Discussion Draft
July 1989

ISSUES IN WATER MANAGEMENT FOR URBAN CENTERS IN THE DEVELOPING WORLD

S. Arlosoroff, Program Manager
UNDP/World Bank Water & Sanitation Program

Water & Sanitation Division
Infrastructure and Urban Development
Department
The World Bank

Summary

Since rapid urbanization is straining the already overburdened water supplies in most cities of the developing world, new sources must be found, developed and piped into consumption areas, and current supplies conserved, within a strong and well-balanced water management framework. Adequate development and use of water resources--in both the urban and national settings--cannot be achieved unless proper legislation, administration, research, technological innovations, education, and professional services are provided.

Pursuing a dynamic policy of water management can bring about significant savings for any nation in every aspect of water development and its efficient distribution and use. Governments and urban decision makers should consider factors such as population growth, rapid urbanization, industrial development, and expected future demands on water consumption in any evaluation of water management needs. However, water demand management at the public system and at the household levels must receive priority in planning and inevestment programs.

Although general conditions in one country or region may differ from those in others, there are certain areas of similarity. With some modifications, the principles, methods, and techniques that have been developed or implemented successfully in one place may be adapted to many others.

Experience shows that enlisting science and technology in the service of water economy can help find solutions to many of the problems arising in this field. For example, advances in water piping appliances and monitoring mechanisms and their effective implementation can delay the construction of new water supplies which are becoming more and more scarce and expensive. Solutions such as these are providing the means to bridge the gap between supply and demand until additional resources can be fully integrated into the water system.

* * *

There is a widening gap between water demand and supply, between consumption and the feasibly available water resources in many of the urban areas of the developing world. In many cases, unless appropriate development and demand management measures are taken, this gap can broaden further and result in continual reduction of service levels, mainly to the low-income groups. It can also lead to a cumulative depletion of water resources, primarily water stored in ground formations, but also surface flows and storage. Under such conditions, water quality becomes highly sensitive to pollution. The potential damage of urban sewage flows, industrial wastes, or even agricultural wastes can accelerate the process and decrease fresh water availability.

Forecasts on the rate of urbanization present a grave situation which could become acute in many cities and towns.

The Urban Explosion

For some time there has been growing world awareness of the scope of rapid urbanization and associated industrial growth in many developing countries. Increasing births and lower death rates, coupled with migration from rural areas devastated by poverty, war, or natural disaster, are predicted to double the world's present urban population in the next 27 years. Most of this expansion will occur in the developing world.

In Africa, the least urbanized continent, urban populaton is growing at a rate of 5 percent annually. If present trends bold, approximately 370 million people, or about 40 percent of Africa's total population, will live in cities by the year 2000. Urban dwellers in East Asia are expected to comprise 80 percent of the total population by 2000 and 35 percent in South Asia (see Annexes 1 and 2). In Latin America, approximately 75 percent of the total population, or 433 million people, will be living in cities by the turn of the century.

Cities of more than five million people can now be found on every continent. Urban projections indicate that by the year 2000 three out of five cities with 15 million or more will be in the developing world. Cities with present populations of 10 to 14 million are expected to double in size over the next 25 years.

It is clear that these demographic trends, with their corresponding industrial growth, are responsible for tremendous demands being placed on water supplies in the developing countries. The future can only mean even more strains on existing sources--financial and hydraulic--as the cost of most new water supply and sewerage systems would be much higher and more complex than in the past.

Conflicting Issues

In many cases water scarcity leads to a scenario in which much of the water supplied is drawn from groundwater reservoirs. The water levels in these sources gradually decrease to the point where little flushing to the sea or rivers occurs. As mentioned above, water then becomes highly vulnerable to pollution. In most cases, the result is that coastal and other aquifers become almost a closed cycle accumulating polluting elements from sources within the urban area or from adjacent polluted rivers or streams.

In the meantime, burgeoning urban populations are producing more and more wastewater. Currently it is discharged into streams, lakes, rivers, and beaches, causing pollution, creating health hazards, and increasing the water treatment costs of downstream users. In recent years it has become clear that both municipal and industrial wastewater can be reused after suitable treatment, thus serving a double purpose: creating new sources of water and preventing environmental damage. The rising costs (investment as well as O&M) of incremental fresh water resources already make the reuse of treated wastewater economical in many cases.

However, a disadvantage is that, as stated above, when groundwater levels are low, wastewater reuse may add its share to pollution and to the salinity increase problems. This would pertain especially, but not solely, in the closed cycle of groundwater use. Problems might also arise with the possible leaching of contaminants into the aquifer through effluent-irrigated soil.

If water supplies are to be increased and water quality maintained, a national policy, legislation, and a strong institutional structure must be in effect to address all of these issues.

Need for a Water Management Policy

To date national efforts and external assistance to developing nations in the water sector have focused predominantly on expanding and improving water supplies and extending services to unserved communities. This has been done through the development of water sources and construction of new distribution systems, both conventional and nonconventional. However, evidence is mounting that the conservation of existing supplies through the management of water demand and more efficient management of water supply agencies is equally important. In many cases, the cost of saving water is significantly lower than the cost of incremental supplies.

Poor consumption practices in many countries result in serious wastage of water, placing additional pressure on scarce supplies. Inadequate maintenance of distribution systems leads to large losses from leakage, as well as to degradation of water quality through the seepage of contaminants into pipes. Even when water resources are abundant, the rising cost of treating, pumping, and distributing water requires that inefficient use and wastage be kept to a minimum. O&M costs in many instances are higher than the total cost of water demand management.

The enormity of these problems vis-a-vis rapid urbanization requires a solution that encompasses management of

both resources and the consumer's access to them. National authorities should promote institutional, administrative, legal, and technical steps to:

1. promote water demand management in domestic, industrial and agricultural consumption (within and adjacent to the city) in order to control and adjust water allocations and prevent degradation of water quality from the overdrafting of ground- and surface water resources; moreover, future investments in new water supplies should be delayed;

2. maintain appropriate standards for sewage effluent reuse in order to supplement the growing urban demand through a water exchange policy and pollution abatement strategies;

3. use wastewater to increase agricultural production in the vicinity of cities and towns as well as decrease potential pollution of clean water resources; and

4. develop feasible water resouces within a cost-recovery policy and in line with the economic value of water.

Legislation and Administration

The need for rigid legal and administrative means to manage a water economy usually arises as a result of an actual or expected scarcity in the water resources of a region, state, or country. Countries or regions that enjoy unlimited water quantities do not usually invest effort in the search for ways to control, develop, preserve, and use water supplies efficiently. However, even in water-abundant regions, the rising cost of treating and distributing water to urban or industrial consumers and the problem of water loss or inefficient use justify, in most cases, the introduction of measures to promote efficient water management, regardless of the level of availability at the river or lake feeding the city.

Adequate utilization of water resources and proper control of the use of water are impossible without an adequate organization, institutional set-up, and legislation suited to the special conditions prevailing in any particular country or region.

It is important, however, to make systems flexible. They must be able to meet changing conditions and to include solutions of problems that might arise as both the original and future laws and regulations are implemented. Examples can be drawn from a

number of cases where unforeseen regional or national developments were handled only because of a built-in flexibility in the physical systems and the legislation governing water development, distribution, allocation, and use.

The legal and institutional criteria needed to provide effective instruments for the rational and adequate management of water inventory, development, conservation, and use of water resources at the regional level are not different is essence from those required at the central, national level.

Efficient Use of Water in the Domestic Sector

It seems that, of all the areas in water-scarce regions or countries, the municipal-urban sector is the most complex and difficult to control and in which to achieve optimum water consumption per capita. In many of the developing countries, this sector is either the largest water consumer in the country, or second largest, after agriculture. It directly concerns almost all citizens in their home and business; every water tap, bath, toilet, or garden sprinkler. It is related to human behavior, makes various demands, and imposes restrictions on people as well as affecting their payments for water consumed.

The fact that the municipalities represent large groups of consumers can entitle them to a special position in the legal-organizational framework of a national water economy. Accordingly, along with its relevant duties and obligations, both to itself and the central water authority, the municipal authority should adopt an appropriate attitude toward the water affairs under its jurisdiction.

Close and coordinated cooperation and clear supervisory function should be maintained between the federal or state water authority and the municipal authority responsible for controlling the urban economy in general. It should be remembered that this cooperation also demands coordination with those agencies in the central government that control the municipal aspect of the local authorities, such as the Ministry of the Interior, or others.

In countries or regions where water is scarce, and in particular those where a regime of water rationing is inevitable, these interrelations take a complex and unique form, of which the following legal-administrative model may serve as an example. It shows how the objectives of water demand and assets management can be achieved, while sustaining the role and responsibility of the local authority. Nations that enjoy unlimited water quantities do not usually take this route, although taking it may well delay and conserve their investments in water supply.

Allocation of Water to Municipalities

An arid or semi-arid country or region can develop a system of legal and organizational provisions for the allocation of water to the municipalities, allowing for varying conditions from one to another.

The nature of the diverse water uses under the municipality's jurisdiction, the share of these uses in overall consumption, and the relative amounts consumed by the various municipalities should all be taken into account in the rationing system. The water allocation and license for the specified uses are based on efficiency in order to encourage water saving and minimize wastage.

Efficient Use of Water in the Urban and Domestic Sector

Education and dissemination of information are very important in achieving water efficiency in this sector. Equally vital are compelling the use of certain equipment by law and strengthening economic motivation through progressive water charges that rise with the increase in use. At the same time, low rates must be maintained for basic consumption, enabling the low-income groups to receive a piped supply at minimum costs.

In such a model, the annual quantity of water available to a municipality is the product of the number of people in that municipality and a prescribed quantity per capita. This quantity is based on the assumption that the municipality must install or promote the installation of water-saving devices within its jurisdiction, and manage its water policy and water system with the greatest efficiency.

If these measures are not taken, the annual water quota allocated to the municipality will not be sufficient. This quota includes the use of water under the municipality's jurisdiction for domestic use, gardens, public services, handicrafts, and commerce, as well as industrial use which could be handled separately. If targets are not achieved, the municipality would be penalized.

The incentive for efficient water use is the quota system of water allocation for domestic and urban use. This system also forces the local authority to maintain the water system and reduces unaccounted-for water within reasonable limits.

In order to ensure the use of water-saving devices, the water authority or ministry should issue regulations, prescribing

the types of devices that must be used in the municipal water system. These will vary and can be modernized from time to time.

No building should be connected to a municipal water system that is within a rationing zone before verification that the stipulated saving devices have been installed. In this context, a set of regulations prescribing the manner of water use should be passed, for example, car washing in garages and service stations. These measures enforce the introduction of special devices and water recycling to guarantee the greatest economy in water use in such services. Regulations for commercial and industrial use should also be instigated.

The municipalities themselves, bound by water law regulations to remain within the limits of the water quantity allocated to them, can express the optimum-use target in their by-laws. By-laws can address, for example, house and individual apartment metering, reflect various provisions and prohibitions, and, most important, outline progressive water charges and the billing and monitoring processes. In addition, the municipalities must invest and contribute to education, publicity, and information concerning the efficient and economic use of water in order to sensitize their citizens and enlist their essential collaboration.

Domestic Water Management

Thus what characterizes domestic water management in this model is the water-metering requirement of every consumer, and the provision that meters be read and bills paid according to the reading, at set intervals. A basic quantity of water is given at a relatively low rate while consumption beyond that will be charged with progressively higher rates.

The principles behind these regulations are:

1. water is a service that must be paid for according to the quantity consumed by the consumer, and

2. the routine bill gives warning of excessive water consumption and enables the consumer to see to it that the water consumption habits of the family are more strictly regulated.

Implementation of the regulations lays a burden on the water supplier, namely, the local authority, and the shortage in skilled manpower often makes it difficult to bear this burden. One solution for increasing the efficiency of the high frequency billing system is mechanized data processing systems. Most local authorities should change to mechanized water accountancy by means of simple electronic computers. This system will yield additional information on the water consumption distribution in

domestic water management and distinguish between various types of water users. It will therefore provide the means for better management, monitoring unaccounted-for water, water distribution, and an adequate cost-recovery system.

Certain problems involved in the actual meter reading should be solved. Improved water meters have made reading easier by having a digital dial, but a sophisticated and quick method of reading has not yet been implemented on a large scale. An example is a system based on electronic transmission of all meter readings in a housing block to a central switchboard. This system would be particularly efficient in multi-story buildings where apartmental water meters are installed on every floor.

If a water-metering law does not exist or is not enforced on an apartment basis, there is usually no individual water metering at all, or water may be metered for the entire house and payment divided according to the number of flats/apartments in the building. In a model where water was separately metered for each apartment, water consumption significantly decreased. Surveys prove that the water consumption per capita falls by an average of 20 percent with apartmental water metering as compared with water consumption under common metering. However, progressive rates and adequate cost recovery should be integrated to sustain the decrease in water wastage.

But even with apartmental water metering, there will still be a quantity of water for common usage. This common consumption is usually divided equally among the tenants. In one model, the construction of multi-story buildings with a high building standard introduced a central hot water supply system. The cold water was metered by apartment, but the hot water was piped to each apartment without metering. Here the phenomenon of increased consumption occurred, as it does when there is no individual apartment metering. In one case, water consumption rose by about 27 percent compared with the water consumption under apartmental metering. Obviously, the knowledge that water billing would be equally divided among the tenants brought about increased use of the common hot water, even in instances where cold water could be used. This not only wasted water, but also the considerable energy invested in heating the water and thus increased the total energy and water bills for each apartment and family.

Our experience has shown that two components play a dominant role in household behavior:

1. Education Campaigns

The effect of education campaigns on a diversified population is, inter alia, dependent on the size of the budget. If the campaign is not continual, it will cease to be effective. However, continual efforts that do not change in style and presentation may in the long run become counter-productive. A well-developed strategy can have an important effect on the prevention of water wastage; particular emphasis should be given to the education of school children and their influence on parents. It is almost impossible to achieve significant reduction of water use at the household and public levels unless effective education is undertaken.

2. Progressive Water Charges

Water charges for the domestic consumer are stipulated either by the authority's order or by municipal by-laws; in all cases, the conceptual basis is the same. In such a model, individual household metering is enforced and the family pays for a reasonable basic consumption in an amount that covers the cost of water supply to the local authority. The authority will pay from the municipal budget for city park watering and other public uses. For consumption in excess of the basic quantity, whether to the household or to the municipal user, the water charge per unit could be almost doubled. Nonetheless, the cost of water should not exceed 3 to 4% of average incomes. However, it appears that only when the payment of water exceeds 2 to 3% of income will income alone act as a significant disincentive to water wastage.

Conclusion

Programs to increase the efficiency of water use and prevent wastage should be conducted on three levels, that of:

1. the individual domestic consumer,
2. public premises where the water user does not directly pay for the water, and

3. the waterworks themselves.

The water authority's activities vis-a-vis individual consumers should involve:

1. conducting educational campaigns through the mass media aimed at all sectors of the population;

2. maintaining disincentive progressive water rates that charge much higher amounts for water consumed in excess of a reasonable quantity;

3. developing efficient and water-saving domestic fittings, assuring their quality, their installation, and, where relevant, their research and development, as well as assisting consumers in obtaining them through special certified outlets, funding arrangements, and so forth; and

4. maintaining the treatment, pumping, and distribution system to minimize water losses and unaccounted-for water.

Efficient Use of Water in Industry

The system of allocating water to industry should be based on statutory norms for the various industrial processes. The allocated water quantity can be calculated by multiplying the norm by the anticipated quantity of production and ultimately by the actual turnover. Special production conditions deserve special consideration. Norms are based on efficient and economic use of water in the production process; thus factories that have not adjusted their processes to economic water use would not be able to manage with the water quantity allocated to them and/or would pay sanction rates. Plants that use water in excess of the allocated quantity would have to pay a penalty rate.

On the other hand, the norms should be set so as to avoid affecting the quality of the end-product, and to optimize the planning of production processes, taking into account charges for effluent quality. Norms should change from time to time according to feedback information and the availability of water-saving devices and manufacturing processes. The authority should allow sufficient time for the manufacturers to accommodate the necessary changes.

In establishing regulations for the efficient use of water in industry, the water authority could collaborate with industry in:

- promoting research and development;
- adopting dry processes developed in other sites;
- lending at a relatively low interest rate for purposes of investment in water-saving facilities and processes;
- financing the separation of water metering for each production process, to facilitate identifying the section in which wastage has developed;
- carrying out joint pilot projects; and
- combining the water use with the effluent quality and charges.

Policies to Ensure Efficient Use of Water in Industry

In some arid or semi-arid countries, industry may not be a major water consumer yet may still have a negative effect on other sectors. Therefore its water use has to be kept down by continual efforts to improve efficient usage. Without these efforts, industrial water consumption could increase to become prohibitive and/or to create a load on municipal systems that in turn would force the reduction of supply to low-income groups. The increased efficiency achieved in a few countries can undoubtedly be attributed in some measure to an overall improvement in measures adopted by industry. A share of the credit must be given to conservation policies initiated by the water authorities. These policies are discussed below.

Water Licensing

Water can be supplied to industrial firms under license and the quantity allocated to any plant calculated on a normative basis. The norms would take into account the following factors:

1. the nature of the end-product,
2. the production process,
3. the existing factory equipment,
4. the raw material in use,
5. the equipment and technologies available for efficient use of water, and
6. the effluent quality and charges.

Norms should reflect the generally accepted efficiency standards that can be achieved by use of available technologies. The norms should from time to time be brought up to date as new technologies and improved equipment and processes make it both technically and economically feasible to cut down on water consumption per unit of output.

A firm's annual water allocation can be calculated by multiplying the planned volume of production for each product by the appropriate norm. The incentive for keeping consumption within licensed allocations is created by a special surcharge levied on excess consumption; this makes excessive water use very expensive. In some areas, the surcharge is around 200 percent of the basic water rate. However, the whole process involves the public sector/water authority or water departments in a thorough evaluation of the industrial processes.

Introduction of Water-Saving Technology

The licensing system can therefore become the major instrument in putting pressure on industrial firms to improve efficient water use. The authorities, for their part, can sponsor research for the development of water-saving equipment and production processes. They can also provide technical advisory services to facilitate the dissemination of information about developments in these fields and their implementation.

The activities listed below have led to large gains in efficient water use and in some cases also yielded considerable fringe benefits, for example, in the form of energy savings and in reclamation of materials for reuse.

1. recycling of cooling waters through cooling towers;
2. recycling of blowdown water from steam and heating systems;
3. recycling of seal-water in vacuum pump systems;
4. reduction of flows by flow regulators or pipe diameters;
5. introduction of accessories such as pressure regulators, volume regulators, automatic and semi-automatic valves;
6. reuse of rinsing water;
7. counter-current rinsing, with one fresh water inflow and one wastewater outflow;

8. use of condensed air bubbling to improve the efficiency of the rinsing process;

9. transfer of used water from one process to another with lower quality requirements;

10. in-plant treatment of wastewater for reuse;

11. use of cooling as a substitute for water cooling, use of closed-cycle heat exchangers;

12. use of low-grade water (seawater, brackish water, treated sewage) for cooling;

13. Reuse of plant or outside wastewater.

Incentive Financing for Investment in Water-Saving Processes and Equipment

In addition to the above measures, authorities should establish a fund that provides financing for investments in water-saving devices and changes in production at attractive concessionary terms. Eligible projects would have to show a savings of at least 10 percent of water consumption at a cost less than the marginal cost of the supply water.

Efficient Use of Water in Periurban Agricultural Areas

Since agriculture is one of the greatest consumers of water, especially in arid or semi-arid countries, control measures for farming close to urban areas must also be addressed. In addition, extensive irrigation within the municipal jurisdiction, for example, irrigation of parks and gardens, may also fall under regulations for agriculture.

Again, the method essential to effective control is allocation. Water allocation for agricultural purposes can be based on a system whereby the farmer has a water license. The basis for control and promotion of efficient use is the application of norms and maximum quantities of consumption related to the various agricultural crops and conditions. In this complex model, allocated water quantity constitutes a multiple of the appropriate norm and the cultivated area. As in the other sectors, the norms should be calculated on the basis of economic and efficient use. If the farmer is wasteful, he will find himself unable to sustain his farm on the water quantity allocated to him.

Here, too, the incentive for efficiency lies within the allocation. The penalty for overconsumption is either in the form of a penalty payment (based on a progressive block rate

structure), or of a reduction in the irrigated area, both giving the farmer an incentive to become efficient. Payment for overconsumption may be made via his supplier or directly to the authorities, in case of self-ownership of the resources or supply equipment.

This model calls for a number of basic prerequisites: (1) metering, (2) allocation, (3) a controlling authority, (4) effective monitoring of the metering system, (5) sanction payments, (6) willingness to take action against defaulters, and (7) support and incentives for the promotion of efficiency.

In order to achieve these essential components, an authority or ministry should issue regulations restricting the use of water in the various agricultural functions. Their implementation may be limited, in the early stages, to "rationing" zones where conditions dictate rigid control. The purpose of the regulations is to encourage and promote efficient methods of water utilization or to discourage and sanction the inefficient ones. However, the basis is the right to consume water by all those who own or cultivate land at a certain point of time when regulations are enacted.

Studies of water consumption in horticulture, for example, indicate that the use of certain irrigation techniques and saving devices has resulted in conserving considerable quantities of water, often a saving of 60 to 80 percent when compared with conventional gravity irrigation systems. In order to provide the incentive for this form of conservation, the regulations could stipulate that water saving achieved through the use of such methods and devices would not affect the consumer's right to receive the full quantity of water originally allocated to him. This rule is relevant as long as farmers can use the water in other plots, or sell part of their allocation to others (e.g., farmers, suppliers, the regional authority).

Therefore, the consumer could be permitted to utilize, when possible, the amount of water thus saved for the irrigation of additional areas, irrespective of whether these areas adjoin that in which the water is being saved. In most cases, this applies to regions irrigating from piped networks. This principle was found to be important in sustaining the incentive for water savings.

In these efforts to increase efficiency, the farmers' cooperation can be secured if their net income is raised through the use of new and efficient methods and devices. To this end, farmers must be given guidance, information, and financial incentives. They must be induced to improve their irrigation systems and save not only water but money and labor. The training and visit system (T&V) could play the dominant role in this function as well as others. The economic incentive to the

individual must be demonstrated convincingly before a water-saving policy can be assured.

The activities of the water authority in this program should consist of the following:

- initiating the legislation, the regulations, and their application and control;
- providing incentives for developing efficient irrigation methods and systems;
- fostering their introduction by the farmers;
- granting loans at attractive interest rates for their implementation, especially during the initial periods until economic viability has been demonstrated in a variety of regions and crops;
- reducing market prices of water-saving appliances, through special incentives for those that have been certified by an Institute of Standards;
- promoting demonstration and pilot projects, and setting up large-scale demonstration farms or projects;
- implementing irrigation extension services (T&V);
- training for farmers as well as professional staff;
- instituting promotional applied research and accelerating its implementation.

* * *

In the future, coastal cities and industries will benefit from the technological advances of large-scale desalination plants. However, this method will still be prohibitively expensive for irrigation and agricultural use for years to come. (Present desalination costs have been decreased to 1-1.3 USD/m^3 which approaches the high costs of incremental conventional water supplies.) Therefore, all feasible measures to use water more efficiently, especially in these two sub-sectors within the urban setting, must be not only encouraged but enforced.

As the past has shown, water does not have to act as a limiting factor in the development of most water-scarce regions. By economizing in water development and usage and fully implementing the reuse of wastewater, a country can meet its domestic demands and still allow the industrial and agricultural

sectors to increase their production levels.

The need to develop a stringent legal, institutional, and administrative framework for water management generally exists only under water-scarce conditions--severely restrictive policies may not be needed in countries where water is plentiful.

Nevertheless, with appropriate structures in place, any developing country can continue to grow while postponing heavy investments in water production and distribution.

Annex 1

WAVE OF NEW MIGRANTS FLOODING ASIAN CITIES

[From: Singapore Press, May 1989]

Wave of New Migrants Flooding Asian Cities

Poverty also becoming more prevalent, says UN study

Across the broad profile of Asia, populations are growing more rapidly than planners anticipated only five years ago and many cities of the region are inundated with a new wave of unemployed migrants.

The region that has shown the world's strongest rates of economic growth over the past two decades is developing a wider gulf between rich and poor as some countries have been left behind while others have grown towards economic maturity.

"A hard fact of economic life in the region is the prevalence of poverty," the UN Economic and Social Commission observed in its survey this year. "Poverty exists not only in low-income countries of the region but also in the middle-income ones."

Although there are few consistent and reliable social and economic statistics for many Asian countries, the best estimates assert that 500 million people - nearly 25 percent - in the region live in poverty. That is almost the same as the combined populations of the US and the Soviet Union.

This development reflects recent Asian demographic trends, especially the rapid growth of cities including both the natural expansion of families and the movement of individuals from the countryside to urban areas.

While Asia once put highest priority on controlling the growth of population, the contemporary issue is a matter of management or distribution of people.

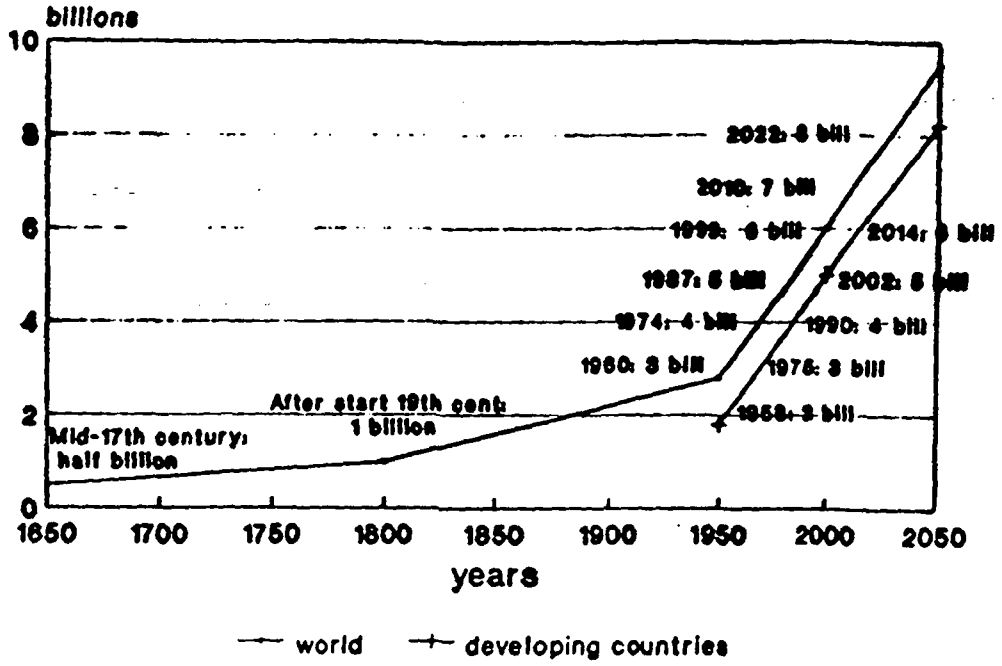
More than 16m in Calcutta

These are some of the elements of the population issue gleaned from many current sources [see charts on next page]:

• WHEN the Asian population hits 1.527 billion in 2000 - as the UN now anticipates - about 44 percent of the people will be living in cities. In 1950, 30 percent of fewer than 2 billion Asians were urban dwellers.

• IN 2000, half of the world's 10 largest cities and 12 of the 25 largest will be in Asia. Calcutta and Bombay will each have more than 16 million residents, Shanghai over 14 million and Seoul and Delhi past 13 million each.

Growth of World Population



Source: UN Population Fund

Youth Population Bomb
(In millions)

	Total	Under 16		Under 5	
Bangladesh	106.7	50.6	47%	18.3	17%
China	1068.6	333.0	31%	99.3	9%
India	802.1	315.4	39%	111.5	14%
Indonesia	172.2	67.9	39%	21.7	13%
Malaysia	16.6	6.4	40%	2.2	14%
Pakistan	111.0	52.4	47%	21.4	19%
Philippines	58.0	24.9	43%	8.8	15%
Singapore	2.6	0.7	27%	0.2	8%

Source: UNICEF, 1987

• THE developing countries of Asia - including India and China - now include more than 2.5 billion people, about half of the world's population. By the year 2000, these countries will total 3.1 billion of the world's expected 6.1 billion.

• WHILE countries such as Indonesia and Thailand have organised successful birth control programmes, their populations have grown faster than the supply of jobs. Both Jakarta and Bangkok are suffering the pains of rapid urbanisation.

• ASIA has grown faster than other developing areas and the industrial world since 1970. But within Asia, the richer countries such as Singapore, Korea and Hong Kong saw per capita income rise nearly 10 times while the poorest countries merely doubled their incomes in the same period.

• BANGLADESH, Burma and Nepal are home to 160 million people, more than Africa below the Sahara and with lower per capita income. India, Pakistan and Indonesia hold one billion residents with average per capita income of less than US$330 (about US$630) a year.

• URBANISATION is destroying farm lands and agricultural growth is trailing demographic growth. More than 70 percent of the world's malnourished children live in Asia; in South Asia there are 500 maternal deaths for every 100,000 live births compared with 10 in the industrial world.

• BETWEEN 30 and 40 percent of the Asian population is under 15, meaning that a rising flood of new job-seekers is entering the urban markets. Many of these youths were born before birth control programmes were started.

The well-known American sociologist Professor Daniel Bell recently wrote that the growth of cities was one "crucial" demographic problem facing the world. The main "time bomb," however, is the growing gap between the older generation and the rapidly-expanding youth population.

"These population imbalances mean that, in the next 20 years, we will see demographic tidal waves sweeping the world," Professor Bell said. "In the heavily-weighted countries, this will mean more than doubling of the rates of entry into the labour forces."

While building economic growth and export industries, many Asian countries have failed to build systems for urban health care, housing, transportation, water and sewerage. They have also been unprepared for the number of people who are living longer than their parents did.

"The impact of such rapid growth cities in the developing countries of Asia with comparatively low per capita income is obvious," Professor P.B. Desai of Delhi University observed recently. "They have attracted people but have failed to absorb and assimilate them."

Focusing sharply on the four largest Asian countries - Indonesia, the Philippines, Thailand and Malaysia - Dr. Trinidad Osteria of the Institute of South-east Asian Studies (Iseas) concluded that they also are confronting "an accelerating pace of urbanisation."

"This emerging phenomenon has shifted the focus of government planners from the inaccessible rural population to the urban poor - the inhabitants of slums and squatter settlements."

The Asian Development Bank (ADB) recently confirmed: "Given that the ongoing structural shift from agriculture to industry in Asia is expected to accelerate in the 1990s, the pace of urbanisation will consequently increase. The major spatial issue in developing member countries will continue to be the growing concentration of urban population in a relative handful of increasing large cities."

There is no direct correlation between the population growth and economic prosperity. But in Asia over the last decade, there is evidence that the countries whose economies have grown fastest are those with the smallest population expansion.

Even those big countries that have slowed population growth are suffering the pains of excess expansion and urbanisation because of the huge bases on which over-optimistic plans were made.

China's paramount leader, Mr. Deng Xiaoping, admitted recently that his country's policy of only one child a family is failing and that population in 2000 would be 1.3 billion instead of the planned 1.2 billion. Authorities are trying to stem a flood of hundreds of thousands of peasants seeking work in the cities.

The Chinese policy of restricting families to just one child has been more effective among city-dwellers than among peasants. In India, population growth is running at 2 percent on a base of about 820 million. Its national goal of reducing natural growth to 1.1 percent by the next century has also been postponed.

Looking to the future, four countries that have set the pace for economic growth and rising prosperity - Singapore, Hong Kong, Taiwan and South Korea - are expected to expand their populations by only one percent a year. Countries that have

shown slow economic growth such as Bangladesh, Nepal and Pakistan will see their populations grow by 2.4 to 3.1 percent.

The ADB estimates that by 2000 the poorest countries in the region including India and China will have per capita incomes of US$440. Without the two giants, the other poor countries are expected to achieve average incomes on only US$310 while the richest nations will be at US$8,250.

These projections were made earlier this year by the ADB in a study that suggested that it should shift its attention from supporting general economic expansion through business and industrial investments to providing more support for alleviating poverty.

"Investment in social infrastructure, in particular public health and education, needs to be expanded both to enhance the quality of life directly and to promote economic growth in the longer term," the ADB urged.

"Social infrastructure is vital not only for humanitarian reasons but also for economic growth and development. Expenditures on primary education, family planning and basic health can result in productivity gains that make them primary investments from an economic point of view."

However, the ADB and other international organisations avoid financing birth control programmes because of religious and political opposition among their sponsoring governments. The dominance of political conservatives in the Reagan and Bush administrations has also meant that US foreign assistance no longer encourages birth control.

'Too optimistic about trends'

But even in those countries that have slowed growth rates such as Indonesia and Thailand, populations are still growing because of the high proportion of young parents produced in previous decades of faster growth.

For Asia, the UN has recently acknowledged that it was too optimistic about future growth trends. The agency noted that population growth in the region fell to below 2 percent annually by 1980, despite a decline in death rates and substantial gains in longevity. The slowing of population growth has been arrested, however, at an annual rate of 1.86 percent instead of continuing to fall as expected to 1.63 percent by 1990.

This small difference in percentage plays out to a substantial difference in projected actual population for the region. The UN in 1984 estimated the size of the Asia-Pacific

region would be 3.381 billion persons in 2000. Now, the estimate is 3.527 billion.

From Iseas, Dr. Osteria is co-ordinating studies in the four Asian countries with the goal of recommending improved co-ordination and delivery of health services for cities.

Planners have concentrated their efforts towards controlling the growth of population and paid less attention to the issues of migration. "To the extent that such migration is not fully justified by economic developments in the city, it contributes to perpetuating massive urban poverty in the midst of economic, cultural, social, political and modern centres of the nations," she said.

Annex 2

BOMBAY'S WATER SUPPLY SITUATION:

DROUGHT AND MIGRATION WREAK HAVOC ON LIMITED RESOURCE

[From: Water and Wastewater International, February 1989]

Bombay's water supply situation:

Drought and migration wreak havoc on limited resource

Honorary Director of the Indian Water Works Association and resident of Bombay, India, S.P. Unvala discusses the many causes and possible solutions to the city's precarious water supply situation, he aptly describes as "five minutes to midnight."

Three successive droughts, resulting in long-term damage to India's economy, have brought into focus the urgent need for planned action to manage water resources effectively at a national level and to focus attention on the almost chaotic conditions in the towns and cities of India to where millions of displaced persons from rural, agricultural areas have migrated.

Ninety districts out of India's 396 districts, covering 16% of the nation, have progressively come under the shadow of drought due to merciless deforestation. In the most industrialized state, Maharashtra, whose capital city is Bombay, droughts are a chronic feature of the rural agricultural areas. The brunt of exodus from these parched regions is taken by Bombay where the population is now estimated at approximately 10.2 million. Two years ago, the estimated mid-year population of the city was some 9.86 million.

Bombay has a total land mass of 438 km² and a population equal to that of other countries such as Lebanon, Belgium, Bulgaria, Greece, or Ecuador, which have a land mass of 10,400, 30,513, 110,912, 131,944; 10,400; and 283,561 km² respectively. Population density of Bombay is 25,300 persons to a square kilometer.

The water supply situation in Bombay is very precarious, considered to be very close to "five minutes to midnight." There is no concerted effort to stop the influx of some 300 people migrating to Bombay each day despite the existing problems of inadequate water supply. They come as fugitives from politically disturbed areas, economically stressed regions or parched agricultural lands to start a business or to seek employment.

The total water supplied during the year ending on March 31, 1986 was 770,150 million liters which meant a daily average of 2,110 ml³. Bombay has gone on record to accommodate the largest slum in Asia. Of the 9.86 million people, approximately 50% reside in slums or near slum conditions. Bombay has 1,680 slum pockets with over 627,000 huts of bamboo and cloth or plastic. The rough distribution of total quantity of water brought to the city shows the following pattern:

The tabulation in Table 1 shows that the purely domestic consumption appears to be 1,275 mld for a population of 9.86 million in 1986, i.e. 129 liters per day per capita, against the national planned average target of 200 liters per day per capita. In comparison, New Delhi, the capital of India is supplied water with over 220 liters per day per capita.

Bombay is the commercial capital of India, contributing 32% of Indian Government revenue; accounting for 25% of India's industry and 10% of nation's industrial jobs but appears to be grossly neglected by the state and central governments. The average of 129 liters per day per capita of 1986, may have decreased to 125 liters per day per capita today. Due to phenomenal growth of Bombay from 1950 up to the present date, the water supply is not only intermittent but unequitable. Only 4% receive water for more than 8 hours. 33% receive water for more than 4 hours. 42% receive water for just 3 hours. And 21% receive water for less than 3 hours. The minimum period as recorded by consumers is very often only one hour in the latter category.

In the year 1985-86, there were 13,206 short supply complaints from the 9 wards of city proper, 8,919 such complaints from 8 wards of western suburbs and 4,669 complaints from 5 wards of eastern suburbs. The maximum for any ward was 3,132 in the B ward which is the most congested and the oldest part of Bombay. The adjoining old portions of the city viz C and D wards recorded 3,016 and 2,798 complaints in 1985-86.

Health aspects

One may become apprehensive about the quality of water when the supply is intermittent, restricted to a few hours in the day and night at poor pressures. During 1985-86, only 323 cases of complaints of contaminated water were recorded; maximum being once again from B Ward and the next case being C Ward. 307 contamination cases were

The water supply in Bombay, India, is intermittent and unequitable due to the phenomenal population growth of the city since 1950. Twenty-one percent of the population receive water for less than 3 hours each day.

Photo credit World Bank

reported in the city wards, 12 in the western suburbs and 4 in the eastern suburbs, S ward recording none.

When such complaints are received, it is normal to expect ingress of sewage from surcharged sewers in congested areas of the city viz, A,B,C,D and E wards; and steps taken to rectify the situation including flushing through hydrants and superchlorination using portable chlorination plants.

The entire water supply of the city is filtered and chlorinated at five different stations and normally it is considered safe to drink water in Bombay. Paradoxically, all major 5-star hotels in Bombay are located in A ward from where 34 contamination complaints were received in 1985-86, i.e. 11% of the city's complaints; however, each hotel has its supplementary treatment system consisting of full filtration and chlorination. For instance, an internationally famous hotel complex has a 14 mld rapid sand gravity filter plant in the second basement below the ground floor and the filter sand is capped with activated carbon. Filtration is followed by chlorination which makes the water as pathologically safe as possible.

Reverting to the quality aspects of the water supply of Bombay in general, there are four groups of sampling points from which water is sampled for bacteriological and chemical examination in each of the wards of the city and suburbs. Sampling points are on the service mains, and samples are collected by mobile squads of trained personnel. During 1985-86 total routine samples taken for bacteriological analysis were 6,597, i.e. some 22 samples per day. 92.08% of these samples were totally free from coliform bacteria. There are 11 service reservoirs whose waters were kept under surveillance throughout the year and 9,645 samples were collected. Out of these samples, 93.05% were free from coliform bacteria. Special samples were collected in connection with 573 complaints of contamination during prophylactic measures and after and this number stood at 4,386 for 1985-86, i.e. approximately 13 samples per complaint showing protracted nature of surveillance. The above figures of sampling exclude almost continuous monitoring of water quality at the 5 treatment stations. The quality of water being thus kept under strict and continuous surveillance, the problem of quantity of water looms large.

Water losses

The water supply system of Bombay suffers the loss of usable water due to evaporation from the surfaces of impounded reservoirs which are sources of water; non-recycling of washed waste from 3 filter plant stations; pipe bursts; leakage and wastage; firefighting operations; and wanton wastage.

Washed waste from filters and clarifiers desludge systems at 3 treatment plant stations is not treated and recirculated. The total water supply arriving at filter plants today is approximately 2,682 mld more than 2,110 mld reported earlier because of pumping additional water from Bhatsa River. Total loss due to the discharge of washed wastewater is 14.09 mld today but may grow to 32.09 mld by the year 2000, since 1,362 mld of water may come to be treated at Panjrapur by that time.

By 1994 the quantity would definitely be about 23 mld and steps should be initiated to treat and recycle this washed waste. This subject is already assigned to consultants for study.

Public awareness and political will are required to move away from today's frightening situation of five minutes to midnight.

Pipe bursts

Within the city limits of Bombay, there are 1,137 km of pipelines made of different materials of construction, namely mild steel and cast iron, some of which are nearly 100 years old. Bursts attended to on pipelines up to 1200 mm diameter were 39 in number during 1985-86. The smallest size pipe attended was 80 mm in diameter. Of the 39 bursts, 33 occurred in city wards; 4 occurred in western suburban wards and only 1 occurred in eastern suburban wards. These occurrences are a true reflection of the age of the pipelines in 3 major divisions of the city; however the quantity of water that could have been lost is unknown. Considering the age of the pipelines statistically [illegible] for over 29 km of pipelines either reflects on the good quality of the the pipelines' construction material or highlights the poor pressures prevailing in the distribution system.

Leakage & wastage

It is deduced from continuous monitoring done on distribution pipelines within the municipal limits that approximately 15% of water supply is lost due to leaks. Considering that approximately half the total length of 1,137 km of pipelines is more than 30 years old, and at least a quarter of total length is more than 60 years old, 15% leakage is a very modest figure. In a comparatively recent situation, a new distribution system of another city in India has recorded continuous leakage of more than 22% in the last 5 years.

The city is divided into 79 water distribution zones, and these zones are further divided into 552 leak detection zones for purpose of control over various facets of water supply maintenance. Each leak detection zone is made of 250 to 300 consumer connections. In 1985-85, for an entire length of 1,137 km, the total number of leaks detected and attended to was 2,227 of which 271 were above ground. This work is coupled with water sampling, and a preliminary precautionary measure where contamination is suspected, tail-end or nearest hydrants are opened to flush the pipeline. In 1985-86, the total number of hydrant opening and pipeline flushing operations was 1,796.

Wanton wastage

Against the above listed sources and reasons for depletion of usable water, measures taken to avoid such losses based on strict vigilance against wastage of water by the consumer are difficult to practice and achieve. In all strata of society whether the water supply is through meters or not, universal metering is not yet adopted in Bombay as a time bound programme. The wastage of water is a common scourge whether the consumer resides in a rich locality or a slum, or whether the consumer is educated or illiterate. Because of intermittent supply available at difficult hours, people keep their taps always open so the first flush of water is wasted since the receiving bucket is not

day's leftover water, almost 2 to 3 buckets for a family of 4, is put down the drain as it is "stale" water.

Water is stored in every household in 2 sets of receptacles; one is the plastic drum of 60 liter capacity where general purpose water is stored and the second, a baked earthen pot or brass tank or stainless steel receptacle of 2-liter capacity where drinking water is stored. The leftover water from both the receptacles is drained to waste every time the fresh supply of water is received the next day. The water supply authorities could if empowered conduct a survey of the wasted water and this may reveal a loss of precious 15% of water, as did a 1986 private survey of 8 buildings in a middle-class locality, all situated on one road in H ward. This is good, potable, paid-for water going down the drain.

There are some buildings which are given the facility of pumping water to the overhead tanks during supply hours. In two buildings out of eight, the pumping continues beyond supply hours, resulting in the supply main on the road being sucked dry and the overhead tanks on buildings overflowing for 30-40 minutes each day. The municipal authorities have to take very long and complicated steps to take any drastic measure; though the authorities could and should insist on level-switches being mounted on such pumping units so that the pump could be switched off once the overhead tank is full.

The tampering of pipelines, creation of artificial leaks, and thefts of controlling devices are daily tactics resorted to by residents to get more water than that receivable from stand pipes installed by the municipality in poor and slum localities. The municipal authorities have to paddle a soft approach since they are left with no options. They either keep on repairing such damages at speeds which are not commensurate with the speed of wanton destruction or face street battles between groups of people over a bucket of water.

One project planned to increase the city's water resources by 440 ml per day involves the construction of an impoundage between the existing impoundages viz Modak Sagar (Vaitarna) and Upper Vaitarna by 1998. The intake tower at Vaitarna Lake or Modak Sagar is shown above.

Precarious scenario

The daily migration of some 300 people into the city, spurred by political strife, drought, poverty and hopes for a better life in a bustling city, exacerbates Bombay's precarious water supply situation. In economically poor localities and in slums, water is supplied through stand pipes and the statistics in Table 2 illustrates the growth of these populations in the city in just one year.

From these statistics, one can infer that the population that arrives in the city at two terminal railway stations and at the State Road Transport Terminus do not leave the city to stay in the suburban areas, and the finite quantity of water continues to be supplied to the increasing population. This is the reason why the 21% group reported earlier that receives water for less than three hours is located in the main city wards and not in the suburbs.

In more affluent localities, the increase in the number of metered connections could be an indicator of how the same quantity of water is made to go round more people. The increase in metered connections in either of the suburban areas is more than 1½ times that in the city indicating residential building activity in the suburbs and growth of economically comfortable people in these areas.

	%	Qty. in MLD
Domestic metered	37.46	790
Domestic unmetered	22.96	485
Industrial metered	9.24	190
Commercial metered	3.69	80
Government viz Railways and Port Authorities	8.04	170
En-route supply i.e. supply to areas outside Bombay	3.76	82
Transmission and Distribution Losses	14.85	313
	100.00	2110

	CITY WARDS	WESTERN SUBURBS	EASTERN SUBURBS	TOTAL
Number of existing stand-pipes 1/4/1985	585	10734	10149	21468
New stand-pipes given in 1985	252	1102	1324	2678
Stand-pipes removed in 1985	10	65	6	81
Number of stand-pipes 1/4/86	827	11771	11467	24065
Percentage increase in one year	41.36	9.65	12.96	12.09

	CITY	WESTERN SUBURBS	EASTERN SUBURBS	TOTAL
Metered connections 1/4/1985	25396	52471	27087	104954
Meters fitted on NEW connections and number of unmetered connections metered during 1985	1101	3427	1911	6439
Total metered connections 1/4/1986	26497	55898	28998	111393
Percentage increase in one year	4.33	6.53	7.05	6.13