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Challenges Facing the Management of Water Resources

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Water is the lifeline of our planet. Across various cultures, we share a common perspective with regard to water as a symbol of reconciliation, healing and regeneration. Water is not only essential for sustaining human life, but also important for public health, food and energy production, and hence the prosperity of our society. Despite this common perspective, however, there is no global consensus on standards for important indicators such as the minimum per capita requirement for water. Various organizations and researchers have advocated different standards, ranging from 20 liters per capita per day (lpcd) for *basic domestic health and hygiene needs* (according to the United Nations Children's Fund [UNICEF] and the World Health Organization [WHO]), to 4,651 lpcd of *drinking water for active and healthy human life* by the Water Assessment Program. As Chenoweth[1] rightly points out, existing estimates of human water requirements based on specific quantities of water for basic domestic functions are much lower than those based upon water quantities actually used by a modern society which utilizes its water resources relatively prudently, and are at least an order of magnitude lower than actual water requirements for satisfying domestic, industrial and agricultural needs.

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Chenoweth also estimated, using a self-proclaimed, more theoretical approach, that 135 lpcd is required for achieving high human development.[2] This estimate has become more relevant in the context of the recent announcement that the Millennium Development Goals' (MDG) target on water, "to halve, by 2015, the proportion of the population without sustainable access to safe drinking water," has been achieved three years ahead of the timeline. Now, therefore, is the time to not only focus on providing access to drinking water to the remaining population, but also to ensure that the quality and quantity of water accessed is sufficient to sustain high human development. Continuing with the estimation, Chenoweth concluded that according to the data from the Food and Agriculture Organization (FAO), all countries, except Kuwait and the United Arab Emirates, have the water required – more than 135 lpcd – to achieve high human development.[3] For Kuwait and the UAE, high human development has already been achieved due to the significant income received from petroleum exports, and the shortage of water compensated for through desalination. This conclusion reconfirmed that the current challenges in the water sector are not about shortage of resources, but rather about the policy, governance and management pertaining to water resources. Based on the findings of various research projects at the Institute of Water Policy, in this paper we present challenges to water policy, water governance and urban water management, and the best practices that can be employed to address these challenges.

Water Policy

A decade ago, Biswas critically reviewed the state of water polices in the developing world and pointed out that rational water policy formulation and implementation had received only lip service, and that practitioners in the water policy profession had failed to formulate, implement and update national or sub-national water policies on a regular basis in most of the countries of the world.[4] He also predicted that water policy issues were likely to continue to receive inadequate attention over the near to medium term. A decade later, Bhullar, from the Institute of Water Policy (IWP), conducted a desk review on the national water policies of 136 developing members of the United Nations (not including island states).[5] Based on secondary sources, the review identified countries with designated national

water policies—that is, countries with a national water policy (NWP), a national water resources policy (NWRP), a national integrated water resources management (IWRM) policy, or a variant thereof. It also listed the countries with documents containing water plans, programs, strategies, or laws instead of a designated national water policy. Table 2.1 summarizes the status of national water policy across five geographical regions.

Table 2.1

National Water Policies in 136 Developing Countries

Region	Countries [information obtained]	Countries with designated NWP	Countries with NWP in other forms*	Countries with NWP under preparation
Africa	49[40]	26	11	2
Asia and Oceania	36[33]	17	12	3
Caribbean	11[11]	5	6	0
Latin America	21[19]	15	4	0
Middle East and North Africa	19[19]	6	13	0

Notes: ∗This category includes countries with water laws / plans / programs / strategies, countries that included their water policies in other documents as well as countries that have formulated draft NWPs but have not approved or adopted them.

Source: Lovleen Bhullar, "National Water Policy: A Brief Review," in Kallidaikurichi E. Seetharam and Mingxuan Fan (eds.), IWP Staff Papers 2011 (Singapore: National University of Singapore Press, 2011), pp. 3–20.

Of the regions covered, in the countries that provided information, Africa had one country with no NWP and nine with no information available, meaning over twenty percent of NWP data was unavailable for the continent; in Asia and Oceania, there was one country with no NWP and three with no information; in Latin America, two countries had no information. Only in the Caribbean and the Middle East and North Africa (MENA) were all countries accounted for, each having an existing NWP in one form or another.

Although the paper did not examine in detail the actual implementation and the impact of these national water policies, it provided evidence that more and more countries are concerned about and have formulated policies,

plans or laws for water resource use and management as compared to a decade ago. However, more intensive studies are required before we can draw any conclusions on the progress of NWP implementation, as we have yet to discern if these NWPs are relevant and can keep pace with the fast-evolving water sector due to climate change, technology advancement, and economic development. In low lying countries alone, climate change is certain to cause significant changes in water use and management. Since the quantitative short and long term effects of climate change are not reliably known as yet, it seems realistic to expect that new NWPs will have to be drafted to deal with the changes in water management as water issues become more apparent. Additionally, it is almost certain that climate change will have an effect in high-lying areas as well, not to mention the effects on developing and developed countries.

While it is crucial for countries to work towards improving the relevance of their national water policies, managing inter-sector linkages and prioritizing water in their national development agendas, it is also critical to realize the risk involved in the policy changes, as only those insights derived from a solid understanding of the circumstances on the ground can lead to desirable policy changes. This, in turn, relies on good quality data and monitoring tools. The Institute of Water Policy has always been active in campaigning for standardized and regular data collection in water and related sectors. Nevertheless, we acknowledge that it requires long term efforts to bring about change, and improved data would only be able to provide policy insights when collected over a period of time.

To assist policy making based on the limited data available for the drinking water sector, Kallidaikurichi Seetharam and Bhanoji Rao at the Institute of Water Policy developed and applied the Index of Drinking Water Adequacy (IDWA).[6] The IDWA was originally proposed and constructed for 28 Asian economies in the *Asian Water Development Outlook* (AWDO) 2007 of the Asian Development Bank (ADB), inspired by the success of Human Development Index (HDI) and the lack of appropriate indicators for MDG monitoring, and building on the work of the Water Poverty Index.[7] The IDWA is constructed by the averaging of five components, namely: water resources availability; access to improved drinking water sources; capacity to buy water; water quality; and water

usage. Each component consists of only one essential indicator. The details on indicators and the calculations for components of the index are shown in Figure 2.1.

Figure 2.1

IDWA Indicators and Estimates

***Resources*:** Estimates of renewable internal fresh water resources per capita, Resource Indicator for country j = [(log R_j – log R_{min}) / (log R_{max} – log R_{min})] x100.

***Access*:** Instead of a percentage of the population with access to sustainable "improved" water sources, the percentage of the population with a "house connection" is used in this index. Access Indicators for country j = the percentage of the population with a house connection x100.

***Capacity to Buy Water*:** Per capita GDP in US dollars (PPP) is used as a measure of a nation's capacity to produce, purchase and supply adequate amounts of drinking water. The capacity indicator for country j = [(log C_j-log C_{min}) / (log C_{max}-log C_{min})] x 100.

***Use*:** This component calculates the per capita water consumption by the domestic sector. The norms for minimum and maximum consumption levels are retained as 70 lpcd (as per the Indian government's standard for minimum water need) and 167 lpcd (as the Singapore level in 1995, which guarantees 24/7 water supply of directly drinkable tap water), and the use indicator for country j is calculated as: [(U_j – 70)/(167-70)] x 100.

***Quality*:** WHO data on diarrheal deaths per 100,000 people for the year 2000 is used as an indirect measure of drinking water quality. The quality indicator based on the diarrheal death rate for country j = (Q_{max}- Q_j)/ (Q_{max}-Q_{min}) x 100.

Source: Kallidaikurichi E. Seetharam and Bhanoji Rao, *Index of Drinking Water Adequacy: International and Intra-national Explorations* (Singapore: National University Press, 2010).

In 2010, the index was further modified and applied at the global level, and to the various states in India and provinces in China, compiled in the monograph "Index of Drinking Water Adequacy: International and Intra-national Comparisons."[8] The IDWA offers a number of advantages, in that it is more comprehensive than the single access indicator used for MDG monitoring, and yet much more straightforward compared to other indices of a similar kind, such as the Water Poverty Index.

Although not its primary purpose, the index can be used to illustrate a country's relative standing in terms of drinking water adequacy. Table 2.2 presents the IDWA and ranking for selected countries. The index helps in visualizing the broad areas of weakness in the water sector of each country; for example, the lack of resources in Singapore and Saudi Arabia, and the low quantity of water used for domestic purposes in Yemen, which requires the government's attention. In many cases, the measures taken to address the pressing issues under the stress and urgency of improving the situation have turned out to be the best practices in its area – for example, Singapore's water reuse and rain water collection to improve the resource availability – these will be discussed later in the paper.

Table 2.2

IDWA for Selected Countries

	Resource	Access	Capacity	Use	Quality	IDWA	Ranking
Japan	49.2	97.0	90.0	86.8	99.7	84.5	14
Singapore	17.4	100.0	100.0	100.0	99.9	83.5	18
Iran	43.0	82.3	68.0	74.8	96.6	72.9	56
Saudi Arabia	13.7	77.0	83.2	75.9	98.1	69.6	65
China	44.6	69.1	60.8	48.8	97.7	64.2	74
India	38.2	30.9	45.1	64.1	88.2	53.3	93
Yemen	20.4	26.2	40.2	0.0	73.3	32.0	125

Source: Seetharam and Rao, op. cit.

At the state level, the IDWA could help with more concrete policy-making. Fan constructed IDWA data for the provinces of China and argued that IDWA could help the national government perceive water challenges from a regional perspective.[9] The example given concerned the measures needed for addressing Beijing's water shortage. The water shortage in Beijing (the municipality has a resource index of 33) has long been a concern of the Chinese government. Over the years, the city and its surrounding areas have been receiving water transferred from the neighboring province of Hebei, which also suffers from a severe water shortage (the province has a resource index of 39). Such an arrangement obviously has its political appeal but should not be considered as a viable

option in the long run owing to its potential damage to the people, economy and environment in Hebei. With the IDWA as a policy supporting instrument, the disadvantages of this arrangement are more clearly illustrated. Longer term solutions would have to be based on a serious discourse on inter-provincial differences and coordinated policies and programs. The IDWA and its variants, based on further modifications and simplifications, could serve to alert central and provincial governments on the gaps to be filled and differences to be bridged by coordinated efforts for all to be well served with an appropriate quantity and quality of water.

The IDWA is only one example of how high quality data could be used to assess, monitor and benchmark performances in the water sector, hence assisting in better policy making. The Institute of Water Policy stresses that the challenges for the water sector are not only to have relevant policies and plans, but also to have adequate monitoring systems to support policy making, without which it would be impossible to formulate the right policy.

Water Governance

The Organization for Economic Cooperation and Development's (OECD) recent study on water governance reconfirmed that the key obstacles to improving water management are institutional fragmentation and poorly managed multi-level governance.[10] Improving water governance across all levels of government is considered a prerequisite for sustainable water policy and crucial to achieving water security.

As defined by the OECD,[11] water governance formally refers to a set of administrative systems, with a core focus on formal institutions (e.g., laws and official policies) and informal institutions (power relations and practices), as well as organizational structures and their efficiency. It considers institutional and policy frameworks that foster transparency, accountability, and co-ordination as part of good water governance. The study identified the main multi-level governance challenges in the water sector and organized those around seven gaps, namely, the administrative gap, the information gap, the policy gap, the capacity gap, the funding gap, the objective gap and the accountability gap. Based on a single proxy

indicator for each gap, the study concluded that given the mutual dependence that arises from decentralized contexts and the network-like dynamic of multi-level governance relations, most of the OECD countries studied face almost all the above challenges simultaneously. Table 2.3 presents the gaps, proxies and results based on the study of 17 OECD member countries.

Table 2.3
Multi-level Water Governance Gaps in OECD

Gap	Proxy	Countries*
Administrative Gap	A mismatch between hydrological and administrative boundaries	9
Information Gap	The existence of asymmetries of information between central and sub-national government organizations	9
Policy Gap	The existence of overlapping roles, or the unclear allocation of roles and responsibilities	9
Capacity Gap	The lack of technical capacity, staff, time, knowledge and infrastructure	11
Funding Gap	The instability or insufficiency of revenues available to the sub-national government to effectively implement water policies	11
Objective Gap	The existence of intensive competition between different ministries	4
Accountability Gap	The lack of citizen concern about water policy and low citizen involvement in the water users' association	9

Notes: *This column counts the number of countries that considered the gap as important or very important to their country.

Source: Organization for Economic Co-operation and Development (OECD), *Water Governance in OECD Countries: a Multi-Level Approach* (Paris, France: OECD Publishing, 2011).

The capacity and funding gaps are the two most important, followed by the administrative, information, policy, and accountability gaps. The objective gap is seen as the least important.

Acknowledged by the OECD study, the Asian Water Governance Index (AWGI) is another tool used to understand governance practices in

water sector. The AWGI was developed by Araral and Yu at the Institute of Water Policy, using the institutional decomposition method.[12] The index covers the three dimensions of institutions, namely water law (using six indicators), water policy (eight indicators) and water administration (six indicators). The three dimensions focus on different aspects of the water governance problem between countries. These indicators are shown in Table 2.4.

Table 2.4
Asia Water Governance Index

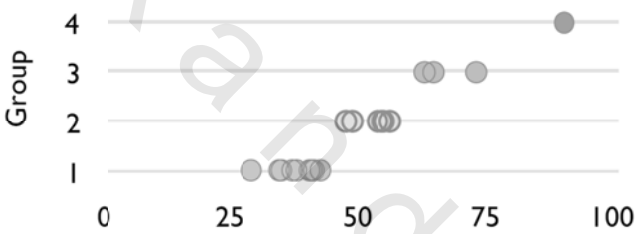
AWGI Dimension	AWGI Component
Water Law	Legal Distinction of Different Water Sources Format of Surface Water Property Rights Legal Accountability of Water Sector Officials Decentralization Tendency within Water Law Legal Scope for Private and User Participation Legal Framework for Integrated Treatment of Water Sources
Water Policy	Project Selection Criteria Linkages with Other Policies Pricing Policy Private Sector Participation User Participation Linkage Between Water Law and Water Policy Attention to Poverty and Water Finance for water Investment
Water Administration	Organizational Basis Balanced Functional Specialization Existence of Independent Water Pricing Body or Apex Body Accountability and Regulatory Mechanisms Validity of Water Data for Planning Science and Technology Application

Source: Eduardo Araral and David Yu, "Asia Water Governance Index," Institute of Water Policy, Lee Kuan Yew School of Public Policy, University of Singapore, undated (http://www.spp.nus.edu.sg/docs/AWGI%20brochure-IWP-LKYSPP%289-10%29.pdf).

Although the AWGI and OECD studies took on slightly different approaches, such as the number and grouping of indicators and the presentation of survey results in identifying water governance challenges, the main focus of each is similar. Contrary to the OECD's

understanding, the index did not aim to rank countries, but was instead used by countries to identify the challenges in their own water governance and to trigger a cross-country knowledge exchange based on comparative studies and advantages. Although the index is constructed by weighing and aggregating 20 institutional components and the resulting measurement is on a scale of 0 to 100 (with 100 being "Leading Governance," 0 being "Lagging Governance"), the actual rankings of countries are not released. Rather, they are arranged into four broad categories. Figure 2.2 presents the preliminary result based on 102 survey responses from 20 countries/states in Asia-Pacific region.

Figure 2.2
Asia Water Governance Index: Overall



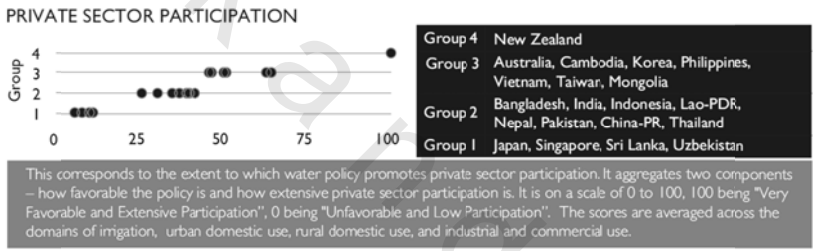
Group 4	Singapore
Group 3	Australia, Japan, Taiwan
Group 2	New Zealand, Korea, China, Thailand, Vietnam, Philippines, Indonesia
Group 1	India, Bangladesh, Pakistan, Sri Lanka, Nepal, Uzbekistan, Mongolia, Laos, Cambodia

Source: Eduardo Araral and David Yu, "Asia Water Governance Index," Institute of Water Policy, Lee Kuan Yew School of Public Policy, University of Singapore, undated (http://www.spp.nus.edu.sg/docs/AWGI%20brochure-IWP-LKYSPP%289-10%29.pdf).

The OECD member countries in the region, namely Australia, Japan, New Zealand and Korea, performed relatively better than other countries in terms of overall water governance. However, the overall index provides only a broad view of how countries perform in governing their water sector, and it is necessary to examine in detail which areas of governance

are especially lagging and how each of the indicators is related to one other in an holistic approach. It should also be noted that for certain indicators there is no consensus on whether a higher score is indeed better, although in constructing the index, higher individual scores do contribute to better overall water governance. For example, from the survey results of the AWGI, we can see that both Singapore and Japan, with overall better water governance, do not promote private sector participation; on the other hand, Australia, which also outperformed most of the countries in overall water governance, has a higher level (or more) of favorable private sector participation. This leads to a debate on whether private sector participation is necessary for better water governance.

Figure 2.3
Private Sector Participation



Source: Ibid.

Overall, it is evident that neither the public nor the private sector is superior in rapidly improving water supply performance; both systems have achieved successes and failures. Historically, water sector infrastructure has mainly been delivered by the public sector through traditional procurement methods, such as design–bid–build and design-and-build, using public financing to award contracts to private sector contractors.[13] For a variety of reasons, including a lack of financing, technology and management skills, and the need for mitigating risks, governments in both developed and developing countries increasingly rely on the use of private finance initiatives (PFIs) and public–private partnerships (PPPs) for developing water infrastructure facilities. Worldwide, as of 2006, water services were operated by the private sector in 11 percent of the cities with a population of more than one million,

ranging from none in South Asia, to 7.2 percent in East Asia, 9.5 percent in the MENA, 13 percent in high income countries, and 17 percent in Latin America.[14] However, not all PPPs have been successful in this area, and for various reasons – such as severe economic crises – there has even been a reversion to public ownership in certain regions—especially Latin America.

A team at the Institute of Water Policy is carrying out a research project to collect sufficient data and information to figure out which type of architecture is seen to be most efficient under various different circumstances. Thus far, the project findings show that for PPPs to work in developing countries, the public sector should first understand the commercial viability of engaging private sector entities, as no private investor invests in a project that is unlikely to return profits. The two key issues, therefore, are whether members of the public could afford water provided by private operators and, if not, whether the rates could be subsidized using public funds.[15]

In some countries – particularly developing countries – citizens still expect water to be delivered free as a basic right—under which neither publicly nor privately operated water utilities could function owing to a lack of revenue. Hence, a simple discussion on whether private sector involvement would improve water sector performance is not sufficient. It is necessary to engage government, the corporate sector and society in a three-way collaborative effort towards defining and driving service delivery. Padawangi presents cases of private water companies, as a result of lack of investment, seeking the support of public financing institutions (the Global Partnership for Output Based Aid in particular) and the involvement of informal leaders and representatives among the urban poor, to expand the water services to poor communities in Jakarta and Manila.[16]

Although these cases show significant improvement in service provision to the urban poor, they raise questions as to whether the provision of services would give the urban poor incentives to voice challenges to a system that still works against them. Nevertheless, with the community distinctly involved, and the poor empowered, the government–corporate–society partnership could result in greater long-term benefits.

Urban Water Management

Even with a relevant water policy and appropriate governance structure in place, dysfunctional water utilities could still undermine the efforts that countries implement to address water challenges, which are very different in urban and rural areas. In general, urban water challenges can be categorized into five main areas, corresponding with each of the IDWA components mentioned earlier:

- *Resource availability*: unlike many parts of the world, physical water scarcity is not the main issue for most Asian countries—rather, it is mismanagement of water resources, inefficient water use and deteriorating water quality, which cause stress on water resources.
- *Access to water*: to give equal access to water, it is believed that a piped water connection into each household is the optimal solution;[17] however, the access rate in terms of house connections is still low in most developing countries.
- *Capacity*: the ability to pay for pipe installation and water tariffs is still low in much of Asia.
- *Quality*: in general, water quality is deteriorating for many reasons outside the water sector.
- *Use*: water for domestic use is not sufficient in some countries as a result of loss in the process of water distribution, which can be very inefficient.

At times, those countries facing the severest challenges have improvised an effective solution to address the above-mentioned challenges; sometimes one solution can tackle more than one aspect of a challenge. In a research project on urban water management in eight Asian cities – Bangkok, Colombo, Kula Lumpur, Manila, Phnom Penh, Singapore, Shenzheng and Jamshedpur – implemented with the support of the Asian Development Bank, we analyzed the performance of water management in tackling the above-mentioned challenges, identifying the factors that contributed to their successful performance over a ten-year period. The next section provides examples of how these challenges have been addressed in selected cities.

Breaking the Constraint of Physical Water Scarcity

Singapore is one of the few Asian countries that faces physical water scarcity. As a small city state with no natural aquifers or abundance of land, about 40 percent of Singapore's water supply was imported from the neighboring state of Johor, Malaysia, under the terms of treaties signed before Singapore became an independent country.[18] Since independence in 1965, the long-term water security of the country has been the main concern of its leaders, and achieving self-sufficiency in water has long been a priority in the country's political agenda. Over the last 40 years, through strategic planning and investment in research and technology, the Public Utility Board (PUB), the national water agency of Singapore, has built a robust and diversified supply of water known as the "Four National Taps." The water supply is comprises:

- *Local catchment water*: rainwater is collected through a comprehensive network of drains, canals, rivers and storm water collection ponds before it is channeled to Singapore's seventeen reservoirs. This makes Singapore one of the few countries in the world to harvest urban storm water on a large scale for its water supply, with two thirds of the country's land used as catchment areas.[19]

- *Imported water*: one of the two water agreements with Malaysia ended in 2011, which brought the country one step closer to self-reliance in terms of water; the second treaty will expire in 2061.

- *Highly-purified reclaimed water, known as NEWater*: NEWater is high-grade reclaimed water produced from treated used water that is purified using advanced membrane technologies, making the water ultra-clean and safe to drink. NEWater has passed more than 65,000 scientific tests and surpasses World Health Organization requirements for water quality. Although mostly supplied to industries, PUB also blends a small percentage of NEWater with reservoir water, which is later treated for domestic use. Since 2003, four NEWater plants have been installed and at present, their production can meet one-thirds of Singapore's water demand.[20]

- *Desalinated water*: in 2005 the first desalination plant was installed in Singapore under the twenty-year build–own–operate model, with a capacity to meet 10 percent of the water demand in Singapore.[21] By 2013, a second desalination plant will be built.[22]

Increasing Water Coverage to the Urban Poor

Even though Asian cities have a higher rate of water access compared to their rural counterparts, improving water coverage and reaching out to the urban poor are still of critical importance. Indeed, there should be a continuous effort to provide coverage to the urban poor as the fast rate of growth in urban populations could offset the improvement in the overall urban water coverage rate. By finding a way to help low-income communities pay for the high entry cost of household metering, installation, and piping, the problems of a low water coverage rate and residents' low ability to pay are addressed simultaneously. The inclusion of the urban poor into the water supply network also helps the poor reduce their expenditures, because many low-income communities are forced to pay private vendors for water, at prices much higher than utility tariff rates.[23]

An example of a flexible approach can be found in Phnom Penh, Cambodia. With the help of the World Bank's International Development Association and the city of Paris, the Phnom Penh Water Supply Authority (PPWSA) launched a new program targeting the urban poor in 2001, after a number of failed attempts. The program provided tiered subsidies of 30, 50, 70, and 100 percent of the connection fee to poor households, depending on their need. In addition, those households that consume a maximum of seven cubic meters (m^3) of water per month only had to pay 60 percent of the real cost. These measures have led the PPWSA to include about 30 percent of the slum population into its network, proving the efficacy of the subsidy model.[24]

Another innovative example is offered by the Maynilad Water Services in Manila, Philippines. Unlike the main water board in Manila – Manila Water – Maynilad Water Services did not pursue an external funding program to extend the water connection to the poor. Instead, it chose a method of community "self-help" for water, called Bayanihan Bayan Tubig, meaning Communal City Water. The program was

launched in 2009 to reduce the cost of obtaining a water connection. Under this scheme, beneficiaries provided physical labor under the supervision of Maynilad engineers to install the pipes that will bring water to their community, hence bringing down the set-up cost.[25] At the same time, a 20 percent discount was applied to the monthly charges for the low-income and informal communities. The success of this method lies in the combination of communal planning, local use of labor, and government subsidies to provide a necessary service to the urban poor.

Monitoring and Reporting Water Quality

The quality of water supplied through a water network is to a certain extent the most critical aspect that determines the success of a water utility as it directly affects the health of the end users.

In the case of the Bangkok Metropolitan Waterworks Authority (MWA), although the piped water that has been supplied has been certified safe for drinking by the Ministry of Public Health and meets the WHO standard, the perception of tap water quality in Bangkok is still very low,[26] and most residents buy bottled water or install water purification units at home rather than drinking tap water directly. In this case, it is the public's *perception of the quality* of water, rather than the availability or actual quality of the water, that is causing a shortfall in use.

To ensure a standard quality of water, the MWA implemented stringent water quality monitoring measures from production to distribution, as well as continuous rehabilitation of the distribution system. The water quality is monitored and reported at three stages:

- Raw water sources.
- Produced water.
- Water in the distribution system and taps.

Around fifty water quality parameters are monitored and reported at these three stages, adhering to a frequency and number of samples in accordance with the WHO standards.

The frequency of quality monitoring is shown in Table 2.5. Analysis includes checking for various physical, chemical and microbiological

agents, heavy metals, carcinogenic compounds, and other parameters. Moreover, the MWA monitors in real-time two critical water quality parameters – residual chlorine and turbidity – at twenty locations in the system, the results of which can even be viewed online to assuage public concerns.[27]

Table 2.5

Frequency of Water Quality Monitoring

Stage	Checking Frequency
Raw water sources	Monthly
Production/treatment plants	From every four hours to monthly (depending on the parameter being checked)
Distribution pumping stations	Daily, with one thousand, two hundred (1,200) total samples per year; one hundred samples are collected per month
Consumers' premises	Fifty random samples from certified areas and fifty random samples from other areas
Real-time monitoring	Sampling every ten seconds for two parameters at twenty different locations within the distribution system

Source: M.S. Babel, A.A. Rivas, and Kallidaikurichi E. Seetharam, "Municipal Water Supply Management in Bangkok: Achievements and Lessons," *International Journal of Water Resources Development*, vol. 26, no. 2, 2010, pp. 193–217.

Reducing Non-revenue Water

In order to ensure the availability of water to households, a number of measures are required, one of which is the reduction in non-revenue water (NRW) to close the gap between production and consumption. The PPWSA is one of the best-performing utilities in this area, with an NRW of 6.15 percent in 2009, reduced from 72 percent in 1993.[28] As revealed in an interview by Mr. Ek Sonn Chan, the General Director of the PPSWA, various measures have been taken to tackle commercial and physical losses.[29] First, all connections are metered and illegal connections are immediately stopped. Incentives were provided to people to provide

information on illegal connections, while heavy penalties were also imposed simultaneously, especially in cases where the staff of the PPSWA were involved. Second, to reduce the physical loss of water in the system, pipes were renewed, leak repair teams were established with a commitment to respond to reported leakages within two hours, and a leakage monitoring system was installed. In the fight against NRW, the PPSWA considers their own staff to be its best resource, and has invested heavily in their capacity-building and provided motivational incentives. A public awareness campaign also helped to make the public an active partner in reducing NRW.

Urban Water Management Best Practices: Barriers and Enablers

In the previous section, selected best practices were presented which addressed various urban water challenges. However, these best practices are not stand-alone factors in achieving successful urban water management. In each city, there are many other aspects that have contributed to this improvement in water management.

For example, throughout the discourse on Singapore's expansion of water resources, political tensions with Malaysia have played a critical role. The leadership of the country placed water security high on its political agenda, and built an autonomous and well-functioning water utility. The country's economic success, clean political environment and efficient government enabled the development of its research and technological capacity, which allowed the implementation of expensive solutions and integrative planning in its water sector.

A similar story of strong leadership can be found in the success of Phnom Penh; however, the leadership comes from within the water supply authority, which has limited power to influence the country's overall political, social and economical environment. Nevertheless, strong political and public support and a reform agenda from within to gain autonomy, financial sustainability and operational capability are the important factors that have led to success in Phnom Penh.

The Institute of Water Policy and the Asian Development Bank have built on the case studies in eight Asian cities and developed the SUCCESS

model (as shown in Figure 2.4) as a framework for water utilities management.

Figure 2.4

Good Practices: The Success Framework

Notes: UFW = uncounted-for-water.

Source: Asian Development Bank and Institute of Water Policy, *Every Drop Counts: Learning from good practices in eight Asian cities* (Manila, Philippines: Asian Development Bank, 2010).

Each component contributes to the whole:

- *Staff*: increasing productivity.
- *UFW*: reducing uncounted-for-water.
- *Collaborative Vision*: ensuring that government, the corporate sector, and society have the same vision and mutual support.
- *Corporatize*: ensuring that accountability exists, as it would in a private company.

- *Empowering*: guaranteeing the inclusion of the urban poor in any planning and development efforts.
- *Sustainability*: outcomes should be financially and ecologically sustainable in the long term.
- *Sanitation*: general sanitation must be an essential part of the water management process.

As stated earlier, the global water crisis is essentially a crisis of governance, or lack thereof. Inadequate leadership and governance is the fundamental reason that struggles exist in the urban water sector.[30] Hence, the implementation of all best practices ultimately depends upon the political will and leadership available.

Strong leadership and a commitment at the highest political levels are often explained as the critical ingredients for successful utility reform. The vision and leadership provided by Lee Kuan Yew, the first Prime Minister in Singapore, and Ek Sonn Chan, the Director General of the PPWSA in Phnom Penh are often cited as key actors in mobilizing wide-ranging commitment and maintaining a steadfast focus on improving the performance of water utilities in those two cities.[31] In both cases, this vision was backed by decisive efforts among the senior leadership to build a motivated and capable workforce that was fully empowered to translate the vision into practice at the operational level.

Both leaders shared a similar starting point, characterized by the tremendous pressure they were facing. In other words, the lack of political commitment in other cities could be partially due to the lack of knowledge about the water sector or the lack of information on the urgency of addressing challenges in the water sector. For example, charging for water is widely recognized as an essential measure to sustain good water services and is often not implemented correctly owing to a lack of political will—which is often caused by the misconception that the poor are not willing to pay for and will not be able to pay for piped water. However, as numerous cases have shown, the urban poor will often actually pay more to water vendors in order to secure clean water. This is certainly the case in Mumbai, which has chronic water shortages, and where the urban poor routinely have to fight for access to clean water and are often charged (and over-charged) for water provided by private vendors. In other cases, utility managers often see the problem for

improving services as a result of a lack of investment. This is another misconception, as even without the initial funding to improve infrastructure, utilities could start to look at improving efficiency and savings from within, and looking at measures that are less expensive. The initiative to make small improvements in service quality could have an effect on building trust between customers and suppliers, which could eventually lead to an increasing willingness to pay and set the utilities on the right track of reform.

Different political, economic and intuitional environments often cast doubt on the feasibility of replicating best practices learned from elsewhere. This is a valid point to a certain extent; however, there has never been a one-size-fits-all solution to solve a problem of this magnitude, and local adjustments must be made to global knowledge in order to produce suitable measures for reform, which can be applied to any city.

At the top, however, insightful leaders and a capable staff all need to be equipped with the right understanding of water challenges and best practices from all over the world; only then can they use their expertise on local circumstances to tailor solutions for their own cities.

Conclusion

Water is becoming an increasingly scarce resource for various reasons, ranging from physical shortages or pollution of fresh water, lack of infrastructure, and fast population and economic growth, to inefficient water use, and competition for water among different sectors. Climate change has added to the uncertainty of water availability. However, it has also been widely acknowledged that most countries have enough water to maintain high human development if they manage their water appropriately; the world water crisis is therefore essentially a failure of water policy and governance.

A major challenge for many countries in the water sector is how to coordinate all the concerned resource policies, legal and regulatory frameworks, and institutions responsible for formulating and implementing these policies.[32] The current and past practices of formulating policies in one sector without adequate consideration of and coordination with the policies in other sectors will become increasingly costly, inefficient, and unsustainable; herein lies a major future challenge for all countries: how to integrate appropriately all the concerned resource policies in the areas of water, energy, food, and 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 difficult and complex in the future. Yet this will be an important and critical requirement that requires accelerated attention from governments, research institutions, and academia.

In this paper, we discussed the current status of water policy around the world and emphasized the importance of completing the policy circle through better monitoring and evaluation schemes. Based on the OECD studies and the Asian Water Governance Index, we identified the gaps in water governance in selected countries and reviewed the dynamic relations among public institutions, private companies and communities in providing water services in urban areas. Moreover, we examined the solutions used to address urban water challenges and provided a SUCCESS framework for urban water utilities management. Through these discussions, we hope best practices in the water sector can be adopted widely.

However, the debate on water policy and governance does not end here. There are many areas which are crucial to successfully addressing water challenges that are not covered in this paper. For example, the relations between water and sanitation and the water–food–energy nexus. We have no substitute for water and no technology to grow food without water; however, this doesn't mean that we should stop seeking technology advancement to address water challenges. Consider the state of telecommunications just 15 years ago, and then compare it with today's situation—mobile phones have connected hundreds of millions of people, who did not have teleconnectivity for decades. Use of mobile phones often even replaced that of existing landlines. In short, we need new solutions to replace traditional technologies.

Finally, we wish to raise a special issue relating to water policy: ethics.[33] As the foundation for improving global water management, we should discourage wasteful practices when it comes to our water and food consumption; ultimately, water governance is first and foremost about governing our own behavior.