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Managing Water Resources in Asian Megacities

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MANAGING WATER RESOURCES IN ASIAN MEGACITIES

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INTRODUCTION

A regional consultation, "Managing Water Resources to Meet Megacity Needs" was held at the Asian Development Bank 24 - 27 August, 1993. Its objective was to develop, through sharing the relevant experiences of a number of megacities, appropriate strategies and action for managing water resources in a manner that will ensure the sustained supply of affordable safe water to large cities in Asia. The participating cities were Bangkok, Beijing, Delhi, Dhaka, Jakarta, Karachi, Manila and Seoul. Overviews were also provided from the cities of London, Singapore and Tokyo. This paper draws on material from the case studies and theme papers, looks at the findings of this consultation and suggests areas for future focus by the concerned agencies.[1/]

HISTORICAL PERSPECTIVE

A number of factors have impacted on water resource management in the subject megacities in the past. For example, *international politics* (the Independence of India in 1947) caused *rapid population growth* in the cities of Delhi, Karachi and Dhaka. *Uncontrolled groundwater extraction* has had a major effect on the water resources of Bangkok, Jakarta, Beijing and Manila. *Flooding* was a major problem in Bangkok when the canals were filled in to provide more roads and alleviate the traffic problem. It was catastrophic for Dhaka in 1988 when more than half the city was inundated. *Economic growth* has had a major impact on improved water resource management in Tokyo, Singapore, Seoul, Bangkok and Beijing. *Conversely large numbers of poor* in the cities of Delhi, Dhaka and Karachi have held back progress in water resources management. *Geographic factors* have also had a strong influence. Delhi is landlocked and has no riparian rights to water. Karachi has a very low rainfall. Singapore has to go to two other countries to secure its water supply. *Special events*, like the Olympic Games in Seoul, provided an incentive to improve water resources management (cleaning up the Han River). For Tokyo, the Second World War and the Middle East Oil Crisis were two events which greatly impacted on the city's growth. In London it was the *age and decrepit state of the existing distribution system* which brought about the innovative ring main design. What has become a common factor however, for all the megacities, is that *water resources* in proximity to the megacity are *becoming scarce* and there are *competing uses* for the water resources being considered to serve the megacities in the future.

Thus it can be seen that water resources management in a megacity is a complex matter with various factors impacting, some of which can be foreseen and some of which can't. Adaptability and flexibility are therefore important, but planning based on a sound knowledge of the reasonable alternatives is even more important. The greatest complication now is that as well as economic problems, there are social, environmental and institutional problems to be overcome and this means that politics will inevitably be a factor, especially in megacities.

COMPARATIVE REVIEW

Table 1 provides for the eight subject megacities, a comparative summary of a number of factors which are important in water resources management. There are some interesting

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1/ The views expressed in this paper are those of the author or other participants at the consultation and do not necessarily represent the views of the Asian Development Bank.

observations which can be made. If Manila and Jakarta are any guideline, financial strength of a utility does not guarantee a good water supply - both have around 55 per cent unaccounted for water losses. The number of staff in a water utility appears to be inversely proportional to the quality of the water supply service. Economic growth is not a prerequisite for acquiring a sewerage system as Delhi, Dhaka and Karachi have better sewerage coverage than Jakarta and Bangkok. The extent of water metering, combined with a tariff system based on water consumption has a direct correlation with hours of water supply service per day. Production volumes (0.6-5.0 million m^3/d) and number of connections (100,000 - 1,800,000) vary enormously for megacities with comparable populations. This is explained by the presence of alternative water supplies (private wells) and type of housing (condominium style) and illustrates why demand has been over-estimated in the past on many water supply development projects. A sound water supply utility can attract public subscription loans to further enhance its financial status (see Bangkok and Seoul). Megacities with high urban poor populations have difficulty in running financially and technically sound water systems due to (a) free water; (b) wasted water; and (c) illegal water use. Those like Dhaka which lacks an industrial water consumer base to cross-subsidise the domestic consumers, are additionally handicapped. Table 1 shows that there is scope for the megacities to learn a great deal from one another.

TABLE 1: Managing Water Resources in Asian Megacities - A Comparative Review

INDICATOR	MEGACITY							
	Bangkok	Beijing	Delhi	Dhaka	Jakarta	Karachi	Manila	Seoul
Population (million)	6.0	11.0	10.0	5.0	8.8	10.0	9.0	11.0
Population Growth	2.5%	3.0%	4.0%	5.1%	2.4%	4.5%	2.8%	2.0%
Urban Poor	20%		47%	40%	15%	40%	35%	0%
Water Service Coverage	75%	95%	69%	65%	44%	83%	70%	100%
Sewerage Coverage	10%		37%	28%	6%	42%	12%	90%
Water Supply Service (hrs)	24	24	7	6	19	4	16	24
Connections (million)	1.0	0.2	1.1	0.1	0.3	0.6	0.7	1.8
Public Taps (1000)	0		14.0	1.3	2.0	21.0	1.7	0
Water Production (million m^3/d)	2.9	1.8	2.3	0.7	0.9	1.6	2.5	5.0
Water Losses (UFW)	30%	7%	40%	50%	52%	-	58%	38%
Metered	100%	99%	53%	68%	100%	1%	100%	100%
Domestic Water Use (lpcd)	240	190	225	120	157	124	116	198
Water Tariff Structure	Block	Flat	Various	Various	Block	Property Tax	Block	Block
Domestic Cost of 30m^3 (US$)	4.72	1.64	0.49	2.46	7.60	-	3.70	5.29
Operating Ratio (Net)	0.43	1.47	1.92	0.85	0.61	1.08	0.37	0.81
Water Sales (Annual)	$175M	$24M	$21M	$11M	$50M	$20M	$90M	$285M
Staff/1000 Connection	5.5	17.0	8.9	21.3	8.7	11.7	9.0	1.9
Groundwater depletion *	▲▲	▲▲	▲	▲	▲▲		▲	
Major flooding *	▲			▲▲	▲	▲		
Water Pollution *	▲▲	▲	▲	▲	▲▲	▲	▲	
Competing uses *	▲	▲	▲		▲	▲	▲	

These data have been sourced from the Water Utilities Data Book (1993) and Case Studies for the Megacity Regional Consultation (1993). The figures should be viewed as indicative only. Operating Ratio is defined as [annual operating and maintenance cost]/[annual billing]. The net figure does not include the costs of depreciation, interest charges or amortization. * ▲ = significant; ▲▲ = serious

COMMON PROBLEMS

Over Exploitation of Groundwater

Bangkok, Manila, Beijing, Jakarta and Dhaka have all suffered from over-exploitation of groundwater. There has been a lack of control especially over the private users which include industries. In most cases, this has resulted in falling groundwater levels, saline intrusion and land subsidence. Groundwater as a permanent but limited resource has in many cases been destroyed.

Unaccounted for Water

This can only be measured in the cities of Bangkok, Beijing, Seoul, Manila and Jakarta. In the other megacities, where metering is not universal, it can only be estimated. Manila and Jakarta with around 55 percent unaccounted for water, appear to be the worst but Seoul with 38 per cent and Bangkok with 30 per cent still have far to go. As one of the consultants noted at the consultation, "if you can't measure it, you can't manage it" and nearly all the megacities need to concentrate not only on universal metering but replacement of meters on a regular basis to ensure accurate measurement of water use.

Flat Rate and Fixed Sum Tariffs

Those megacities like Karachi, Dhaka and Delhi that use property valuation or size of connection to determine the amount paid for water, will always be short of finances and will waste their water resource because there is no incentive to do otherwise. Likewise, flat rate tariffs as used by Beijing do not penalise excessive use.

Tariff Levels

All megacities are guilty of charging too low a tariff for domestic water supplies in particular. Even Bangkok, which has been known to have an annual "profit" over $50 million does not charge a tariff sufficiently high to discourage domestic consumption below 200 litres per capita per day. The extra revenues could go toward drainage, sewerage and wastewater treatment. In some cities like Karachi, Delhi and Dhaka the urban poor are given free water and yet it costs the utility a great deal to supply it. Thus legitimate revenues are denied the utility. Low tariffs also discourage water conservation and reuse, which in some cases, would otherwise be a viable option.

Garbage to Drains

In Karachi, Manila, Jakarta and Dhaka the open drains are often clogged with garbage and when flooding inevitably occurs the garbage is distributed widely through residential areas. A viable alternative garbage disposal is needed, together with public awareness and hygiene education.

Lack of City Planning/Control

There seems to be land use planning, but no actual control. In a number of the megacities like Bangkok, Jakarta and Manila industries were allowed to flourish without control - and only more recently have industrial estates and their locations been controlled.

Intermittent Water Supply Service

Four of the eight megacities have intermittent water supply services - Karachi being as low as 4 hours service per day. The impression given on the sub-continent is that 24 hour water supply is impossible. People are unaware of the health risk associated with illegal connections (which leak) and

the vacuum conditions which apply to an intermittent supply. Intermittent supply is itself given as a reason against metering (because it cannot be accurate) and the chance to attract more revenue from sale of water.

Population Growth Control / Urban Poor

With population growth rates still well above 3 per cent per annum, Delhi, Dhaka and Karachi appear headed for trouble in the future. Population control through family planning etc. is still relatively ineffective. The same three megacities have very high proportions of urban poor and Manila is not much better.

Water Resource Management Agencies

All of the eight megacities exhibit problems of overlapping jurisdiction of a large number of agencies in respect to the management of water resources. Where there are focal co-ordinating agencies like the National Water Resources Board in Manila, such agencies do not appear to have the requisite power nor resources to monitor and control adequately. In the case of Karachi, the influence of the Karachi Metropolitan Corporation over the activities of the Karachi Water Supply and Sewerage Board makes it difficult for the latter institution to function as an autonomous body.

Low Sewerage Coverage

Lack of investment funds and the ability to sustain operations through cost recovery are cited as the main reasons for low sewerage coverage in the megacities.

Government Agencies Delinquent on Paying Water Bills

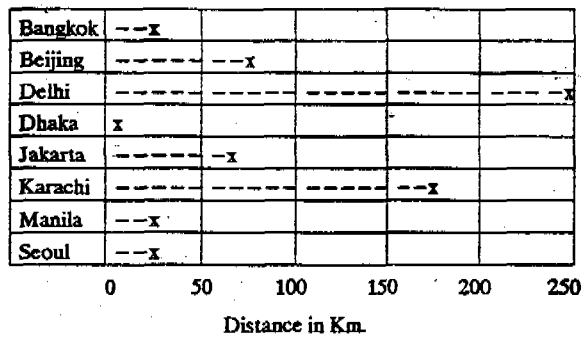
In most of the megacities, (including Bangkok, where MWA has a sound financial position) government agencies are major defaulters in paying water bills. This is especially prevalent where governments provide a subsidy to operational expenses, as they treat the issue as a mere paper transfer.

Distant New Water Sources

A common finding is that as demand for water increases in the megacities, the water utility has to look further and further afield for new sources to develop (see Figure 1). The obvious result is higher costs in the long run - but also this leads to greater vulnerability and of course the problem of competition with other existing and future users.

Figure 1

Distance of Current Water Source from City Center



Weak Human Resources

There is no question that a water utility needs to be operated as a commercial entity if it is to be successful. Singapore PUB is the best example of that. Yet many of the megacity water utilities are staffed by unqualified people on low government salaries and having no motivation to provide a quality service. This deficiency is greatest in the financial and management staffing areas.

LESSONS LEARNED

Planning

Mostly the evolution of the subject megacities is notable for its lack of planning, so responses have come about mostly as a result of perceived chaos. In Beijing, as in Singapore, condominium-style housing provides controlled high density living. In Delhi, New Delhi was created and industrial estates are now clearly identified. In Karachi, the emphasis is currently on the planning *process* per se. Dhaka has decided to focus its attention on the city itself, rather than its growing environs. The concept of buffered satellite towns (Jabotabek) is being developed outside of Jakarta, which has already adopted an integrated urban infrastructure development planning approach. It seems that in Manila the private sector has taken its own initiatives with major commercial developments. Seoul may be one of the better examples of a planned megacity and this may not be so much a reflection of good planning but more the ability of their management to make decisions. One of those was to remove all government agencies en-bloc outside of Seoul and create a much larger "Metropolitan Region of Seoul". National plans for reduction of population growth naturally influence the growth of megacities too. In that respect Beijing and Jakarta can claim to have had some success.

Water Resources Management

Perhaps the most important lesson to be learned from the past in water resource management, is that a groundwater resource available to a large city represents the most economic water supply, but it is a finite resource which can be completely lost if over-exploited. The subject megacities' water resource management is characterised by the large number of agencies which have jurisdiction over various aspects of water resources. This is not helped by the fact that there are often three and sometimes four management levels of government to consider; international, national, regional and local. Interbasin transfer of water has been initiated in Bangkok, Jakarta and Manila. An Indus River Accord has been signed by the Province of Sindh on behalf of Karachi to guarantee that city water. Conjunctive use of surface water and groundwater is being implemented in Beijing and London. Bangkok has introduced demand management through public awareness campaigns and revised cropping patterns - but is yet to allow pricing as a tool of demand management. Water reuse is strongly promoted in Karachi, Beijing, Tokyo and Seoul. In Jakarta, where raw water is charged at source, a river cleansing program is underway and canals are being lined to limit water transmission losses. Rainwater collection is being proposed in Delhi and Tokyo. Seoul has been successful in environmental improvements with the cleaning up of the Han River. Dhaka operates wastewater treatment lagoons which discharge only during the wet season. In water resource management there is no universal solution. Whereas in the past, water was available on a first come first served basis, it is now a scarce resource and allocation is needed. It may be reasonable to vary the standards of design such as reliability of supply, to more equitably share a water resource. It will also be important to consider water supply and wastewater disposal as an integrated development where the solutions for one cannot be found without consideration of the other. Environmental impacts of alternative proposals need to be evaluated. Economic and social factors are equally important. Financial and human resources must

be found to undertake the necessary data collection and monitoring to provide a sound basis for future decision making - as this is a dynamic process. It is generally believed that in respect of megacities unified control is desirable. Planners must consider increasing catchment yields, recharging of aquifers, water pollution control, demand management (especially in the industrial and agricultural sectors) reducing water losses and water reuse. Planners should also consider both public and private water supplies in the overall scenario of water resource management.

The institutional challenge in megacity water resource management far exceeds that in the agriculture or hydropower sectors. Security and dependability of supply are critical. From a legal perspective, there are four components to be integrated and reviewed regularly; these are (1) policies, (2) laws, (3) organizations and (4) implementation processes. Megacities are constantly evolving in response to the environment. The challenge is to provide a better balance between the static aspects (laws and organizations) and the dynamic aspects (policies and implementation). To address the recurring problem of overlapping jurisdiction, governments should require written agreements between agencies involved in water resource management, identifying the agency and its responsibilities. To counteract the influence of politicians in water resource management it is suggested that a permanent blue ribbon multi-sectoral monitoring and advisory committee be established. One of their tasks should be to see that specific policies are developed to address the needs of the poor.

Water Utility Efficiencies

On financial aspects, some useful approaches have been tried. Manila and Bangkok have employed a tariff increase tactic very successfully. The tariff is marginally increased every month for a period of up to 18 months. Manila has the best tariff package, in that it has a water rate plus a sewer rate plus an environmental rate all rolled into the one bill. Bangkok has innovative collection methods, where customers can read their own meter and work out their own bill and pay it through local banks. Delhi has a very successful "pay and use" community public toilet/shower which is run on a private concession basis. Dhaka has a private user fee for groundwater extraction. Amnesties for illegal connections have been successfully undertaken in Manila where 15,000 new connections were revealed during one amnesty period. Decentralization of operations has been successful in Bangkok (zones of about 2000 connections are being isolated) and this is now being tried in Manila, in an attempt to reduce unaccounted for water. Regular meter replacement is now understood as being critical to accurate measurement of water losses. Singapore has lead the way here and Seoul and Bangkok followed. Only now have Jakarta and Manila begun to concentrate on this key area. Uniquely, Beijing has its own water meter factory. The example of Bangkok in reducing unaccounted for water from more than 60 per cent to less than 30 per cent in 10 years is one which others could follow. Beijing helps to keep water losses to a minimum by lowering the water pressure in the distribution system between the hours of midnight and 5.00a.m. Seoul has introduced public awareness campaigns to save water and in its own housing construction projects in the city it uses water saving devices like dual-flush toilets, low-flow showerheads and one-touch faucets. Delhi, which previously operated a water supply and sewerage "undertaking" has now converted to a water supply and sewerage "board" which is expected to give it more autonomy. Tokyo has replaced lead service pipes with stainless steel ones to reduce losses.

In consideration of the urban poor, first priority should go to providing them with safe potable water. In this regard, connections which are illegally made to an intermittent piped water supply service pose a serious health risk. Much more hygiene education and public awareness is needed for the poor. A concerted effort needs to be made to see that the poor are not exploited by water vendors. It is not uncommon in a city like Manila for the poor to pay up to 100 times the unit cost of water paid by those

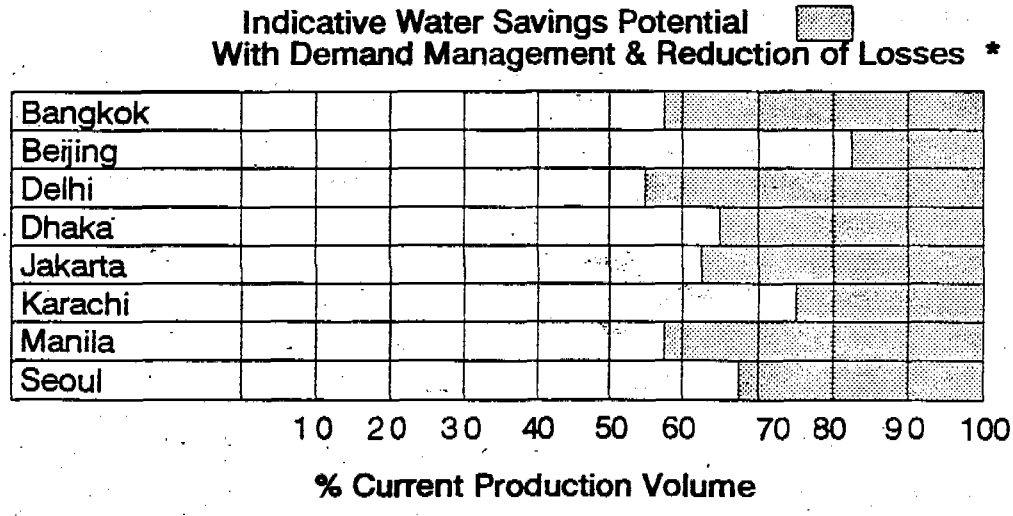
with house connections. A water utility should at the very least provide a bulk supply of water to slums and squatter settlements and then allow the community, assisted if necessary by an NGO to distribute that water. Water connection fees should not be prohibitive to the poor. There is no reason why this fee cannot be absorbed in installments over a period of months or years.

It is time for governments to make official written policy statements regarding water resource management and then let the concerned designated agencies administer those policies. This particularly applies to tariffs and water utility staffing. In the case of tariffs, governments should decree the objective of revenue generation and let the utility set the tariff to achieve it. In the case of staff, the utility should be free to hire and fire staff and pay what is needed to attract the best staff on the open market - as befits a commercial organisation with $50-$100 million annual turnover.

There are still too many water utilities which have been unable to significantly reduce high levels of unaccounted for water. It is time to consider a more sociological approach which takes the methods of Bangkok MWA (with decentralization) one step further from zones of 2000 connections down to zones of 500 connections and incorporates individual caretaker responsibility for each zone. That caretaker should become the utility's day to day interface with the people and serve them in every capacity possible, e.g. assistance in remedying leaking plumbing systems in their homes. He should be able (with modern communications) to respond rapidly to the presence of any visible leaks in the distribution system and discover these himself by walking his territory regularly. It is also time for utilities and governments to take a new look at what is represented by O & M costs. For too long, reduction of unaccounted for water has been considered a capital investment expenditure - but it is not, and should be part of the annual O & M operating budget - not part of a one-off project.

Demand Management was perhaps the most important topic of the consultation. Figure 2 gives an indication of the water savings potential using demand management and reduction of water losses in the subject megacities. It is obvious that such options must be carefully considered before going to the more popular "new sources" solution. It has to be recognised however that until a utility has universal metering and the meters are regularly replaced to ensure accuracy, there is not a great deal

Figure 2



* Assumes 150 lpcd and equivalent reduction of consumption in non-domestic uses. Also assumes 15% unaccounted for water.

which can be done in demand management. Why are we looking at demand management now? The first reason is there has been rapid megacity growth; secondly, tapping new sources has become more difficult and certainly more expensive than in the past; thirdly, water has become more scarce with competing uses and fourthly, investment funds have started to dry up. Another factor is that demands have consistently been over-estimated in the past, partly because alternative sources have been ignored as well as people's willingness to pay for the new service. As a result, revenues expected were not generated. It is finally being realised that water is an economic good and that there is elasticity in the relationship between consumer price and consumed volume. Current tariffs in most of the megacities encourage excessive consumption. They mostly fail to cover financial costs let alone long-run marginal costs or economic costs (which include the externalities of opportunity cost and environmental costs). Excessive consumption leads to increased pollution and premature investment. Demand management can be achieved through mandatory instruments (which are usually for crisis intervention) or through market based instruments (for crisis avoidance). A demand management program may include willingness to pay surveys, reduction of unaccounted for water, water conservation campaigns, pollution charges, groundwater charges, assistance with improving consumer plumbing and most important of all, a tariff structure which penalises excessive consumption. It has equity considerations too, because the water saved can be diverted to the unserved poor.

Wastewater

Separate bureaus or offices for water supply and sewerage seem to operate well in Seoul, as they do in Singapore. Currently there is pressure on MWA in Bangkok to at least provide financial support for the proposed new sewerage/wastewater disposal facilities. Karachi has a successful example of low cost piped sewerage in the Orangi Pilot Project, where communities and NGOs combined to show what appropriate design and community self help can do. Dhaka is proposing "district" sewage treatment facilities in an effort to minimise investment and operating costs. Piped sewerage systems are the preferred solution to wastewater disposal in megacities because they are unobtrusive, avoid the garbage problem, protect the human and physical environment and provide opportunity for water reuse. There is general agreement that these sewerage systems must be separate rather than combined (with stormwater) systems. While investment costs are high, there are economies of scale in megacities and the benefit/cost ratio is high. The investment costs are still only a fraction of that required to provide adequate housing of the same people - and the most compelling argument for sewerage and sewage treatment is the risk of (a) widespread disease and (b) destruction of aquatic organisms serving the food chain. Interceptor sewers, as used along the Han River in Seoul, provide a staged practicable alternative to the final fully sewered solution. Ironically, sewerage systems which work best in densely populated areas of a city, have in the subject megacities been provided initially to the less densely populated high income areas. Remote controlled micro tunnelling is a new technique becoming popular for installing piped sewerage schemes, without the high cost and inconvenience of disturbing the surface. Sewage treatment in megacities normally follows the activated sludge process rather than the oxidation pond approach which is highly land intensive and therefore costly in a megacity. In Tokyo and Singapore more sophisticated treatment processes are used and the facilities are also located below ground for aesthetic reasons. Sewage treatment is often double the cost of water treatment. However a solution which only involves screening and discharge through a marine outfall can be as low as 10 per cent of conventional treatment for sewage. Stabilization ponds located in the sea are being considered now for coastal environments - as a low cost appropriate solution. Water reuse possibilities exist where water sources are located more than 60 km from the megacity. In the meantime, the case studies have indicated that a great deal of improvement can be made in the desludging of existing septic tanks. Typically the O & M requirements seem to be forgotten after the capital investment has been made.

FUTURE FOCUS

Governments

Priority should be given to the preparation of a government policy statement on water resources management. Such statement should require written agreements between agencies with overlapping

jurisdiction; require demand management approaches; require water utilities to be run as commercially viable organizations staffed by the best personnel available on the open market; state the objectives of revenue generation from tariffs imposed by water utilities and make transparent the policy of government regarding any subsidies or cross-subsidies in tariff structures; require water utilities to reduce unaccounted for water (preferably by using more sociological approaches); require industries to adopt water reuse policies; require the water resource management co-ordinating agency to constantly monitor and revise policy, law, organizations and implementation of water resource management so they are mutually compatible and provide the basis for establishment of a permanent blue-ribbon advisory/monitoring committee.

Megacities

Special attention needs to be given to city planning on the one hand (especially the location and control of industries) and population growth control on the other. Collection and disposal of garbage requires more commitment. Hygiene education and public awareness programs about water use, water conservation and water pollution need vigorous and on-going promotion if the risk of an epidemic disease is to be avoided.

Water Utilities

These agencies must acquire the ability to attract and retain competent professional staff who should then administer the stated government policy to the best of their abilities. Emphasis must be given to serving the urban poor with potable water and to reducing the unit cost of water to these people to levels more equitable with the rest of the served population. Utilities should be encouraged to learn from similar agencies with successful experiences in other countries. Financial viability must be the first consideration of every utility, for without that it cannot begin to provide a satisfactory service to its customers.

Universities

There is considerable scope for university post graduate research assignments on intermittent water supplies, unaccounted for water, water metering and water quality monitoring. It is important to learn how much water people would use when the amount they are required to pay for it is varied.

Funding Institutions

Major funding institutions should require a government policy statement on water resources management before beginning to consider a loan for new development in that sector and if necessary have it modified before proceeding with a loan appraisal. They can also help by providing appropriate tools to government agencies, such as the "Water Utilities Data Book."

CONCLUSION

The much heralded water crisis in megacities will only occur as a result of either poor planning or poor management. Good management will ensure there is no shortage of funds for development. Domestic water supply uses only a small portion of the total water resources available to a megacity, and because "municipal preference" ensures domestic water supply is first served, it is unlikely for a water crisis to ever seriously impact large human settlements for any length of time. There are steps which can be taken to minimise the possibility of widespread waterborne disease. We have seen that there is more than one path to sustainable water resource development, but success will only come if that path is pursued with the necessary degree of political will. Discipline is the key ingredient and while (as in school) it can be taught, in the end it must be self-imposed if development is to be sustainable.

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Arthur C. McIntosh is of New Zealand nationality. He obtained a Bachelor's degree in Civil Engineering from the University of Canterbury, New Zealand in 1966. His water supply and sanitation experience includes an initial eight years with consultants in Australia, Canada and New Zealand followed by 16 years with the New Zealand Government, World Health Organization and Asian Development Bank, working in twelve developing countries located in Asia, the Pacific and the Caribbean. With the Asian Development Bank for the last eleven years, he has been the driving force behind a number of regional activities, including a Regional Study on Domestic Shallow Well Water Supplies (with emphasis on sociological approaches to development and women and water), a Water Utilities Data Book for the Asian and Pacific Region (the first of its kind) and the Regional Consultation on Managing Water Resources to Meet Megacity Needs (which is the subject of this presentation.