks in neighboring countries that do not supply through meters would, if a full day's pressure could be maintained, return per capita consumptions in excess of 400 lcd. In such cases, however, wastage leads to inadequate supplies and many areas obtain supplies only for a few hours a day, and this had been achieved by allocating inordinate manpower resources to manipulate valves to distribute available water. This daily quest for water can get so intense that local ward politicians have been known to take over control of the valve manipulation crews in order to secure supplies to their wards.

Failure of the Malaysian Systems

Despite the above successes in controlling demand, the process of reading meters, issuing bills and ensuring collections has been, comparatively speaking, neglected over the last 30 years. A 1987 National Non Revenue Water (NRW) study estimates NRW to vary between 40% to 50% in many States of Malaysia. Penang is an exception, with only 20% NRW.

It is now argued that where losses over 40% occur, about 20% of this can be attributed to Under Registration and Under Billing compounded by low efficiencies of collection. The remaining half can be attributed to theft or to physical losses but even so, in the Malaysian context where over 60% of mains are of asbestos cement of over 30 years age, some of them of immediate post World War II vintage, many are now beyond their economic life spans. These pipes have been attacked by acid and sulphate ground waters; the cement matrix of these pipes have been softened and the pipes weakened. Recurrent bursts rather than long standing leaks contribute to losses to the ground. (At a burst rate of 1 pipe burst/km/year, a 6000 km system will have 6000 bursts per annum or 16 bursts per day. If each burst remains unattended for 24 hours, which is common, a considerable wastage from bursts results)

A prioritied pipe replacement program, based on analysis of frequency of bursts and type of breakages, rather than a costly but inconclusive leak detection exercise is required. This is a long term exercise which is more amenable to an annual budgetary provision, made say. from depreciation allowances rather than from a massive injection of capital raised from a loan and to be implemented within a few years.

Revenue Enhancement: an Immediate Objective

Revenue enhancement procedures - long neglected in the post independence period because of the mind-set that water is an amenity that should be provided either free or at least in highly subsidized form to the new electorate by governments, must now be given priority. Because social welfare costs have been heavy and because growth has been high-up to 7% per annum or a doubling of demand every 10 years, there has never been enough money available to pay for renewals and replacements - the emphasis being on new constructions and more and more mains and capacity. As a result. service has been poor and standards have spiralled downwards.

Revenue Enhancement will focus on the commercial aspects of a water supply. A commodity is supplied, for which certain agreed standards of pressure, flow and quality are assured. In return, supply is metered; bills are issued and payment is expected: if necessary enforcement procedures are implemented. Much of this is the outcome of internal control, such as meter maintenance and audit of readings, externalities relate to consumer satisfaction, consumer consumption profiles, and pricing policies to ensure the product is affordable. Where neglect is manifest in internal processes - these can be remedied with comparatively low expenditures, but with immediate and sometimes spectacular returns of investments.

The following observations are based on a composite study of waterworks encountered over the last 20 years in Malaysia and some neighboring countries.

The Consumer Profile

A. The Rural Demand

Due to increasing pollution of streams and surface wells, and as a matter of social policy, a drive to supply 100% of population with piped water has put pressure on waterworks. In the case of widely dispersed rural populations, it is not economic to supply individual services to households, however stand-pipe supplies are frequently abused and self closing taps are immobilized leading to waste.

Much thought has been given to meet this problem, but so far, the best solution is the Philippines Barangay Water Cooperative, where a village forms a cooperative under the auspices of the water Supply Company, they are given a subsidized bulk supply which is metered and they in turn sell water to their constituents at fixed prices (about P 0.07 per US gallon) - any profits made assure regular payment of water bills, and excess profits are shared by the members.

B. The Urban Slums

In the case of urban slums, (up to 20% to 50% of urban population in Asian cities may be so classified), due to density of population, privacy of users is a problem. Usually stand-pipe taps are immobilized and rubber hoses, which keep branching in binary fission, are laid to households. This again leads to waste and danger of contaminated water. A good solution practiced for many years in Penang and now almost universal in Malaysia is to give interest free loans to consumers to make connections to their houses. and to input instalment payments, some of them lasting over 5 years into their water bills. This has proved successful and there are few defaults of payments. But what of their capacity to pay?

C. A Social Survey of Consumers

The ability of consumers to pay, is a prerequisite for a successful billing system. A social survey carried out in Penang in the early 70s was the basis of a three stepped domestic tariff in Malaysia. Arising out of a survey carried out between the then City Water Department and the newly formed University Science, a profile of consumers at that time can be summarized in the following table:

Table A: Consumption Profile, Penang Island 1972

type of dwelling	sample size	avg. month consumed	avg. no. heads	avg. per capita consumption
fishing village	50	28 m^3	7	136 lcd
squatter slum	52	30 m^3	8	116 lcd
detached bungalows	38	71 m^3	5	440 lcd
housing estate	56	39 m^3	6	230 lcd
shop houses	98	69 m^3	10	220 lcd
city terrace houses	51	53 m^3	9	200 lcd
total	345	50 m^3	8	208 lcd

D. Affordability of Water

It is to be noted that although the above sample was not exactly representative, nevertheless, the average monthly consumption of 50 m^3 was average for domestic consumers as a whole. By 1990 the average occupancy per customer account was nearer to 6 heads due no doubt to the proliferation of flatted condominiums and speculative ownership of these, nevertheless, average per capita demand remains at 230 lcd and average monthly consumption had dropped to 42 m^3/month. This process is a common occurrence in the cities of South East Asia.

Notwithstanding the above, a recent survey (1989) indicated that slum density remained at 8 heads per account. The difference between 120 lcd for slums and 220 lcd for city houses must be due to the existence of a water flushing cistern or otherwise.

Because of this, it was successfully argued that significant concessions could be given to the low income consumers by charging the first 20 m^3 of consumptions at a subsidized rate, the next 20 m^3 consumed at an "average" cost and consumption above 40 m^3 at the cost of new water - the same as charges for industry/commercial premises.

E. The Three Tiered Domestic Tariff

If the first block were charged at RM 0.35 and the next block at RM 0.60, the impact on squatter slums would be as follows:

0 - 20 m^3	20 x 0.35 =	RM 7.00
20 - 29 m^3	9 x 0.60 =	RM 5.40

		RM 12.40

Assuming a family income of RM 300 per month, the above represents 4% of monthly income.

In other States, average occupancy per consumer premises can be nearer to 5 heads, it is therefore usual to have lower cut-off points such as 215 m^3 and 30 m^3 respectively.

A case can be made that even if average costs go up to over RM 1.50 (which will happen when water needs be ported over 100 km) water can still be affordable. In such a scenario, the first block can be reduced to 10 m^3/month to be charged at RM 0.50/m^3 and the next block between 10 to 30 m^3/month, charged at RM 1.20/m^3 whilst the 3rd block as well as industrial/commercial consumers can be charged at RM 2.00/m^3.

For such a case, a marginal user must reduce his consumption to 16 m^3/month, when he pays:

0 - 10 m^3	10 x 0.50 =	RM 5.00
10 - 16 m^3	6 x 1.20 =	RM 7.20

		RM 12.20 or an average of RM 0.76/m^3

This is still better than the Barangay Association charge of P 0.07 per US gallon which works out to be RM 1.9/m^3 for which they could only afford 7 m^3 of usage per month. (4 jerrycans of water of 50 liters may be a limit of transportability).

F. Industrial / Commercial Water

This can vary between 10% of total demand to 40% of total demand, which is an average for the three cities of Bangkok, Singapore and Penang.

The average consumption per industrial/commercial account in Penang is 200 m^3/month; that of Bangkok is only 100 m^3/month. Even at RM 2.00 per m^3, the average monthly bill is RM 400 per month - less than the pay of a labourer.

In a recent analysis, the industrial ratio in Kuala Lumpur was shown to be only 27%. If it were 37% instead of 27% an increase of 10% metered water of 300 million m^3 at a charge rate of RM 1.20 would mean an increase in revenue of RM 36 million per annum. Considering there were only 70 000 industry/commerce meters out of a total of 700,000 meters a good strategy would be to concentrate on the meter reading process and meter change process on these 70,000 meters. This could achieve an immediate and most cost effective return on effort and investment. The returns on this effort can be re-invested in control of the remaining 630,000 domestic meters.

Revenue Enhancement Processes

The Billing Process

The poor results of reading and billing crept up on Malaysian Waterworks in the late 60s and early 70s when billing was done by Addressograph machines and payments posted into electro-mechanical ledger card machines. Growths in excess of 7% per annum were experienced, but this was not reflected in the staffing ratios of the Addressograph operators nor of the ledger card machines. Moreover, mechanical ledger card machines were getting obsolete and no new purchases were added - no spares were readily available. Posting of payments fell behind the issue of bills by 5 months or more. This made it nearly impossible to enforce payments, and collection efficiencies dropped to below 80%. Again, the process of input output of cards was so cumbersome that no analysis of billing statistics were possible - low reading efficiencies and poor control of meter readers resulted. Computers were introduced in the late 70s but there was a slow learning curve, and it was not until the 80s that collection efficiencies rose to above 95%.

The billing process is a scheduled and batch controlled process - reading is organized into reading blocks, each of which should be read in a fixed schedule. No straggling blocks can be allowed. Early attempts at billing, which only catered to systems analysts and their machines, failed. The interposition of a data control and in-put section, controlled by a disciplined "sergeant major", was necessary between the computer room and the meter readers. Internal control of process is vital - Penang Waterworks provided the necessary controls and succeeded the first time around; KL waterworks did not, and several degrees of failures ensued over the years.

Collection Procedures

In order to service consumers, some waterworks employed bill collectors who went to consumers premises. Apart from poor security, it was not possible to keep track of consumers who did not pay on first or second visits. It became impossible to tell whether a non-updated payment was due to non-collection or due to the collector not reporting payments on time. Such a dilemma was solved in Bangkok, by the collector leaving a bill if no payments were made after the first visit. Subsequently it became the responsibility of the consumer to go to the waterworks branch office to pay his bill. Collection efficiencies of over 90% became possible. Computerized receipting machines and tight communication procedures followed by stringent enforcement subsequently improved collection efficiencies to above 48%. In Penang, efficiencies of collection are consistently above 99.5%.

Consumer Satisfaction

Enforcement procedures can become a cat and mouse game between consumers and meter disconnectors. In the end, the axiom that a satisfied customer is willing to pay for goods received holds true. For collection efficiencies above 95%, a satisfactory service, both as regards to pressure and quality is a prerequisite. Often a fall in services is followed by poor payments which further exacerbate the situation. Very close coordination between capacity building and revenue enhancement and improvement of distribution systems has to be incorporated into an integrated plan. <u>This means integrated and competent management</u>.

A Need for Integrated and Competent Management

The practice so prevalent in Malaysia of privatisation only involving the privatisation of the treatment processes, followed by bulk sales to the water undertaking, without due regard to the overall business practices of the organization is therefore very short sighted. Under these circumstances it is hard to see how privatisation can bring the effects of improved efficiency to waterworks.

Analysis of Data

This has been shown necessary to transform a poorly controlled billing system into a viable system. Types and sizes of meters; date of fixing in consumer premises, serial numbers of meters - these and other strategic information can be stored in computer memory available for reference within an instant. Other statistical data such as consumption per premises and ratio of industrial/commercial consumptions, give invaluabie information for management.

However, the storage of more data is also a double edged sword. A well controlled system of inputting changes must be devised. For example, when meters are changed and the new meter readings are not input into the computer, some astronomical sums may be billed to consumers.

Lately, there has been much talk that privatisation by itself, can lead to improved performances of waterworks. The immediate riposte to such claims is that many do not see how the replacement of a public monopoly by a private monopoly can lead to improved efficiencies. It has been agreed that some form of standardized performance parameters can be used to measure efficiencies, but not much progress has been made. The waterworks of Bangkok, Singapore and Penang have cooperated in this field and some performance parameters have been incorporated into their annual reports. Some graphs are included in the Appendices to ndicate some of these parameters and how they may be used to induce comparison, competition and encouragement between water undertakings.

As another example, even before the output meters is filtration plants in Perlis, (which were subject to a 5 year maintenance programme by a private company) could be read accurately, a control of the average meter consumptions per consumer account per meter reading block, enabled control to be placed on meter readers in Perlis. Over a 1 year period, average returns per account increased from 23 m^3/month to 27 m^3/month. (See Table B)

Conclusions

It is agreed that long term planning and capacity building is necessary to keep up with demand of the burgeoning populations of Asian cities. However, after the consultants walk away, the waterworks must be run to achieve adequate returns on the investments. The only proper way to achieve this is to focus on the commercial aspects of waterworks, taking into account the whole gamut of processes from collection of water, treatment of water, distribution, billing collection and customer relations, inclusive of enforcement of payments.

The current trend to equate privatisation as a means to achieve commercialization, but stopping with BOT schemes is not satisfactory.

Table B: Analysis of Consumptions: Perlis Supply C2.1993

	m^3	accounts	m^3/month	comments
Sanglang	90,122	3,832	23.5	rural
Berembang	28,911	1,281	22.5	rural
Kl. Perlis	119,551	4,316	27.7	commerce
Arau	170,887	7,419	23.0	residential
Kangar	249,621	9,498	26.3	city
Santan	204,212	6,992	29.2	industrial
P. Besar	44,022	3,303	13.3	water stress
etc. etc.				
total	1,829,778	67,826	27.0	
average cost			RM 0.417/m^3	

WATER SUPPLY AND SANITATION COLLABORATIVE COUNCIL
WORKING GROUP ON INSTITUTIONAL AND MANAGEMENT OPTION

CASE STUDY - ISRAEL - DEMAND MANAGEMENT
(Chapter II of casestudy on rural water & sanitation)

Socio economic condition - policies - legal institutions

Mixed population of various religious and ethnic background, present 90% urban and 10% rural. Villages and cooperatives high rate of literacy, low rate of infant mortality, 2-2.5% of population growth, 4-5% of real GDP growth. (presently $15,000)

Demand management (D.M) concepts were incorporated in water code (1959) where the water commission was entrusted with the overall responsibility for water resources and for promoting efficient use of water through a number of instruments and policies including economic, financial, administrative and technological.

A set of institutions were established like the departments for efficient use of water in agriculture, urban and industrial sectors, as well as the Dept, for water pollution prevention and re-use of treated human wastes.

Research institutes were established for improved irrigation techniques and the increase of agricultural yields per unit of water. As institute for the research, development, testing and promotion of water conservation technologies was created.

Nation wide educational campaigns, through the general media and schools were started as well as special courses within various institutes, all intended for human resources development toward efficient use of water strategy.

OBJECTIVES

Objectives of national program are all aimed at decreasing unnecessary water demand in the 3 sectors, delaying the execution of expensive water projects, incorporating environmental targets with the increase of water/effluent for irrigation. Basic supply to reach total population while overuse to be priced close to margingal costs.

ACTIVITIES AND ACHIEVEMENTS

Complete and comprehensive water metering system has been implemented (to include individual metering of apartments in condominions etc).

Establishment of progressive blocks of water rates to all sectors. Basic urban consumption is provided under low rates. Upper block for irrigation use is over 25 CM/3 resulted in significant reduction of use. Automated increase of rates through a formu.a use was installed by parliament.

Research and development of techniques, methods and technologies to reduce water consumption in the urban sector as well as increase agricultural and industrial production were incorporated in the public and private sector work.

Special financial instruments were introduced (including World Bank credits during the 1970-80's) for the efficient use of water strategy execution, and re-use of sewage effluents.

Regulations and economic means have been introduced in order to substitute fresh water for high quality treated effluents for unlimited and limited irrigation projects. Thus environmental goals were incorporated in the water sector policies and its production targets.

RESULTS - The nation has maintained high standard of living, health and production (agriculture and industrial) with almost the same quantity of water during the last 25 years. Agricultural production in real terms increased by 300% as well as the industrial production.

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WATER SUPPLY AND SANITATION COLLABORATING COUNCIL

WORKING GROUP ON INSTITUTIONAL AND MANAGEMENT OPTIONS

CASE STUDY - ISRAEL (PERIOD 1960 - 1975)

SOCIO - ECONOMIC CONDITIONS

Israel, (20,000 KM2) has a mixed population of various religions and ethnic groups. Limited natural resources including water and land. Very dynamic ethnic group with substantial support from abroad for the urban and rural sectors. Rural population a is mixed society of educated and traditional farming community.

POLICIES - LEGAL

Rural development, water and sanitation management were all placed under the responsibility of one ministry and was given high priority in the infrastructure development strategy.

Water code (law) abolishing rights and installing a public water ownership and legal framework was passed by parliament. Allocation and price system were introduced. Low interest capital was made available to national firm as well as regional water systems and individual rural communities.

INSTITUTIONAL SET-UP

Water commission, national water company and state water planning corporations were established in order to assure comprehensive and sector control mechanisms, thus concentrating management functions in the hands of the public sector to assure adequate water and land resources management and preserve production factors for future migrating groups.

OBJECTIVES

To reach high level of water and sanitation sector development, management, high efficiency and coverage, minimization of water losses within the national system and the (individual users of water), land and environmental resources secure and protected through the planning and investments (low interest) for sanitation and sewerage systems were done with a macro concept. Sewerage (Collection and treatment) was integrated with the fresh water conservation strategy and implementation, thus delaying the execution of expensive water projects and protecting ground water and the water bodies.

ACTIVITIES AND ACHIEVEMENTS

Regional associations and projects were planned, supported by public capital, and have reached coverage of the total rural and urban population for potable purposes as well as irrigation. (Coverage of potable approx. 98%).

Allocation and prices are aimed at promoting efficient use of water. Farmers have enlisted private sector partners to develop and manufacture irrigation and water supply fittings and systems.

Schools for technicians and university faculties (engineering, economics, agronomy) were promoted in close collaboration between the rural population and the authorities.

Joint funding of research and extension system was initiated.

Rural associations with their movements and the government have promoted special courses health ,hygiene and nation wide sector management schools.

PROBLEMS ENCOUNTERED

Land and water scarcity has lead to differential policies where sub-sector groups did not enjoy equal socio-economic support.

PROBLEMS AND FAILURES

The enforcement of water conservation in the urban sector was found to contradict other human rights and laws and thus has achieved limited coverage throughout the country. Regulations are enforced in many of new houses. Water bills are usually less than 2% of family expenditure and therefore lack the necessary economic incentive. Adequate policy yet to be enforced.

Supervision of production and consumption calls for significant logistics and financial needs as well as problematic (in a western democratic country) to execute, as it calls for public sector intrusion into individual territories.

Urban water demand is rising with GDP/GNP and standard of living especially as a result of high water use in modern appliances (dishwashers, garbage grinders, washing machines) larger lawns at home and all hamper the policy to reduce demand environmental demand for larger parks and green areas, etc.

Demand management and environmental management both act to undermine the trend to minimize public and government involvement in the sector. One must find the balance between the two objectives.

The contradiction between urban utilities goals to increase their income through larger sales to upper and middle class consumers hamper their willingness to genuinely cooperate in large scale retro-fitting campaigns which lead to decrease in consumption. In agriculture the wish to preserve quotas through actual use tend to enhance non-efficient use.

SPECIFIC LESSONS LEARNED AND CONCLUSIONS:

In water scarce countries, regions and cities demand management policies could produce low marginal costs water resources, in most cases much cheaper than new resources to be developed.

Demand management campaigns and implementation programs are highly educative and could "overflow" toward other sectors like energy and food conservation.

Introduction of demand management methods within the production sectors (agriculture and industry may lead to major management achievements in its general cycles, saving of energy, raw material, chemicals etc.

Introduction of demand management reduces the total use of resources, reduces water pollution and encourages the awareness and handling of other environmental issues. (air, noise etc).

In the Middle-East the economics of water conservation is beyond doubt when cubic meter of water saved could cost 10-30 cents while marginal costs on new resources could reach (USD/CU.M. (ex.plant).

Water conservation by wasteful users can produce large additional quantities for redistribution to unserved urban and rural residents.

In Israel Unaccounted for water has been reduced from average of more than 30% to 15%. The target is to reach 10% nationwide. The lesson is that campaign against losses and illegal supply is a possible effort if proper institutional set-up is achieved, and if politicians will understand the importance of the issue and will allocated the needed human and financial resources.

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