Regional Conference
on
Promoting Sustainable Consumption in Asian Cities

WATER DEMAND MANAGEMENT

By: Prof. Saul Arlosoroff

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CONTENT

SUMMARY

Water is more than just a commodity. It is an essential element to all life and is basic to many economic activities. Therefore, its economic value must be recognized and addressed in all policy and sector activities in order to initiate and promote the wise and efficient use of water resources in all sub-sectors, especially in the large urban centers. Using water in an efficient manner and managing competing demands in any city, country, or region are essential steps to ensure that water is no longer undervalued and misused in our world.

This conference, and others to be initiated in-country discussions, and the support of the media, should be an integrated part of a global campaign to foster water conservation and to demonstrate to all governments of developing countries that substantial economic, social and environmental benefits will be generated by using water more efficiently.

In order to achieve demand management goals, we all should pursue the establishment of adequate policies, strategies and action planning for a step-by-step program to be adapted to the conditions of each site. Appropriate technological implementations, water metering, and pricing policies are indispensable elements in this global campaign as part of legislative, regulatory, and institutional reforms, to accommodate demand side management.

Appropriate water management should be seen as an integrated element in the developing countries' strategy toward sustainable development. It is directly linked to natural resource and environmental management – A major challenge confronting the developing countries. Let's examine a few of the major components of this global and Asian challenge:

In this decade alone, the world population will increase to 6 billion, with the growth mainly occurring in the developing countries. By the middle of the next century, only 50 years from now, there will be more than 10 billion – the increase will be mainly in the urban centers of the developing countries, while the growth of Asian urban centers will overshadow the ones in the other continents.

Water use in developing countries is increasing at an accelerated pace, due not only to growing populations, but also as a result of the higher standards of living, increased per capita use, rapid industrialization, and the expansion of irrigation to supply the needs of the population growth. This forecasted growth has serious implications for environmental sustainability locally and globally. Neither economic development nor environmental management are expendable – both are essential. They must be integrated in a wise strategy that reconciles economic development and environmental health. Governments will have to follow innovative and clear strategies to accommodate this huge economic development without the further

destruction of the environmental infrastructure. Water resources management and water conservation are essential components of a strategy aimed at achieving these goals of sustainable development.

National goals can only be achieved by the collective efforts of all water using sectors, the different levels of governments, and the public. Water conservation provides a unique opportunity for a collaborative national campaign:

- National and local governments should initiate creative approaches, courageous policies, regulations and their enforcement. They should test the use of incentives and sanctions, tax measures, support to Retro-fitting and new technological modifications, and initiate water abstraction charges, local 'water-markets' and tradeable permits. The introduction of realistic full-cost pricing of water in a step-by-step action plan is essential for strategic implementation of Water Demand Management (WDM) in the urban and industrial sub-sectors, as well as in the agricultural sectors.

- The industrial and institutional reform, in many developing countries, must include water conservation and pollution abatement components as an integrated activity. Re-use of waste-water within industries or within an industrial zone, re-use of municipal wastes, for irrigation of fields and parks, and industrial cooling are just examples of key elements that reconcile pollution abatement with water demand management. Water efficient processes match energy conservation and reduction of total pollution in many of the rehabilitated industries in the western countries. They contribute to improved industrial management and its profitability and need not obstruct industrial economic viability. It is a common myth in many developing countries that industrial environmental management undermines the economic basis of the industry. Japan, Germany, and Singapore, as an example, have the toughest environmental and water management standards, while these countries are of the top economic performers.

- The governments, the public, the multilateral and bilateral funding and donor agencies all have a role in the water conservation activity. We all have been wasteful users of water – pumping more than we need. Polluting water and returning it to nature after inadequate treatment or no treatment at all. The time has come to move from constantly augmenting supply to managing demand. Reduction of water use delays new projects, sometimes indefinitely. It reduces pumping and treatment costs, decreases sewage flows and their disposal costs, increases utility's income through a reduction of leakages and improved water metering and thus provides the financial resources for well managed operations, terminating the vicious cycle of utilities mismanagement and inefficient distribution and use.

- Cities in Asia have often conflicting policies and rules – some of which actually

foster increased water consumption. Low water prices are a known culprit within this contest. If municipal and industrial water users will pay realistic water prices, utilities will be able to maintain their systems, minimize losses, and maximize the quality and the level of service. When national and city governments stop subsidizing the expansion of water supply systems and have to take out loans and pay considerable interest for new projects, there may be a turning point in their attitude toward the implementation of demand management versus a supply augmentation strategy. The savings on interest payments alone in one year could possibly finance a city wide Retro-fitting program leading to a 15 to 25% reduction in water use.

- High rates of unaccounted for water are common in the cities of the developing countries reaching extreme levels of 40-60% of the water produced. No utility can function under such conditions for a long time. A universal and appropriate water metering system is a must whether for production, for block-metering (essential for leakage detection and flow management), or for micro-metering at the household, office, park, restaurant or industrial site.

- Rate structures have been changed in many utilities from regressive to progressive block-rate paying more per unit for the higher water consumption. Progressive block-rates encourage conservation and reduce waste. However, a proper well maintained water-metering system is a pre-requisite condition for that. The introduction of private sector assistance to local governments can prove to be a very important and effective tool, to reduce losses, install and read meters etc.

- Contractors can be paid on the basis of the real water savings achieved. Contractors can also undertake the whole demand reduction program. They will move from house to house and execute a citywide Retro-fitting program, while the customers will pay for the installation through the water bills.

CONCLUSION:

Water conservation and demand management is more than just a water consumption issue. Above all, it is a strategy promoting efficient and wise use of scarce resources. Urban water demand management means securing the whole water cycle – using less, keeping the water clean and decrease of contaminants downstream. Conservation is based on the recognition that water is an economic commodity and a valuable production factor. It should be priced and allocated accordingly, while securing the basic needs of the poor and low-income groups.

For conservation strategies to succeed, all sectors of government and the economy - public and private - should collaborate. We must do a better job in disseminating information, informing countries and local government of successful case-studies and full-scale projects. The international organizations should promote the

dissemination of successful case-studies between countries to avoid or minimize duplication, to avoid repetition of mistakes, and to enhance collaboration between user.

INTRODUCTION

Historically, the predominant approach to water resource development has focused on developing new supplies and structures to manipulate available supplies in order to meet perceived water needs. Hallmarks of this strategy include large dams, rivers, diversions, large water supply and waste treatment works, and many other such structures. All of these measures form necessary components of societal infrastructure, and have undoubtedly contributed to the advance of human civilizations. However, because the water supply management approach considers water needs as requirements that must be met, and not as demands that are variable and changeable, this water supply management strategy may lead to overuse of the resource, overcapitalization, resource wastage, pollution problems, and many other problems of varying severity. A most important fact, about these problems, is that the prevailing strategy in most cases does not suggest permanent, cost-effective solutions to them.

It is beginning to be understood, by governments of all levels, that these types of problems require a fundamental change in order to be solved efficiently and effectively. In this case, the new policy places water demands themselves, not structural supply solutions, at the center of concern and develops large, capital intensive new supply systems only after opportunities have been fully analyzed for lowering or mitigating the proposed demands in a more socially beneficial manner. This new approach is referred to as water demand management (WDM). While not dismissing traditional aproaches, water demand management relies much more on socioeconomic techniques like economic analysis, establishment of incentives and disincentives, water conservation technologies, reduction of unaccounted for water, re-use of treated waste water, public education, water equity rights modification and other related techniques. These approaches have proven very cost effective in modifying water demand patterns, and in many cases, lowering the demands themselves, substantially. Structural components of demand management include: comprehensive metering, leak detection and repair, installation of water savings techniques, water auditing, changes in water pricing concepts and others.

Experience in various regions like the state of California, the countries of Singapore and Israel, and others show that if fully pursued and implemented, demand management could:

- Reduce water demands by 30-50% with no deterioration in life-style
- Significantly reduce capital requirements for expansion of water supply
- Reduce the generation of pollutants, and therefore the requirements for new

or expanded waste treatment systems

- Enhance the development and adoption of new technologies with an impact on similar management of energy use
- Promote financially sustainable water systems
- Expand the coverage of available water development funds thus enabling cities in the developing countries to expand their water supply systems to the poor, low-income groups and unserved suburbs
- Help meet the water needs of growing irrigation and industrial users located in or around urban centers and the needs of a growing world population

WATER DEMAND MANAGEMENT – SOME GENERAL CONCEPTS

Water demand management (WDM) places much more emphasis on the socioeconomic characteristics of water use. Demand management is much more aggressive in its use of economics to influence the origin of water demands to provide incentives for satisfying given "ends" in the cheapest possible manner. In other words, the various water uses are seen as consumers which can be influenced and governed by incentive structures, technology modifications, public education and other means. This is no more than applying public concerns and arrangements to currently unmarked natural resources. This is not to say that traditional supply management actions are no longer required – only that they need to be significantly re-evaluated and changed.

Applied to environmental issues, it follows that an effort is required to rethink basic approaches, which to date in most Western societies have been very focused in two areas – the erection of physical structures and the use of the law to provide answers to certain behaviors. The reality is, however, that most environmental problems, such as resource overuse and water pollution are allocational in nature. Legal and engineering approaches to these types of allocational problems are often very blunt and ineffective. WDM will focus on the use of economic instruments to influence water use, the fostering of new technologies and increased levels of public awareness and education about water uses.

ECONOMIC TECHNIQUES

The aim is to promote other water use practices in the sense of moving toward increasing conservation and sustainability in the use of water resources. Because of the scope of this paper is limited, only selected concepts will be dealt with here.

There are two main issues relating somewhat to economic theory that strengthened even further the case for water demand management. These are: the issue of resource scarcity, and the concept of economic efficiency. They will not be dealt with specifically. However, they are the engines of the case studies mentioned in this paper.

REDUCTION OF UNACCOUNTED FOR WATER (UFW)

(a) This issue is possibly the most acute and first priority action within a WDM strategy. Levels of unaccounted for water could reach over 50% in large cities (see bibliography World-Bank, Tech-paper no' 72).
Efforts to reduce excessive unaccounted for water (UFW) in developing countries are hampered by several factors: lack of awareness of the practical possibilities and the potential financial and operating benefits by top management; lack of motivation at the operational level; and, particularly, lack of resources. This section is intended to clarify some of the issues, correct wrong impressions, and stimulate the interest of administrators and operators in making the resources available to improve reduction and control.

Recent national and international publications have identified the problem of unaccounted-for water, but little has been done to relate it to the conditions in developing countries. Nor have efforts been made to show how action can best be taken by management, in logical steps, to achieve effective control even when operational problems seem insurmountable.

The waterworks manager has many problems – perhaps more political and institutional then technical – but, first and foremost, the aim will be to provide enough water, at adequate pressure over the whole are served, to meet increasing demands. For this the manager must have the human, technical, and financial resources to meet both investment and operating costs. Demand management strategy, which includes reduction of UFW is an integral component of the utility goal.

Typically, the utility manager faces a situation in which the authority seeks to continue its traditional policy of improving the supply of water either by developing new resources or by expanding works. Data relating to the existing supply is likely to be inadequate for a realistic assessment of the supply situation; available figures on the quantity of water produced and consumed may be so inaccurate as to call for a good deal of interpretation by an experienced professional. The different divisions within the authority frequently lack confidence in the figures produced by the others, which perpetuates ignorance of true data and hampers opportunities for improved control. Excessive UFW is usually a clear indication of poor management and lack of maintenance. Excuses may be offered for delayed action, but it is necessary to begin to accurately measure and assess the data to determine immediate and long-term strategy, which will necessarily include improved maintenance practices. Metering of production, maid supply to the city and consumption is essential to achieve the objectives of the utility, without it, the goals can not be achieved.

It is essential to demonstrate one way of proceeding, step-by-step, in producing

more accurate data as a basis for the whole decision making process. A clear picture of the existing situation will facilitate the development of a strategy for whatever improvements are warranted and most economic to execute. They may be in the area of physical supply conditions or in the equitable collection of revenue necessary for the financing of improvements, the level of leakages, illegal use, inaccuracy of metering, etc.

If the production of accurate data demonstrates the existence of either an excessive loss of revenue from water consumed or an excessive loss of water from leakage – or indeed both types of loss – the action plan should go on to show how, by cost-benefit analysis, a strategy should be developed and implemented by stages to effect those improvements found to be economically justified. Such levels of water and revenue losses prevent most utilities from becoming manageable and efficient which reduces the suitability for private sector involvement, or private sector participation (PSP) considered today as a potential step toward achieving the utility objectives.

(World Bank, just as an example, has prepared a narrative slide presentation on reducing UFW, which can be obtained from the Economic Development Institute (EDI). An instructor's guide and participants manual with reading exercises and case studies are also available. Interested utility managers could always order these for their staff).

(b) CASE STUDY ON PRIVATIZING THE BATTLE TO REDUCE UNACCOUNTED FOR WATER (Use of an external firm). [From conservation et al. See bibliography].

Unaccounted for water (UFW) is a problem everywhere, but most of all in developing countries. In many cases Consultants or specialist Contractors provide temporary advice, training and assistance to the existing utility in the hope that this will lead to better performance in the future. Poor metering, fraud, leakage, theft and overflows are institutional as well as technical problems, however. So long as responsibility for long-term success rests with the utility the chances are that the institutional aspects of the problem will prevail. Privatizing UFW control by devolving it to a financially separate and accountable body allows both these aspects of the problem to be addressed together.

The benefit of privatization this component of the utility responsibility is that UFW control will become a source of income and profit to local private-sector companies. These will have a much stronger incentive to keep it lower than the utility that employs them. The experience presents contrasting results from a privatized contract in France, which halved UFW in less than 2 years, and other projects in Korea and Malaysia which, while successful in the given context had a much smaller impact on UFW. It is essential to develop a set of criteria that privatization would need to satisfy to minimize the cost of UFW to the utility and community it serves.

Several methods of privatization are described leading to a formula that meets all the criteria. This takes the form of a company set up by the utility in joint venture with a Consultant (probably a local firm supported by an International consultant). The consultant manages the JV on behalf of the utility for a fixed term and this role is subject to competitive bidding. The utility and the Consultant share the profits of the JV. This approach to privatization encourages:

- Speedy reduction in UFW
- Maximum use of local staff
- Optimum balancing of long-term control and reduction of UFW costs.

The longer effective action to reduce UFW is postponed, the more it costs. Privatization of this action yields the greatest benefit when the delay between identifying the need and doing the work is kept to a minimum. The need for improved UFW control and the value of the benefits this would bring can usually be established at the Master Planning stage of a project. The Master Plan should also be used to identify other measures to reduce demand and ease pressure on existing and future capital and operating costs.

Integrating water conservation (WDM) into the master planning process means that consistent sets of targets can be derived for different combinations of source development, UFW control and demand management. These options can be compared on the basis of economic and other criteria. The resource requirements of the preferred option can then be used to develop a coordinated program and budget for upgrading the system. The benefits of improved UFW control could be brought forward by as much as 2 or 3 years if the Terms of Reference for the Master Plan were broadened to include the preparation of Tender documents for the privatization of UFW control.

In many developing countries water shortages obstruct both the normal operation of the system and UFW control. Rationing by intermittent supply damages both the physical supply system and the credibility and esteem of the utility. Many of these problems can be traced back to inadequate revenue. Unrealistically low tariffs and poor revenue recovery lead to a progressive decline in the supply, abuse by consumers, the use of unsanitary shallow wells and the emergence of an informal, unregulated and inefficient system of water vendors, tanker supplies and private boreholes. In such cases the terms of reference for privatization could be extended to include all most of the major functions of the utility. The Consultant would then not only assist the utility to improve its financial and technical performance but also to match the supply to the latent demand and ability to pay for water in the community it serves. A method of providing incentives to the Consultant to provide the greatest supply at least cost can be developed.

National governments as well as local ones should consider the form of PSP-private sector participation as a step be step strategy for comprehensive privatization of water utilities.

CASE STUDIES

GENERAL COMMENTS:

Selected case studies were chosen for this paper. The writer decided to start with Israel, a western Asian nation which has embarked on a comprehensive water demand management strategic plan from its early days as a developing country. It allows the decision makers to have a significant retrospective view of the results 50 years later.

Other case studies selected deal with large urban centers in Asia concerning the objective of the conference.

They are mainly from Israel, Singapore, China, Korea, Malaysia as well as short sections on the USA and Canada.

Case studies were selected to present a selected and diversified issues of water demand mgmt.. More comprehensive ones are presented from Israel and Singapore while the others present cases of national policies and selected cities, only.

ISRAEL – CASE STUDY

SUMMARY

This section focuses on Israel as a case study of water resources management. However, the section concentrates on Water Demand Management (WDM).

Development and water experts, who have an interest in the Middle East and in the economic development process of semi-arid countries, often pose the following question: how does Israel prosper with less than 300 cubic meters of water (per capita per year) while international organizations define arid countries with less than 1000 c.m./cap. /year as highly stress countries, where water becomes a severe constraint to socio-economic growth.

This section will try to clarify some of the policies, legislative basis and selected economic issues that enabled Israel, a semi arid country, to reach a GDP of $17000 per capita per year, supply much of its agricultural needs (except grains), export agricultural products, and maintain a high standard of living, all with very limited fresh water resources.

The basis of the past strategy as well as the future one lies with a balanced combination of measures: legislative, institutional, economic, and technological focusing on water demand management, increased efficiency of water use in agriculture and the industry, re-use of most of its treated sewage effluents as well

as the economic and integrated use of its total surface and ground water resources. Potential future water markets (internal and possibly regional) continuous updating of water pricing policies and future large scale sea and brackish water desalination will enable the country and its immediate neighbors (as part of the peace process) to continue their social and economic growth despite the water scarce conditions that all entities of the middle-east are facing.

THIS SECTION IS BASED ON A RESEARCH WORK DONE BY THE WRITER (S. ARLOSOROFF) WITHIN THE HARRY S. TRUMAN INSTITUTE, HEBREW UNIVERSITY, JERUSALEM.

INTRODUCTION

The policy of Israel to meet the growing demand for water focuses on combined supply and demand activities and investments, while the long range solution lies with brackish and sea-water desalination. Present activities are aimed at delaying the high investments and the associated costs involved with the integration of large scale sea-water desalination, an expensive unlimited source of water, which will be a major source of fresh water as of 2015 and on. The 3 main instruments are:

Re-use of sewage effluents.

Recent regulations have increased the quality levels of sewage treatment of effluents in order to maximize its re-use potential and minimize the health and environmental risks as well as enhancing the trading instruments for the exchange of fresh water allocations, with treated effluents mainly for irrigation purposes. The policy concentrates on reduction of fresh water allocations to the farming community and replacing it with treated wastewater effluents. (Total sewerage costs borne by the city).

Water conservation/improved efficiency of water use.

Continued policies concentrate on mixed tools including: (a) allocations, norms and progressive block rates for each sector, and (b) research, development and implementation of agronomic techniques as well as wide scale implementation of technological means to improve water use efficiency and reduce water consumption in the domestic sector, commercial, industrial and the irrigation of agriculture products as well as irrigation of urban parks and gardens.

Sectoral water allocations – based on norms representing optimal use.

Recently major changes in the approach toward the water sector have been initiated, including elimination of urban allocations, imposing sanctions for unaccounted for water (if rises above approved levels), and the possible introduction of "water markets," trading with administrative allocations on an

economic basis between members of a sector, between sectors, and hopefully in the future between Israel and its neighbors.

THE REGION

Many of the Middle East and North Africa countries face an environmental crisis, much of it as a result of water scarcity and the existing and potential pollution of their water resources. It is estimated that the investment needed to deal with and solve the problem could reach US $70-80,000 million in the period of 1995-2005 (World Bank).

The hydro-geological conditions are in constant deterioration. As extraction from ground and surface water resources increases, so do the problems associated with low water levels and decreased quality. Inadequate human and industrial waste discharges as well as inappropriate waste water re-use programs lead to higher concentrations of chemicals and organic contaminants.
The concentrations of heavy metals and toxic compounds have already reached alarming levels in various sites in the region and the projected future cleaning costs could reach prohibitive levels unless urgent and strict measures are introduced.
The expected population growth in the region is likely to exacerbate the problems. World Bank forecasts indicate growth of approx. 40 per cent in population (from 250 million in 1990) to 350 million by the end of the century. Some regional governments may be unable to generate the financial and human resources needed to provide adequate water and sanitation facilities to meet the future demand.
Already, almost 20 per cent of the total population in the region lack an adequate potable water supply and almost 35 per cent lack appropriate sanitation. Less than 20 per cent of the urban water supplied in 1990 has been properly treated; in the industrial world this figure is above 70 per cent.

Most of the countries in the Middle East therefore face serious water scarcity and pollution problems already, while water shortages are reaching acute levels. During the last 20 years the average water availability per capita has dropped from 3500 m/3/capita and will fall to approximately 1500 m/3 per capita by the year 2020 for the whole region. Israel, the kingdom of Jordan and the Palestinian Autonomy are in the most acute level. All fall below 300 m/3/capita. (Cubic meter per capita or c.m/c

ISRAEL – GENERAL BACKGROUND

The present population of Israel is approximately 6.0 million and is increasing at an approximate rate of 2.2-2.5 per cent per year. Best estimates for the year 2020 indicate a potential population of 10-13 million Israeli citizens. (The variation is mainly due to unpredictable future immigration levels).

Present average of urban water consumption (domestic, commercial, and industrial)

is approximately 110 m/3 per capita per year. It would have been today approximately 150 m3/c if not for past efforts that have resulted in over 30 per cent savings. Present industrial forecasts coupled with projections for urban water consumption per capita converge at an estimate of 110-120 m/3 per capita per year by the year 2020. These figures assume a much higher standard of living coupled with the continued of rigid and wide-scale implementation of demand management policies. When multiplied by the projected population, the level of urban and industrial water demand will amount to approximately 1000-1300 mcm (million cubic meters) of fresh water per year out of approximately 1700 mcm/year total available fresh resources.

Inelastic agricultural demand for water to supply basic fresh food (dairy products, eggs, and vegetables) are estimated at 25-30 m/3 per capita; this adds an additional 220-330 mcm/y.

Re-use of treated effluents in Israel will reach 70-75 per cent of the total DCI (domestic, commercial, industrial) use which amounts to almost 100 per cent of the total sewered flows (the entire population will be sewered by 2010). The estimated treated effluent flow by 2020 will be approximately 700-1000 mcm/y.

DEMAND MANAGEMENT IN THE AGRICULTURE AND INDUSTRIAL SUB SECTORS

This endeavor includes continued efforts, both technological as well as economic, and agronomic to further reduce water demand and improve the efficiency of water use, for the production sectors, Incremental costs of water saved in these two range from US $0.05 – 0.40 (per cm). The figures for irrigation assume increased production per unit of water in real terms; they do reflect changes in the basic production cycle that is adapting to more economical cropping patterns like genetic engineering as well as modifying industrial processes.

The levels of "indirect" additional water production through savings and improved efficiency of water use are very important as they represent permanent reduction in demand. Israel has already gone a long way in its efforts in these two sectors. The term 'effort' is much more complicated than it sounds. It means the large-scale application of appropriate irrigation technology (drip, sprinkler, automation), changes in industrial water use and water processes (like 'cascading' water uses and cooling methods). Training, public education, and effective extension services has been and must accompany the promotion and implementation instruments. Finally, the efficiency of pricing mechanism and the application of a market or trading system can play a dominant role in the whole operation.

The significant achievements of Israel's agricultural sector have lead to 300% real term increase which clearly identify the significant results over 45 years in economic as well as physical terms. A comparison of prevailing prices for irrigation water between most irrigating countries and Israel illustrates and partially explains the gap in the countries agricultural yield/c.m, and the potential for reducing agricultural

water demand. Presently Israeli farmers pay an average of 0.20 $/c.m (3 blocks, the upper over 0.3 $/c.m), one of the highest in the world.

URBAN WATER CONSERVATION

"Unaccounted for water" (UFW) causes significant water and financial losses to urban utilities and municipalities. Unaccounted for water has been substantially reduced in Israel (down to 10% on average from 25% 15 years ago), but remains a serious problem in other Middle Eastern countries, where for example, UFW rates in some cities are over 50 per cent and represent critical water and financial losses. Leakage, estimated to account for about 50 per cent of the total UFW, could reach 30 c.m per capita/year. A utility's annual economic losses could equal approximately US $15 million per one million urban residents in Israel.
There is no doubt, given experiences in Israel, Singapore and other countries, that these losses can be reduced to more reasonable levels. Large sums of money can be saved and reinvested in the utility for further conservation and maintenance efforts, as well as development of new resources.

Studies done in Israel and California show that the costs of water saved through leakage control vary significantly, from US $0.15 – 0.35/m/3. UFW reduction activities are usually an integral part of improving utility management; in many cases utilities cannot reach financial viability without lowering UFW to less than 20%. Comprehensive urban demand management addresses demand reduction at the commercial, household, and utility levels and, if applied on a large scale, should reduce the cost of water and demand for water in the Middle East region as a whole. Demand management efforts in Israel, Singapore, California, and other regions have produced convincing results using water conservation kits (Retrofitting). The strategy and the kits (including toilet flush reduction, two-volume flushing, regulated shower heads, flow regulators in the kitchen and bathroom sink taps, leakage control and technologies to improve garden and park irrigation) achieved demand reductions of 10-25 per cent (sometimes 20-40 per cent). Retrofitting should be done in first priority in commercial buildings, where no economic incentive influences the water demand however the potential saving at the domestic consumers is usually greater.

REUSE OF HUMAN AND INDUSTRIAL WASTE WATER EFFLUENTS

As stated before, water effluents become an integrated water resource and are traded for fresh water. Israel has completed most of its efforts at establishing and adopting water demand management for existing industries while new industries are currently installing efficient cooling systems and pre-designed internal 'cascading' facilities. The price mechanism as well as effluent charges are gradually being enforced and are contributing their share to industrial water demand management. Many of the industries are located in the urban sector and are subject to the additional utility prices. The industrial sub-sector has observed an increase of 250%

of industrial production per unit of water (in real terms) following 20 years of demand management campaign.

Re-use of urban sewage effluent should be analyzed in the context of industrial and urban conservation. When effluent charges are enforced and subsidies are removed, market forces may typically produce the optimum results. However it is reasonable to assume that local re-use for irrigation purposes will be the most cost-effective solution, mainly in areas where aquifer pollution is not expected. This option dictates the use of economic tools to define the upper level of investments in urban water conservation (retrofitting and reduction of UAF) as most of the wasted water will be later used as effluent for irrigation purposes. Re-use of effluents in Israel in restricted to industrial field crops (cotton, maise etc) and to horticulture using mainly underground drip irrigation.

WATER MARKET – A TEMPORARY OR PERMANENT SOLUTION?

Water in Israel is used within a system of allocations (annual or multi-annual) while in most countries it is user rights that determine the demand. In many regions, a person who owns land (or cultivates it) has the right to the water flowing beside or under the plot. In other regions various quota systems allocate the amounts of water on an annual, monthly, weekly, daily, or even hourly basis. Veteran users usually have the rights to continue to use the resource, when shortages prevail.
In Israel it has been shown that the efficiency of water resource allocation and use can be substantially improved through the increased use of price and trading mechanisms. Trading water on the margin or using a system in which urban/industrial demand is met by supply from farmers selling quotas reduces inefficiency of administrative allocations. Irrigation water in Israel was, and is today, partially subsidized when supplied by the National Water Company, and administrative allocation system which create a 'rent seeking' operation for the development of new resources and higher demand both lead to certain inefficiency which could be improved if the law will be changed to allow trading between consumers using the national water system, as conduit and or using the aquifers as common – pools allowing one to pump more and others less to be compensated by the farmer.

CASE STUDY: SINGAPORE EXPERIENCE IN WATER DEMAND MANAGEMENT

(see bibliography Singapore Public Utility Board)

In 1950, the population of Singapore was a little over a million and the demand for potable water was 142,000 cubic meters a day. By the middle of the 90's, the population has increased by 3 times but the water demand has increased by more than 7 times as result of industrialization the, the commercial sector growth and high

standard of living. Daily consumption averages over 1.05 million cubic meters. Over the past 10 years, the growth rate in Singapore's water demand averaged 3.0% per annum. Such a rate of growth has not only presented a great strain on Singapore's limited water resources, but has also demanded a strong emphasis on Water Conservation as well as on the management of the Water Distribution System. Singapore is trading water with Malasia, however the capacity is limited.

TOTAL APPROACH IN WATER CONSERVATION

A total approach in water conservation is adopted. It can be broadly summarized as follows:

- Keep Unaccounted-For Water Low
- Conservation in customers' premises
- Tariffs and use of economic incentives and disincentives.

Keep Unaccounted-For Water Low

Unaccounted-For Water (UFW) is the difference between the total amount of water supplied to a transmission and distribution system and the consumption of water accounted for (which includes water sold to customers and other functions). UFW is taken as a measure of the efficiency of the water supply system. The question of how much that percentage should be depends on the economics of reducing the water loss – whether it will be more profitable to take action to reduce water loss further as compared to the postponing of a new development, and the relative costs.

In Singapore, the UFW for the early nineties has been reduced from 11% in 1988 to 6.7%. UFW can be traced to:

- Meter inaccuracies
- Losses through leakages
- Illegal connections and others

Meter inaccuracies occur because of:

- deterioration of meter accuracy caused by age, use and the effects of the quality of water.
- Inherent under-registration of even new meters caused by their being subjected to flows below their threshold of accurate registration.
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In Singapore, the entire water supply system from waterworks to customers' taps is fully metered. Electro-magnetic flow-meters are used to meter the production at each waterworks. The accuracy of these works output meters is of particular importance as an error would grossly affect the water balance account. For this

reason, calibration tests are carried out monthly for these meters using the draw-down of clear water storage tanks in the waterworks.

Leaks are unavoidable in a water distribution system. The leakages (especially underground leakages) which go undetected, constitute real loss in the water distribution system. On the other hand, leakage and other losses which have been detected and attended to can still contribute to UFW losses if they are not reported in a timely fashion and repaired.
The extent of loss from a leaking watermain depends on the length of time between the occurrence of the leak and the isolation of the main. Here, public cooperation in reporting leaks is essential. This cooperation can be achieved through continual public education on water conservation starting with the young in schools. To facilitate public reporting of such leaks and quick repair, a 24-hour Water Service & Operations Center receives and promptly investigates such reports. Prompt response to such reports encourages future public cooperation' and support to the whole conservation campaign.

To minimize the time required for identification, location, and isolation of water-mains, drawings showing all mains and valves are maintained and updated regularly through a Computerized Mapping and Information System which stores records of all water-mains and appurtenances in digital form to facilitate easy updating and retrieval. Exact nature and sites of leakage are registered on the computerized maps for early detection of sections to be replaced.

Leakage detection night tests are carried out for the entire distribution network during 11 months of the year, leaving one month to re-test the leak-prone regions. The test procedure involves:

- Isolating the sub-region by shutting off all the strategic boundary valves and individual services valves to customers.
- Setting up a waste detecting water meter with flow recording chart at the waste detecting meter connection position.
- If the meter continues to register after all the boundary and service valves have been shut, it would mean that there is a leak in the sub-region. The team then carries out step tests by isolating section by section of the distribution system until the leaking section is identified. If calls for high level of valves maintenance and their quality as well.
- Further investigations are then carried out using mechanical, electronic and computerized acoustic instruments to locate the leaks for repair.

  Four types of leak detecting equipment are currently being used:
  Stethoscope
  Geophone
  Electronic Leak Detector
  Leak Noise Corrolator

The intensive leak detection program has contributed significantly to keeping underground leakage to a very low level and has reduced by at least 50% the amount of water that would have been lost.

Mains Replacement and Rehabilitation

Conscious of the need to use more durable and corrosion-resistant piping materials to reduce the incidence of main leaks, the PUB and its water department has since 1980, prohibited the use of unlined galvanized iron pipes. Since then, only corrosion-resistant pipes made of copper, stainless steel and galvanized iron pipes which are internally lined with materials such as uPVC or high density polyethylene are allowed for use, between the main system and the taps.

An island-wide survey was conducted in 1983 to identify all unlined galvanized iron connecting pipes and unlined cast iron watermains in the distribution system. Based on the survey and customers' reports on discolored water, poor water pressure and leakages, a comprehensive replacement program to replace old unlined cast iron mains with cement-lined ductile iron pipes and unlined galvanized iron connecting pipes with stainless steel or copper pipes was carried out.

The various measures and replacement programs implemented to renew and rehabilitate the transmission and distribution system have proven to be effective. The number of leaks has decreased by more then 70%.

Illegal Connections

There are few cases of illegal or unauthorized draw offs. In 1992 for instance, there were only 2 documented cases. As a deterrent, anyone found responsible for carrying out an illegal draw off is prosecuted in court and fined up to a maximum of S$50,000 under the Public Utilities Act.

WATER CONSERVATION IN CUSTOMERS' PREMISES

Since 1981, the PUB has continued to pursue its long-term water conservation plan to ensure that water is being efficiently used.

Water Conservation Measures

The following measures have been implemented by the PUB to conserve water:

- Specify the installation of water saving devices (such as spring-loaded nozzles, constant flow regulators, self-closing delayed-action taps, thimbles, etc) at all non-domestic premises and high-rise residential apartments.
- Encourage industries to reuse or recycle their process water whenever possible, or economic to do so.

- Encourage the substitution of potable water with non-potable water (such as treated sewage effluent, so called industrial water, rain water, sea water, etc) for non-potable use in industrial and commercial premises.
- Establish liaison with government authorities to discourage the setting up of water intensive industries and to grant investment allowance incentives to companies which have invested in plant and equipment to conserve a substantial amount of potable water.
- Water audit and advice to customers
- Continue to educate the public on the importance of water conservation through talks and exhibitions to schools and both private and public organizations. Water conservation is also included in school textbooks used in Singapore.

Tax Incentive for Water Conservation Project

In line with Singapore's national effort to conserve water, the Economic Development Board (EDB) grants investment allowance incentive to companies which have invested in plant and equipment to conserve substantial amount of potable water. Taxable income of an amount equal to a specified percentage (up to 50%) of the cost of the plant and equipment are exempted from tax.

TARIFFS

Water tariffs are recognized to be one of the ways of curbing demand growth and encouraging the efficient use of water. As such, they are reviewed periodically. To encourage customers to conserve water, block tariffs are used for domestic consumption. In addition to the water tariffs, a water conservation tax of 5% on all consumption above 20 cu m/mth for domestic consumption and 10% on all non-domestic consumption was introduced in April 1991. With effect from April 1992, this tax has been revised to 10% and 15% for domestic and non-domestic customers respectively. The revenue generated by the tax is future promoting the conservation efforts of the country city and country as a whole.

LEGISLATIVE MEASURES

The Water Supply Regulations and Singapore Standard CP48:1989, Code of Practice for Water Services also stipulate measures which customers must comply with. (see following)

Only approved pipes and fittings are allowed to be used in the potable water reticulation system to prevent wastage and contamination of the water supply. They are constantly reviewed to ensure conformity with current standards and requirements.

In addition, only licensed water service workers are allowed to perform any water

service work. This is to ensure that a high standard of plumbing work is maintained.

SINGAPORE STANDARD CP48:1989 - CODE OF PRACTICE FOR WATER SERVICES - Section Seven: Water Conservation

7.1 General

It is important that every customer must help to conserve water and curb water wastage. Water conservation measures must be adopted in domestic and non-domestic premises.

7.2 Water Conservation Measures

It is mandatory to adopt water conservation measures in the following areas:

Toilets/washrooms in all non-domestic premises (including the common amenities of condominium)

- Install self-closing delayed-action taps at all wash basins.
- Install self-closing delayed-action shower taps at all shower points.
- Install constant flow regulators at all wash basin mixers, shower mixers and bib taps.

Kitchens/stall/cooking areas in all non-domestic premises

- Install constant flow regulators at all sink taps.

Canteens (excluding cooking areas)

- Install self-closing delayed-action taps at all wash basins and wash troughs.

Laboratories

- Install constant flow regulators at all wash basins and sink taps except for safety reasons.

Vehicle Washing Areas

- Construct earth removal platforms and water recovery systems for washing of vehicles at construction sites.
- Construct water recovery systems at vehicle washing point for other premises where washing of vehicles are required.

Condominium/Residential apartment units/Hotel rooms/Massage rooms/Hospital Wards

- Install constant flow regulators at all wash basins, wash basin mixers, showers, shower mixers, bib taps and sink taps.

Other areas

- Set up water recycling system to reuse water for cooling purposes.
- Construct a rain water collecting system, wherever possible, to collect rain water for non-potable usages such as gardening, washing, etc.
- Set up water pre-treatment plant for boiler usage to reduce boiler blow-down.
- Set up water recovery system for boilers, wherever possible, to recover condensate as make-up water.

Note:
Constant flow regulators are not required w here water pressure at the fitting is less than 1 bar. As a guide, these regulators need to be installed only where the static water pressure at the fitting exceeds 1.5 bar.

CASE STUDY – WATER CONSERVATION IN CHINA

(See Bibliography)

By the middle of the 1990's, there were 515 cities in China, of which the urban population amounted to approx.15% of the total population. Their gross industrial product was 70% of the whole nation's economy. Urban water supply has been recognized as the fundamental facility for adequate urban management, economic development, and improvement in living standards.

PRACTICE AND PROGRESS ON UWC (URBAN WATER CONSERVATION) IN CHINA

Much attention has constantly been paid to urban water conservation (UWC) in China with the development of the urban economy. The policy of laying equal stress on both water resource development and water conservation started in the 1980's in order to balance supply with the increased demand.

The Water Act of the People's Republic of China issued by the People's Congress in 1988 decided that planned water consumption must be formulated and the water saving practised strictly, viz. the water saving is put into national law. The Supervision and Management Measure for the Application of Building Toilet Utensils as well as some other standards were issued by the government identifying urban water conservation as an issue for legislative management.

Since the mid 80's cumulative total water saving of the cities all over the country has reached more than 10,000 million m3. The industrial water reuse rate has increased to over 50% from 20% in 1983 and the water consumption per 10,000 Yuan (RMB) industrial product has been reduced by more than 40% in real terms. Significant economic, social, and environmental benefits have been achieved.

ACTIONS TAKEN:

- Saving water resources, alleviating the conflict between supply and demand. According to the statistics of cities all over the country, the average water saved annually is about 1,100-1,200 million C.M.
- Reducing the discharged wastes in order to protect the water resources and urban environment. The amount of annual water saving is equivalent to at least 900 million m2 of wastewater being re-used by all sectors.
- Effectively controlling the urban soil subsidence.

- Decreasing industrial water consumption, saving energy and reducing production costs and pollution.

A) Enhancing public awareness. The acute situation of water supply and the practical and strategic significance of water saving are spread by all means including the media, schools, etc. B) Water conservation offices were established all over the country at provincial, county, city, and town levels.

Implementing management of water demand. Industrial water consumption accounts for more than 70% of the urban water use, and consequently the strengthened management of industrial water consumption can seriously benefit the total urban water conservation efforts. Local uwc managerial sections have been carrying out the various management measures to reduce industrial water consumption.

Accelerating water saving technology development. Industrial water saving depends on the technology development concerned, which results in extensive research and application of water saving technology as well as the construction of water-saving demonstrative projects in order to assist and influence the industry in China. The petroleum, metallurgical, papermaking, printing and dyeing industries have developed unique water saving technologies, methods, changes of processes, use on non fresh water for cooling etc, etc.

Future policies in water saving will be enforced all over China in order to promote the economic development despite its water shortages.

POLICY GOALS: By the year 2000-2010 half of the increased water demand by the industry will have to be met by means of water saving. Implementation of urban water saving instruments must be reinforced, regulations be formulated and enforced, investments increased, and technical innovations developed.

R&D on water conservation technology. Difficulties faced by the water users concerning water conservation will be dealt with by research and development by all sectors.

Economic Measures. Low water prices are the main reason for water wastage. A rational and national water pricing system will be established step by step in accordance with the national regulatory policy on prices. The principles of overcharging for overuse and charging for sewerage costs will be enforced.

Re-use of treated human wastes. Urban wastewater re-use is an important source to meet industrial demand and reduce the use of fresh water resources. The total sewage discharged in the early 90's amounted to over 35 billion m3/y most of which is untreated. Policy will lead to large investments in treatment and re-use.

Sea water desalination and use. In order to meet the water demand by industry along the coastal cities, sea water desalinating will be exploited and utilized.

The utilization of sea water could significantly assist the economic development of coastal cities. Economic and technical problems will be analyzed and addressed.

To conclude: China will not have any other choice but to promote and enforce urban and industrial water conservation in all towns and cities, especially the coastal and the mega-cities.

WATER CONSERVATION IN BEIJING

Beijing is the capital of the People's Republic of China. Its urban population consists of about 8 millions. There are 10 waterworks and approximately 2500 wells. The volume of annually sold water is estimated at 300 million cubic meters in the city.

With the development of the city economy and population, the water demand increases at a rate of 3-3.2% per year.

In view of the importance of water resource in urban development and management, the municipal government is accelerating construction of new water facilities, and has allocated the highest priority to water conservation measures.

Since the early 80's, water conservation has become the most important policies and investments in order to support the city growth despite its limited water resources. The guidance of the municipal government with commitment to a series of laws and regulations aimed at demand mgmt. are the main tools to achieve the city goals.

More than ten years of practice has proven than advocating water conservation energetically, spreading advanced technology and developing facilities for water conservation could be a very successful strategy in parallel to development of new water plants. It has reduced substantially the rate of demand growth for water. As most of the available new water resources are being utilized, the rapid development of the city enforces water demand management. A solid foundation has been laid for further reforms and strategies to promote the city economy and optimize its performance as a modern city.

Over the past 15 years, the total volume of conserved water was over 1500 million cubic meters. Specific efforts to address the goals of water conservation in the industry has enabled a substantial increase in production per unit of water.

Over the past 15 years, the municipal government has made an investment of over 15 billion Yuen to build more than 2000 industrial water conservation facilities. The city and government policy is to prove the feasibility and enforce rigid water conservation policies to change the historical concept of supply management.

Water serves as an indispensable and precious resource for a city like Beijing. Wasted water can not be replaced. Water conservation is the most important undertaking for the benefit of the future generations.

WATER CONSERVATION IN DALIAN CITY (LIAONING, PROVINCE)

DALIAN'S CURRENT WATER SUPPLY

The population within the Dalian municipality responsibility is approximately 6 million, of which over 2.5 million is urban. Dalian City itself has a population of approximately 2 million.

Principal economic activities in Dalian are harbor transport and transshipment, tourism, fisheries and industries, including machinery, metallurgy, textiles, food processing, electronics and building materials.

Prior to 1980, Dalian had effectively exhausted locally available sources of fresh water, both from surface flows and from under ground. In 1983 the first stage of Biliu Reservoir Project was inaugurated. This project involved the supply of water from sources to the northeast of Dalian through a system of reservoirs, pumping stations and pipelines from a distance of up to 150 kilometers. The first two stages of the project are now completed and have the capacity to increase the water supply to Dalian by 380,00 m3/day. The third stage will add another 620,000 m3/day to the available supply, for a total of 1.0 million m3/day from this source. Costs per unit of water are at least 4-5 times than the costs of the previous resources.

DEMAND MANAGEMENT OPTIONS

The City of Dalian has been in the forefront in the area of water demand management and conservation in China. It has an established Water Conservancy Office, which oversees the implementation of water demand quotas, the coordination of conservation activities and public education at the local level. In conjunction with the Water Supply Company, the office has access to water metering data which covers approximately 95% of all consumers, and has instituted programs to locate and repair leaks and other losses in the water distribution system.

PRICING POLICY

Prior to 1991, typical prices charged to water consumers were 0.15 yuan/m3 for domestic users and 0.21 yuan/m3 for industrial users. The first water demand management option being implemented by Dalian is the raising of prices charged to all consumers to better reflect actual production costs and produce incentives for consumers to reduce demand. This policy means that between 1991 and 1994 prices will increase by over 400%, to range between 0.9 yuan/m3 for domestic

consumers and 1.2 yuan/m3 for institutional and commercial consumers. Further increases have been implemented since 1994. This new pricing policy will likely be an effective method to decrease demand for water, and will place the onus more directly on individual consumers to conserve, rather than on a centralized authority.

WATER REUSE

When industrial consumers pay for actual water costs, the incentive to reuse water is much higher. Industries within Dalian are leaders in the reuse of water, with statistics showing that approximately 80% of industrial water is presently reused.

In the commercial sector, pilot projects are being designed for the study of grey water reuse in large commercial and institutional facilities such as hotels. The feasibility of installing grew water treatment facilities and recirculation systems in new buildings has been examined, as well as retrofitting existing buildings with the required equipment as part of a World Bank supported project.

REDUCTION OF WASTED WATER

In the domestic and institutional sectors, Dalian has conducted a demonstration project in the Dalian University of Technology students' dormitories on the use of low consumption fittings such as toilets and taps. They hope to expand this demonstration project and test the viability of these fixtures throughout other parts of Dalian.

The other area where potential exists to reduce wasted water is in the distribution system. Many pipes were installed during the early part of this centry in Dalian, and leaks are believed to be significant. An ongoing repair program exists on an "as required" basis.

REPLACEMENT OF FRESH WATER

Within the industrial sector, the use of sea water for "non-contact" processes such as cooling water is practiced extensively, as well as some "contact" uses in industrial processes. The large majority of this sea water use occurred in the chemical industry, a thermal power plant and a petrochemical plant.

The replacement of fresh water with sea water in some domestic or institutional uses such as toilet flushing is being considered. Incremental costs are compared with costs of other resources and measures.

Any initiatives taken to replace fresh water with sea water in "contact" processes must take into account the bylaws which govern waste discharges and policies to recycle water. Because of the corrosive nature of sea water, treatment facilities are expensive to build, and so in order to meet dilution requirements of discharged wastewater. Industries may increase the use of sea water rather than decreasing or recycling it, and discharging the wastes into the ocean.

LEGISLATIVE CONTROLS, SOCIAL CAMPAIGNS AND EDUCATION

Dalian has instituted public education programs, local committees and media campaigns to promote water conservation. Contests and awards have been part of the activities promoted to increase awareness of responsible and rational water usage.

Through the Water Conservancy Office, enforceable quotas on water use were established for industries, commercial business, institutions and farms. The Office set fees for water use and stiff fines for consumers exceeding their quotas. This quota system is a variation of pricing structures used in other countries where prices for water increase with the amount consumed. The penalties for high consumption are built into the price structure.

By giving the Water Conservancy Office the authority to grant licenses and establish quotas, a mechanism exists for legislating industries and commercial enterprises to implement water conservation measures as a condition of their license. There are draw-backs to the system.

SPECIFIC PROJECTS PROPOSED BY THE WATER CONSERVANCE STUDY

Reduction of UFW (unaccounted – For – Water)

This project ranks as priority one in terms of internal rate of return for the Water Supply Company, and has the potential to save the greatest amount of water. The project will involve historical and physical analysis of water line breaks and leaks in Dalian, sector by sector metering, and development of a systematic program for replacement or repair of the problem areas of Dalian's existing distribution network.

Water Conserving Retrofitting

The Dalian University of Technology is estimating a 40% reduction in fresh water consumption by a full scale retrofitting of plumbing fixtures to low consumption fixtures. Over a ten year prior, the savings in costs over the required capital cost payback are estimate to produce approximately a 30% internal rate of return when completed and if results will meet the expectations the project will become a demonstration one for the city and the province.

Large Scale Conservation Projects are being implemented in hotels, breweries, steel plants, power plants, dye industries, and others.

CASE STUDY – KOREA

(See Bibliography)

INTRODUCTION

Overview of Korea

The republic of Korea (Korea) is located at the eastern end of the Asian Continent and adjacent to the Yellow Sea. The total land area is 99,450 km2: farmland constitutes 21,379 km2 (22%); forests cover 63,762 km2 (64%); and only 4% of the total land is used for housing, public and industrial sites.

At the end of 1995, the population of Korea reached more than 44 million representing a population density of 450 persons/km2, one of the highest in the world.

Characteristics of Water Resources

The annual average precipitation is about 1,274 mm, roughly 1.3 times the global average. However, the average annual rainfall per capita is about 3,000 m3 which is only 10% of the global average.

Two thirds of the annual precipitation occur in between June and August, which is largely discharged to the sea accompanying heavy floods.

Korea has an economic potential of about 127 billion m3 per year of water resources. However, 45% is lost through evaporation and infiltration.

WATER CONSERVATION POLICY

Background

Heavy seasonal fluctuations in precipitation in Korea necessitate a large volume of reservoirs to mitigate such unbalances. However, the Country lacks proper sites for construction of dams and the costs for land acquisition are skyrocketing. In some municipalities, the available source of water falls far behind the water demand particularly during dry season and, therefore, water shortage arises regularly. Deterioration of raw water quality and the need for higher water quality standards result in the ever-increased capital and operational costs.

Rapid increase in water consumption, shortages of water resources, the high costs for developing and maintaining of the new water sources, and the limited capital source have made it imperative to manage water demand and water resources more efficiently.

Furthermore, the fact that water charge is comparatively inexpensive in Korea leads to excessive and unreasonable water demand. Water pricing needs to appreciate and reflect its economic value, if the authorities wish to continue and enhance its economic growth.

The responsible authorities have launched a water conservation program since 1990 in an attempt to harness the ever-increasing water demand. Reuse of typically non-potable sources of water have been conceived as viable alternatives to new water supplies. The efficient distribution of the produced water resources and the adoption of water saving devices have been encouraged.

The Government is constantly reviewing water rates in appreciation of the needs of pricing water at its real value. The importance of establishing water saving ethics through education and communication is receiving attention. Industries which suffer from shortage of water have embraced the following measures to reduce demand:

- Recycling cooling water through cooling towers
- Changing production processes
- Reuse of water washing operations
- Reuse of wastewater
- Installation of water saving devices

Introduction to Wastewater Reusing System.

Major water savings can be obtained by re-use of municipal and industrial wastewater. Reclamation involves the treatment of wastewater to permit an environmentally safe use of the treated water for applications such as in toilet flushing, street cleaning, landscape, agricultural and industrial use. This measure reserves the fresh water supply for drinking , food production and other high-quality uses.

Reduction of Non-revenue Water (Unaccounted for Water – UFW)

Non-revenue water (UFW) is the difference between water produced and water paid for. NRW includes meter underrun water, water used in flushing water mains, fire fighting water, water taken illegally from the distribution system, loss through leaks, water exempted from charge due to bad taste or odor, and unaccounted-for water due to defective meters.

An analysis carried out in 1991 indicated that UFW in Korea reached approx. 35%, of which system leakage was approx. 20% and unclassified other use was approx. 15%.

The major problems caused by the high UFW with regard to managing water supply systems as follows:

It is a loss of water produced and, if properly controlled, would delay the need for expanding facilities. Reduction of leakage is the most economical way to increase supply capacity, beside domestic and commercial retrofitting.

It reduces the capacity to obtain revenue and so is a financial loss, resulting in an inability to properly manage the utility, causing financial problems to maintenance, replacement of work pipes etc, which in turn increases

losses.

Water rates have to be increased unjustifiably to cover the financial loss.

It allows, in case of low pressure, infiltration of non-potable groundwater into the distribution pipes through holes and broken joints resulting in water pollution causing health hazards.

Leaks destabilize ground conditions causing road and pavement damage and also increase wastewater flows.

In consideration of the above, the responsible Ministry (M0C) set out a 10-year program starting in August 1991 to reduce UFW. The program includes leakage reduction, meter management and measures to counter illegal connections to reduce UFW down to 20% by the year 2001. The leakage water will be decreased down from approx. 20.1% to 12%, and other UFW from approx.15% to 8% respectively.

Meters will be installed inside and outside private premises.

If the metered water consumption is not compatible with standard water consumption of similar scale businesses, then the service pipeline and meter will be checked carefully.

A penalty will be imposed on any illegal use equal to five (5) times the legal rate for the period of illegal use.

* Part of the penalty imposed will be awarded to the person who provided the information on illegal use.

Pricing Policy

In Korea, water utilities adopt similar water tariff structure with progressive rate blocks. A minimum quantity is provided to domestic consumers at a specially low rate. Domestic use consumes about 70% of the supply.

Sewerage charge are calculated based on water consumed but the operations are maintained separately from that of water supply.

Water tariffs do not reflect the real cost of water and have been set more on social and political considerations. It is intended to price water closer to its real value. Additionally a consolidated policy for water and sewerage rates will have to be established.

Water Conservation Arrangements

Enforced instruments have not yet been initiated to govern arrangements for conserving water including the domestic and commercial retrofitting with water conservation means. However, the City of Seoul has its own regulations to impose the provision of water saving toilets, one-touch faucets and low-flow showerheads in houses and apartments constructed by the City itself. The Korea Housing

Corporation has introduced water saving toilets, as the first step toward a broader program.

A regulatory framework on water conservation retrofitting installation is currently under preparation by the authorities.

Retrofitting toilets, showers and washing machines in households in order to reduce water demand is an attractive and effective way to achieve immediate decrease of water wastage. Such devices, when installed, automatically lead to conservation without any efforts demanded from the consumers and will lead to direct monetary savings. Demonstrating projects, assisted by the World Bank or self funded, are being executed.

CONCLUSIONS AND RECOMMENDATIONS

If demand increase is uncontrolled, the reserve stock capacity is expected to reduce from about 10% in 1991 to 6% in 2000, and to less than 2% by the year 2010 even with further development of reservoirs. Demand management and water conservation are therefor the only alternatives available to Korea. The Government indeed launched a water conservation program in 1990 under the direction of MOC (Minister of Construction).

The high and still growing water consumption (per capita) and pollution of resources have not only exacerbated the water scarcity situation but also increased water treatment costs. This clearly demonstrates again the imperative need for demand management and water conservation including pollution control.

Korea is in its initial stage "the of water conservation era", as other developing countries are in similar situations. Major programs presently under implementation are as follows:

- Reuse of properly treated wastewater effluent for non-potable water supply (industrial, irrigation and possible double – systems).
- Piping network and household leakage reduction as well as unaccounted-for water reduction
- Introduction of water saving fittings by the non-governmental bodies as a demonstration projects.

Further consideration will be given to the following measures:

- Evaluation of water reuse potential for non-potable uses.
- Encouraging industrial water conservation efforts.
- Transformation of pricing policy to conservation-oriented rates
- Establishing programs for water saving retrofittings.
- Introduction of campings for public information and education
- Development of a standard benefit-cost evaluation methods including both

qualitative and quantitative factors to be used on the potential and planning measures.

CASE STUDY – MALAYSIA
(See bibliography, C. Harrison, Conservation)

The Johor Bahru Project(South Malaysia)

Johor Bahru and its hinterland occupy the southern tip of South West Malaysia and have a population of about 800,000 people. A causeway links the town to Singapore. Historically, the island of Singapore was supplied from the mainland and the Singapore Public Utilities Board still operates a number of sources and treatment works in the State of Johore. Johor Bahru gets about half its treated water on the trunk mains feeding Singapore. The rest of the supply comes from a dam and treatment works belonging to Johor Bahru but operated under contract by a private company. Water losses in Johor Bahru were difficult to estimate precisely but were of the order of 35%. Singapore and Malaysia both enjoy high rates of economic growth and Johor Bahru, at the junction between the two, is an economic HUB with a rapidly growing population and industrial base. Demand for water in the region is rising rapidly.

The project started as a consultancy assignment on fairly standard World Bank terms, won in competition with other consulting firms. The contract was in two phases, a Study phase of 12 months followed by an Implementation phase of 18 months. There were difficulties in mobilizing the resources necessary to carry out repairs to the system and install meters, as new pressure valves and other items needed for the project. The delays that resulted from these problems gave rise to an extension of time but it was clear to both the client and the consultant that further help with setting up the leakage control system would be needed.

The consultant proposed a solution based on the rates agreed in the consultancy proposal but in which he would act as a contractor. This takes the form of a fixed price contract to finish the setting up of 147 leakage control districts, with leakage in each reduced to less than 20% of the supply. The contractor is paid a portion of his lump sum pro rata for each district meeting the target (i.e. set up with losses less than 20%). In addition the contractor finances and manages sub-contracts for the minor works and repairs needed for the project, reimbursed by the client at cost plus a fee to cover finance and management costs. The project continues until losses in all 147 districts are below 20%.

The results so far are very encouraging. Supply from the sources has leveled off despite rapid growth in consumption. Losses in many districts are down to 13% or less.

Lessons from the Toulon (France) and Johor Bahru Contracts

The conclusion must be that although the contractor is pointed in the right direction, neither contract aims him precisely at defined target. The beneficial elements of the Toulon and Johor Bahru contracts that it is nevertheless important to retain are:

- clearly defined budget
- incentive to reduce existing losses quickly
- incentive to be efficient
- freedom of action for the contractor
- simple administration
- contractor responsibility for minor works
- shared benefit giving client and contractor a common interest in success

Elements that it might be advantageous to add are:

- contracts open to competitive tender as well as direct negotiation
- incentive payments linked to long term total cost of water losses and control, including:
  - capital cost of setting up the control system
  - long-term operating cost of the control system
  - marginal cost of supplying water losses from existing sources
  - capital cost of developing new sources to supply water losses
- simplicity of project preparation
- targets defined without the need for precise determination or explicit statement of existing losses
- ability to include other services in terms of reference that it would be sensible to carry out alongside water loss control (e.g. mapping, modelling, condition surveys, rehabilitation studies).

There are other demand Mgmt. Activities in Malaysia, however in order to diversify the case studies mentioned in the paper, this innovative project was selected.

The benefits of both the examples (speedy reduction in losses, economical uses of resources, clear budget) can be obtained with price competition and incentives to minimize long-term costs by the use of a Target Cost Reimbursable contract that includes the cost of water losses in the target cost.

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