Water Resources Development,
Vol. 24, No. 1, 145–176, March 2008

Routledge
Taylor & Francis Group

ASIAN WATER DEVELOPMENT OUTLOOK, 2007

Achieving Water Security for Asia

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ABSTRACT *Sponsored by the Asian Development Bank, Asian Water Development Outlook is a future-oriented analysis of water security for the Asian countries. The future water problems of the Asian countries and their solutions will be very different compared to those of the past. While historical knowledge will be useful, solving water problems of the future will require additional skills, innovative approaches and new mindsets. It will also require a determined attempt to coordinate energy, food, environment and industrial policies of a nation, all of which have intimate linkages to water. Each will affect the other, and, in turn, be affected by the others. Policies in all these areas will be also influenced by exogenous forces such as demographic transitions, advances in technology and information and communication systems, climatic change, globalization, free trade and increasing social activism. All these and other associated developments will mean that water management in Asia will change more during the next 20 years than in the past 2000 years.*

In-depth analyses prepared for the Outlook indicate that the Asian countries are not facing a water crisis because of physical scarcities of the resource, but because of poor management. With the knowledge, technology and experience that are now available within the Asian region as a whole, the water problems of all the Asian countries can be solved. Given adequate capacity development, intensified political will, and appropriate investments, one can be cautiously optimistic of Asia's water future.

Introduction

The Asian Water Development Outlook is the first attempt by the Asian Development Bank (ADB) to make a forward-looking assessment of the possible water future for the most populous region of the world. It is now increasingly being recognized that water is likely to be a major critical resource issue of the world, and that the social, economic and environmental future of Asia is likely to depend on how efficiently and equitably this resource will be managed in the coming years.

The Outlook is aimed at Asian policy makers and those interested in understanding the complexities and dimensions of the current and the future water problems, and how these can be addressed successfully in policy terms. Its main objective is to raise awareness of water-related issues and to stimulate an informed debate on how best to manage Asia's water future. These are important and complex issues, and their timely management can contribute to the achievement of all the water-associated Millennium Development Goals and beyond.

This report brings together a wide range of water-related issues, problems, and challenges from a future-oriented, multidisciplinary, and multi-sectoral perspective from around the Asia and Pacific region. It highlights important topics that have been neglected or are being inadequately considered in most countries of the region. Among these is the urgent need to address the inherent

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0790-0627 Print/1360-0648 Online/08/010145-32 © 2008 Taylor & Francis
DOI: 10.1080/07900620701760556

interrelationships between the water and other important development-related sectors, such as energy, food and the environment. The future of the Asian countries will be determined not by developments in any one of these sectors, but rather in the interactions between all of them. Developments in all of these sectors will affect water, and, in turn, water developments will affect all these sectors. The accelerating change in demographics, for example, rural-urban migration and an increasing elderly population, is another unexplored area with major implications for water management. The importance of South-South knowledge and experience transfer in an Asian context through the identification and objective analyses of good practices is emphasized.

The report is cautiously optimistic on Asia's water future. It points out that with existing knowledge, experience and technology, the water problems of the Asian developing countries are solvable. The main constraint is not physical scarcity of water, although this could be an issue in some areas, but inappropriate management practices.

The Outlook, which is expected to be the first of a series of analyses on the future water situation of Asia, focuses on urban water and wastewater management. It notes that the status of provision of clean and drinkable water continues to be a serious concern in many Asian urban centres. Of even greater future concern are inadequate wastewater management practices—the collection, proper treatment and safe disposal of wastewater. As a result of this neglect, water bodies in and around urban centres are often seriously contaminated, affecting the health of both people and ecosystems. However, to improve the situation, there must be reliable data on physical as well as social, economic and environmental factors, currently lacking in many countries, on which to base sound policies. Solving urban drinkable water and wastewater problems will require strong political will, accelerating demand from the civil society to solve these problems, adequate financial and managerial support and intensive capacity-building efforts at all levels.

The report is an independent analysis commissioned by ADB, and is the result of a collaborative effort by a team of eminent experts led by Prof. Asit K. Biswas, and ably supported by Mr. Geoffrey Bridges, Mr. Arthur McIntosh, Prof. Bhanoji Rao, Prof. Olli Varis and Dr. Geoffrey Wright, with support from ADB staff. We hope that, as a result of this combined and systematic effort, the water problems of the future, including urban water and wastewater management, will receive accelerated attention from policy makers and civil society, and lead to their timely and cost-effective resolution.

ADB's commitment to the sector is shown in our Water Financing Programme 2006–10, in which investments in water are expected to double and be directed toward reforms and capacity development programmes in rural communities, cities and river basins; and in the associated new Water Financing Partnership Facility to mobilize co-financing and investments from development partners. We encourage other partners to join us in this crucial endeavour.

Ursula Schaefer-Preuss
Vice President for Knowledge Management
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The Changing Water Management Landscape in Asia

According to Leonardo da Vinci, water is the driver of nature. It could have been considered to be an overstatement in the 16th century during his lifetime, but nearly half a millennium later, Leonardo's view on water can be considered prophetic. It is increasingly being realized that water is the lifeblood of the planet and it is certainly not an overstatement to claim that without rational water development and its efficient management, the future social and economic development of Asian developing countries will be seriously constrained or even jeopardized. The eminent economist and Prime Minister of India, Man Mohan Singh, has noted that if India's current economic growth rate is to be maintained and if all the people of the country, especially the poor and the vulnerable, are to share the benefits of rapid economic growth, two resource issues need priority consideration: energy and water. The Prime Minister further noted that if

these two issues can be properly addressed, and if all the members of the society can have adequate access to energy and water, many of the existing societal problems can be resolved.

It has been well known for millennia that human survival and ecosystem conservation depend on the reliable availability of adequate water of appropriate quality. It is equally well known from prehistoric times that food and agricultural production requires water. As the human population grew, the food requirement increased as well, and with it water demands for producing the necessary food. The water-food interrelationships have always been important, but in recent years, these linkages have become more and more complex because of social and environmental concerns, technological developments, globalization and management practices.

With the advent of the industrial revolution, the situation changed dramatically. The industrial requirements for water started to increase very significantly, as did the need for the collection, treatment and safe disposal of wastewater. In quantitative terms, the industrial water needs of many Asian countries have now exceeded domestic needs and are increasing at a much faster pace, especially as industrialization often has had to start from historically low bases.

Environmental issues for water management became important during the 1970s, not only in Asia but also the rest of the world. Increasingly, all development activities, including those on water, had to consider environmental implications seriously and comprehensively. These considerations received considerable momentum during the 1980s, and are now universally accepted as an integral requirement for efficient and rational water management.

With rapid industrialization and demands for a better quality of life, energy requirements have also risen. In recent years, the energy needs of Asian developing countries are increasing very rapidly and are likely to continue to do so for the foreseeable future. This comparatively recent development has major water-related implications, which for the most part have been ignored by both water and energy professionals and policy makers.

Water and Food

Water is essential for food production. As the Asian population grows in the coming decades, more and more crop production will be needed for human and animal consumption. Equally, as Asian countries continue to make economic progress, an increasing number of people will become affluent; thus, many are likely to change their dietary patterns and eat more protein, such as in meat and milk. This will further increase water requirements because animal husbandry requires more water than crop production.

However, this does not mean that water demands for producing this additional food requirement will increase concomitantly. This is because there is no one-to-one relationship between water requirement and food production. Crop yields can be increased in different ways, including more efficient use of fertilizers and pesticides, better quality seeds and improved management practices. In addition, the food produced should not be the only consideration. In reality, it is the food that is available to consumers that counts. Regrettably, in many Asian countries, 25–50% of crops, fruits and vegetables produced at present are not consumed because of heavy losses at every stage of production, transportation, distribution and storage. A reduction of these losses alone would increase food availability greatly, without any reference to water. Accordingly, there are many factors that affect the total food availability to consumers, and water is not necessarily the most important factor. These issues have complex interrelationships and are often location specific. Thus, it is often

dangerous, and mostly misleading, to draw generalized conclusions about the quantity of additional water that may be needed to increase the availability of food to consumers in Asian countries, without additional comprehensive studies.

Agriculture is by far the major user of water in Asia. In many Asian countries, agricultural water use accounts for nearly 90% of total water use. However, this percentage has been declining steadily in recent years in Asia as a whole, as in the rest of the world. In contrast, industrial water use has been increasing. Nevertheless, in absolute quantitative terms, agricultural water uses in most Asian countries have been increasing.

A major problem with agricultural water use has been that many Asian countries have been pursuing incorrect policies in terms of water and energy used for groundwater pumping. At present, farmers in some sub-regions do not pay for the actual volume of groundwater pumped for irrigation. In addition, energy costs for pumping are very heavily subsidized by many governments. Accordingly, farmers often pump more groundwater than is needed for optimizing crop production. This over-pumping is resulting in a steady decline of groundwater levels in many Asian aquifers. As the groundwater levels decline, more energy is needed to pump the same quantity of water. Because the energy costs for farmers are heavily subsidized, the financial losses of many public electricity boards are continuing to escalate. This has contributed to a vicious cycle of overuse of groundwater, declining aquifer levels, increasing losses to the electricity boards and increasing adverse environmental impacts (such as land subsidence), none of which are sustainable on a long-term basis. Thus, major policy changes in the water and energy sectors will be needed in the near future to balance water and energy uses and stabilize the levels of declining groundwater tables.

In the future, these types of intersectoral policies need to be carefully analyzed, formulated and implemented. Equally, the policies in any specific sector have to be coordinated with the policies in associated sectors. The current and past practices of formulating policies in one sector without adequate consideration of and coordination with the policies in the other sectors will become increasingly costly, inefficient and unsustainable. Herein will lie a major future challenge for Asian developing countries: how to integrate appropriately all the concerned resource policies in the areas of water, energy, food and the environment; the legal and regulatory frameworks necessary to support these policies; and the institutions responsible for formulating and implementing these policies. Such integration has been very difficult to accomplish in the past and is likely to be even more complex and difficult in the future. Yet, this will be an important and critical requirement of the future that must now receive accelerated attention from Asian governments, research institutions and academe.

Water and Environment

An increasing social and political concern arose in the 1970s about the impacts of water development and management policies and practices on the environment. Since about 1995, the implications of environmental management policies on water development and management have received increasing attention. During the past 35 years, water and environment policies have affected each other in many significant ways, sometimes positively, but at other times adversely. These interacting impacts—in terms of their distribution in time and space and in scale—are mostly site specific.

During the early part of the global environmental movement, the primary focus was on how to stop all types of pollution. For example, during the United Nations Conference on

the Human Environment, held in Stockholm in 1972, the main water-related concerns considered were preventing water pollution and impacts of acid rain on forests and lakes. Shortly after, there was a backlash from some sectors of society on all types of large infrastructure development projects. This was especially relevant for large dams and irrigation projects. In this 'small is beautiful' era, all large development projects attracted considerable criticism, some of which was justified but some was unrealistic.

During the 1980s and 1990s, large water development projects all over the world, and especially in Asia, came under considerable criticism from social and environmental activists and the non-government organization (NGO) movement. This movement probably reached its peak with controversies associated with the construction of some large dams—the Sardar Sarovar and the Tehri dams in India, and Arun II Dam in Nepal—and the Nagara Barrage (to prevent saltwater intrusion) in Japan. These controversies had both positive and negative impacts on future water development activities.

On the positive side, many social and environmental considerations that were not properly addressed earlier started to receive accelerated attention. Environmental and social impact analyses became the norm, rather than exception. Issues such as involuntary resettlements and adverse environmental and ecosystem impacts due to large infrastructure development projects, became important concerns. Indeed, the pressure from certain sectors of society was such that these shortcomings not only received considerable attention, but planners and policy makers were forced to respond to them promptly and adequately. Consequently, many undesirable or even unanticipated aspects of the development activities were properly considered and appropriate ameliorative actions were often taken. This probably would not have happened, at least within the observed time scales, without concerted opposition from certain sectors of society.

The negative consequences of these controversies have been that many water infrastructure development projects that should have been constructed for poverty reduction, employment generation and raising the living standards of the people made little headway. Several funding agencies stayed away from supporting these projects because of the controversies surrounding them, which consistently received considerable national and international media attention. For some unexplained reasons, water projects created more controversies than other types of development activities.

The situation has started to improve in recent years, especially during the present, post-2000, period, when it is being increasingly realized that infrastructure development must receive priority attention in all Asian developing countries. Equally, however, these structures need to be planned and managed in such a way that they are technically feasible, economically efficient, socially acceptable and environmentally friendly. As societal perceptions have changed and the knowledge base to plan and manage water infrastructure has improved, it is now possible to improve the earlier practices significantly by maximizing the positive economic, social and environmental impacts, minimizing the negative impacts, and ensuring that the people who are likely to pay the costs of the projects (i.e. those in involuntary resettlement) are explicitly made their direct beneficiaries. With this changing mindset and better understanding and appreciation of environment-development linkages, it is probable that the overall discussion of water development and environmental issues will become more objective and less polarizing in the future.

While this aspect of large water developments and their environmental implications has received considerable attention from the media and policy makers, another environmental issue has received somewhat benign neglect: increasing water contamination from point

and non-point sources because of accelerating domestic, industrial and agricultural activities. The provision of clean water supply has received considerable attention from policy makers in Asian developing countries, but commensurate interest in wastewater collection, treatment and disposal has often been conspicuous by its relative absence. Regrettably, there are only limited signs that this attitude is starting to change.

However, increasing water pollution is a major issue for nearly all Asian developing countries. Unless the present perceptions and attitudes change radically, it is likely to be a critical water problem in the future. This is because at the domestic level, nearly all water that enters the household is eventually discharged as wastewater. Even in many urban centres where wastewater is collected through sewer systems, it is often discharged to freshwater bodies, land or oceans with only limited, or even no, treatment. This means that the problem of increasing wastewater contamination is not being solved: it is being simply transferred from one location to another. The philosophy has been somewhat akin to 'out of sight, out of mind'.

The situation is becoming even more serious and complex with industrial wastewater discharges, which also, for the most part, receive inadequate treatment in nearly all Asian developing countries. Few Asian urban centres have functional secondary and tertiary waste treatment plants. Many primary waste treatment plants are non-functional for significant periods of time because of poor design, inadequate management and political interest, public apathy and similar causes. Even when these plants function, most operate below their design efficiencies. The domestic wastes are primarily organic, and as a result they degrade over a limited time. However, the situation is more complex and serious for industrial wastes, which contain significant amounts of conservative elements that may be toxic to human beings and ecosystems, and are not easily biodegradable.

With fast industrial and urban growth, environmentally-sound wastewater disposal in all Asian developing countries is rapidly becoming a serious social and human health issue. In addition, as the nearby surface water and groundwater sources for urban centres are being increasingly contaminated with domestic and industrial wastes, these sources will require higher levels of treatment before they can be used safely as potable water. The treatment processes needed to decontaminate polluted sources are likely to become increasingly sophisticated and expensive, which may not be an attractive or feasible alternative for many urban areas because of economic and technology management constraints in the coming decades.

Because wastewater management is often viewed, at least in terms of practice, primarily as collection and then disposal in nearby rivers, lakes and oceans, water bodies within and around urban centres are already highly contaminated. Land disposal of wastewater is also contaminating groundwater, which is often an important source of drinking water.

These assessments refer only to point sources of contamination from domestic and industrial users: non-point sources are not covered. Because the use of agricultural chemicals in many Asian developing countries is still somewhat limited, non-point sources of pollution are still not as serious as point sources. However, as there is increasing emphasis to increase crop production per unit area to enhance both farmers' incomes and food security, more and more agricultural chemicals are likely to be used in the future. This will further aggravate the water quality situation, because control and management of non-point sources of pollution are very complex and difficult tasks, as even the most developed countries like Japan and the United States have experienced.

Thus, in a macro sense, a major challenge facing Asian developing countries is how quickly and how efficiently current wastewater management practices and processes can

be substantially improved. Considering the cost of construction and efficient operation of wastewater management systems, and the number of trained and experienced personnel needed to manage them—ranging from managers to plant operators and technicians, who are mostly not available at present—the resolution of this problem in the foreseeable future will be a Herculean task.

Another macro issue in the water and environment area is likely to stem from the increasing acceptance of the concept of environmental flows. Many countries have now accepted, or are in the process of accepting, that the environment is a legitimate user of water. This means that certain quantities of the flows in rivers have to be earmarked for environmental and ecosystem use.

It is highly probable that in the foreseeable future there will be increasing acceptance of this concept in Asian developing countries. This will present two types of problems, one conceptual and the other practical. At the conceptual level, considerable work needs to be done with regard to how environmental flows of rivers can be reliably estimated for the various Asian countries, with different climatic regimes, physical and ecosystem conditions, and other associated requirements. How can such flows be reliably estimated for both perennial and ephemeral rivers? Considerable progress has been made on estimating environmental flows in recent years, but much work remains before the scientific community agrees on a reliable and uncontroversial methodology.

At the practical level, water resources of many of the Asian rivers are already fully allocated and, in some cases, over-allocated, especially during the dry seasons and drought periods. Under such conditions, new allocations of water to the environment will mean that some existing allocations to domestic, industrial and agricultural sectors have to be reduced. Socially and politically, it will not be an easy task to reduce the current allocations to existing users so that this amount can be diverted for environmental use. In addition, for transboundary rivers, as well as interstate rivers in federal countries such as India and Pakistan, this will raise new sets of legal issues, especially when inter- and intra-country treaties already exist for water allocations to various state parties. Considering it often takes 20 years or more to negotiate new water allocation treaties for transboundary and interstate rivers, implementation of the concept of environmental flows will not be an easy process in many Asian locations.

Finally, the impact of the environment, especially through natural disasters, on water and sanitation infrastructure, cannot be forgotten. As much as possible, infrastructure has to be designed to withstand floods, earthquakes and other natural disasters—the 2004 tsunami in Aceh Province, Indonesia, being a good example.

Water and Energy

As the energy needs for Asian countries continue to increase significantly, the water requirements of the energy sector are likely to reach unprecedented levels as well, a fact that has mostly escaped the attention of water and energy planners. Large-scale generation of electricity invariably requires water. Without water, hydropower, an important source of electricity in many Asian countries, cannot be generated. Equally, thermal power generation from coal, oil or natural gas requires major quantities of cooling water. Nuclear power requires even more cooling water. If the current rate of 5–8% in annual increase in electricity consumption is to be maintained in many Asian developing countries for the indefinite future, as is expected at present, water requirements for the energy sector need to

be carefully assessed, and then factored into national water policies. Already, in countries such as France, the major user of water is the electricity-generating industry, not the agricultural sector.

In spite of the burgeoning electricity demands of the electricity-generating industry for water, the growth rates of which are likely to remain at similar levels or even accelerate further in the coming decades, not one Asian developing country has seriously assessed the current and future water requirements of its energy sector. Furthermore, assuming that this water demand has to be met, what are the implications for water allocation to other existing uses, and also in terms of impacts on aquatic ecosystems? There is no question that the water requirements for the energy sector will increase significantly in the future, even if it is assumed that the existing systems for generation and distribution of energy become increasingly efficient in the coming years.

In addition, there is considerable momentum in the production of crops for biofuel. If efficiently produced, biofuel can contribute to improving the energy security of some nations, but this will not come without social and economic costs. It will also have significant implications for many other natural resources, especially land and water, in terms of their availability and use patterns.

Asian biofuel production will require more and more water if this sub-sector expands as expected. As the use of agricultural chemicals such as pesticides and fertilizers increases to improve the yields of the biofuel crops, water bodies around such production systems may witness higher levels of non-point pollution. Accordingly, the production and processing of the biofuel crops are likely to bring with them attendant water quantity and quality implications. As long as these implications are clearly thought through in terms of social, economic and environmental considerations, and appropriate remedial measures are implemented as and when required, the problems may be manageable. However, as of now, virtually no country has carefully analyzed the water, land and social implications of increasing biofuel production, and then made appropriate policy decisions. These are important issues that need to be carefully analyzed by national policy makers in the future to enable them to make coordinated policies in terms of energy, land, water, environment and poverty reduction.

In addition, just as the energy industry requires large quantities of water to function, the water sector is equally an important user of energy for its operation. Energy requirements for pumping are already very significant in nearly all Asian countries. As water and wastewater treatment plants increase exponentially in coming years, the energy needed for their proper operation and maintenance will increase concomitantly. Thus, the water and energy sectors will be even more closely interlinked in the future than they are now. This will require increasing coordination and integration of policies related to the management of these two sectors.

Furthermore, with the reduction in the costs of desalination in recent years, it is becoming an important source for increasing supplies of water. Membrane technology is likely to be increasingly used in the future for wastewater treatment. By using the new generation of membranes and improved management practices, seawater desalination costs have fallen by a factor of three during the past decade. At the current cost of producing desalinated or decontaminated water (approximately US$0.45–0.60 per cubic metre) through reverse osmosis, the technique has become cost-effective for many countries for special situations and conditions (for example, island countries such as Singapore). The cost of purifying brackish water is now even less: US$0.20–0.35 per cubic metre, depending on its salt

content. These recent technological breakthroughs are bringing new alternatives toward solving water quantity and quality problems, but have many other implications, especially in energy and technology management, which need to be carefully assessed before they can be successfully and extensively used on a sustainable basis in Asia.

Thus, it will become increasingly important for planners and policy makers to concurrently consider water and energy policies, especially in terms of their symbiotic relationship: each affects and is affected by the other. This interlinkage is likely to only intensify further in the future. Formulation of policies in either sector that do not consider such interlinkages and interrelationships are likely to become increasingly counter-productive, especially in social, economic and environmental terms.

The rapidly changing landscape in Asia means that water management practices and processes are now faced with complex and intersectoral challenges from other resource and development sectors, the types of which have been seldom faced in the entire human history. Meeting these challenges successfully and in a timely manner will require new and innovative approaches and solutions. Past experiences and present practices are no longer enough.

Water-related Trends

Unlike in the past, it is no longer enough to consider only the current water trends to ensure efficient water management in Asia in the future. It will be increasingly essential to identify the present and probable future trends in other sectors that will significantly affect water management directly or indirectly. This will not be an easy task because much of Asia is undergoing a massive economic and social transformation, which is unleashing forces that often may have significant water implications. Some of these forces are known but are often unquantifiable while others are as yet unknown. In addition, Asian countries are not homogeneous in their social and economic development, or in the different factors that are likely to affect their development processes. Thus, it is not possible to draw a generalized picture of water-related trends in Asia that will be equally applicable all over the region. The issue becomes even more complex when the potential impacts of globalization, free trade, communication and information revolution and concurrent quest for energy, food, environment and water securities are considered. All these will affect the quantity and quality of available water through numerous pathways.

In spite of the differing Asian conditions and situations, a general overview can be considered for several overarching transformational forces likely to affect Asian water management practices and processes. Among these transformational forces are demography, climate change and technology, discussed below.

Demographic Transformation

Asia currently accounts for slightly over 60% of the global population, and also for almost two-thirds of global population growth. The Asian population is expected to grow by nearly 500 million within the next 10 years, and virtually all this growth is expected to be in urban areas.

South Asia is among the most densely populated areas of the world and has the highest concentration of poor people in the world. While the population growth rates in countries such as Bangladesh and India have declined, they have not in Nepal and Pakistan.

Southeast Asia is less populated than South Asia, but it also has crowded areas, especially Java, part of the Philippines and deltas of rivers such as the Red, Mekong, Chao Phraya and Irrawaddy. During the 80-year period 1970–2050, the population in this region is estimated to grow three-fold. The corresponding estimate for South Asia is 3.4-fold, and for the People's Republic of China (PRC), two-fold.

Large and growing populations exert increasing pressures on natural resources such as land and water. However, the relationship between human population size and demand for natural resources is not a simple one. Throughout history, social and economic changes and factors, such as technological developments and better management practices, have affected pressures on the natural resource base. This pattern is likely to continue for decades to come.

In the past, population growth has generally been considered to be exogenous to water management. This is not correct. Populations affect water in terms of demand, use patterns and management practices. Similarly, water affects populations directly in terms of health (for example, water-borne diseases affect mortality rates), and indirectly, through such issues as regional development, employment generation and gender-related matters.

In terms of demographic transformations, two issues that are likely to affect water in increasing ways are urbanization and ageing. These issues need special consideration.

Urbanization

Globally, the rural and urban population is now roughly balanced. However, Asia has been behind Latin America in the extent of urbanization. Accordingly, Asian countries are likely to witness a massive urbanization process during the next two to three decades. While it is estimated that the Asian rural population will remain almost stationary between now and 2025, the urban population is likely to increase by 60%. Changes in population densities in South and Southeast Asia and the PRC are shown in Figure 1 for 1970–2050.

Massive urbanization, which is unprecedented in the entire Asian history, will present new types of water-related challenges that all countries will have to face. These challenges may not be similar to those expected at present. They could be of a wholly different character, and some may even be counter-intuitive. For example, considerable attention has been paid in recent years to the water and wastewater problems of the mega cities, defined by the United Nations as having populations of more than 10 million. While Asian mega cities consume the lion's share of national resources and interest, they represented only 3.7% of the global population in 2000. This is expected to increase to about 4.7% by 2015. The percentage of population living in the next category of large cities, between 5 and 10 million, is even less: 2.8% in 2000, and rising to 3.7% by 2015.

In contrast, urban centres of 500 000 or less accounted for 24.8% of the global population in 2000 (nearly seven times that of the mega cities) and this is projected to increase to 27% by 2015; these centres have received scant attention from national and international institutions, and water and development professionals. Yet, the annual average population growth rate for these smaller urban centres is expected to increase from 23.2% during 1975–2000 (comparable growth rate for mega cities was 5%, or less than a quarter) to 28.2% during 2000–15, compared to 7.5% for mega cities. Figure 2 shows that the majority of the cities in Indonesia and India have a maximum population of 500 000 while in the PRC, cities with populations of 500 000 and below are a close second to cities with populations ranging from 500 000 to 1 million. Thus, solving the future water and wastewater problems of these small urban centres will need at least as much attention

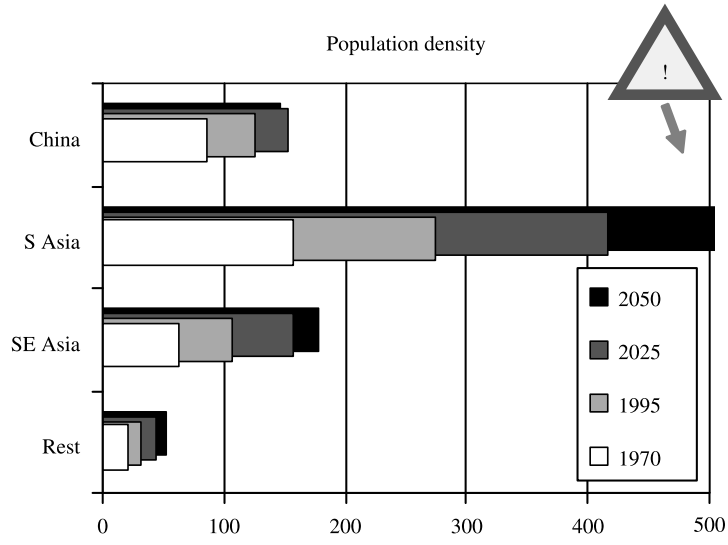

Figure 1. Population density in selected parts of Asia and in the rest of the world (persons per square km)

as the mega cities, if not more. Their water problems are likely to be significantly more difficult to resolve than those of mega cities, because these smaller centres do not have adequate the financial and political power and technical and management capacities to handle their much higher urbanization rates. Even though the number of people involved in smaller centres is 6.7 times that of the mega cities—and their growth rates are expected to be four times those of the mega cities—it is a strange anomaly that these smaller centres are receiving conspicuously less attention from national and international policy makers. Unless the present policy and focus changes radically, these centres are likely to be major water and wastewater 'black-holes' of the future.

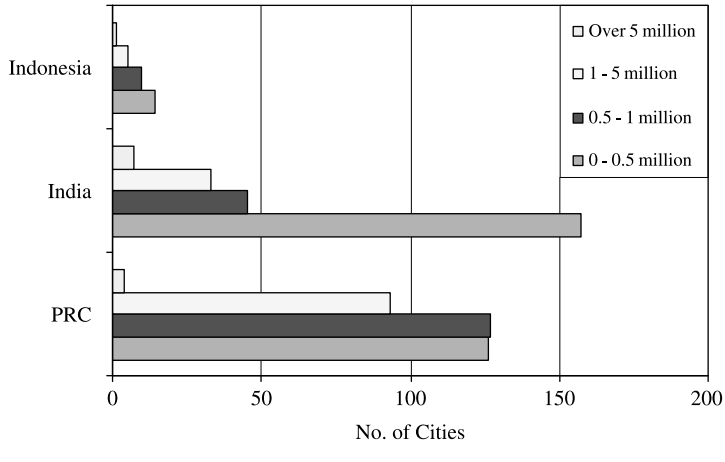

Figure 2. City size for capital cities and urban agglomerations. *Source:* Asian Development Bank and Cities Alliance (2006, chapter 2).

Another issue worth noting is the dissimilarity in the urbanization processes between the mega cities of the developed and developing world. Cities such as London and New York grew progressively over nearly a century. This gradual growth enabled these cities to develop effectively their water and wastewater infrastructure and their management services. In contrast, the growth rates of the Asian mega cities such as Dhaka, Jakarta or Karachi in recent decades have simply been explosive (Figure 3). They have invariably found it very difficult to run faster even to stay in the same place. Most simply have not been able to cope with the explosive growth rates.

To a certain extent, many of these mega cities have managed to provide water to their residents, especially to the reasonably well-maintained residential areas. However, in many cases, the water provided is not drinkable without additional treatment. Furthermore, they have progressively fallen behind in the collection, treatment and environmentally safe disposal of wastewater. Wastewater may be collected from sections of these cities, but often is discharged to nearby rivers, lakes or oceans without any treatment or with only primary treatment. Because of this continuing neglect, water bodies in and around many urban centres of Asian developing countries are now heavily contaminated. This has already resulted in serious environmental and health problems. It is likely that if there will be a water crisis in the future, it will not come because of actual physical scarcity of water, as many predict at present, but because of continuing neglect of proper wastewater management practices. Continuation of the present trend will make

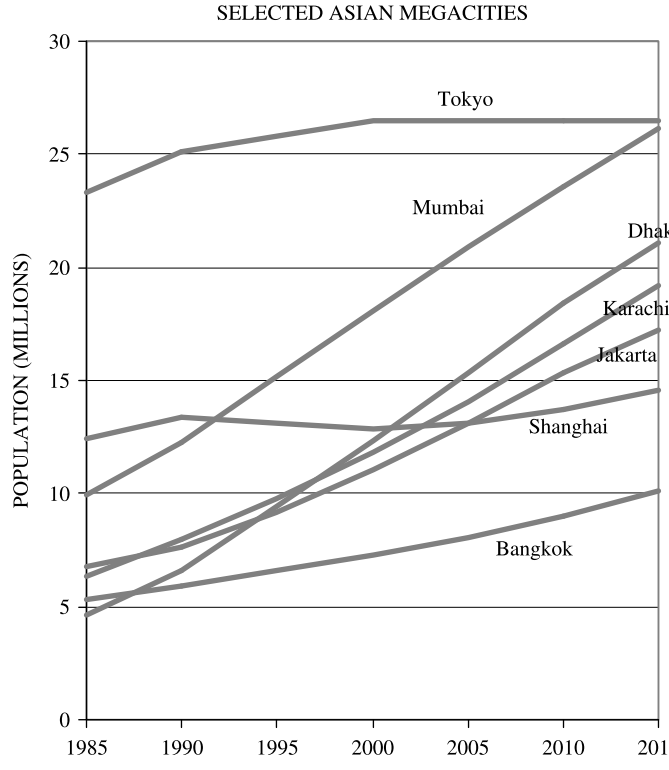

Figure 3. Population increase in selected Asian mega cities

available water sources increasingly more contaminated, and will make provision of clean water increasingly expensive, as well as more complex and difficult to manage.

Another major difference in terms of water management between developed and developing countries is that as the urban centres of the former expanded, their economies were growing as well. Accordingly, it was possible for them to harness financial resources for efficient urban water and wastewater management. For example, Japan could invest heavily in the conservation of urban water infrastructure after 1950 because it was also concurrently experiencing rapid economic growth. Such extensive infrastructure development and major improvements in management practices meant that unaccounted for water in a mega city such as Tokyo could be reduced from an estimated immediate post-war proportion of 90% to about 8% at present, one of the best in the world. Equally, cities such as Tokyo could invest heavily to control urban flooding, which would have been difficult if Japan's economy was not expanding during this period.

In contrast, the rates and extent of urbanization in developing Asia have generally far exceeded the capacities of national and the local governments to plan and manage the demographic transition process soundly, in terms of providing clean water and wastewater management services efficiently, equitably and sustainably. The impacts of this inadequately managed urbanization process are manifested in extensive air, water, land and noise pollution, which is having, and will continue to have, major impacts on human health and quality of life of urban dwellers, as well as imposing major costs on the respective economies.

Another urbanization-related problem is the sudden, fast rate of vertical growth, especially in the central business areas, often after decades, or even centuries, of primarily horizontal expansion. This has invariably contributed to a sudden surge in population densities in these areas, with concomitant high water and energy requirements, as well as the generation of high waste (wastewater and solid wastes) loads per unit area. The urban centres have simply not been able to cope successfully with such near instantaneous accelerating demands for water and wastewater management services. The problem is compounded by the prevailing unsatisfactory water supply and wastewater management services, the absence of long-term planning, inadequate management of technical and administrative capabilities, lack of investment funds and high levels of corruption.

However, there are signs of hope. For example, in the PRC, the importance of providing clean drinking water and proper wastewater management services has started to receive increasing attention. Because the PRC's economy has grown very substantially in recent years, the country can afford to provide good water and wastewater management services to its urban citizens. Tariffs have risen to meet costs, which has even resulted in lowered industrial consumption. Water and wastewater issues have become priority considerations for its national, regional and local policy makers. It is probable that countries such as the PRC will make significant progress in urban water management during the coming decades.

Ageing Population

A major factor that is still not being adequately considered in Asian countries is the implication of an increasingly ageing population on water-related issues. The age structure of the global population, including in Asia, is undergoing rapid changes. For example, the number of elderly people (aged 65 and over) was 131 million in 1950. This increased to 480 million in 2006, and it is estimated that it will reach 1465 million by 2050.

The issue of an increasingly elderly population has yet to receive adequate attention in Asia, except to a certain extent in Japan. However, it is likely to be an important policy issue in nearly all Asian countries during the next three to four decades. At present, countries such as the PRC have a major demographic window of opportunity to restructure their economic development activities during the next two to three decades, with a trained, experienced and energetic workforce. However, after 2010, the number of elderly people will start to increase quite rapidly, so much so that by 2030 the PRC will have more elderly people than the current population of the United States.

An increase in the number of elderly people will be also an important issue for the countries of South Asia (including India) and Southeast Asia. The steady ageing of populations in East (excluding the PRC) and South (excluding India) Asia, and the two most populated Asian countries (PRC and India) are shown in Figure 4. It will be a complex problem for Asian countries to adjust to this increasing elderly population. It will have major social and economic implications, and will affect the water sector through direct and indirect pathways.

The relationship between water management and an increasingly elderly population is completely unexplored territory at present, not only for Asia but also the world as a whole. It is likely that they will affect each other in a variety of ways, a few of which can be discussed in an anecdotal fashion.

First, in the context of rural and semi-urban areas of many Asian developing countries, and in the absence of water and wastewater connections at the household level, people are forced to use communal land and water bodies for hygienic purposes. For elderly people, routine daily hygiene practices become a chore, especially when physical movements become difficult or when they are sick. With improvements in health care, education and

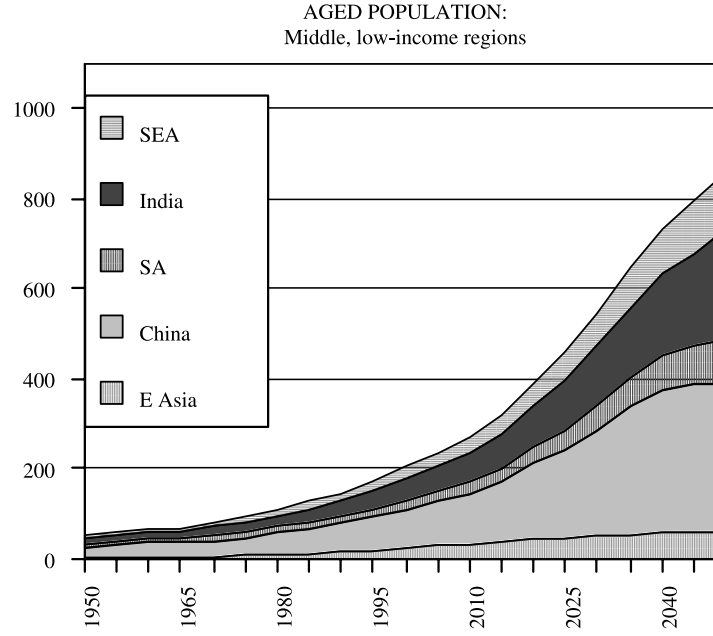

Figure 4. Increasing elderly population in Asia. *Note:* South Asia (SEA) excludes India, and East (E Asia) Asia excludes the PRC.

nutrition, people will be living for increasingly longer periods. An absence of water and wastewater collection facilities at home will pose particular burdens on an increasing elderly population.

Second, as the older generation of people retires from work, considerable knowledge, experience and collective memory will be increasingly lost. In a country such as Japan, many knowledgeable and experienced people will retire from the water sector during the next five to ten years. The overall institutional knowledge and experience levels in the water sector may decline very suddenly, which cannot be readily replaced by younger and new recruits. This has already been identified as a serious issue by the appropriate ministry in Japan.

Third, it is generally the young people who migrate to urban areas in search of better standards of living. Thus, the percentages of young people in the rural areas will continue to decline, with an attendant decline in their economic, social and cultural activities. This will accelerate the breakdown of the extended family systems. Consequently, the family support that was available to the earlier generations of elderly people will continue to decline steadily. This will contribute to increasing social and economic problems in terms of deteriorating lifestyles of the elderly and social stress to their family members who may have migrated to the urban areas.

Finally, virtually no research has been done on the water requirements of the elderly, and their interrelationships with water through various social, economic and cultural pathways. Not a single Asian institution is conducting serious research concerning these new issues, but they need to be studied diligently in the future.

Climate Change

It is now widely accepted that the global climate is changing. This is creating a new level of uncertainty in water planning and management processes because it is difficult to manage water projects efficiently without appropriate information about the possible future distribution of rainfall and temperature patterns over space and time. With the present state of knowledge, it is not possible even to predict with any degree of confidence the annual average changes in rainfall and temperature over a country as a whole, let alone for specific areas considered for planning purposes. Furthermore, for water planning and management, changes in annual average rainfalls and temperatures over a country, or a large region, even if they could be predicted with a considerable degree of confidence, are likely to be of very limited use. Unfortunately, it is still not possible to predict even such macro changes in the climate parameters for the future.

What is needed for efficiency and long-term water management is not annual average climatic information, but the extent of probable inter-annual and intra-annual variations. It is simply not possible to forecast these with the present state of knowledge.

This, of course, is a global problem, and not strictly related to Asia. However, the problem is even more complex for the Asian monsoon countries, where most of the annual rainfall occurs within 60–100 hours, although these durations are not consecutive. It will be a very difficult task to predict how the rainfall patterns may change during these few hours of intense annual rains, which must be stored properly so that water is available for various uses over the entire year, and between years, especially during prolonged drought periods.

The current consensus is that climate change is likely to increase the frequency of extreme events such as droughts and floods. If so, water infrastructures and management practices have to be more robust and flexible in the future. Technologically and

economically, it will not be an easy task to build in the appropriate flexibility and robustness without significant increases in our current knowledge base. This is unlikely to happen during the next 10, or even 20 years because of the complexities of the climatic processes involved, which are still not fully understood. Building flexibility and robustness in the design, construction and maintenance of water infrastructure will also mean higher financial costs, which may further strain the economies of some countries.

Thus, climate change is likely to introduce high levels of risks and uncertainties that the water profession simply may not be able to handle with any degree of confidence, at least in the short term. Superimposition of 'normal' climatic fluctuations with the expected changes in climatic patterns will make efficient water planning and management an exceedingly complex and difficult task during the post-2025 period. This aspect needs urgent attention and accelerated research from water scientists and climatologists, especially in the Asian monsoon counties, if serious water-related stresses are to be avoided in the future.

Technology

Like climate change, technological developments are likely to introduce another set of uncertainties in water management practices and processes. However, unlike climate change, technological developments are much more likely to bring positive surprises in numerous aspects of water development and management.

The information and communication revolutions have had radical impacts on water. The management and analysis of water-related data have become far simpler economic and efficient processes than ever before in human history. Information storage, retrieval and exchange have improved exponentially in recent years. South-South knowledge transfer, which was in its infancy some 25 years ago, has now come of age because of tremendous improvements in information management and exponentially declining costs. In future, these developments are likely to advance even further.

Another area that will have a major impact on water-use patterns will be biotechnological advances. These advances will help in the development of pest-resistant and drought-resistant crops, as well as crops that can be grown in marginal quality water, such as saline water. The net impacts of these probable developments may be that more crops can be grown with lower quantities of water, and also with the use of marginal quality water.

Biotechnology is likely to help in many other ways. For example, a new variety of rice under field trial can survive for 3–4 weeks under floodwater. Every year, hundreds of thousands of tons of rice crops are lost in Asia due to prolonged submergence under floodwater. These new varieties of rice crops will be able to withstand most flooding.

Similarly, biotechnology is making rapid advances in wastewater treatment. It is highly probable that there will be further very substantial improvements and breakthroughs in these areas during forthcoming decades. These could have profound effects on water quality management, which is now a very serious problem throughout almost all of developing Asia.

Another area where remarkable progress has been made during the past decade is membrane technology. With the new generation of membranes and improved management practices, seawater desalination costs have reduced from US$1.50 to about US$0.50 per cubic metre during the past decade. Because a large proportion of the Asian population lives within 100 km of a coast, provision of clean water for domestic, commercial and industrial needs is no longer a physical constraint.

The water profession, in general, has not fully appreciated the implications of technological advances, which are likely to affect water-use patterns and requirements very significantly. However, even when the new technologies become available and are cost-effective, national capacities to manage them need to be properly developed. Capacity building for managing water resources in the coming years, in spite of considerable rhetoric, is still not receiving enough attention in most Asian countries. It should be realized under a rapidly changing Asia, that tomorrow's water problems can no longer be identified, let alone solved, with today's knowledge and yesterday's experience. A whole new mindset will be needed to identify and solve future water-related problems, which will require substantial attention and additional investments to capacity building.

All the existing and the probable future trends indicate that there will be tremendous opportunities to solve the future water problems of all Asian countries. There will also be new sets of constraints that have to be overcome. The opportunities and constraints may differ from country to country and even within a country. Equally, solutions may be location specific. Asian countries that focus on finding and implementing solutions for the water-related problems that they are likely to face in the future will make remarkable progress in terms of water management. Water should no longer be a constraint for them to accelerated economic development or poverty reduction.

Urban Water Management

Water has many uses and its efficient management covers a multitude of issues, including nearly all development sectors and most disciplines. Accordingly, it is not possible to cover all aspects of water in one single issue of the Asian Water Development Outlook (AWDO). In addition, as noted, Asia is a large heterogeneous continent, where a set of issues of primary concern to one country may be of little interest to another. Thus, for the first edition of AWDO, the main focus is on urban water management. This is because in all Asian countries the highest priority is invariably given to domestic water use. With accelerating urbanization in Asia, management of the entire water cycle in an urban context has become a priority consideration. Equally, at present urban water management is the major component of the Asian Development Bank (ADB) loan portfolio for the water sector. Other water issues, including rural water management, will be considered in subsequent AWDO reports.

Urban water management consists of three fundamental, but interrelated, services. First is the provision to households of clean water that is drinkable without additional treatment. Second is the collection of wastewater from all households and from industrial and commercial sources, which thereafter requires proper treatment and disposal in an environmentally-friendly way. Third is the efficient disposal of stormwater, especially during the monsoon seasons. Frequently, only the first provision of drinking water is considered, while the other two services receive inadequate attention. Furthermore, even for drinking water supply, the focus tends to be on quantity: quality issues receive much less attention.

The importance of clean water supply and wastewater management became an important international issue following the United Nations Water Conference, held in Mar del Plata, Argentina, in March 1977. The Mar del Plata conference was the only meeting ever held on water at a high political level. This conference proposed that the decade of the 1980s should be declared as the International Water Supply and Sanitation Decade, with the very ambitious

objective of providing clean water and sanitation to every human by the end of 1990. The proposal was subsequently approved unanimously by the United Nations General Assembly.

A retrospective analysis of that decade indicates that even though it did not reach its goals, it was a remarkably successful event. Because of the promulgation of the concept, hundreds of millions of people received accelerated access to water supply and sanitation, which may not have happened otherwise.

Subsequently, the Millennium Development Goals (MDGs) incorporated part of the objectives of the water supply and sanitation decade. One of the goals is to reduce by half the number of people not having access to clean water, between 1990 and 2015. An improvement in sanitation is not a component of the MDGs. In 2002, the Johannesburg Summit recommended an equivalent sanitation goal to reduce the number of people having no access to sanitation by half within the period 1990–2015.

Considerable attention is now given by national and international institutions to the achievements of the MDG on water supply, and to the Johannesburg target on sanitation. However, in much of the global discussions during recent years, the focus has been almost exclusively on achieving the numerical targets: the real objectives and the philosophy behind the two targets are seldom discussed.

When the idea of the International Water Supply and Sanitation Decade was first proposed, its objective was that everyone should have access to clean water that is drinkable without any additional treatment. Similarly, it was expected that access to sanitation, at least in the urban context, meant that wastewater would be collected from households and then properly treated for safe disposal to the environment.

During the intervening years, somehow the philosophies behind these goals were lost, and the emphasis was transferred to the achievement of the numerical targets. For example, there has been limited discussion on the quality of the water supplied to the urban households. The discussion has almost exclusively focused on the provision of certain quantum of water, irrespective of quality in terms of drinking. Consequently, in many Asian urban centres, each household or block of flats now acts as a mini-utility. Water of indifferent quality is collected and stored in underground tanks and then pumped to overhead tanks. This water is then treated, sometimes even with membranes, before it can be consumed. Where the main utilities supply water intermittently (2–4 hours per day), the mini-utilities at the household level transform it to a 24-hour water supply, followed by treatment, all at high economic costs. This certainly was not the thinking behind the supply goal of the water and sanitation decade.

A similar anomaly also exists with the sanitation goal. Wastewater may now be collected from urban areas, but is mostly either not treated, or only receives partial treatment, before discharge to rivers, lakes or oceans. Thus, the contamination and health problems are simply shifted from the urban areas where the wastewaters originate, to another location where fewer people may be affected. Because of this transfer of the problem from one location to another, rivers, lakes and oceans in and around urban areas of developing Asian countries are now seriously contaminated. This is already having serious adverse health, social, economic and environmental impacts. If the present unsatisfactory trends continue, in one or two decades Asian developing countries will probably have to face and cope with a crisis about water quality management that is unprecedented in human history. Therefore, it is absolutely essential that new wastewater treatment facilities are constructed on a massive scale and are properly maintained, so that the water contamination problems can be progressively reduced.

By seriously diluting the definition of access to clean water and considering sanitation only in a very restricted sense, developing countries, including many in Asia, are mortgaging their future in terms of water security. Such mindsets, including the tenor of the global water policy dialogue, have to change very significantly.

The Asian situation is very similar to the rest of the developing world. Studies carried out in Mexico by the Third World Centre for Water Management for the Inter-American Development Bank indicate that if instead of sanitation access to proper wastewater management is considered, only approximately 11% of the population in Latin America was covered in 1990. No similar study is available for Asia, but a ballpark estimate of the Asian developing countries is likely to be somewhat similar to that of Latin America. If a similar approach is taken as the MDG to formulate a target for access to wastewater treatment, it will mean that by 2015, Asian developing countries need to increase access to around 50–60% of the population by 2015, about four times that at present. This will not be an easy task, and yet this must be the real target for Asian countries.

Meeting that target is all the more worthwhile because investing in the water sector is investing in all the MDGs, not just Target 10 and the Johannesburg target on sanitation. Safe water supplies immediately improve people's health and save them time, which they can use to study or improve their livelihoods, so they can earn more, eat more nutritiously and enjoy healthier lives. Improved sanitation protects the poor from socially and physically degrading surroundings, health risks and exposure to dangerous environmental conditions. It is easy to see how $1 invested in the water sector turns into a benefit equivalent to $6. However, all too often the expectation and analysis of benefits from water supply and sanitation projects are limited to the most common intended result—better health.

Access to Clean Water

No sane person will argue with the fact that all human beings should have access to clean and drinkable water and proper wastewater management. When people do not have access to one or both of these services, the social, economic and environmental costs are high, as is the overall cost to the national economy. The main issue is not the need for these services, which are now universally accepted, but rather how can these be provided to everyone cost-effectively, equitably and promptly.

In many Asian developing countries, including most of South Asia, intermittent water supply is at present the norm rather than an exception. Yet, problems associated with an intermittent water supply are well known. Among these are the provision of contaminated water by consumers, wastage of water at all stages, the need for bigger pipes in the network (thus higher economic cost) for water delivery in a short time, unreliable metering, high levels of corruption, and stress among the urban poor to obtain their supply each day.

For most Asian urban centres, at least those with populations of 1 million or more, there is no reason why continuous water supply or drinkable quality cannot be provided on a regular basis. The common excuse currently offered for the intermittent water supply is that there is not enough water to ensure a continuous supply. A quick review will indicate to any reasonably intelligent person that the professed reason has absolutely no scientific, technical or economic validity. For example, supply may be intermittent, but during the short period the supply is available, most consumers withdraw enough water, which is then stored at the household level to provide a continuous supply. If the supply were continuous, the households would use a similar

amount of water, but spread over the entire day. In addition, in many Asian urban centres, more than 50% of water that enters the system never reaches its designated consumers due to leakages and poor management. Urban areas such as Male now provide a continuous drinkable water supply with an average household consumption of less than 10 cubic metres per month. Yet, other Asian urban centres that supply more than two to three times this amount to each household claim that they do not have enough water to assure continuous supply!

The main reason for the current unacceptable situation is widespread mismanagement of the water utilities, and as a result the utilities cannot be run professionally; there are high levels of corruption and an apathetic and disenchanted public, which has now been conditioned to expect only sub-optimal results from their utilities.

Water Pricing

There are many reasons for the current untenable situation. Probably the most prevalent one is the view that water is a social good, and so should be provided free of charge or at highly subsidized prices. In contrast, current studies indicate that without appropriate water pricing, the present vicious cycle of waste, inefficiency and lack of services to both the rich and the poor will continue. Lack of income of the utilities due to inadequate water pricing will ensure that the water systems are not properly maintained, and investment funds are not available for updating technology, improving management and technological capacities, expanding the networks and providing wastewater management. There is no question that the era when drinkable water could be provided to everyone free of charge or at highly subsidized rates on a long-term basis is now over.

What is needed is the exact corollary of the present vicious circle by its replacement with a virtuous circle. This will mean a system where the users pay for the services they want, the poor who cannot pay receive targeted subsidies, utilities provide water supply and wastewater management services efficiently and accountably, users cover the costs of the services and public funds are used for public purposes.

Of course, this does not mean that we now have all the answers on how water should be priced for different consumers and for different uses. Some hard questions need to be asked and answered. For example, how can it be ensured that the poor have adequate access to reliable water and sanitation services at affordable prices while the rich are not subsidized? How, by whom and through what processes should these services be managed in order to ensure that the objectives of the provision of reliable services, economic efficiency, universal access and maximization of social welfare are met consistently and concurrently? What type of institutional frameworks and governance practices are needed to improve the present delivery services very substantially? How can all these requirements be achieved efficiently and quickly, and the means used be socially and politically acceptable to society as a whole? These and many other similar questions need to be asked and answered by every water utility, either public or private, and by the government services that regulate them.

What is becoming increasingly evident is that there is no single ‘best’ solution that would be applicable for all Asian countries. What is needed is the identification of a community of ‘good practice’ models from Asian urban centres that have made remarkable progress in providing clean water and wastewater management services in

recent years. If such models were available, including an assessment of the enabling environments needed for such practices to function, those Asian urban centres searching for an applicable model could select the one that best suits them. The selected model then has to be carefully adapted to suit the specific local conditions.

Public–Private Partnership

The discussion of private sector involvement in water and wastewater management has often become emotional, with hardened positions of both proponents and opponents. The issue was strongly and emotionally debated during the Second World Water Forum in The Hague in 2000, and the Third World Water Forum in Japan in 2003. The opponents of the private sector involvement argued repeatedly and vehemently that water pricing is a 'code word' for handing over an essential public service to the private sector, which will then make unseemly profits at the cost of the poor. During the Hague Forum, it was widely assumed that a few multinational corporations would 'control' the water-related services of the urban areas of the world. They would become so big and powerful that the public regulators would not be able to control them.

By 2003, when the Third World Water Forum was convened, the goal posts of the debate had shifted. In 2000, a few multinational corporations were increasing their outreach at a very rapid pace, but only a scant three years later the same companies were in retreat. Saddled by huge debts and significant losses in many concessions, and facing steeply declining share prices, most of them had to curtail their expansion plans in the developing world.

The focus of the discussion is slowly changing for the better, focusing on the end societal goals, that is universal equitable provision of clean water and wastewater management at affordable and economic prices. The means—how the services are provided and by whom—are less relevant, as long as the goals are achieved.

In this respect, past discussions have not focused on the main issue. At present, only about 5–7% (estimates vary) of the global population receive water and wastewater services from the private sector. Under all foreseeable conditions, it is highly unlikely that even 15% of the global population will receive such services from the private sector by 2025. Accordingly, if at least 85% of the global population continues to receive these services from the public sector, the main focus for discussion needs to be on how the existing public sector services can be improved very significantly in the coming years.

It should be noted that two of the most efficient water-related service providers in the world, Singapore and Tokyo, belong to the public sector. Equally, some of the worst performances in Asian developing countries can be found in the public sector. Similarly, the performance of the private sector has not been consistently better than the public sector. Some water management concessions given to private sectors have been successful, but others have not. Results have varied within a country (for example, a private concession in Morocco, Casablanca could be considered a success but not that in Rabat), and sometimes even within the same metropolitan area (a private concession for one half of Manila has worked but that in the other half has not), or over time (a private concession in Buenos Aires only worked initially).

Two other new factors are worth noting. First, is the emergence of new Asian private companies that have developed enough expertise and technical and financial knowledge to consider management concessions within Asia, and later perhaps beyond Asia. In the electricity sector, a Singaporean concern is already managing the services in Sydney. It is

probable that private sector companies and public-private consortiums from Asian countries, especially from India, Philippines and Singapore, may become increasingly active over the next decade.

The second is the increasing outsourcing of specific activities and services that the local private sector can perform more efficiently than the public sector. These could be in a variety of areas such as information technology, meter reading and billing, leak detection and repair, vehicle management, etc. Public sector institutions, such as the Public Utilities Board of Singapore and National Water Supply and Drainage Board of Sri Lanka, are already forging ahead with outsourcing, resulting in 'win-win' situations.

In the future, what is needed is an increasing dialogue between the public sector, the private sector and civil society so that a mutually acceptable good solution is formulated specifically for the concerned urban centre. The main objective should be to provide continuous drinkable water supply and adequate wastewater management to all the residents, cost-effectively, equitably and promptly. How this can be accomplished, and by whom, should be best left to the urban centres concerned without external interference and dogmatic beliefs.

Wastewater Management

In general, wastewater management has received far lower priority in Asian developing countries than has the provision of water supply. In addition, in most of the locations where wastewater management has been considered, the main focus has been on the collection of wastewater from urban areas for disposal elsewhere with limited, or even, no treatment. As more and more water is supplied to urban areas, and concomitant progress is not made on its collection, treatment and disposal practices, the overall water quality situation will deteriorate progressively.

A major problem facing Asian countries is the provision of wastewater management in slums and peri-urban areas. Where individual or communal toilets are not available, open defecation creates health, social and environmental problems. It also is against human dignity, especially for women, the elderly and the sick. There is an increasing emphasis on controlling open defecation in these areas, but much more remains to be done, not only in terms of an expansion of hygienic toilets and their long-term maintenance, but also the collection and safe disposal of grey water. Provision of toilets, although an essential and important improvement, is not enough; it must be an integral component of a functional wastewater management policy. This is an area where significantly more progress is needed in Asian developing countries.

Rehabilitation of Urban Water and Wastewater Works

Much of the discussion during the recent decades has been on the construction and operation of new infrastructure for water supply and wastewater management. There is no question that, with rapid urbanization, Asian countries have to move increasingly aggressively to construct and maintain new works.

However, there is another issue that needs urgent attention from all Asian policy makers. This is the rehabilitation and redevelopment of earlier water and wastewater infrastructure. Some of the infrastructure is well over 50-years old, and is not only past its

economic life, but is also too small in view of the increasing population density and higher per capita water use.

Even in Japan, many of the water and wastewater facilities were built during the 1950s and 1960s and need to be progressively replaced with new designs and materials that comply with the latest construction standards and planning and design requirements. The investments in new water and wastewater infrastructure started to decline in Japan after 2000, and now are less than what is required for rehabilitation. If this trend continues, an increasing number of facilities that should be replaced will not be rehabilitated. Consequently, they may be left to deteriorate. If so, they will require much higher investment later and may impose some social and environmental costs on the areas concerned.

While Japan seriously started to rehabilitate its structures, the same cannot be said for most Asian countries. In fact, very few have drawn up operational plans with regard to how old infrastructure can be rehabilitated, both in terms of geographical coverage and over time. Even the extent of the problem is not known in most countries, nor is it known what type of investment funds and technical and managerial capacities will be needed for their timely and cost-effective renewal. This is an area that deserves more attention from all Asian countries in the future.

Index of Drinking Water Adequacy (IDWA) for Asia

The Human Development Index (HDI) is now a universally accepted indicator for overall national progress. It combines one indicator each of health and education with per capita income. Therefore, it is possible to ascertain what is lacking at the country level on the three important dimensions of human development.

Inspired by the success of the HDI, an attempt has been made to develop an index of drinking water adequacy (IDWA) and this has been applied to 23 developing member countries (DMCs) of ADB, which together account for 3.4 billion people (2004 estimated), and cover nearly 99% of the population of all 44 DMCs (see the Appendix). However, not enough information is available from the other 21 DMCs from national and/or global sources to fully develop the IDWA.

It should be noted that the IDWA values indicated in the Appendix are preliminary estimates. As more water-related data become available, and as the quality of data improves, IDWA will also improve. Furthermore, in time more methodological breakthroughs are likely, which will further advance the technical and intellectual foundations of the index. Detailed information on how the IDWA has been computed can be found in the CD-ROM attached to the AWDO report.

IDWA has four important components: per capita estimates of renewable internal freshwater resources; access; capacity to buy water; and per capita water use by the domestic sector. To these factors is added an indirect proxy of the quality of drinking water. This is because of a paucity of reliable water quality data in nearly all the DMCs. The proxy used for water quality is deaths from diarrhoea per 100 000 people in 2000.

It should be noted that IDWA, in its present form, is not intended to provide a reliable ranking of countries with regard to access to safe drinking water on a sustained basis. Therefore, the Index should not be used for inter-country ranking.

Even in its current form, IDWA provides a much better picture of the national situations than access-only indicators. In fact, each of the five components could trigger a message, depending on the country-specific situation. IDWA can assist development policy,

programmes and projects as a tool for assessment, monitoring and benchmarking. For national policy makers and external support agencies, it could also be an instrument to make a good case for additional improvements and investments in drinking water so that the index value can move higher, toward 100.

IDWA can also assist countries in targeting one or more of its components to move further up the scale. For example, Papua New Guinea has adequate water resources, but not the wherewithal to supply water, which could receive priority attention. Similarly, Malaysia has an edge over the Republic of Korea in terms of resources and access, while the latter has a high level of capacity that needs to be converted into access, even in the absence of adequate water resources. India and the PRC have almost identical IDWA values, but there are stark differences in some of the components. The comparatively high use component in India has limited importance, especially when poor water quality is considered.

At its present stage, IDWA is limited to water only: wastewater management is not considered. Conceptually, IDWA can be extended to incorporate wastewater management, if reasonable data for at least two additional indicators are available. These could be access to sanitation facilities and the extent of collection, treatment and disposal of wastewater. Unfortunately, such data are not currently available at national levels. A separate composite index of wastewater management can also be considered when water quality data in the DMCs improve significantly.

Ways Forward

There is no single way forward for Asian DMCs to ensure their future water security. Because of differing climatic, physical, social, economic, environmental and institutional conditions, and because countries, and even parts of countries, are at different stages of development, there are simply no universal solutions. The Pacific Islands, for example, because of their generally small size and fragility, have quite different water problems to those of larger nations and have developed their own regional action plan. In addition, because the national, regional and global conditions that affect water are changing rapidly, there is also a time dimension to the solutions—what may have been a viable solution a decade ago may not be so a decade from now. This means that water policies need to be updated periodically so that they reflect the requirements of the time and the foreseeable future.

On the basis of current assessments of water resources, we can confidently predict expected water demands of the future, available technology, knowledge and experience, that Asian DMCs should not experience or expect a crisis in the future because of physical scarcity of water. This is a conclusion that ADB reached approximately a decade ago and there is no reason to change that finding. It is important is to realize that, irrespective of the high level of rhetoric on the looming global water crisis and possible water wars due to increasing water scarcity, the fact is that there is now enough knowledge, technology and expertise available in Asia to solve all its existing and future water problems. Nevertheless, some Asian DMCs will find it more difficult than others to ensure their future water security. However, this is likely to be the general situation not only for the water sector, but also for all other development-related sectors in those countries.

If some of the Asian DMCs face a water crisis in the future, it will *not* be because of physical scarcity of water, but because of inadequate or inappropriate water governance, including management practices, institutional arrangements and socio-political conditions,

which now leave much to be desired. A continuation of the present state of affairs will ensure that the water situation in Asian DMCs can only improve slowly. Considering the expected population growth, continuing urbanization and increasing economic activities, this may mean, at least for the water sector, having to run faster to stay in the same place. This cannot be the preferred or acceptable solution.

Major and fundamental changes in water governance practices are needed in nearly all the Asian DMCs. There are many success stories in Asia of very significant improvements in water governance. For example, during the past 30 years Singapore has made remarkable breakthroughs in its governance practices, and as a result it is now has one of the best, if not the best, water supply, wastewater management and overall catchment managements in the world. In the process, the Public Utilities Board of Singapore has gained full confidence of the public in the level of services it consistently provides. Most of this transition has taken place within about two decades.

Similarly, the Phnom Penh Water Authority has managed to reduce its unaccounted-for water from about 90% in 1993 to about 8% at present, in spite of difficult political, economic and social conditions during this period. The utility now provides a continuous drinkable water supply, and is fully autonomous and financially independent. It uses absolutely no outsourcing to the private sector, and within a decade has shown what can be achieved given good leadership—which has radically transformed its governance—and full political weight behind that enlightened leadership.

It is now important for improving the performance of the water sector that a comprehensive search be made to identify similar success stories from all over Asia in areas such as water supply, wastewater management, irrigation and hydropower development. These successes need to be reviewed independently by knowledgeable and experienced water experts in terms of their veracity, long-term sustainability and potential replicability in other parts of Asia. It will also be essential to analyze the enabling environment of each success story to see how and why it managed to make remarkable progress while most other Asian urban centres did not. We need to understand what conditions were instrumental in catalyzing the process, which, in turn, ensured their success.

A set of successful Asian good practice models is essential for South-South knowledge and experience transfer in the context of the special monsoon climatic conditions of the region. A major reason that European and North American models have often not been successful in Asia is not only differences in climatic conditions, but also in social, economic and environmental conditions and institutional and legal frameworks. Thus, successful models from Asian monsoon areas are likely to be more replicable to other Asian DMCs than are models directly imported from Europe and North America. However, the Asian models should only be applied after appropriate modifications for site-specific conditions.

Within this overall context and philosophy, some suggestions follow that will probably be useful across most Asian DMCs for the way forward to water security. Nevertheless, it should be noted that the degrees of emphasis or priority given to each issue will vary from one country to another.

Improving Data Availability and Reliability

A major issue in preparing the Asian Water Development Outlook has been the paucity of data on all aspects of water-related issues in Asian DMCs. Even when data were available, their reliability was often unknown. The problem was further compounded by the presence

of either inconsistent national datasets or different data from various national sources on the same parameters, and/or significant differences in many cases between national and international datasets.

As a general rule, the Asian DMCs have better information, and also for longer periods, on water quantity than on water quality. Very limited, if any, information is available on the extent of water reuse and progress on recycling. This is an important gap because in all the Asian DMCs, water quality management will become a priority national issue in the foreseeable future, and there will be very significant increases in water reuse through formal or informal means. Similarly, availability of data is considerably better on hydrological, climatic and similar physical factors than on social, economic and environmental parameters. This situation appears to be improving, but slowly.

It is simply not possible to plan, develop and manage water resources in any country on a long-term sustainable basis without the availability of reliable data on physical as well as social, economic and environmental factors. Equally, it is not enough to collect data that are necessary and reliable: data must be readily accessible to the people who need them, ranging from national and international organizations to research and academic institutions, NGOs and civil society in general. If the status of water development and management is to be improved, it is essential that collection, quality and management of data receive significantly higher priority in all Asian DMCs than has been the case to date. Data accessibility needs to be substantially improved as well.

It should be noted that adequate and reliable data are needed at national, regional and local levels, depending on the specific water activities that need to be carried out. Equally, without good data it is not possible to adequately monitor progress or performance of policies, programmes or projects. Without monitoring definitive statements cannot be made about the success of specific water-related activities or their cost-effectiveness and impacts on people and the environment.

Major international institutions such as ADB should encourage and assist DMCs to develop and maintain consistent datasets across the entire Asian region. Such an effort will unquestionably improve data availability and accessibility, and may contribute to the reduction, or even elimination, of unreliable and conflicting datasets. For example, when the background work was carried out for the present report, it was noted that national and international datasets on achievements toward the MDG on water supply were very different. Some examples are given in Table 1 below. National datasets often tended to provide more optimistic pictures of progress. This may also be due to data errors and/or definitional problems in the data. For example, access to water can be defined in different ways by different countries and/or national and international institutions. Clear definitions of the data that are being collected are needed so that users are aware of the data's relevance, appropriateness, comparability and limitations.

For data aggregation at national levels, all local datasets must use identical definitions of the parameters for which data are being collected. Equally, for comparison of national datasets, all DMCs should use consistent definitions and similar processes for collection, analysis and interpretation. This is not happening at present at any significant or consistent scale, and as a result apples and oranges are often being aggregated and compared. Accordingly, the present situation often may not give realistic views of water-related conditions, or help in formulating and implementing efficient policies, programmes and projects. To ensure efficient water planning and management in the future, data availability, quality and access need to be improved significantly.

Table 1 Proportions of populations in selected countries receiving water and sanitation services (%)

Country	Source and date	Overall water	Urban water	Rural water	Overall sanitation	Urban sanitation	Rural sanitation
Cambodia	WHO/UNICEF (2004)	41	64	35	17	53	8
	Ministry of Planning (2005)	–	76	42		55	16
Fiji	WHO/UNICEF (2004)	47	43	51	72	87	55
	FAO (2002)[a]	70					
Sri Lanka	WHO/UNICEF (2004)	79	98	74	91	98	89
	ADB[b] (2000/1 data yr)	82	98	70	80	97	–
	NWSDB (2005)[c]	–	39.5	–	–	–	–
Viet Nam	WHO/UNICEF (2004)	85	99	80	61	92	50
	Viet Nam Government (2004)[d]	70	–	58	–	–	41

Notes: ADB = Asian Development Bank; FAO = Food and Agriculture Organization of the United Nations; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

[a]Gateway to Land and Water Information, University of South Pacific, Samoa—Fiji National report.

[b]Country Strategy and Programme Update 2006–2008.

[c]National Water Supply and Drainage Board Annual Report (NWSDB) (2005), excludes some large municipalities, such as Kandy and Jaffna.

[d]Viet Nam Government (2004) Report on Viet Nam Development Goals.

Forging Partnerships for Water Management

In the late 1990s, certain international institutions (not ADB) strongly and consistently promoted the participation of a few multinational corporations as the panacea for solving water and wastewater problems of major urban centres of the developing world. As noted earlier, by the early 2000s, it was already generally recognized that these corporations were not going to deliver services as expected in terms of bringing new investments, connections for the poor and significantly improved management practices. All these and other advantages were expected to make service delivery efficient, reliable, economic and equitable compared to the conditions that were prevalent under public sector utility management. The multinational corporations concerned also soon realized that they were not going to make a very attractive return for their shareholders for the next two to three decades from providing water and wastewater management services.

This form of public-private partnership did not work as well or as consistently as its proponents had anticipated. It is now also fully accepted by all the concerned parties that the existing water supply and wastewater management gap between what is needed and what is available at present in the Asian DMCs, is huge, and 'business as usual' will not be able to provide the solution within a reasonable timeframe. A new paradigm of 'business unusual' is needed that can solve the region's water and wastewater problems, preferably within a decade, in a cost-effective and equitable manner. This will require the formation of a new form of partnership, different from the earlier models, with three distinct partners—government, corporate (public or private), and society—each having very specific responsibilities for which it should be held accountable; let us call this the GCS model.

The tasks of government in this tripartite relationship could include formulation of an overall framework within which the three parties can operate, and the promulgation of regulatory regimes for the service providers. This would include such issues as determining the levels of service; identifying the beneficiaries; stipulating progress to be made over time in terms of extending service coverage and beneficiaries to be reached; establishing implementable policies for water pricing and cost recovery; ensuring proper standards of construction; and formulating transparent and enforceable legal procedures for awarding and managing contracts and the resolution of potential conflicts.

The corporate partner could be public or private. If public, it should be an autonomous and accountable government entity with operational and financial autonomy and free from political and bureaucratic interference. In fact, many water utilities in Asian DMCs now fail to function efficiently because of the 'excess baggage' they carry in terms of unnecessary rules, regulations, administrative requirements and consistent bureaucratic and political interference. Under the existing conditions, it would indeed be a miracle if a utility succeeds in providing reliable levels of services efficiently and equitably to all on a sustainable basis. The responsibilities of the corporate partner must include high levels of consumer satisfaction and it should be fully accountable to its customers. The Phnom Penh Water Supply Authority is one such autonomous, public corporate partner; it has already revolutionized the water supply of that city. This type of model needs further consideration for possible use by other Asian DMCs. For example, Phnom Penh Water Supply Authority improved its system by forging harmonized partnership with the Japanese Government, ADB, French Government and World Bank.

The corporate partner could equally be a private company or a public sector company from another country or another region of the same country. However, whether it is a public or a

private entity, it will have to abide by the same set of requirements and obligations. Each urban centre should select which corporate model would best suit its needs, opportunities and constraints, and should be determined without any preconceived dogma or hidden agenda.

The third partner should be civil society, which as a general rule needs to move away from its current apathetic response to poor and unacceptable levels of water and wastewater service delivery. Consumers will have to pay a fair price for receiving water and wastewater services, so they need to be encouraged to demand good quality service—and here, there is a need to explore both social and for-profit marketing opportunities to drive up demand. The responsible civil society organizations should be empowered to demand necessary reforms, ensure that the urban poor receive the expected benefits, and complain vociferously when the system does not provide the stipulated levels of services.

The GCS model, if implemented properly, has the potential to improve water and wastewater services in urban centres of many Asian DMCs. The model is also very flexible. Each urban centre can devise its own model that will best suit its specific social, economic, institutional and environmental conditions and constraints. The selection and adoption of the final model should come after a thorough review of the community of good practice models available from the Asian monsoon countries, an issue that has been discussed earlier.

Improving Water Quality

Water quality management has mostly been a neglected issue in Asian DMCs. The health costs and social impacts are likely to be very substantial at present. While these have not been carefully assessed for the region, the annual economic cost is likely to be billions of dollars. If the current trend continues, the costs are likely to escalate very significantly in coming years.

Institutional responsibilities for water quality management are highly fragmented at present. Equally, most institutions are not geared to manage water quality, let alone address the broader problems of the future. Accordingly, institutional strengthening and restructuring, inter-institutional coordination, and capacity building in technical, administrative and managerial aspects are urgent requirements, as are significant improvements in the formulation and implementation of legal and regulatory regimes, and transparency and non-corruptibility of the associated administrative and management processes.

While economic instruments (bulk water charges, water rights, tradable permits, polluter-pays-principle, incentives when appropriate, etc.) can help the region in improving the current water quality conditions, a combination of economic instruments and a command-and-control system is likely to prove useful.

Conventional funds available for investments in controlling water pollution are now grossly inadequate. In addition, not all the funds available are being used efficiently. Considering the massive additional funding needed to manage water quality because of past neglect, it is highly unlikely that the public sector can generate the needed investment funds. Funding that can be generated from the private sector and multilateral and bilateral agencies will be useful, but even this is unlikely to be enough. New forms of funding mechanisms are required, which need to be available on a sustained basis for a reasonable period of time. Loans for longer periods, such as 40-year loans that are currently provided by the Japan Bank for International Cooperation, should be considered by other funding agencies.

In spite of the current deteriorating water quality in many Asian DMCs, the issue is not receiving the political priority and social attention it deserves at national and local levels. Overall governance, including political, legal and institutional conditions, has often

contributed to an environment that has not encouraged new investments. This situation needs to be changed.

Water quality management is much broader than simply construction and the operation of wastewater treatment plants. A more comprehensive perspective is essential, which should consider factors such as the formulation and implementation of national water policies within which quality should be a priority issue, regular monitoring and evaluation of water quality, the presence of appropriate and functional legal and institutional frameworks, and a well-structured capacity-building programme at all levels.

Enhancing Capacity Development

Capacity development is an important requirement for Asian DMCs to ensure water security in the coming years. Unfortunately, even though the rhetoric on capacity development has been quite high in recent years, appropriate capacity development that specifically addresses the needs of any one country has not received systematic and continuous attention. The attempts have often been ad hoc, have not addressed the priority areas that can really make a difference, and have generally built up capacities that are more appropriate for European and North American temperate climate conditions than for tropical and subtropical Asian conditions. Thus, instead of being a part of the solution, most of these programmes have produced short-term results of a marginal nature.

Educational and training programmes for water professionals need reviewing. Often they are academic and are not solution or application oriented. The academic programmes need to be restructured if they are to solve the problems of the future rather than the problems of the past. In other words, much of the current efforts for capacity development need a thorough review.

In this connection, it is useful to look at past Japanese efforts to build water management capacities. Japan invested nearly 70 cents for each dollar spent on infrastructure development in the education sector. In contrast, only about 7 cents are spent on capacity development in the water sector for each dollar spent on infrastructure development. The Asia and Pacific region recommended boosting the level of investment for capacity development during the Fourth World Water Forum. However, the world forums invariably produce a plethora of recommendations, very few of which are implemented. The recommendation on capacity building has been no different to this general rule. However, capacity development must receive a much higher priority from both national water authorities and external support agencies. Equally, the external support agencies must ensure that the types of capacity development activities they support will actually help to improve substantially the water management practices of Asian DMCs, where conditions are different from those in the industrialized countries. Further, the results must be sustainable over the long term.

Looking to the Future

As noted earlier, the future water-related issues of the Asian DMCs are likely to be quite different from those in the past. While historical knowledge is always useful, solving the water problems of the future will require additional skills, innovative approaches and new mindsets. It will also require a more holistic approach that can successfully coordinate the energy, food, environment and industrial policies of a nation, all of which have intimate linkages to water. Each will affect the others and, in turn, be affected by the others.

Policies in all these areas will be similarly influenced by external forces such as demographic transitions, advances in technology and communication, globalization, free trade and increasing social activism.

All these factors will make future water management in Asia a far more complex task than ever before. It will be a formidable challenge, but one that must and can be met because the knowledge, experience and technology to solve the problems in a timely manner already exist within Asia, not in one location but within the region as a whole. A synergistic net needs to be cast to identify and collect all the successful attempts for possible replication in other parts of Asia.

One is reminded of William Shakespeare's immortal words as to how the water future of the Asian DMCs will develop:

The fault, dear Brutus, is not in our stars
But in ourselves, that we are underlings.

Appendix 1: Index of Drinking Water Adequacy

AWDO proposes a new Index of Drinking Water Adequacy (IDWA). The IDWA is an average of five component indicators on most relevant variables (Figure A1): (1) per capita renewable internal fresh water resources;[1] (2) percent of population with *general* access to a sustainable 'improved' water source, which is one of the target indicators in the Millennium Development Goals (MDGs); (3) national capacity to purchase water, based on the proxy measure of per capita gross domestic product in purchasing power parity dollars (PPP $); (4) the extent of use of water by the domestic sector on a per capita basis measured against a norm; and (5) diarrheal deaths per 100 000 people used as an indirect measure of water quality. The IDWA not only allows cross-country comparisons, but also helps in ascertaining which component is weak in a particular country, requiring priority attention.

Index of Drinking Water Adequacy

Index computation methodology is essentially the same as the one adopted to compute the Water Poverty Index (WPI), which was the method used for computing the Human Development Index (HDI) over the years. The method simply involves taking the variable, for example resource per capita, R_j for country j, and then estimating the percentage as follows:

$$\text{Indicator for country } j = [(R_j - R_{\min})/(R_{\max} - R_{\min})] \times 100$$

The index is computed for 2004 for 23 developing member countries of the Asian Development Bank, accounting for 99% of the total population of all 44 DMCs. The IDWA values of the 23 DMCs are given in Table A1 to demonstrate the use and implications of the new index.

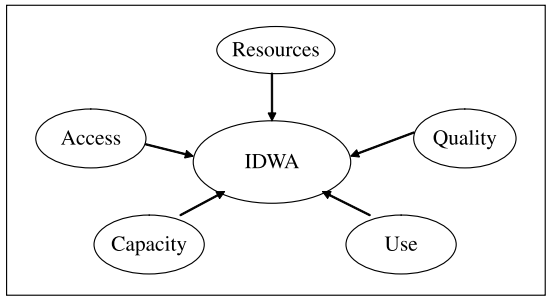

Figure A1. Index of drinking water adequacy

Table A1. Ranking based on IDWA

	Resource	Access	Capacity	Use	Quality	IDWA
Malaysia	85	100	79	100	99	92
The Rep. of Korea	61	90	100	100	99	90
Philippines	73	81	59	100	84	80
Viet Nam	71	81	42	100	87	76
Kazakhstan	72	82	69	50	98	74
Azerbaijan	58	71	52	100	89	74
Kyrgyz Republic	77	71	31	100	87	73
Thailand	68	99	73	32	93	73
Uzbekistan	54	77	31	100	98	72
Turkmenistan	48	64	31	93	77	63
Tajikistan	78	47	18	100	67	62
The PRC	65	71	64	16	92	61
India	60	82	46	56	57	60
Indonesia	80	71	49	13	84	59
Mongolia	81	51	34	31	66	53
Sri Lanka	66	73	55	−35	96	51
Pakistan	49	88	36	0	21	39
Nepal	75	87	25	−31	32	38
Bangladesh	56	67	33	−22	53	37
Myanmar	83	72	26	−52	49	35
Papua New Guinea	100	22	37	−58	57	32
Lao PDR	88	37	31	−7	2	30
Cambodia	77	24	37	−56	14	19

Comparing Malaysia and the Republic of Korea, the latter has relative paucity of water resources and not quite 100% access. It has capacity to purchase/exploit water resources at a much higher level than Malaysia, but it is not translated into full access, and hence IDWA is slightly lower.

The People's Republic of China (PRC) and India have about the same IDWA, but some of the component differences are glaring. Thus, the PRC has lower access, despite higher economic capacity. It has constrained use, but high quality. India enjoys better access and higher use but low quality.

Bangladesh and Myanmar have IDWA on the low side, with the two countries respectively occupying the 19th and 20th positions. Both fail especially on use, wherein the level is way below the norms adopted. Myanmar has a relatively higher level of resources that have helped to step up access to a relatively high level. The country, however, fails on purchasing power and quality.

Cambodia has the lowest IDWA despite a fairly high level of resources. It has to step up 'investments' to move up on all other components.

Note

1. Internal renewable water resources comprise the average annual flow of rivers and recharge of groundwater (aquifers) generated from endogenous (internal) precipitation. Natural incoming flows originating outside a country's borders are not included. Estimates of internal renewable water resources per capita are from the World Bank's World Development Indicators, 2006, and they refer to 2004.

Reference

Asian Development Bank and Cities Alliance (2006) *Urbanization and Sustainability: Case Studies of Good Practice*. Available at: http:www.adb.org/Documents/Books/Urbanization-Sustainability/