

Water Management for Major Urban Centres

ASIT K. BISWAS

Third World Centre for Water Management, Atizapan, Mexico

The great city is that which has the
greatest man or woman;
if it be a few ragged huts, it is still the
greatest city in the whole world.

Walt Whitman
Song of the Broad-Axe

ABSTRACT *The provision of clean drinking water, sanitation and stormwater disposal has become a major challenge for the urban centres of the developing world. The number of cities with a population of more than 10 million has increased from one in 1950, to 16 in 2000, and is expected to increase to 21 by 2015. In 2000, 47.2% of the global population was urban, and this percentage is increasing steadily. The rapid rate of urbanization has far exceeded the management and financial capacities of all the levels of governments of all developing countries from about 1960. While more and more people have received access to water and sanitation in recent years, much more remains to be done. At the present rate, it is unlikely that the Millennium Development Goal of reducing by half the proportion of people without sustainable access to drinking water by 2015, can be achieved universally. The problems faced by the major urban centres of the developing world are analysed, and the opportunities and constraints they face are assessed.*

Introduction

From the dawn of human history, water has been an essential requirement for the survival of humans and ecosystems. Water has played a critical role in human development. For much of history, droughts and floods have periodically inflicted serious damage to society.

As the urban centres started to develop in a very serious manner, especially after the Industrial Revolution in the developed world, the provision of clean water and disposal of wastewater and stormwater became increasingly important issues. However, by the early part of the second half of the 20th century, these problems for much of the Western World had been solved. In addition, the Western economies had become stronger and more resilient than ever before, and thus floods and droughts had progressively less and less impact on such societies. When they occurred, they could either be controlled, or their adverse impacts could be reduced by the construction of the appropriate infrastructure and increasingly more efficient management practices.

Correspondence Address: A. K. Biswas, Third World Centre for Water Management, Avenida Manantial Oriente 27, Los Clubes, Atizapan, Estado de Mexico, 52958, Mexico. Email: akbiswas@thirdworldcentre.org

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However, the problems have mostly worsened for developing countries during the second half of the 20th century. Increasing population growth, rapid urbanization, inadequate levels of economic development and the absence of appropriate management and technical capacities meant that an increasing number of the urban population did not have access to basic services such as water, sanitation and stormwater management. At the global level, this issue received attention in 1976, during the United Nations Conference on Human Settlement, held in Vancouver, Canada. Subsequently, it was addressed firmly and directly by the United Nations Water Conference, held in Mar del Plata, in 1977. The Water Conference recommended that the period 1981–90 be declared as the International Water Supply and Sanitation Decade. The objective of the Decade was to provide clean water and sanitation to every person in the world by 1990.

A retrospective analysis indicates that the Decade had a major impact by putting water supply and sanitation higher up the international political agenda, in both developed and developing countries, than otherwise might have been the case. It also contributed to accelerated progress in terms of provision of clean water and sanitation to a large number of people, both in actual and percentage terms. However, in spite of this noteworthy progress, the goals for the Decade proved to be too ambitious to reach. In the end, the world fell far short of achieving its objectives.

The challenge was subsequently partially picked up by the Millennium Development Goals (MDGs), one of which explicitly stipulated that, by 2015, the objective will be to “reduce by half the proportion of people without sustainable access to safe drinking water”.

This MDG differs in three important aspects with reference to the Decade objectives. First, its objective is more modest: reducing by half the proportion of people who do not have access to a water supply compared to the universal coverage championed by the Decade. Second, the MDG, unlike the Decade goals, did not specifically refer to sanitation. This, of course, is somewhat surprising, since any water supply project introduces new water in the urban areas, nearly all of which subsequently becomes wastewater, which must be collected, treated and disposed of in an environmentally-sound manner. Provision of urban water supply, even if it becomes universal by 2015, will not be sustainable by itself, unless adequate arrangements can be made for wastewater collection, treatment and disposal. Third, the MDG has 50% more time to achieve its objective compared to the Decade: 15 years against a decade. However, current analyses indicate that even though one-third of the time period to achieve this MDG goal is over, pro rata progress has been much slower than necessary to achieve the final objective.

The sanitation issue was later considered and agreed to at the Johannesburg Summit in 2002. Accordingly, if the MDG goal for water supply and the Johannesburg recommendation on sanitation are to be achieved by 2015, accelerated progress has to be made during the next 10 years. Such an accelerated progress will require that the best practices in providing access to water supply and sanitation from different parts of the world be carefully analysed and assessed. These best cases could then be modified appropriately for possible application in other developing countries, in line with their social, economic, political, legal and institutional requirements. Regrettably, some 25 years after the Decade started, serious, comprehensive and objective evaluations of the best examples from different parts of the world are mostly still missing at present.

Urbanization and Water Management

Any discussion of urbanization should begin with a definition of what is 'urban'. Unfortunately, there is no international agreement as to what is an urban area. It is almost universally agreed that any settlement having more than 20 000 people is urban. However, many countries consider areas of less than 20 000 people as urban as well. Thus, aggregating global statistics on urban areas and analysing them becomes problematical. For example, if the Indian government considered settlements of more than 5000 people to be urban, as some countries do, India will have a predominantly urban population.

Countries generally define 'urban' based on one or more criteria, which include population size, population density, social and economic factors such as percentage of people involved in non-agricultural activities, administrative or political status of the settlement or census designations. The UN World Urbanization Prospects, 1996 Revision, points out that 46% of the countries it considered defined urban on the basis of administrative criteria, 22% used population numbers and sometimes population densities, 17% used other criteria, 10% had no definition and 4% considered their countries as entirely urban or entirely rural.

Historically, human societies had a predominantly rural lifestyle. For example, in 1800, only about 3% of the global population lived in urban areas. This increased to 14% by 1900, when 12 cities had more than 1 million people. The urbanization process advanced dramatically during the next 50 years. Thus, by 1950, the world had become almost 30% urbanized, and the number of cities with more than 1 million inhabitants had increased to 83.

During the period 1950–2000, the growth rates of the urban population in almost all countries was higher than the rural population. However, the world is heterogeneous, and there were significant differences in growth rates in different urban centres. If the growth rates of the 524 urban centres that had more than 750 000 population in 2000 are considered, 41 of them had growth rates of less than 1% and six had negative growth rates during the period 1950–75. This trend of low levels of growth rates continued during 1975–2000, when 122 cities had growth rates of less than 1% per year, and 21 of them had witnessed negative growth rates. Most of these cities were in developed countries and China. This trend is expected to accelerate during 2000–15. Table 1 shows some of these trends.

General historical experience has been that as the population of a city increases, after a certain point its population growth rates start to decline. Accordingly, cities that tend to grow at higher rates generally have smaller populations. For example, during 2000–15, of all the major urban centres, only Dhaka and Lagos will have annual growth rates of around 4.0%. Eight other megacities will have growth rates of less than 1%.

However, there are exceptions. For example, the population of Mexico City was 2.9 million and that of Sao Paulo 2.5 million in 1950. Even with such large populations, their annual growth rates were 5.2% and 5.6% respectively. Consequently, their

Table 1. Population growth rates for cities with more than 750 000 inhabitants in 2000

Population growth rates	Number of cities		
	1950–75	1975–2000	2000–15
More than 5%	28	3	0
More than 5%	130	51	6

Source: UN Population Division (2002).

Table 2. Population growth rates (%) of megacities in the sequence of their evolution, 1950–2015

City	Growth rate (%)		
	1950–75	1975–2000	2000–15
New York	4.2	1.2	0.2
Tokyo	1.0	0.2	0.5
Shanghai	3.1	0.5	0.4
Mexico City	5.2	2.1	0.8
Sao Paulo	5.6	2.2	1.1
Mumbai	3.6	3.1	2.3
Los Angeles	3.2	1.6	0.6
Kolkata	2.3	2.0	1.7
Dhaka	6.6	7.0	4.0
Delhi	4.6	4.1	3.5
Buenos Aires	2.4	1.1	0.6
Jakarta	4.8	3.3	3.0
Osaka	3.5	0.4	0.0
Beijing	3.1	1.0	0.5
Rio de Janeiro	4.0	1.2	0.5
Karachi	5.4	3.7	3.2

Source: UN Population Division (2002).

population increased by a factor of four by 1975, making them the first two megacities of Latin America having more than 10 million inhabitants.

Similarly, during the period 1975–2000, Dhaka started to grow at an annual rate of 7%, as a result of which its population increased by six times by 2000, when it became a megacity of more than 10 million people. The city with the highest growth rate during this period was ArRiyadh, which increased annually by 7.4%. On the basis of current trends, no large city is expected to grow at such a high rate during the 2000–15 period (Table 2).

Initially, the United Nations defined a megacity as an urban area having more than 8 million people. As urban centres became bigger and bigger, a megacity was later redefined as having more than 10 million people.

If the current definition is accepted, the world had only one megacity in 1950, New York. By 1975, the number of megacities had increased to five, and, by 2000, to 16. It is estimated that by 2015, this number will increase to 21, and New York will become only the 7th largest city in the world (Table 3). In 2000, only four megacities out of 16, were from the developed world. By 2015, even though the total number of megacities is expected to increase to 21, not even a single new megacity will join this list from developed countries.

According to the analyses carried out by the United Nations Population Division (2001 Revision), the following trends can be discerned between 2000 and 2030 in terms of urbanization:

- The global urban population will increase from 2.9 billion in 2000 to 5.0 billion in 2030. Nearly all of this increase will take place in developing countries. The urban population is expected to grow at an annual average rate of 1.9%, compared to global population growth rate of 1%.
- The urban population of developed countries will increase marginally from 0.9 billion in 2000 to 1.0 billion in 2030.

Table 3. Evolution of megacities, 1950–2015 (population in millions)

1950		1975		2000		2015 (projected)	
City	Population	City	Population	City	Population	City	Population
New York	12 339	Tokyo	19 771	Tokyo	26 444	Tokyo	27 190
		New York	15 880	Mexico City	18 066	Dhaka	22 766
		Shanghai	11 443	Sao Paulo	17 962	Mumbai	22 577
		Mexico City	10 691	New York	16 732	Sao Paulo	21 229
		Sao Paulo	10 333	Mumbai	16 086	Delhi	20 884
				Los Angeles	13 213	Mexico City	20 434
				Kolkata	13 058	New York	17 944
				Shanghai	12 887	Jakarta	17 268
				Dhaka	12 519	Kolkata	16 747
				Delhi	12 441	Karachi	16 197
				Buenos Aires	12 024	Lagos	15 966
				Jakarta	11 018	Los Angeles	14 494
				Osaka	11 013	Shanghai	13 598
				Beijing	10 839	Buenos Aires	13 185
				Rio de Janeiro	10 652	Metro Manila	12 579
				Karachi	10 032	Beijing	11 671
						Rio de Janeiro	11 543
						Cairo	11 531
						Istanbul	11 362
						Osaka	11 013
						Tianjin	10 319

Source: UN Population Division (2002).

Table 4. Distribution of urban population, 1975–2015

Types of urban settlements in terms of population	Annual average population increase (millions)			
	World		Developing countries	
	1975–2000	2000–15	1975–2000	2000–15
More than 10 million	6.3	7.7	5.0	7.5
5–10 million	1.9	6.3	2.8	5.9
1–5 million	13.7	19.1	10.9	17.3
0.5–1 million	4.5	4.3	4.2	4.5
Less than 0.5 million	26.3	29.8	23.2	28.2
Total	52.8	67.2	46.3	63.4

Source: UN Population Division (2002).

- The rural population of developing countries is likely to increase by 0.2% annually during this period. The rural growth rate is expected to turn negative in 2025 for the first time in human history. Asia will continue to have the largest rural population in the world during 2000–30, with 2.297 billion in 2000 and declining to 2.271 billion by 2030. In contrast, Africa's rural population will increase from 498 million in 2000 to 702 million in 2030. The rural population of Europe, Latin America and the Caribbean and North America will also decline during this period.
- Globally, urban cities with populations of between 5 to 10 million will expand the fastest during 2000–15, and cities with below 500 000 inhabitants will account for the highest percentage of such populations (Table 4). The trends are likely to be similar for developing countries.

While the megacities of the developing world have attracted the most attention from the various international organizations in recent years in terms of provision of adequate water supply and sanitation services, it should be noted that they account for a very small percentage of the global population, even though they consume a lion's share of the national resources and interest in terms of the various necessary infrastructure development and management. If megacities are defined as those having more than 10 million residents, only 3.7% of the global population lived in such large urban agglomerations in 2000. By 2015, this is likely to increase to 4.7%. The percentage of people living in cities of between 5 to 10 million are even less than in megacities: 2.8% in 2000, increasing to 3.7% in 2015. In other words, percentages of the global population living in cities of more than 5 million will increase from 6.5 in 2000 to 8.4 in 2015.

While the megacities present tremendous management challenges at present, and will continue to do so in the foreseeable future, much of the recent urban growths are being witnessed in medium to small sized urban centres of developing countries. This trend is likely to continue in the coming decades, and may even accelerate. Thus, in 2000, cities with less than 500 000 inhabitants accounted for 24.8% of the global population (nearly seven times that of megacities) and this is expected to rise to 27% in 2015.

It should be noted that urbanization and the formation of major urban metropolises are not new phenomena. For example, cities such as London or New York started to grow significantly in the 19th century. However, two major differences should be noted which have made the urbanization process and provision of water supply and sanitation services

in the megacities of the developed world very different in comparison to their counterparts in developing countries, nearly one century later.

First, is the rate of growth. The development of these earlier urban centres in the developed world was a gradual process. For example, most of the population growth in cities such as London and New York was spread over nearly a century. Gradual growth rates enabled these cities to progressively and effectively develop the necessary infrastructure and the capacities to manage their water supply and sewerage services. Since it was a gradual development, the increases in population were thus manageable.

In contrast, most of the urbanization in the large cities of the developing world such as Dhaka, Mexico City, Sao Paulo or Jakarta occurred during the post-1950 period, and the really explosive growth generally took place after 1960. These major urban centres simply could not cope with the very high and continually increasing urbanization. They were not only unprepared to manage such explosive growths, but also they did not have the financial and management capacities to manage this work. Thus, the overall quality of life declined rapidly during such periods of high urbanization. As noted earlier, between 1950 and 1975, the population of Mexico City increased more than fourfold, a significantly larger increase compared to what the urban centres of the developed world had witnessed earlier.

To a certain extent, many of these megacities could handle the provision of a water supply, but they generally fell progressively behind in constructing and managing sewage and wastewater treatment facilities. Even in a region like Latin America, where many cities made reasonably good progress in installing sewerage systems, concomitant progress did not occur in wastewater treatments. Currently, for the most part, less than 10% of collected sewage in major urban centres of Latin America are treated properly and then disposed of in an environmentally-safe way. Thus, in major Latin American cities, ranging from Bogota to Buenos Aires, and Mexico City to Santiago, millions of cubic metres of untreated, or partially treated, sewage is discharged daily into nearby water bodies. Many of the governments often claim that some 20 to 30% of their wastewaters are treated, but these are highly inflated figures that are not compatible with the real situations.

Second, as the urban centres of the industrialized countries expanded, their economies were improving concomitantly as well. Accordingly, these centres were economically able to harness financial resources to provide its citizens with appropriate water supply and sewerage services. For a country like Japan, it could invest heavily in the construction of urban infrastructure, including water supply, sewerage and flood control services after the Second World War because its economy continued to expand very significantly during the post-1950 period. Such extensive infrastructure development and major improvements in management practices in Japan meant that water losses due to leakages from the urban water supply systems could be reduced drastically from an immediate post-war estimate of 90% to about 8%, which is one of the lowest losses encountered anywhere in the world at present. Equally, cities like Tokyo spent enormous amount of funds during the post-1950 period to control urban flooding which would not have been possible if Japan's economy had not expanded during this period as well.

In stark contrast to the above, during the past four decades, economies of the developing world have not performed very well. Issues such as high public debts, poor governance and inefficient resource allocations have ensured that the investments needed to construct all types of new urban water and sanitation-related infrastructure and maintain the existing

ones have not been forthcoming. Lack of proper planning, poor management and practices and pervasive corruption have further aggravated the situation in many urban centres.

While considerable progress has been made in recent years in providing drinking water in urban areas, commensurate advances in sanitation have been, for the most part, missing in much of the developing world. In the past, sanitation has proved to be a poor cousin to water supply. Thus, it is not surprising that the Millennium Development Goals considered water supply but not sanitation. Consequently, the major water problem that developing countries are likely to face in the coming decades is not likely to be physical water scarcity, although it will not be an easy problem to solve, but continued deterioration of water quality. Water sources within and near major urban centres of the developing world, from Dhaka to Mexico City, are already heavily contaminated. In the absence of adequate water quality management practices and the absence of political will, the local situations are deteriorating steadily. Herein is likely to be the future water crisis of the developing world.

While continuing urbanization poses a major challenge in terms of provision of water supply and sanitation services, the importance and the contributions of such urban centres towards the development of stronger and more stable national economies should not be underestimated. It has been estimated that the urban areas of the developing world, which contained about 47.2% of the total population in 2000, contribute nearly two-thirds of their total Gross National Products, and also play an equally important prominent role in terms of social development and cultural enhancement. Accordingly, the urbanization process presents both challenges as well as opportunities. The main issue is how to manage the urbanization process properly for all its inhabitants.

A main problem for the major urban centres thus stems from the fact that the rates of urbanization have generally far exceeded the capacities of the national and the local governments to soundly plan and manage the demographic transition processes efficiently, equitably and sustainably. Provision and maintenance of the needed infrastructural development, services and employment are critical. The accelerating urban growth rates have generally overwhelmed the limited management capacities and resources of the governments at all levels. Unquestionably, unplanned and poorly managed urbanization processes have been an important source of social and environmental stress in all developing countries. The impacts of this poorly managed process have manifested in extensive air, water, land and noise pollution, which have, and will continue to have, major impacts on human health and welfare of the urban dwellers of the developing world for many years to come. The problem has been further compounded by increasingly skewed income distribution which is continuing to worsen with time, high rates of unemployment and under-employment, corruption at all levels, and high crime rates.

The two major problems faced by the major urban centres have further intensified an already difficult and complex situation. First is the sudden fast rate of vertical growth, often after decades, or even centuries, of primarily horizontal expansion, especially in the central business areas. This contributed to a sudden surge in population densities of these areas, with concomitant high water requirements and generation high waste loads per unit area. The existing water supply and sanitation services and the poor planning and management capabilities of the concerned authorities have mostly been unable to cope successfully with such almost instantaneous growths in higher demands in water and sanitation services in such areas.

Second, the overall water-related problem of the large urban centre is further compounded by the presence of informal and squatter settlements. Such settlements may

account for 30–60% of the total urban population. For example, it is estimated that approximately half of Mumbai's population lives in such squatter areas. These areas are highly congested, leaving very little, or no space, for the provision of an in-house water supply and/or public sanitation facilities. As more and more poor people from rural areas migrate to urban centres, areas and densities of such squatter settlements often increase regularly.

The situation is further compounded by the fact that nearly all levels of governments have generally given a lower priority to informal settlements in terms of developments. Areas where rich and important people live receive higher priority in terms of budgets. In addition, urban planners often believe that adequate cost recovery for the provision of services to such settlements are not possible, since they are inhabited by poor, or very poor, people and/or the cities do not have adequate resources to provide highly subsidized water and sanitation services to these settlements on a long-term, reliable basis. Accordingly, informal settlements are often neglected, or receive lower priority in terms of management time, allocation of resources, and thus services, compared to rich and middle-class areas. Furthermore, the population of these informal settlements often grows steadily due to the continuing influx of rural migrants, searching for better economic conditions, and thus quality of life. Accordingly, whatever limited services are available in the informal settlements become overwhelmed with the arrival of the new migrants. The limited water supply and sanitation services that may be available become progressively less and less adequate for serving an ever-increasing population. This contributes to progressive reduction of services available that were inadequate to start with, and this deterioration, in turn, further increases the environmental and health conditions of the people living in such areas.

There are some signs that these situations have started to change. The work of activist NGOs are bringing the plights of the poor people in the squatter settlements to the attention of national and international organizations and the media. This has increased the awareness of the problem, and has started to improve the overall water and sanitation conditions in informal settlements in many developing countries. In addition, private sector concessions in several urban centres now specifically stipulate performance indicators, which they must meet in terms of access to water supply and sanitation in such areas, as well as stormwater disposal. All these new developments have started to improve the existing situations, but much remains to be done.

Constraints to Urban Water Availability

The provision of clean drinking water to the rapidly growing urban centres of the developing world and safe disposal of wastewater faces numerous constraints, which are complex and interrelated. Only a very few resolutions or declarations of various international fora (the United Nations General Assembly resolution on the International Water Supply and Sanitation Decade is an exception), have had any visible and perceptible impacts. Even for the Decade, it was evident during the 1970s that its goals, however laudable, would be impossible to achieve unless major structural changes were made in terms of resource allocation to the sector, both nationally and internationally. Not surprisingly, not only were the goals not met, but also fell considerably short. However, the Decade did manage to put water supply and sanitation issues higher up in the political agendas of many governments of developing countries and external support agencies, especially towards the beginning and end of this period.

Unfortunately, no serious evaluation was carried out as to what were the actual impacts of the Decade *per se*. Accordingly, the lessons that could have been learnt, both positive and negative, from the Decade experiences are unknown at present. For example, would the global situation have been different had there been no Decade? If so, how would it have been different, by how much, and why? What were the regional variations in terms of achieving the goals of the Decade, and why? Anecdotal evidence indicates that developing countries concerned and many external support agencies were already becoming aware of the importance of water supply and sanitation issues by the early 1970s, and that part of the developments that have occurred since 1980 probably would have occurred even without the Decade. However, the Decade provided a strong focus for water supply and sanitation issues, and some countries took advantage of this fact to accelerate their programme of activities in this area. Thus, overall, the Decade probably contributed to an improvement in access to water supply and sanitation services, perhaps significantly, which otherwise may not have occurred.

There are numerous major constraints that have to be overcome simultaneously before full access to water supply and sanitation services can be assured in major urban centres of the world. Overcoming these constraints will not be an easy task, nor is it likely to be achieved universally within the next decade, irrespective of the Millennium Development Goals. However, the future is not completely bleak, and there are many positive and encouraging signs. For example, in the coming decades, as the population growth rates in developing countries continue to decline, gradually they will have to run less and less fast to stay at the same place. As various developing countries approach a stationary population, they are likely to be in somewhat better positions to be able to provide clean water and sanitation services to all their citizens on a reliable and sustainable basis. Population stabilization will mean that they will not have to continually chase a moving target, as is the case at present. However, these developments are likely to be noticeable in about one generation, and not in the immediate future.

Some of the major constraints to achieve the ambitious goal of providing clean water and sewage services to the large urban centres of the world will be briefly discussed herein.

Water Scarcity

Water scarcity presents both a challenge and an opportunity in terms of urban water supply and sanitation. It is a challenge because new sources of water which could be developed cost-effectively for major urban areas of the developing world, are mostly not available. From Istanbul to Johannesburg, and Jakarta to Mexico City, there are simply no new sources of water that could be harnessed economically and in a socially and environmentally-acceptable manner which can quench the continually increasing urban-industrial thirst.

Since the existing sources of water that could be developed cost-effectively have already been developed, or are in the process of development, and water that has been harnessed has already been fully allocated (in fact, in many cases over-allocated), an additional supply of drinking water can only be obtained by transferring water which is currently being used by other sectors, especially agriculture. National policies, explicitly or implicitly, give the highest priority to the domestic sector amongst all the uses. However, socially and politically, it would not be an easy task to transfer water from the agricultural to the domestic sector. Some such transfers can already be noted. However,

these transfers generally did not occur because of deliberate policy decisions: they occurred as an indirect result of other policy decisions.

A good example is the case of water availability in Chennai (formerly Madras) in India. In order to improve water use efficiencies in the agricultural sector, it was decided to line the irrigation canals. A direct result of this policy was a *de facto* transfer of water from the agricultural to the urban sector. Farmers who used the seepage water from the unlined canals to grow crops suddenly discovered their livelihood was gone. Most of them were forced to migrate to the city to seek alternative ways of survival, and thus adding to the squatter population of Chennai. Such practices are exacerbating the conflicts between agricultural and urban water users around many major cities all over the developing world, ranging from Manila to Mexico City. These conflicts are likely to increase significantly in the future, both in terms of their intensities as well as their geographical distributions, as various interest groups clamour for more and more water and supply becomes restricted.

Urbanization also brings opportunities. Urban centres may be important users of water, but such use takes place within a limited geographical area. Since domestic use does not contribute to actual consumption of water, all the water that is being supplied to the households can be recaptured as wastewater through sewage networks. If this wastewater can then be properly treated, it could then serve as a 'new' source of water, as is currently the case for Singapore. While treated wastewater may be restricted to specific types of water uses due to quality considerations and cultural reasons, it can be used for agricultural, industrial and commercial purposes, thereby releasing higher quality water for those uses that warrant it. Furthermore, the marginal cost of providing additional good quality water of the same volume as the treated wastewater would generally be much higher, and the time required to obtain a similar quantity of additional good quality water from a new source would be much longer.

Wastewater is produced in urban areas, irrespective of whether it is used or not. Equally, it is essential that wastewater be treated adequately in order to reduce environmental and health hazards for the people living in and around the urban areas. At present existing unsatisfactory wastewater disposal practices can be observed in the urban areas of most developing countries.

Thus, increasing water scarcity could at least in one sense be considered to be an opportunity that could encourage urban areas to collect and treat wastewater properly so that it could be subsequently used as a 'new' source to alleviate water scarcity.

High Economic Costs

Economic factors are becoming an increasingly important consideration for the provision of a water supply and sanitation to the urban areas of developing countries.

For much of the developing world, for the most part, all the easily exploitable sources of water have already been developed, or are currently in the process of development. This means that the water sources that are yet to be developed are geographically, technologically and environmentally, more complex to handle. Accordingly, the costs of harnessing and bringing this new water to the urban areas are becoming very high in real terms, especially compared to the cost of the earlier, or even the present, generation of water projects. For example, the average cost of providing storage for each cubic metre of river flow in Japan has increased nearly fourfold during the past 15 years. Approximately 20–30% of this additional cost can be attributed to the new social and

environmental requirements which were not considered earlier. The major part of the additional cost is due to the fact that the new projects are inherently more complex to construct techno-economically, and are often located in more inhospitable terrains. Therefore, the construction costs of these new projects are significantly higher when compared with already completed projects, or those under construction.

The situation is not much better either with the treatment of wastewater. Most of the wastewaters produced in the urban areas of developing countries are either not treated at all, or receive inadequate treatment. Many governments, ranging from Egypt to Mexico, have often legislated high water quality standards because of internal and/or external political reasons, and faulty and incomplete appreciation of the problem. No consideration is generally given to the fact that the standards that are appropriate and can be implemented for cities such as London or New York may be irrelevant, impossible to implement and often may even be counterproductive for Lima or Yaounde. Equally, no serious analyses are generally carried out as to whether the standards adopted are essential for health reasons, or whether the countries concerned have the necessary financial resources, management capabilities and legal enforcement capacities to implement the stipulated standards. Not surprisingly, promulgation of such inappropriate standards generally have not even helped in maintaining, let alone improving, the quality of effluent discharged to water bodies in and around urban centres. Proper water quality management will undoubtedly be one of the major water problems of the future.

Financing and Management Constraints

Availability of adequate funds and release of the funds in a timely manner to operate and maintain existing water and wastewater facilities in the urban centres of the developing world is a major constraint at present. Water utilities in developing countries are predominantly in the public sector, although private sector involvement is being considered in one form or another in some parts of the world. The operation and maintenance of existing water supply and wastewater treatment systems, as well as the construction of new systems, are often constrained by lack of funds.

The economic situation is further compounded by inadequate pricing and inefficient billing and bill collection systems in most utilities of major urban centres. While this situation has improved very significantly in some countries like Sri Lanka (Biswas *et al.*, 2005) and Morocco, the situation has remained very similar in many major cities of Asia, Africa and Latin America. A review of the Asian urban cities indicates the following (ADB, 2003 and personal observations) shortcomings:

- Less than 50% of the connections are metered properly. Currently, major cities such as Kolkata have no metering, and many cities have very little metering. Regular monitoring and replacement of faulty meters are exceptions rather than norms. In practical terms, metering has become irrelevant since the cost of reading and maintaining meters, and billing in a city is often significantly higher than the total amount collected from the consumers.
- Monthly household water bills in many major cities such as Beijing, Tianjin, Hanoi, Mumbai and Tashkent are less than \$1.00. In contrast, the average monthly bills for well-managed utilities such as those in Hong Kong or Singapore are significantly higher. Very low monthly bills encourage extravagant

consumption and high wastage rates. Electricity to water bill ratios average 18.5 for Faisalabad, 12.7 for Karachi, 9.2 for Tashkent, 7.8 for Kathmandu and 7.7 for Delhi. These ratios, whenever they are over 4, generally indicate low water tariffs and poor management practices.

- The financial management of many utilities leaves much to be desired. For example, accounts receivable should be less than the equivalent of 3 months of sale. However, it is nearly 20 months for Mumbai, 17 months for Karachi and around 11 months for Dhaka and Shanghai.
- The utilities have different concepts of what constitutes operation and management expenses. Many normal operation and maintenance expenditures are often left for rectification by new investment projects. Such expenditures include replacement of pipes, valves, water meters, service vehicles and reduction of unaccounted waters. Thus, major investments are made in constructing new systems, which are subsequently not properly maintained. This steadily increases system inefficiencies due to continuing deterioration. Accordingly, new investment projects have to be conceived to rehabilitate the badly managed systems. The process contributes not only to inefficient use of capital but also the system efficiencies start to decline steadily from the inception because of poor operation and maintenance practices. During the entire process, the customers of the water utilities receive a poor and unsatisfactory service, consistent with low water and sanitation charges.
- Utilities are often overstaffed, and for the most part the staff available are not properly trained and are inefficiently used. This generally contributes to inefficiency and low financial return. For example, staff per 1000 connections is around 2 for a well-managed utility like Singapore, but very high for Tianjin (49.9), Mumbai (33.3), Beijing (27.2) and Chennai (25.9). The high ratios indicate poor efficiency and management practices. Low staff ratios could, in a few cases, indicate that many services are being contracted out to the private sector.

Management Constraints

One of the major reasons for the poor performance and/or efficiencies of water utilities is their poor management. The main reasons for the poor management stems from two factors: unattractive salaries and regular political interference in management practices and decision-making processes of the water utilities.

In many urban areas, the management remuneration rates are determined by the government salaries, since the utilities are in the public sector, and thus follow public service rules. Since private sector salaries are much higher than their public sector counterparts, bright and competent managers generally tend to gravitate towards private sector enterprises, where, in addition, there is also much less day-to-day interference from the politicians, and thus better job satisfaction rates. It must be appreciated by the politicians that multi-million dollar water and wastewater utilities cannot be managed efficiently by unqualified and inexperienced managers, with continual political interference, ranging from the recruitment of staff to how resources are allocated.

Analyses of compensation packages of water managers in the Asian developing countries show very wide variances. For some utilities, the annual salaries are less than \$1000, but in a few countries it could be as high as \$100 000. Not surprisingly, the well-

managed urban utilities of Hong Kong, Singapore, Taipei and Kuala Lumpur pay high salaries, and consequently they tend to attract and retain good managers and accountants.

The more efficient utilities also give their managers more financial autonomy and authority to make prompt and efficient management decisions. For example, the Metropolitan Waterworks Authority of Bangkok has the financial autonomy to raise investment funds in the local bond market. Its overall performance is good, and hence the general public subscribes to its bonds. Similarly, the Public Utilities Board of Singapore has considerable autonomy in staffing, finance and procurement of goods and services. It also has a clearly enunciated tariff policy, which although high, is acceptable to the people and politicians as a whole. Thus, its policies can be implemented efficiently, without any political interference.

In contrast, the situation in Mexico is very different. The head of a water utility is a political patronage position. The head is appointed primarily because of his/her political connections to the party and the existing political structure, and not because of professional and management expertise (Rodriguez & O'Neal, 2006). The entire top management structure of the water utility changes with each new Mayor, thus preventing the formulation and implementation of any long-term coherent policy and plans. The average stay of a utility manager in Mexico is only two years. The absence of a firewall between electoral politics and utility management invariably contributes to serious management deficiencies.

Another issue is the extensive use of public taps in certain major urban centres. It is a good indicator of poor management practices. The water utilities that are better managed in Asia, such as those in Bangkok, Kuala Lumpur or Singapore, do not have public taps, because they already have 100% coverage. Public taps often indicate lower levels of service, as well as higher water wastages. In addition, utilities cannot recover revenue from such taps, and city authorities are reluctant to subsidize them directly from city taxes.

Environmental and Health Issues

Water quality and health are major factors that must be considered for efficient urban water and wastewater management.

In a vast majority of the urban centres of the developing world, drinking water directly from city supply systems entails considerable health risks. Thus, not surprisingly, people often boil the tap waters prior to drinking. In addition, sales of water filters and bottled water have increased, and continue to increase in recent years. For example, the sale of bottled water in all urban centres of the developing world has increased exponentially during the past decade. This explosion in demand for bottled water is now a common phenomenon in all developing countries, ranging from Brazil to India and Dhaka to Mexico. This demand stems from only one factor, that is, the intense fear of the consumers, often justified, that the water supplied by the public utilities is not of good quality, and thus drinking it may entail significant health risks.

Ironically, even though consumers have taken to drinking bottled water in ever increasing quantities, the quality of water bottled often leaves much to be desired. Absence of legal standards, and/or lack of mechanisms for enforcing whatever legal standards that exist, mean that quality control is left almost exclusively to the bottlers. Combined with the poor quality control practices of the bottlers, it means that in many cases the consumers are not getting safe bottled water for drinking which they are paying. The general

perception is that the quality and taste of bottled water is invariably better than tap water, which is not always true.

In many developing countries, quality standards do exist for bottled drinking water, but adherence to the standards is purely voluntary. Equally, since there are no specific regulatory requirements for establishing a bottled water plant, anyone who wishes to construct one can do so without indicating the source of water, technology used to purify it and the final quality of water bottled. Absence of regular, or any, monitoring by the competent authorities further gives the bottlers a free hand. Accordingly, the quality of bottled water is basically unknown in most developing countries.

Concluding Remarks

On the basis of the above analysis, it is evident that the provision of clean water, sanitation and disposal of stormwater to all the residents of the large urban centres of developing countries will be one of the major challenges of the 21st century, the magnitude and the complexity of which no earlier generation has had to face. Regular rhetoric at various international fora will not resolve this difficult and complex problem. The world at present has really two choices: to carry on as before with a 'business as usual' attitude which can only contribute to incremental changes that would endow the current and the future generations with a legacy of inadequate water supply and sewage services, or continue in earnest an accelerated effort to change radically the mind-sets of the decision-makers and the water managers so that the people in urban centres have access to safe drinking water and sanitation facilities within one generation. It would not be an easy task to accomplish, but given adequate political will and efficient management, it can be achieved. One is reminded of the warning of William Shakespeare that "men at some time are masters of their fates. The fault dear friends is not in our stars but in ourselves that we are underlings".

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