CHALLENGES AND REALITIES OF WATER MANAGEMENT OF MEGACITIES: THE CASE OF MEXICO CITY METROPOLITAN AREA

Cecilia Tortajada

Megacities—characterized as metropolitan areas of 10 million or more inhabitants—have become an important focus in terms of water provisions, sanitation services and the related impact of urban development on natural resources. While basic needs of residents of smaller cities are very similar, the emphasis placed on megacities lies in the fact that these massive urban conglomerates have grown to almost unmanageable dimensions. This, in turn, has made water provision and sanitation services to the entire population a bleak, if not unachievable, task.[1] In most megacities of the developing world, clean water is both scarce and expensive to produce. Large sectors of the population in such densely populated urban areas do not have access to potable water, and even larger sectors of the population do not have access to sanitation. Non-revenue water—water that is produced and enters the distribution system but that is never billed to consumers because it is lost due to leakages or illegal connections—is up to 30 to 40 percent. Infrastructure is either scarce, becoming complex or deteriorating. In addition, water supplies are largely underpriced and necessary investments are estimated to reach billions of dollars. However, as complex as these matters are, the real challenges in terms of water provision point in another direction. The main problem in urban concentrations, which is further heightened in megacities, is the lack of appropriate management, adequate institutions and sustainable planning to address these challenges beyond short-term approaches.

To provide an overview, this study first analyzes the nature of megacities on a global scale, addressing the delicate relationship between economic development and urban resource management in the face of environmental sustainability. This topic then unfolds through an analysis of the Metropolitan Area of Mexico City (ZMCM), a megacity accounting for approximately 20 to 22 million people and recognized for its diminishing supply of natural resources, among them, freshwater.[2] Emphasis is placed on declining groundwater supply, complexities with infrastructure

Journal of International Affairs, Spring/Summer 2008, vol. 61, no. 2.

and concerns regarding sanitation. While the central focus of this argument is the ZMCM water supply, a comparative analysis points out the similarities and differences among megacities across the globe, such as Dhaka, São Paulo and Bangkok. Ultimately, this paper attempts to demonstrate that the problem of water access in megacities has less to do with water scarcity and more to do with water mismanagement.

Megacities as a Growing Phenomenon

As urban growth continues to increase worldwide at escalating rates, megacities remain a growing phenomenon. According to the Organisation for Economic Cooperation and Development (OECD), as globalization progresses, urban regions—in particular, cities with populations exceeding 10 million people—are playing increasingly important roles in the global economy in terms of competitiveness, thus becoming major centers for both local and national policies.[3] Yet, most megacities have focused on economic growth with almost no consideration for environmental sustainability.[4] As a result, these extensive metropolitan areas have created alarming levels of water and air pollution, solid waste and deterioration of their own natural resources. These problems have also reached surrounding regions affected by urban sprawl. The most serious environmental problems are associated with the disorganized expansion of legal and illegal settlements, over-exploitation and degradation of surface and groundwater sources, air pollution, solid waste and the indiscriminate destruction of natural resources. This has created what seems to be an endless vicious cycle in which the deterioration of the environment has resulted in social erosion and vice versa. Mexico City and its surrounding areas have not been an exception.

While Mexico City has achieved high economic growth, its development is still deeply polarized and asymmetric. Economic and social development has flourished in some parts of the megacity resulting in prosperity, but inequalities have become increasingly acute in other parts of the region.[5] In order to maintain and improve the living standards of a growing population, major investments are needed to protect basic resources. Failing to address environmental degradation—such as shrinking freshwater sources—is counterproductive to economic development in the long-run. This holds true because while most megacities focus on increasing foreign competition and employment at the cost of their natural environment, foreign investors tend to be most interested in megacities that not only have the most appropriate institutions, infrastructure and human resources, but also liveable environments and natural resources that will sustain economic activities.[6]

Although all megacities face similar challenges in terms of access to natural resources—like clean water and ensuring adequate control of air, land and water pollution—these urban conglomerations differ in terms of growth rates, types of population, infrastructural needs and environmental conditions. In the developing world, metropolitan areas tend to have high population growth, consistent needs for infrastructural development and increasing deterioration of their environment. In contrast, in the developed world, megacities tend to have slower urban growth, infrastructures that already need to be replaced and more regard for the protection of their environment. In both developing and developed megacities, migration of formal and informal settlers plays an important role in terms of demand and provision of services.[7] In Mexico City and its surrounding areas, illegal settlements are a critical problem. In 2003, there were 804 irregular settlements in Mexico City with approximately 60,000 families.[8] In Mexico State—the most populated of the country's thirty-two states—illegal settlers are creating mushrooming cities that lack basic services. Much of this population is established not only in valleys and hills, but also in areas prone to flooding, which can result in flood hazards that can destroy entire communities. Legal and illegal settlements in flood-prone areas and their social and economic related costs have been heavily felt in several other megacities in addition to ZMCM, such as São Paulo and Dhaka. In most cases, it is a problem of which control and solutions go beyond the water sector and which is vested in land-use planning institutions.[9]

Due to their differences in terms of population, location, climate, infrastructure and environmental concerns, each megacity needs to plan and implement its own tailored solutions at its own pace according to local economic, social, environmental and cultural conditions. Yet, a common denominator uniting megacities—mainly in the developing world—is that rates of urbanization have surpassed the capacities of both local and national institutions to provide the population with the necessary services. According to the UN Population Division, the number of megacities has increased from sixteen to eighteen from 2000 to 2005 alone, and this number is predicted to reach twenty-seven by 2025.[10] It is noteworthy that the majority of megacities at the global level are located in the developing world (see Table 1).

In spite of urban growth, the percentage of urban populations living in megacities worldwide has remained about 8 percent from 2000 to 2005. On the contrary, it is in urban conglomerates of less than 500,000 people where the percentage of urban population at the global level is still the highest (52 percent) by cities with 1 to 5 million inhabitants (22 percent).[12] This means that, despite the rate of increased urbanization throughout the last decades, the highest percentages of the world population do not live in megacities; they are more likely to live in small or medium-sized cities. While the growth of small and medium sized-cities is projected to escalate and, with it, the challenges of providing adequate water services, it is the megacities that have turned to almost unmanageable dimensions and require a reexamination of water management.

Furthermore, megacities are not restricted to their geographical boundaries but extend to the regions surrounding them. The escalating demands of megacities in terms of clean water, among other basic necessities, have resulted in negative impacts on the surrounding states and regions, which have been forced to supply megacities with additional commodities.[13] Since megacities continue to increase in size, demand requires the implementation of development models based on social equity and environmental considerations, not only at the local level, but also at the regional level.

Despite these bleak realities, alternatives exist to improve the governance of megacities in order to provide citizens with better access to clean water and other services, as well as improved environmental conditions. OECD, for example, suggests that governance-related issues should be addressed at the metropolitan area level in order to maximize the potential of the urban region.[14] Some of the actions mentioned to improve metropolitan governance include encouraging local governments to work in partnership with business communities, introducing greater transparency and accountability in decisionmaking, developing better frameworks for long-term strategic planning, and improving public access to information and public services, all of which could lead to positive results.[15] The limitations that OECD identifies for achieving better governance at the metropolitan level, however, include a fragmentation of the administrative jurisdictions, a strain on the financial and fiscal ability of local authorities as well as the lack of decisionmaking processes that are both transparent and accountable.[16] There is also a lack of ability to coordinate and effectively communicate between cities that form part of metropolitan areas.

Complexities of Water Resource Management in Megacities

From the late 1990s to the present, water management trends have included, at least in theory, the implementation of concepts such as sustainable development, river basin management and integrated water resources management approaches. An emphasis has been placed on multi-sector approaches, as well as higher considerations for social and environmental issues, with increasing importance given to governance-related issues.[17]

In the water sector, attempting integrated approaches has made water management goals even more complicated to implement than before, particularly in the context of megacities due to their sheer size.[18] With the added expectations on implementation of water governance issues, even more complex processes have been introduced—such as transparency and accountability, or multilevel participation and multilevel decisionmaking—even when the most basic and pressing needs in terms of water supply and sanitation have not yet been solved.

Megacities require large investments to cover the needs of all sectors of the population in terms of water supply, drainage and sanitation. However, in addition to

Table 1: Number of cities based on size, urban population and percentage of urban population

Size Class	1950	1960	1970	1980	1990	2000	2005	2010	2020	2025
10 million or more										
Number of agglomerations	2	2	2	4	10	16	18	20	24	27
Population	23,613	30,842	39,489	69,249	144,876	228,726	268,263	307,776	393,619	446,822
Percentage of urban pop.	3	3	3	4	6	8	8	9	9	10
5 to 10 million										
Number of agglomerations	5	10	16	20	20	28	31	33	43	48
Population	31,402	64,520	115,322	149,327	147,151	195,724	217,440	235,469	303,898	336,651
Percentage of urban pop.	4	6	9	9	6	7	7	7	7	7
1 to 5 million										
Number of agglomerations	71	98	142	196	267	334	361	414	495	524
Population	131,091	181,160	262,015	366,178	503,978	636,646	711,205	820,652	992,137	1,057,574
Percentage of urban pop.	18	18	20	21	22	22	22	23	24	23
500,000 to 1 million										
Number of agglomerations	120	156	201	258	328	399	446	477	521	551
Population	81,667	109,886	140,469	179,172	226,084	276,268	312,845	331,978	365,330	389,614
Percentage of urban pop.	11	11	11	10	10	10	10	9	9	9
Fewer than 500,000										
Population	469,023	609,890	774,489	976,625	1,252,464	1,516,545	1,654,882	1,798,732	2,154,686	2,353,571
Percentage of urban pop.	64	61	58	56	55	53	52	51	51	51

Source: World Urbanization Prospects, the 2007 Revision Population Database, United Nations Population Division. See http://esa.un.org/unup/.

the enormous investments, a main constraint for the efficient provision of water supply is that governments have multiple, fragmented institutions with responsibilities that are often not clearly defined or overlap with each other. This makes any long-term decisionmaking almost impossible, leaving strategic planning in the utopic realm, resulting in escalating degradation of the urban environment.

Although considered basic needs, water supply, drainage and sanitation are not always an investment priority in megacities. This is because lack of water, both in terms of quantity and quality, does not affect the entire population to the same degree. In general, wealthier populations have access to tap water in their houses, as well as functioning drainage and sewage systems, while less affluent sectors of the population depend on standpipes or purchase their water from vendors. Many poor regions are either connected to a public sewer or septic tanks, or have to dispose their wastewaters in surrounding rivers, lakes or even on their own property. Lack of tap water and drainage in megacities, therefore, is a problem faced by less affluent sectors and is therefore their problem alone. Sanitation is an increasingly serious issue which only a select few communities have to face directly but which affects the health of the entire region.

As previously stated, water management also faces the complexity of flood-prone zones. For example, the number of humans exposed to floods has tripled during the last two decades to almost 2 billion at present.[19] The main reason behind this problem is the concentration of hundreds of millions of people in mushrooming cities in both deltas and floodplains. On the other hand, megacities sprouting in arid and semi-arid regions face water scarcity on a daily basis, not only because of mismanagement but also because of an actual water scarcity problem to begin with. Regarding water for irrigation, megacities devour enormous amounts of provisions which have to be transported from the countryside, often at great distances.

Megacities and the Escalating Case of Water-related Challenges

The debate on water resource management in the international arena most often focuses on integrated water resources management, river basin management, good governance and public participation. In spite of this rhetoric, priority in megacities is the provision of clean water even at increasing social, economic and environmental costs.

Investments for water supply and sanitation in the developing world, including megacities, has escalated considerably. In the case of Mexico, water supply and sanitation investments were estimated to be $1.7 billion per year in 2002.[20] In 2005, China invested a total of $9.7 billion on flood control, infrastructure, soil, water and ecological projects and hydropower development.[21] At this point, many scholars and water activists have pointed out the failures of achieving the development goals at the international level; cities provide water that is not always potable, and collection of sewage has been conveniently considered as sanitation even when it is not treated.[22]

Varis et al. summarize the situation and future prospects of seven rapidly expanding megacities in various parts of the developing world: Jakarta, Johannesburg, São Paulo, Mexico City, Riyadh, Istanbul and Singapore.[23] In their analysis, the authors conclude that megacities are dramatic cases of urbanization and water-related challenges. A main constraint is that even though the provision of water for various sectors is quite important, water is not the only aspect of infrastructure development needed in megacities. Transportation, energy and housing should also be developed.

The water footprint of a megacity goes far beyond its city limits. Megacities import food from the international food trade, the bulk of which has been produced using water irrigation practices. Megacities also import massive amounts of other resources such as energy, metals and fiber products, which can interrupt hydrologic systems, both qualitatively and quantitatively. In order to be sustainable, megacities need flourishing economies, strong social and environmental policies, proper governance systems and adequate mechanisms for public participation. All of these aspects are intertwined with the various roles that water plays in megacity development, and the water sector is often an important contributor.[24]

Finally, economic growth, as well as social and environmental factors, should be considered simultaneously. Competitive megacities are better able to attract resources to invest in infrastructure, thereby providing quality services for the population and, in turn, better economic and social opportunities for large sectors of their population. The challenges to achieving this are immense. However, initiating the necessary processes and frameworks for financing, managing, maintaining and providing efficient services, as well as finding long-term solutions that combine social, economic and environmental view points, is necessary. Otherwise, freshwater access and sanitation become unmanageable.

Water Governance in the Mexico City Metropolitan Area

Applying this overview of megacities to a case study, this section offers examples of the complexity of clean water services faced by the ZMCM. It is important to stress that, more often than not, inefficient, costly and unreliable water supply services in Mexico City are the result of inappropriate management practices, not merely the result of an actual scarcity in water supply.[25] To reiterate the size of this megacity, the ZMCM has an approximate population of 20 to 22 million people.[26] It generates approximately 35 percent of the national GDP in Mexico, which makes it strategically quite important from both an economic and political standpoint for the country.

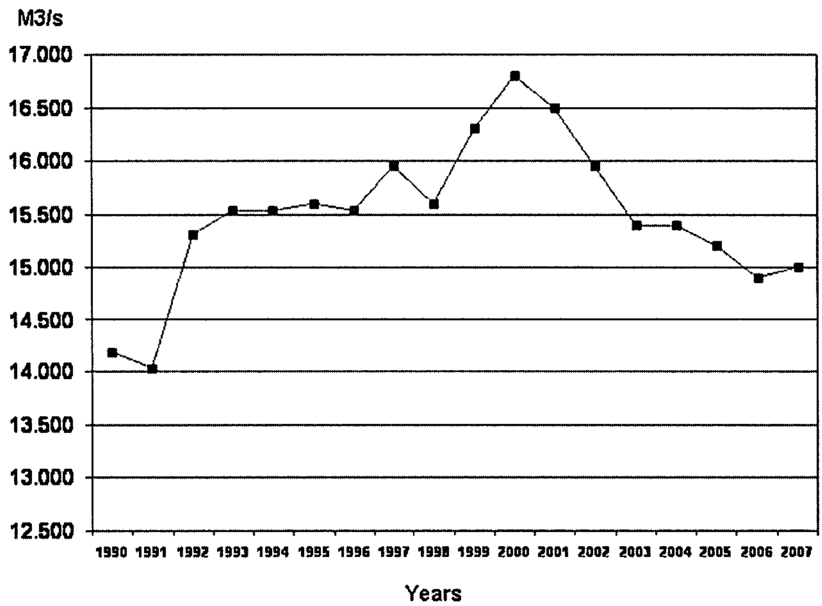
High rates of migration, in addition to rapid urban development, have made Mexico City not only one of the largest cities in the world, but also a city with one of the highest population growth at the global level.[27] The phenomenal growth rate witnessed between 1950 and 2005—from 2.9 million people to more than 20 to 22 million at present—has made it almost impossible for institutions to respond to the rapidly increasing needs of the population in terms of water supply, drainage and sanitation.

The rapid growth of the ZMCM has been the result of policies that have favored social services, long-term major investments in all sectors (energy, water, transportation, telecommunications, etc.) as well as heavy subsidies and industrial production. Even though government planning strategies have been focusing on decentralization efforts for decades, tax subsidies, as well as numerous social, political, educational and cultural factors, have made the city more attractive than other regions within Mexico.[28]

The multiple levels of public sector institutions that are involved in the solution of water-related problems make decisionmaking a very complex process not only in the ZMCM, but in all megacities. In Dhaka, a city with approximately 12 million inhabitants, organizations responsible for water supply include government institutions at the federal, city and municipality levels, the private sector and even donors.[29] The World Bank, for example, was the main donor of the Fourth Dhaka Water Supply Project and insisted that changes in governance and management be implemented at both the Dhaka Water Supply and Sewerage Authority (DWASA) before the credit was approved.[30] In the case of the São Paulo Metropolitan Area, decisionmaking in water-related issues for their 18 million people involves federal, state and municipal levels of the city of São Paulo, as well as the additional thirty-nine municipalities that form part of the megacity.[31]

The ZMCM includes two different political entities and their several levels of government. Decisionmaking depends on decisions based in the sixteen boroughs of Mexico City, thirty-seven municipalities in the Mexico State—each municipality consists of an independently elected representative—and the private sector companies which are also involved in service provision. Another important issue is that from 1997 onward, the citizens of Mexico City were able to elect their own government. Prior to this, the mayor of Mexico City was appointed directly by the president, who, from 1929 until 2000, belonged to the same political party. The government of Mexico City, therefore, has often been considered an extension of the federal government, with criteria and priorities mirroring that of the federal government.[32] This means that, for better or for worse, there was agreement on the policies that would be followed in the metropolitan area. Currently, the different political parties represented in the governments (federal, state, boroughs in the case of Mexico City and municipalities in Mexico State) have diverse interests, priorities and criteria. This

Figure 1



diversity, while unquestionably positive in terms of democracy, has resulted in a more serious lack of coordination and agreement in terms of economic, social and environmental policies. The reality is that political criteria prevail even when this is not always positive for the megacity.[33]

Groundwater Supply in Mexico City and Beyond

The added complexity of the ZMCM for its water management, in addition to its large population and fragmented government, is that it is located in a naturally closed basin, making it vulnerable to floods. In addition, its own rivers have become wastewater canals. Furthermore, increasing subsidence has resulted in extensive damages to the water supply and sewerage infrastructure, as well as degradation of the quality of the groundwater on which its own survival depends.[34]

The water supply in ZMCM will provide for 20 to 22 million people; the economic sector depends primarily on local groundwater sources (70 percent) and on inter-basin transfers from outside basins. Infrastructure for distribution of water within the city has become very large and complex. It is comprised of sixteen dams having a total storage capacity of more than 2,800 cubic kilometers, a primary network with more than 1,000 kilometers and a secondary network with more than 12,000 kilometers.

In order to supply the necessary water for the needs of the social and economic sectors of the megacity, the rates of extraction from the aquifer have been much higher than the recharge rate for decades. At present, approximately 45 to 54 cubic meters per second is abstracted per year, but the natural recharge rate is only about half of this figure.[35] This has resulted in very serious overexploitation, with the groundwater table decreasing by around one meter each year. It is estimated that approximately 670 legal wells exist for groundwater extraction.

Likewise, the megacity of Dhaka, Bangladesh, depends heavily on groundwater. The water supply system for the city that was constructed more than one hundred years ago was based on surface water. However, the cheaper and easier option was the availability of groundwater, which resulted in a supply system based on groundwater. At present, with surface waters heavily polluted, institutions face the challenge of providing services to a population increasing at approximately 6 percent per year, while simultaneously trying to reduce dependence on groundwater. This is a system that is clearly unsustainable.[36]

Available data indicate that the groundwater table is falling at an alarming rate of more than 2 meters per year. Groundwater is being mined in significant amounts. Consequently, the discharge of the tube wells are being reduced at a much faster rate resulting in higher cost of pumping and drying up of the bore holes. The life of bore holes has been reduced from twenty years in the late 1960s and early 1970s to less then five years now. Investment in new deep wells is quickly becoming economically unattractive.[37]

Deficit between supply and demand is expected to widen again from 2004 but at a much faster rate due to the inability of the DWASA to secure necessary funding for the construction of two more surface water treatment plants. At the same time, construction of new and replacement old deep tube wells will not produce designed discharge as the groundwater reservoir of both the primary and secondary aquifers have nearly been exhausted. Though a new initiative of exploiting deep aquifers (more than 300 meters deep) have yielded some promising results in a certain area of the city, any large scale development of the deep aquifer will have to be carefully evaluated for its technical, economic and environmental viability.[38]

According to official figures the water extracted from the aquifer to supply water to the population of Mexico City from 1990 to 2007 has reached almost 17,000 cubic meters per second. This figure is significantly higher that the groundwater recharge rate, illustrating how this trend in groundwater extraction is unsustainable (Figure 1).

The problems related to the extraction of groundwater in Mexico City are not new. Several issues relating to the city's survival were identified decades ago. Since soil is composed of clay, the more water that is abstracted from the aquifer, the more susceptible the soil is to compaction. Subsidence of several parts of the city has resulted in extensive and costly damages to both surface and below ground infrastructure, including water supply and drainage.

The ZMCM is not the only megacity which suffers from severe subsidence. Bangkok is also affected by subsidence in certain areas of the city. In the case of Bangkok, subsidence rates are estimated to be 1.5 to 2.2 centimeters per year as of 2001, a much lower figure compared to that of one decade ago which was 5 to 10 centimeters per year.[39] In comparison, the central area of the ZMCM has subsided approximately 10 meters during the 1900s, varying from 10 centimeters per year in the central area to 20 to 25 centimeters in the area of the International Airport of Mexico City.[40]

Both megacities have established mitigation measures in the attempt to reduce the abstraction rates of their aquifers. These have included policies, economic disincentives and, in the case of ZMCM, protection of conservation or rural areas for natural recharge purposes. However, conservation areas are under increasing threat because of steady growth in both urban and rural areas. Regarding rural growth, 35 of the 44 rural settlements that still exist in Mexico City and which include 400,000 people, are also located in conservation areas.[41]

Access to Tap Water in Megacities

In terms of access to water, in the developed megacities, such as in London and New York, all residents normally have access to tap water in their houses. In the developing world, a common problem in most megacities is that millions of their inhabitants do not have access to clean water in their houses or nearby. These populations depend on either standpipes, vendors or provision of water from tankers provided by the public sector. In these cases whether or not residents are consuming good quality water is uncertain.

In ZMCM, as in the São Paulo Metropolitan Area, approximately 90 percent of the population has access to water, either through a water connection directly to the house or from common faucets in the neighbourhood.[42] In the case of ZMCM, most of the water sources are located to its west, north and south.[43] Thus, the water supply is irregular and unreliable for the population living in the eastern part of the city, the subsection most affected by water shortages. An alarming figure is that in Jakarta, only approximately 41 percent of the population had access to tap water in 1996, a figure which increased to 56 percent in 2003 despite the changes in the institutional arrangements and the involvement of the private sector.[44]

Non-revenue waters are one of the main challenges facing megacities both in developed and developing countries. The Office of Water Services (OFWAT)—a water regulatory agency of England and Wales—provided Thames Water (a private sector company) a target to reduce water losses to 805 million liters per day for 2006-2007. In Mexico City and its surrounding areas, non-revenue water is approximately 30 percent. In the case of Tokyo, on the other hand, non-revenue water accounts for only 9 percent.

Lack of investment tends to be the most frequently mentioned reason for high, non-revenue water. However, lack of managerial skills and manpower, as well as inefficiency and poor planning, are also considered major causes for the low performance of utilities providing the water supply.

Unreliability of water quantity results in extra expenditures for certain sectors of the society in ZMCM. In fact, it is estimated that the population without access to tap water pays 6 to 25 percent of their daily salaries in purchasing 200-liter containers of water.[45] Nevertheless, mistrust in the quality of Mexico City's tap water also has negative impacts in terms of extra expenditures for all sectors of the society irrespective of their economic status. Drinking water for most of the people in the ZMCM, even when they have access to tap water, comes mostly from 20 to 30 liter containers of drinking water that are sold commercially. A main problem, however, is that companies that bottle water in the ZMCM are not monitored and thus water quality of the containers is not always in accordance with the specific norms and regulations.[46]

The perception that the quality of tap water is not suitable for drinking purposes has an enormous impact on the economy of the country. Mexico is the second largest consumer per capita of bottled water in the world, with consumption increasing from 11.6 billion liters in 1999 to 17.7 billion liters in 2004.[47] At present, per capita bottled water consumption in Mexico is nearly twice that of the United States, even though its per capita GDP is about one sixth that of the United States.

The Third World Centre for Water Management has carried out analyses on water quality in Mexico.[48] According to this study, in 2005 alone, the expenses due to waterborne diseases in the country were estimated to be $260 million, with the highest mortality in population between zero and four years of age and above sixty-five years of age. Nevertheless, despite the economic importance of the impacts that water-borne diseases have had on the country for decades, these findings have not been documented thoroughly and addressed properly by health and water-related institutions. In summary, the problems related to the drinking water supply in megacities include multi-dimensional, multi-sectoral and multi-regional issues, which depend on the interests and capabilities of more than one institution and which require multi-stakeholder coordination.

Wastewater Collection

In addition to water supply, the other main challenge for megacities in terms of water is collection of wastewaters and their proper treatment and disposal. It is said that 2.6 billion people lacked improved sanitation facilities in 2002, which is a number too big to be ignored by governments and by the international community.[49]

Table 2

Year	Drinking Water		Sewerage	
	Kw	Cost (US $)	Kw	Cost (US $)
2000	591,829,613	38,321,468	84,842,136	5,710,795
2001	566,768,577	39,530,171	99,243,291	5,346,993
2002	588,677,032	46,346,748	74,017,076	6,916,613
2003	576,205,581	48,835,272	96,594,510	8,776,726
2004	607,504,879	57,002,123	86,928,012	9,133,175
2005	597,053,712	60,505,762	98,899,836	11,222,121

Source: Sistema de Aguas de la Ciudad de Mexico, personal communication, 2008.
Note: Exchange rate 1 US dollar = 10.8825 Mexican pesos

Not even the United Nations considered sanitation important enough to be included in the Millennium Development Goals. It was not until the World Summit on Sustainable Development organized in Johannesburg in 2002 that sanitation goals were considered as a part of a global effort to improve the quality of life of the populations as well as quality of the environment.

In the ZMCM, about 50 cubic meters per second of wastewaters are disposed without treatment.[50] Almost all of this water is used for irrigation purposes, resulting in very significant health and environment-related problems and concerns.[51] In 1996, the Inter-American Development Bank approved a $1,035 million project for the Mexico Valley Sanitation Project. Unfortunately, this much-needed project did not proceed, mainly due to economic and political reasons.[52] In 2004, water institutions from Mexico City, Mexico State and institutions at the federal level were working jointly with the Inter-American Development Bank (IDB) and the Japan Bank for International Cooperation (JBIC) to develop the terms and references related to the construction of four wastewater treatment plants. The total budget for this project was approximately $1 billion, of which IDB would contribute $365 million for the collectors system, the JBIC would provide $410 million for the wastewater treatment plants and the federal government, Mexico City and Mexico State governments would provide $260 million.[53]

This enormous sanitation project was abandoned for years by the federal government, Mexico City and Mexico State authorities, being reconsidered only recently. Seven treatment plants, instead of the seven mentioned initially, are now expected to be constructed with a total capacity of 40 cubic meters per second.[54]

The approximate investment will be $2,345 million. Only time will tell if the project will be completed.

Energy Consumption and its Relation to Water

Concerning energy, megacities require massive quantities of power. Megacity residents consume about five to ten times the energy of the national average. In addition, all large-scale electricity generation requires an enormous amount of water, either as hydropower or for cooling purposes, as do bioenergy sources, making water an important prerequisite to satisfy the energy requirements of megacities.

For the ZMCM, the daily consumption of fuel in 2004 was estimated to be 306,000 barrels equivalent of gasoline or petrol, or 48.6 million liters per day. In 1990, the estimated figures were 37 million liters per day, that is, there was an increase of 31 percent in fourteen years.

Drinking water to Mexico City has to be pumped to a height of more than 1,000 meters.[55] Equally, because of the increasing soil subsidence, wastewater also has to be pumped up to discharge from the city. The above has made water supply and sewerage very energy-intensive and expensive. In 2000, for example, energy used in the ZMCM on pumping clean water, treating water for drinking purposes and collecting wastewater and rainwater was 2.436 Peta Joules.[56]

Table 2 shows the consumption of energy in Mexico City from 2000 to 2005 to supply clean water to the users of Mexico City, as well as to transport wastewater out of the city. As it can be observed, the necessary energy needed to pump clean water has cost the country almost $600 million per year between 2000 and 2005.

Strategies for Drinking Water and Sanitation: Lagging behind the Needs

Strategies to increase water supply and sewerage services have focused mainly on infrastructure development throughout the years. The different strategies (e.g., the 1995 Master Plans for Drinking Water and for Sewerage for Mexico City) have outlined the necessary infrastructure to improve supply, storage and transportation of drinking water in Mexico City, as well as the storage, transportation and disposal of wastewater and stormwater.[57]

For several years now, the program on drinking water for the ZMCM has considered constructing new infrastructure to transfer more water to the metropolitan area from even more distant and expensive sources. These alternatives have considerable economic, social and environmental costs.

In the case of the transfer of water from Cutzamala River, the construction of its fourth stage would have an initial investment of $502 million to increase the volume of water only by 5 cubic meters per second, from 19 at present to 24 cubic meters per second.[58] If the water transfer from the Amacuzac River was implemented, in addition to the cost of the infrastructure, the annual electric power consumption for this system would be about 5 percent of the annual national electricity production, representing 16.5 million barrels of oil per year. In terms of investment, each cubic meter of water from the Cutzalama River is estimated to require an investment of $23 million. This figure would increase by a factor of four if the source of water were the Amacuzac River.[59] This is a very clear example of the costly impacts that the disorganised growth of the megacity has imposed in the surrounding regions, creating acute economic, social and environmental problems.

Considering the above, it will certainly be more acceptable from the economical, social and environmental view points to implement demand management practices like reduction of unaccounted losses, water pricing and other water conservation practices, before embarking upon extremely expensive new water development projects, with high social and environmental costs.

It is estimated that the large volumes that are lost due to leakages in the distribution systems in the ZMCM—representing between 30 and 40 percent of the total volume of water that it is distributed—are second only to human consumption. It would thus be preferable to focus first on repairing the distribution networks before embarking on such expensive projects, especially if water would still not reach the consumers due to the losses.[60]

As Iracheta mentions, water in the metropolitan area is both scarce and expensive.[61] In spite of this fact, water is not reused or treated after use but discharged raw, with the associated environmental and health-related problems, to another basin. Unfortunately, even then, long-term and rational planning, as well as coordinated policies for the development and management of the metropolitan area, including water resources, is still not the priority for the federal government or the government of Mexico City and Mexico State.[62]

In 2003, the government of the Mexico State filed a lawsuit against the federal government and the government of Mexico City. This occurred as a result of the lack of response from the federal government and city government to the request of the government of the Mexico State to renegotiate the agreements to transfer water to Mexico City from one of its sources, the Lerma River. The lawsuit demanded the payment of $2.5 billion as compensation for the use of water from the Alto Lerma from 1970 up to that moment. It also demanded that the federal government become responsible for the operation of the infrastructure, which is operated by the government of Mexico City since the construction of the projects even though they are located in Mexico State. Finally, it demanded that the federal government implement actions to recharge the aquifers.[63] Even though Mexico City pays the federal government for the rights for the bulk water it receives from the Mexico State, the lawsuit from the Mexico State asked for compensation for the environmental damages that have been caused due to the overexploitation of the Lerma River.[64] The decision of the Supreme Court was expected to set precedents for similar cases in the future. However, in October 2005, the newly elected governor of the Mexico State publicly declared that he would withdraw the lawsuit, since he preferred to work with the federal and Mexico City governments to find an amicable solution.

Solutions on the Horizon: When Efficiency Overcomes Size

While the size of the geographical area does matter, so too does the planning and effectiveness of decisionmakers. There are two urban conglomerates in the developing and developed world, respectively, which have lately improved the provision of water supply and sanitation to their populations to levels higher than any city in the United States or Western Europe, irrespective of their size in terms of population. These are Phnom Penh, Cambodia and the country of Singapore.

In the case of Phnom Penh, in 1993, the non-revenue water was 70 percent, the tariffs (as is typical in all developing country cities) were lower than the cost of water produced and the water utility faced serious economic and human resources constraints. Their billing system was quite inaccurate and the actual volume of water billed represented approximately 28 percent of the production. From those actually billed, the collection ratio was only about 50 percent.[65] Finally, the total annual income was only about 0.6 billion Riels, against an operating cost of 1.6 billion Riels.[66]

By 2006, the Phnom Penh water utility developed an operational billing and collection system through which the customer database increased from about 20,000 in 1993 to almost 160,000 in 2006, and the collection ratio increased to 100 percent. The tariffs have been increased to more realistic values, and non-revenue water is now less than 10 percent (lower than London and similar to Tokyo). The difference in Phnom Penh was achieved as a result of leadership, political support, managerial skills and human resources development.[67] The water supply in Phnom Penh provides clean water now to 100 percent of the population, a striking difference from only ten years ago.

Singapore is an exceptional example of what planning and management, as well as long-term vision, can achieve in a period of time as short as forty years. Singapore, being a water-scarce country due to a limited amount of land where rainfall can be stored, has developed—and implemented—innovative solutions that have included both demand and supply management strategies. Demand management strategies have included water transfer from the state of Johor in Malaysia, management of their reservoirs, desalination and development of very high technology to treat used water and produce very high quality water, known as NEWater. Supply management strategies have included conservation practices, tariffs to promote water conservation and large public education campaigns. Overall planning and management strategies developed in Singapore have not been matched anywhere in the cities of the developed world, irrespective of their size.

It has been said that solutions in Singapore can be implemented because of the small size of the city-state. Nevertheless, supply and demand management strategies are, or should be, common practice everywhere, especially in megacities where the needs to properly manage the water resources available is more pressing due to the size of the population that has to be served. For water policies to be useful for the cities and their population, these management strategies have to be implemented. In only a few cases is there the will, the skills and the vision to implement them. Singapore is one of these few cases.

Further Thoughts

The supply of clean water and sanitation services in megacities should be viewed as an integral component of rapidly expanding urban areas. Clean water and sanitation services should not be considered in isolation, but instead in relation to issues such as their geography, climate, population growth, urbanization, migration, economic development and social expectations. While most of the cities in the developed world are growing slowly, cities in developing countries are growing in a disorganized and unplanned manner, resulting in heightened pressures to provide water supply and sanitation services to their ever-growing populations.

Provisions of services do not only include operational alternatives, such as the development of massive infrastructure, which is a necessary, but not always ideal, alternative. They also involve the development of a very complex series of issues that have to be adapted to each case, which include management aspects, governance concerns and decisionmaking adaptations—mostly shared between several actors—to suit the local conditions, develop a basket of economic instruments as alternative measures and encourage human resources skills to accelerate socioeconomic development.

An issue that is normally disregarded, but is of high importance, is that economic activities and naturally available water resources—rainfall, springs, lakes or rivers—do not always go hand in hand. In addition, most megacities have either exploited or polluted their surface and groundwater resources, making it necessary to transport water—many times hundreds of kilometers—at increasingly higher economic, social, environmental and political costs in order to cover their own needs.

Finally, megacities are faced with challenges that require immediate action. One of the most important challenges is governance. Governance-related issues are not just the domain of the government any more. The increasing participation of the private sector and societal actors—who are willing, and also demanding, to participate in solving problems that affect them—has made decisionmaking very complex. These complexities increase exponentially within the context of a megacity. Nonetheless, improving water governance in megacities should be of the utmost concern.

NOTES

1 World Health Organization, United Nations Children's Fund and Water Supply and Sanitation Collaborative Council, *Global Water Supply and Sanitation Assessment 2000 Report* (New York: United Nations, 2000).

2 The ZMCM has more than 20 million inhabitants living in approximately 5,000 km^2, or 20 percent of the population at the national level in 0.25 percent of the land of the country, with population densities that vary from 130 to 13,500 persons/km^2.

3 *Reform of Metropolitan Governance* (Paris: OECD, 2000).

4 According to a survey conducted by the Economist Intelligence Unit's Liveability Ranking, only two megacities are within the first fifty most liveable cities: Tokyo in 16th place and London ranked 47th. This survey assessed living conditions in more than 125 cities in the world and considers forty indicators in the categories of stability, health care, culture and environment, education and infrastructure. See also "The Reinvention Test," *Economist* (3 May 2007).

5 Government of the Federal District (Mexico City) and the National Institute of Geographic and Information Statistics (Instituto Nacional de Estadística, Geografía e Informática [INEGI]), "Estadísticas del medio ambiente del Distrito Federal y Zona Metropolitana 2002," *Environmental Statistics of the Federal District* (Mexico City: INEGI, 2005).

6 Siemens AG, "*Desafíos de las megaciudades,*" (Munich: Siemens AG, 2007).

7 UN-Habitat, United Nations Human Settlements Programme, *Innovative Policies for the Urban Informal Economy* (Kenya: United Nations, 2006).

8 *Una visión del sistema urbano ambiental* (A Vision for the Urban Environmental System), (Mexico City: CentroGeo, 2003).

9 United Nations Development Program, *Beyond Scarcity: Power, Poverty and the Global Water Crisis* (New York: UNDP, 2006).

10 United Nations Population Division, *World Urbanisation Prospects* (Revision Population Database: 2007), http://esa.un.org/unup/.

11 United Nations Population Division, http://esa.un.org/unup/p2k0data.asp.

12 Ibid.

13 Olli Varis, "Megacities, Development and Water," *International Journal of Water Resources Development* 22, no. 2 (June-December 2006), 199-226.

14 In this context, a metropolitan area is considered a large population nucleus, together with adjacent communities with a high degree of social and economic integration. Also, the OECD in "The Reform of Metropolitan Governance," states that governance "defines the process by which citizens collectively solve their problems and meet society's needs, using government as an instrument" (October 2000), http://www.oecd.org/dataoecd/3/17/1918016.pdf.

15 Ibid.

16 Ibid.

17 Cecilia Tortajada, "Intentos del nuevo milenio hacia el desarrollo sostenible" (delivered to the City Council of Zaragoza, Spain, Agenda 21: 2007).

18 Cecilia Tortajada, "Who has Access to Water? Case Study of Mexico City Metropolitan Area," *Water Resources Development* 22, no. 2 (June 2006) 353-376. This is an occasional paper to serve as background for the United Nations Development Programme (UNDP) report, *Beyond Scarcity: Power, Poverty and the Global Water Crisis* (New York: 2006).

19 Varis (2006).

[20] Mexico Country Paper (Washington, D.C.: Inter-American Development Bank, 2002).

[21] Geoff Bridges, *Asian Water Development Outlook 2007: The People's Republic of China* (Manila: Asian Development Bank, 2007).

[22] Asian Development Bank, *Asian Water Development Outlook 2007* (Manila: Asian Development Bank, 2007); and Asit Biswas (Stockholm Water Prize Laureate Lecture, World Water Week, Stockholm: 2006).

[23] Olli Varis et al., "Megacities and Water Management" in *Water Management for Large Cities*, ed. Cecilia Tortajada et al. (London and New York: Routledge, Taylor and Francis Group, 2006), 191-208.

[24] Ibid.

[25] Organisation for Economic Co-operation and Development (OECD), Economic Surveys (Mexico and Paris: 2002).

[26] See footnote #2.

[27] Tortajada (2006).

[28] Albert Chong and Florencio López-de-Silanes, "Privatization in Mexico," Inter-American Development Bank (Washington, D.C., August 2004).

[29] Azharul Haq, "Water Management in Dhaka," *International Journal of Water Resources Development* 22, no. 2 (2006), 291-311.

[30] Ibid.

[31] B.P.F. Braga, M.F.A. Porto and R.T. Silva, "Water Management in Metropolitan Sao Paulo" in *Water Management for Large Cities*, ed. Cecilia Tortajada, et al. (London and New York: Routledge, Taylor and Francis Group, 2006).

[32] Government of Mexico City, Ministry of Environment of Mexico City and Friedrich Ebert Foundation, Towards the Agenda 21 of Mexico City (Mexico: Friedrich Ebert Foundation, 2004).

[33] Ibid.

[34] Water quality of the aquifer has been a main problem for years. Coliforms as well as bacteria responsible for gastroenteric diseases and acute diarrheas have been found in the southern and western parts of the city, with the highest contamination in the center of the Mexico City. The gastroenteric diseases which result from the consumption of unclean water have been for years a main cause for child mortality at the national level and at the level of the ZMCM. See Soto et al., in M. Mazari-Hiriart, L. de la Torre, M. Mazari-Menser and E. Escurra, *Mexico City: Depending on its Water Resources, Ciudades 51* (Puebla, Mexico, July-September 2001), 42-51.

[35] National Institute of Statistics, Geography, and Informatics.

[36] Haq (2006).

[37] Ibid.

[38] Ibid.

[39] Bangkok State of the Environment (Land Subsidence: Bangkok, 2001), 44-47.

[40] Government of Federal District and INEGI.

[41] Government of Mexico City et al.

[42] Braga (2006).

[43] Cecilia Tortajada, "Water Management in Mexico City Metropolitan Area," *Water Resources Development* 22, no. 2 (June 2006), 353–376.

[44] Achmad Lanti, "A Regulatory Approach to the Jakarta Water Supply Concession Contracts" in *Water Management for Large Cities*, ed. Cecilia Tortajada, et al. (London and New York: Routledge, Taylor and Francis Group, 2006).

[45] Tortajada (June 2006).

[46] Boris Marañón Pimentel, "Los costos económicos en salud asociados al deficiente servicio de agua potable: el caso de las enfermedades diarreicas en México," (report for the Centro del Tercer Mundo para Manejo del Agua, A.C., Mexico City; 2008).

47 J.G. Rodwan, "Bottled Water 2004: U.S. and International Statistics and Developments," *Bottled Water Reporter* (April/May 2004).

48 Boris Marañón Pimentel, "Economic and Health Costs Related to the Lack of Reliable Drinking Water Supply Services in Mexico City," (2008) In press.

49 "Water for Life: Making it Happen" (Geneva: World Health Organisation, 2005).

50 In the case of Jakarta, only 1.9 percent of the population has access to drainage. See Lanti (2006).

51 Globally, ZMCM is the largest single producer and exporter of wastewater that is used for agricultural purposes. From the beginning of the 20th century, wastewater from the city has been diverted to the Mezquital Valley, about 100 kilometers north of Mexico City. This area has become an important agricultural area by using this untreated wastewater, with 110,000 ha of official and unofficial command area, and more than 50,000 water users in the different irrigation districts. The continuous transfer of wastewater for over a century and the excessive irrigation by the farmers to counteract its salinity have resulted into groundwater recharge of the local aquifer. The groundwater level table has gone up and several springs have appeared, becoming a source of water for the local population. Unfortunately, no serious and reliable study is currently available on the quality of groundwater or the springs in the valley, as well as their overall impacts on human health and the environment.

52 STAT-USA (2004), http://www.stat-usa.gov.

53 Alfonso Iracheta, "Estado de México: la otra cara de la megaciudad," *México Megaciudad: desarrollo y política, 1970-2002,* P. Ward (Mexico City: Porrua, 2004), 491-603.

54 CONAGUA, *Equilibrio Ecológico en el Valle de México: Necesidad Vital,* Coordinador de Asesores, Comisión Nacional del Agua, Ciudad de México.

55 Government of Federal District and INEGI.

56 Secretaría del Medio Ambiente del Distrito Federal, "Estrategia local de acción climática del Distrito Federal" (Mexico City: Secretaría del Medio Ambiente del Distrito Federal, 2006).

57 Dirección General de Construcción y Obras Hidráulicas, Gobierno del Distrito Federal, *Plan Maestro de Agua Potable del Distrito Federal (1997-2010)* (México; DGCOH, 1997), DGCOH, *Plan Maestro de Drenaje Profundo (1997-2010)* (México: DGCOH, 1997).

58 The total cost of the Cutzamala System at $1,300 million (mainly construction and equipment costs) was higher than the national investment in the entire public sector in Mexico in 1996, in the areas of education ($700 million), health and social security ($400 million), agriculture, livestock and rural development ($105 million), tourism ($50 million), and marine sector ($60 million). For a detailed analysis, see Cecilia Tortajada, "Water Supply and Distribution in the Metropolitan Area of Mexico City," *Water for Urban Areas,* ed. J. I. Uitto and A. K. Biswas (Tokyo: United Nations University Press, 2001).

59 Instituto Nacional de Estadística, Geografía e Informática, "Cuaderno estadístico de la Zona Metropolitana de la Ciudad de México" (Mexico City: INEGI, 2003).

60 There is a disagreement in the information related to the volume of water that is lost in the ZMCM due to the leakages. In 2000, the Mexico City government estimated that this volume was about 11.233 m^3/s, or 32 percent, while independent sources mention that this figure was 22.94 m^3/s, but representing 37 percent. See Iracheta (2004).

61 Iracheta (2004).

62 Ibid.

63 Perló Cohen, Manuel González Reynoso and Arsenio González-Reynoso, "Guerra por el agua en el Valle de Mexico? Estudio sobre las relaciones hidráulicas entre el Distrito Federal y el Estado de México," Programa Universitario de Estudios sobre la Ciudad, UNAM, Friedrich Ebert Stiftung y el Gobierno de la Ciudad de México (2005).

64 In 2001, the Mexico City government paid the federal government approximately $109 million, or $299,000 per day. See Iracheta (2004).

65 http://www.adb.org/Water/Champions/chan.asp.

66 Ek Sonn Chan, "Bringing Safe Water to Phnom Penh´s City," Phnom Penh Water Supply Authority, Cambodia, presented at the workshop, "Thirty Years from Mar del Plata," organized by the International Center for Water and Environment, in Zaragoza, Spain, March 2007. See also http://www.rmaf.org.ph/Awardees/Lecture/LectureEkSon.htm.

67 Ibid.