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Avoiding 'Day Zero': Challenges and Opportunities for Securing Water for Megacities

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Abstract

Water is a non-substitutable, essential, finite and fugitive resource (Savenije, 2002). As such, there is no escaping the politics of water. It is manifest in decisions regarding reforms to governance and management. It is manifest in decisions regarding appropriate technologies. Cities, through global processes such as Agenda 2030 and forums such as ICLEI and World Water Week learn from each other. These are collective social spaces occupied by civil society organizations who share strategies and tactics, and the private sector, who compete for markets and contracts, promoting patent-protected technologies. It is these groups coming together who determine who gets what water, when, and where. It is the job of academics to understand the how and why, and of (academic-)activists to fight for equity of access and sustainability of use. Evidence drawn from around the world and over time consistently shows that water flows toward money and power. Outcomes are generally socially inequitable, environmentally unsustainable and economically inefficient. How to shift existing processes toward improved practices is not clear, but positive outcomes do exist.

Introduction

Politics has been described as 'the art of the possible'. In particular, it involves the authoritative allocation of scarce resources, otherwise known as who gets what, when and where. In the context of cities, we must augment these definitions by stating that urban politics involves decisions regarding what goes where. Given these definitions, it seems problematic to separate out 'politics' from either economics or ecology: decisions affecting access, allocation, use and management of water within cities are intertwined with questions of economics (e.g. how to martial the financial resources necessary to build systems of delivery?) and ecology (e.g. how does capturing for human use a fugitive resource such as water alter the character – and possibly the sustainability – of natural ecosystems?). Recognizing the interrelationship among social, economic and environmental factors, we focus our attention on decision-making in relation to questions regarding water and systems of supply:

- Whose needs are being satisfied? (the stakeholder question)
- What is the water for? (the demand question)
- Where does the water come from? (the supply question)
- How is it accessed? (the freshwater delivery question)
- What is its quality? (the treatment question)
- What happens to it after it is used? (the wastewater conveyance question)
- How is the system financed, established, managed and governed? (the governance question)
- What is the impact (social, environmental, economic) of the overall system? (the sustainability question)

Embedded in the answer to each question are trade-offs, compromises, the exercise of influence – in other words, the social relations of power. Urban water systems are organic, evolving through time as

cities themselves evolve and change. Even a cursory review of available information reveals that the discourse surrounding urban water security is negative. It goes something like this: cities are growing rapidly; water availability is limited (due either to First Order Scarcity, i.e. natural limits, or Second Order Scarcity, i.e. poor management and limited human, financial and technical resource capacity, or a combination of both); the finances available for necessary infrastructure upgrades are limited; the time for action is short; and a changing climate makes planning for the future extremely difficult.

A 2018 article from the BBC listed twelve cities facing 'day zero' scenarios: Bangalore; Beijing; Cairo; Cape Town; Istanbul; Jakarta; London; Mexico City; Miami; Moscow; Sao Paulo and Tokyo (https://www.bbc.com/news/world-42982959). A year later, an article in U.S. News and World Report provided a slightly different list: Bangalore; Beijing; Cairo; Cape Town; Chennai; Jakarta; London; Melbourne; Mexico City; Sao Paulo; and Tokyo (https://www.usnews.com/news/cities/slideshows/10-cities-most-at-risk-of-running-out-of-water). Beyond these candidates, one might list a host of others – indeed, all cities face challenges related to sustainability irrespective of their natural resource endowments, built environments and human resource capacities. These challenges are well known and are encapsulated in documents such as the Sustainable Development Goals (specifically SDG 11 – Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable; see https://sustainabledevelopment.un.org/sdg11) and ICLEI's *Resilient Cities, Thriving Cities: The Evolution of Urban Resilience* (available here: http://e-lib.iclei.org/publications/Resilient-Cities-Thriving-Cities_The-Evolution-of-Urban-Resilience.pdf). Inter-governmental organizations such as UNHabitat serve as the entry point for projects devoted to urban sustainability (see https://open.unhabitat.org/projects). The point being made here is that no city is wholly prepared to meet the interrelated challenges posed by environmental, economic and social actors, forces and factors. At the same time, despite the massive sustainability challenges faced by all cities, there are successes, best practices, emerging networks of collaboration, and a shared perspective on the need to act now.

In the balance of this paper, we focus on the following elements. Next we provide a brief overview of water in development, with a particular focus on cities. The relevance of this section lies in the general lessons to be learned through time regarding why certain things have been done at certain times in particular places. The third section focuses specifically on water for cities, highlighting the politics underlying much of the (in)action in relation to particularly household water and sanitation. Comparative data is offered for several cities facing 'day zero' scenarios. The final section presents lessons learned from the preceding sections and reflects on the necessary steps to be taken in order to develop the 'political will' necessary to act in support of environmental sustainability, social equity and economic efficiency. The paper is meant as 'food for thought' as we contemplate the ways and means of achieving urban water security.[1]

Power, Politics and Development

Water is power. It drives industry. Its delivery to people wins elections, enhances authority, and builds legitimacy. Historically humans settled around water – at the mouths of rivers; in mid-stream; around lakes, springs and wetlands – moving to the resource. Over time, however, we have managed to reverse this flow, so much so that water no longer runs along its hydraulic gradient; rather, it flows toward

[1] In Appendix 1 we present a short document meant to complement this longer paper, and to help guide our workshop deliberations.

money, people and power. 'As in all ages from antiquity to the present, the pattern of water distribution read like a map of society's underlying power and class structures' (Solomon, 2010: p. 87). So, while ancient Romans were among the first to treat water as a public good by building aqueducts to deliver fresh water to large urban centres, 'Public basins and fountains used freely by ordinary people … received only 10 per cent of total aqueduct water' (2010: p. 87). But that 10 per cent was more than enough to ensure the political legitimacy of the empire's ruling class.

The settled spaces we inhabit today are the result of relatively recent events in world history and largely the result of having discovered how to bend water to our will. Civilization is a direct result of a combination of human's ability to correctly predict water resource availability, and innovations to make more of it available when and where it was needed (and to compensate for those times when our predictions were wrong). Karl Wittfogel, in his 1957 classic, *Oriental Despotism*, proposed a causal link between the character of social organization and the extent of irrigated agriculture: the more complex the system of irrigation, the more likely you would find an authoritarian regime whose leaders were able to command the labour of thousands in the service of the kingdom or empire. Publicly available potable water and sanitation systems in ancient Rome were only possible because of slave labour and a highly militarized society. Wherever you look through world history you see the same pattern in river basins great and small: from the Nile to the Tigris-Euphrates, to the smaller river systems in Central America and Europe. In Western democracies such as the United States, the advent of two World Wars separated by a global economic depression and followed by the Cold War gave American policy-makers the 'nationalist' motivation to drive industrial production and to create the infrastructure – particularly large hydraulic-works – to sustain that production. And in that drive, came business and 'the consumer society' along for the ride.

Today, China and India are engaged in a sustained, state-directed hydraulic mission. While this 'mission' extends to many other parts of the Global South – often with the help of Chinese engineering companies – early 21st Century democracies everywhere are having a very difficult time generating either the social consensus or financial capital necessary for infrastructure maintenance, let alone new development. Given the challenges created by a changing climate, ensuring urban water security will require concentrated political commitment at the highest levels of government. But how to fashion such a commitment?

As Tony Allan (2002) has shown us through the metaphor of the 'hydraulic mission', our understanding of what water is, what it might be and should be for, changes as new knowledge reveals new things to us about resources and about ourselves. The complexity of water and the diversity of needs and wants ensure that decisions regarding access, use and management are highly political. In an age of democracy, climate change and highly networked globalization, arriving at consensus regarding large scale projects is more and more difficult: Who will benefit? Who will pay?

Urban Challenges

Providing adequate water and sanitation for the world's urban masses is perhaps the greatest challenge of the 21st century. According to ICLEI, '[t]he world has become predominantly urban, and cities are the place where the main challenges of sustainable development are being tackled. Although only occupying 2 percent of the land, cities are responsible for 70 percent of global GDP, greenhouse gas emissions (GHG), and global waste and over 60 percent of global energy consumption' (quoting UN-Habitat, 2016). Not all cities are the same, so face very different sorts of challenges. Those that arose out of the so-called first demographic transition fostered by the industrial revolution face significant challenges

related to aging infrastructure: how to repair it, replace it and upgrade it. This is primarily a so-called First World problem. Those cities that have arisen out of the post-WWII, post-colonial second demographic transition face the primary challenge of meeting the needs of rapidly expanding populations that have over-stretched existing infrastructure and, in many cases, exist in a sort of parallel peri-urban space: part of the greater metropolitan area, but largely unacknowledged – except to be regarded as a major problem – to formal authorities.

The absolute number and percentage of people living in cities has increased dramatically over the last 60 years, with roughly half of all urban dwellers living in Asia. While Asia's urban population has dramatically risen as a percentage of total world urban population, Europe and North American percentages have fallen significantly. In addition, the size of the world's largest cities is also increasing dramatically (for a selection of major cities facing significant water-related challenges see Table 1).

Two major challenges identified by UN-Habitat are (i) providing water and sanitation and dealing with wastewater in the largest and fastest growing cities, especially in their informal settlements; and (ii) prioritizing water for low-income households.

Table 1: Some Comparative Data on Cities Facing Day Zero Scenarios

City	Governance	Popula-tion (Millions)	Geography	Precipitation	Water supply	Issues
Cape Town	Party political	3.74	coastal	515mm/a; winter rainfall (April-Oct)	Complex system of mainly surface water	Drought; Slums; Inter-basin transfer
Chennai	Municipal Corporation	4.64 7.09 (GMA)	Coastal (avg. 6.7 MASL)	1382.9 mm/a; 65% in monsoon season (Oct-Nov); Feb-Apr is dry season	Surface water reservoirs; desal plant; high groundwater table	Flood; Drought; Slums; Down-stream of agric.
Jakarta	Special Capital Region; elected governor, 106 councillors; 5 mayors and 1 regent chosen by governor; Water supply managed by 2 private corporations	10	Coastal (-2 to 50 MASL; avg. 8 MASL)	1816 mm/a (Nov-May rainy season)	80% surface water mainly from Citarum River and Jatilukur Reservoir; balance from ground-water	Subsi-dence; Flooding; Slums; Low % of house-hold connect-ivity' 9% green space; Sewer-age covers 1.9% of pop.; 4% housing covered by WWTP
Melbourne	Melbourne Water managed by independent Board of Directions & Minister of Water (Victoria); water responsibility falls to state government; waste management to councils	5	coastal	602.6 mm/a; Aug-Dec. but fairly stable across whole year	Elaborate surface infrastructure; 3000 km of sewerage lines; 1300 kms of delivery; $3.1 billion desal plant	Drought; Low-density (sub)urban-isation
Mexico City	Federal District; 13 boroughs; 'mayor' & directly	8.84; 21 in GMA	Inland valley (drained lake bed; Lake	846 mm/a (May-Oct)	Surface water 2/3; groundwater 1/3; long distance	Flooding (17th C canals and tunnels); over-

	elected reps (6 yrs/no reelection); party political; CONAGUA (Federal) + National Water Commission		Texcoco); 2240 MASL		Cutzamate system; 11,900 km of pipes; elaborate drainage system	abstraction of groundwater; low recharge rate; subsidence (impacting wastewater management and runoff); deforestation; air pollution; unaccounted for water 36%
Sao Paulo	State-owned, publicly-traded, water and wastewater company, Sabesp, provides water & sewerage services in the city and across the state	12.18	Inland; 799 MASL; 70 km from ocean	1454 mm/a (Oct-Mar but rains in all months); upper catchment forest cover	Cantareira System (1880s) provides 50% of water through surface system (6 reservoirs across 5 basins); 80% of all water from Alto Tiete Basin; 20% of water from groundwater; Iguape system being developed	31% unaccounted for water; pollution; drought; flood; Slums (20% of pop.); $22m in sediment managem't
Tokyo	Water managed by Bureau of Waterworks located within dept of Local Public Enterprises; wastewater by Bureau of Sewerage; Tokyo Metro. Assembly approves budget, revises water charges	13.4	coastal	1528.8 mm/a mostly over 4 months (2 typhoon; 2 monsoon); 1623.5 mm/a in Western mountains; 36% forest cover	Surface water (14 dams); 27,500 km of pipes	Seismic stress on infrastructure; Drought

It is a truism to say that access to improved water and sanitation is less about pipes and pumps and more about enabling the poor to help themselves. Put differently, non-resource specific interventions will go a long way to improving access to the water resource itself: better incomes through employment opportunities; the right to land and security of tenure; better information about citizen's rights; and better organized communities able to speak with one voice are all important elements of realizing access to improved water and sanitation.

One of the primary impediments to better provision is poor state-civil society relations. A non-responsive or even repressive state is generally ignored or avoided by the very citizens it is supposed to serve. How to build trust where past practice counsels mutual suspicion is an important question in water for cities. Participatory budgeting is regarded as one means of bringing the state and the citizenry closer together, with the Porto Alegre example being most commonly known. But in many parts of the world, we are a long way away from transparent and accountable decision making, particularly as it relates to allocating resources to improve services for the poor.

Poor governance combined with incompetent public utilities led the rush toward private sector providers, particularly large multinational companies based in the UK, France and elsewhere, throughout the 1990s and into the early 2000s. By and large, this 180 degree turn from public to private was an unmitigated disaster. Rare is the example where a private sector provider followed the terms as

agreed to in their contract. For most of the last 10 years, the donor world has been retreating from the private sector toward a middle ground where it is recognized that only oversight and regulation by a competent state authority will be able to ensure a provider's delivery on contract.

For a while these public-private-partnerships, or PPP's as they are popularly known, were regarded as the best way forward with a relatively positive example to be found in both Rand Water, as the bulk provider to major municipalities such as Johannesburg in South Africa, and Johannesburg Water, as an independent company with the City of Johannesburg as its sole shareholder, as the provider of water to consumers in the municipality. Johannesburg Water further sub-contracts many of its activities to private companies. This success stands in stark contrast to the negative social, economic and environmental outcomes of privatization in Cochabamba, Bolivia and Jakarta, Indonesia.

Increasingly, municipalities have realized that PPPs are not enough, and that communities must be directly involved as well through, for example, civil society organizations. In highly unequal societies, such as South Africa or Brazil, with gini coefficients of income inequality nearing 0.6, differential service is regarded by the poor as a continuation of neglect and disrespect. Without community involvement, then, it is not possible to achieve buy-in regarding the possibilities for expansion and delivery.

While there are many issues related to under-performing utilities, it seems clear that the state (through goal setting, subsidies, incentives, and regulation) and the market (through responsiveness to consumer needs) have roles to play in ensuring that the provider or providers – be it a public or private entity – has enough incentive to deliver as per the terms of their contract.

It is a delicate balancing act. When it goes wrong, it goes very wrong indeed, as the so-called 'water wars' in Cochabamba, Bolivia showed. But when it goes right, as seems to be the case in Johannesburg, success tends to breed success as the state and civil society move closer together in building trust and social capital. Moving toward successful delivery of water and sanitation services then seems to require utility-state-civil society negotiation and improved relations.

Given the variability of settlement patterns particularly in the primate cities of the Global South, whether expansion will mean networked or non-networked systems, prepaid meters with automatic shut-off points (or not), step-wise tariff structures, and adherence to global standards that may be beyond the technical and financial ability of the city, are all issues that require an open conversation. History shows that where non-transparent decisions have been taken 'on behalf of' the poor, even where a desire to help is the true motivator, there will be problems. The so-called 'toilet wars' in Cape Town, South Africa are an excellent example of this.

Let us now turn briefly to a discussion of the ways and means of increasing and expanding improved water and sanitation to slums. Why slums? Because approximately 1 out of every 7 human beings lives in a slum, with significant incidence of slum-dwelling as a percentage of urban living spread across most of the global south. It is also clear that the incidence of slums are on the rise, with massive increases in the last 30 years.

No two slums or informal settlements are alike. Hillside favelas in Brazil present very particular challenges. As do the densely packed shacks across an African plain, such as that in Kibera, which is part of Nairobi, Kenya. Squatting and informality raise challenges not only of access to a water resource in sufficient quantity and quality to meet personal needs; these are often unserviced areas, so solid waste management is a significant and related challenge. Blocked channels in rivers and streams result in

standing water which can become breeding grounds for disease carrying mosquitoes. Storm water run-off systems are often choked by solid waste, so creating persistent threats of flooding, and where human and animal waste is poorly managed, flooding can result in widespread disease outbreaks, such as cholera. In order to deliver a service there are many and highly specific requirements, often times none of which are present in slum areas. So key questions arise:

- Enumeration: who is in the house? Apartment? Shack?
- Who in the dwelling will be responsible for payment?
- Who owns the land?
- Are there any official maps?
- Is there a register of households?
- Will the service depend on state support? Individual or community investment?

And challenges:

- The dwellings have no official addresses
- The geography of the settlement poses service difficulties
- There is no road access
- Landowners do not want squatters to receive services

What is clear is the conventional model of in-house water delivery and water-borne sewerage disposal will not work in slums. While it may work for part of a city, such as the high-income suburbs of Johannesburg, Jakarta and Sao Paulo, it may not work for all or parts of poorer areas. Moreover, it is these poorer areas that tend to become magnets for informal settlements and the expansion of squatters into very dangerous landscapes – such as hillsides or low-lying drainage areas that are particularly susceptible to the negative effects of extreme events. What UN-Habitat counsels is a turn toward the unconventional. In their estimation, the conventional model of piped water into each dwelling and a sewer connection for wastewater and toilets, has managed to serve perhaps one-half of the world's population. Despite 30 years of global focus on making this a universal system, it has failed, and will continue to fail. Indeed, in many parts of the world, where large populations reside in arid environments, this is precisely the wrong type of system necessary.

Two very positive examples the authors put forward are PROSANEAR (the Water and Sanitation Program for Low-Income Urban Populations) in Brazil, and the Oranji Pilot Project, which initially focused on the neighborhood of Chisti Nagar, a slum area of the Pakistani city of Karachi, whose 2013 estimated population is 23.5 million. PROSANEAR was a World Bank and government of Brazil supported project rolled out across more than a dozen municipalities. Its aim was to ensure adequate water supply and sanitation for everyone in Brazilian cities. Given the massive economic inequalities in Brazil, this was no easy task. The innovation here was to involve un- or under-serviced communities themselves in the design, planning, roll out, and management of what was termed 'community provision'.

The successes realized in Brazil were extended to other municipalities around the world. In the estimation of sanitation expert Duncan Mara, the Oranji Project was a beautiful example of South-South cooperation and knowledge transfer: devised in Brazil and successfully rolled out in Pakistan, where more than 850,000 were positively affected by community provision-oriented projects. These projects can only be as successful as the physical conditions in which they are rolled out. While the city of Cape Town, for example, has initiated a pilot project of water and sanitation provision in its high-density

townships, extension of this provision to flimsily built shack areas is not possible – at least not beyond a standpipe. Slum upgrading is therefore necessary. But it is often controversial.

'Decanting' areas in Kibera, where shack-dwellers are moved out of their residential spaces into government constructed housing, while their area is then demolished and rebuilt, is painfully slow. Such a government run scheme also smacks of paternalism (the state knows best) and is subject to all sorts of graft and corruption. Evidence suggests that new homes being built for people without displacing them is more well received, especially if the new locations do not shift the residents too far away from where they have established themselves and feel comfortable. It still raises the question of 'ownership' of the project by those ostensibly at the centre of the initiative, i.e. the 'beneficiary' of the new housing. Baan Mankong – Thai for 'secure housing' – seems to offer an example of the way the state, the private sector and the people can work together. Designed to reach 300,000 households in 2000 poor communities in 200 Thai cities, the program channels infrastructure subsidies and housing loans through the national government agency, the Community Organizations Development Institute, directly to low-income communities, that plan and manage the implementation of improvements of their housing and basic services. This not only improves provision for basic infrastructure – including water and sanitation provision – but also ensures a stable, legal relationship between households and water utilities by providing secure tenure for residents.

Without doubt, the world is rushing headlong into a brave new social order – an urban order with a vast array of challenges, threats and opportunities. While the challenges are many, and a continued failure to act by those with the capacity to do so, a serious threat in so many ways – from ill health to social disorder and violence – the evidence shows that the new urban reality presents many opportunities, first and foremost to rethink how we design and inhabit settled social spaces, and what our relationship is to the environment around us as we seek to satisfy our wants and needs.

What is very clear is that people need and deserve respect. Where the poor are consulted and made partners in problem solving, the innovations are remarkable as are the results. Where they are treated as either undisciplined children or a problem to be contained or both, whatever the state attempts to do on their behalf will be met with contempt.

Systems of Delivery

Savenije (2002) has described water for cities as 'small water'. In other words, in comparison to the massive amounts of water that goes into irrigated agriculture – i.e. some 70% of blue water – cities' demands for blue water pales in comparison. But this is not to imply that delivering water for cities is that much easier than delivering water for agriculture. To the contrary, providing water for cities is both complicated and contentious. While it is 'small water', it is required on a 24-7 basis.

On the face of it, the method of drawing water for cities is relatively straight forward: find a source of supply, collect and, if necessary, treat the water before distributing it to various consumers (households, business and industry, use in public goods such as parks and other green spaces), collect it after it has been used, and treat it again before reintroducing it back to the source. We call this the system of supply. However, each step in the system of supply presents a wide variety of challenges.
Let's begin with the source of supply. What is the source of supply? Is it a surface water body such as lake? Is it groundwater, or both? Where is this source: a natural lake located upstream, groundwater directly beneath the city or a 'well field' located at some distance away? Is the source downstream? Out

of the basin altogether? How much water is there? What is the flow rate of the resource? Its recharge rate? How is its quality? Each of these questions have an associated number of issues related to them.

Questions regarding source of supply reflect human settlement patterns. Where are the people? Are they at the top of the watershed? Is the city somewhere along a river's banks at mid-stream? Or is it a coastal settlement? No two cities or settings are exactly the same. Each throws up challenges expected and unexpected. Bangalore – or Bengaluru as it is also called – and Johannesburg are million cities at the top of watersheds whose primary challenge stems from this location. Bangalore receives somewhere in the region of 1000 mm rainfall annually with the bulk of it coming during a five month period, June-October. The average temperature stays quite warm throughout the year, meaning that evaporative demand in the dry season is much higher than that in Johannesburg, where the winters can be quite cold. In comparison, Johannesburg receives about 25% less precipitation than Bangalore, receiving the bulk of it during the warm summer months. Average temperatures are quite a bit cooler, however. What does this suggest for storage options in the two cities?

Urban growth has generally seen two dramatic spikes in recent history: the first great demographic shift followed the industrial revolution in Europe. People were driven off the land and into the towns. And wealth creation over time led to further immigration and natural population increase. The second demographic shift followed the end of the 2nd World War and the end of colonialism. Cities of the global South grew dramatically, in particular the capital cities, most of which have since achieved primate status, having between 10-20% of the total population of their countries residing in the greater metropolitan area. While Johannesburg (as a mining town) and Bangalore (as an historical settlement taken over by the British as an administrative centre during the colonial era) have modest origins, they have grown rapidly in recent years. Today they are home to several million inhabitants, their activities, interests, needs and so on. The pace of population increase has taxed even the most creative and well-equipped urban managers in terms of keeping up with necessary services such as water, santitation, housing, electricity, transportation and so on. As a result, and as is typical across the global South, many of the residents of Johannesburg and Bangalore reside in poor or un-serviced slums and squatter settlements. Moreover, the gini coefficients of income inequality in these two cities are among the highest in the world, illustrative of the fact that almost unimaginable wealth rubs spatial shoulders with equally unimaginable poverty.

So, what are the challenges facing these cities in terms of 'water in – water out'? Let's take a quick tour of each segment of the system. In order to provide water to people in a city, it must be collected from somewhere. Availability varies dramatically, as does the quality of the water available. The city of Halifax, Nova Scotia in Canada, is blessed with pristine lakes located upstream and far from any significant human settlement, industry, mine and so on. The delivery system utilizes gravity, so there are no expenses related to pumping water uphill (as there are in Bangalore, where water has to be pumped up to the plateau on which the city perches and much of it from a great distance). There are fewer water treatment costs for Halifax as well, given the initial state of the resource. This contrasts dramatically with cities such as Dhaka whose groundwater supply is contaminated with arsenic, or other downstream cities, such as Maputo who must deal with all sorts of effluent in their water that accumulates along the resource use chain by upstream cities and other users (such as farms and mines). This situation is not limited to the global South, of course. For example, lots of problems happen to the waters of the mighty Mississippi in the United States as it snakes its way through several states and many cities. Almost all urban water systems – even those in the deliberately constructed cities of fast-growing states such as China and Brazil – are cumulative and reactive. What this means is that the initial system was based on several assumptions such as the current and projected growth of the city.

Cities such as Johannesburg, Harare and Nairobi were deliberately laid out to reflect the contemporary political economy of settler-based colonialism. If one lived on the 'right side of the tracks' there would be every modern service imaginable. But if one lived on 'the wrong side of the track' – next to industry and so on – your access to services differed dramatically. In some cases, there were no services provided at all. This was deliberately done so as to discourage Africans from 'settling' in these colonial centres of commerce, industry and administration. So, high density housing estates were serviced by standpipes and shared latrines, while low density housing had in-house flush toilets and running, treated water. Following the end of colonial rule, and in the South African case, apartheid rule, people have crowded into the cities looking for economic opportunity and expecting access to water and sanitation as 'their constitutional right'.

Obviously, a system deliberately designed to serve the few continues to have a great deal of difficulty in serving the many. The same may be said for Bangalore, and pretty much any other city of the global South, be it large or small. So, people queuing at a public standpipe in Bangalore is hardly surprising; indeed, we seem to expect that this is the best we can do under the circumstances. But is it? Which leads us to distribution. Like collection and treatment, distribution faces many of the same challenges.

Just because there was enough financial capital, political will and human resources available to construct the initial supply and treatment system – be it a dam, or a system of well-fields where the water is moved either by gravity or diesel-powered pumps to a water treatment centre where the resource is made ready for human use and consumption – does not mean that it was distributed equitably, efficiently or sustainably; not even from the start. Initially, and across the post-colonial world, systems had been constructed on the basis of 'Western knowledge'. Leaky pipes in temperate zones where there were upwards of 300 precipitation days per year (and free winter storage in the form of snowpack) were 'good enough'. Running the same pipes through the desert or across the tops of watersheds, however, meant that a great deal of 'unaccounted for' water was in fact wasted, meaning beyond the use possibly ever again of the people of that particular city. Some of these systems are now almost 100 years old, and in dire need of upgrading, extension, and so on. But how to do this? Cities are often bankrupt or run by corrupt officials and their cronies. Where will the money come from if people are to be properly served? Where is the human resource capacity? Who can afford appropriate technology if the mistakes of the past are not going to be replicated today and tomorrow? And all of this seems to be a race against time: before the system collapses under the weight of ever-increasing demands. In Bangalore there are some 10,000 km of water supply transmission and distribution pipelines, and another 7000 km of lateral sewers and outfall sewers. As of 2006, there were an estimated 350,000 connections and 6350 authorized public fountains (used by the poor and unserved of the city). How to keep this in good working order? At the same time, the costs of fuel used to pump the water up from the Cauvery River to the city bleeds the city almost dry. What is to be done?

Improved water metering is regarded as one way of ensuring the cost-effectiveness of delivery. In many parts of the world, pre-paid water meters have been introduced, particularly in high density settlement areas of cities. This system is often regarded as highly controversial, impinging on people's 'human right to water'. The city of Cape Town, for example, introduced a series of pilot projects to install metres which deliver 300 litres of government legislated 'free basic water' to poor households. Once the limit is reached, householders must purchase additional water on a user-pay, pre-paid basis. There are many people in Cape Town's townships such as Khayelitsha who view this as an infringement on their right to water. But look at it from the City's viewpoint: water falls free from the sky, but systems of delivery cost a lot of money.

Where water is delivered into parts of the city that are unable to pay for it, not only is the water lost to other prospective uses, but the loss of revenue makes it doubly difficult for the city to deliver its existing services and to extend services to the historically disadvantaged. Yet, distribution based on cost-recovery seems somehow to remain a highly contentious issue across the global South, and in parts of the global North as well, such as in the scattered rural and aboriginal communities across much of Canada. How to get water to these folks without going bankrupt yourself? In some cities, surveys reveal that people are happy to pay for water (and electricity and so on) if and only if the service is reliable: people want to pay for water that they can get when they need it and of good quality for those needs. They do not want to pay for erratic delivery of water that might kill them.

So, what happens to the water after it is used? In industry – is it treated to a quality that makes it unharmful to humans downstream (or, in fact, in the same city, if, as in the Zimbabwean city of Harare, the main source of water is a dam located downstream where water has to be pumped up into the city, used, and then it goes back into the system)? In households, is grey water separated out from black water? In slums, are people just dumping their 'night soil' into the streams that feed the aquifers, rivers and lakes that hold the water for other users? We are back to the same old issues: appropriate technology, human capacity, and the cost of it all. Which leads us back to the source itself. As mentioned in regard to Harare, questions regarding the shape and condition of the water supply and distribution system become even more important if you are drawing from the same point into which you are then depositing liquid and solid waste. If the system draws water beyond the rate of replenishment then other sources and/or use practices will have to be found or devised. Water Demand Management (WDM) has become popular in the last two decades: we can make 'more' water by using wisely the water that we have. So fixing leaky pipes and ensuring that industry and households do not pollute the resource do not add an absolute amount to the system, but it does make more water available than would have been available had it leaked away or become unusable due to pollution. At the same time, there are important considerations of who or what is downstream. Many cities simply dump their waste into their water systems and hope it floats away. Coastal cities face numerous problems because of this practice. In effect, they are destroying the very house in which they live. But those upstream often use the practice of 'out of sight out of mind' as a low-cost management strategy.

There is one more important aspect to our system: we often fail to adequately consider the water that enters the system informally, through natural processes. Most cities have decided that the best thing to do with this water, when it isn't used as green water by the city's green spaces, is to get it out of the way as fast as possible. So while we have devised a system of delivery for use; we have devised a parallel system of storm water management that regards this informal water as somehow problematic. This is understandable, in some ways, given where we have settled. Cities across the tropics face seasonal floods. Given that Bangladesh is a country in a floodplain, unless more than 40% of the city of Dhaka is under water, then it is not considered a state of emergency. Flooding is part of life, but, even so, it is very poorly managed there. But should it be made to run away as fast as possible? Should it not be integrated into the entire system of supply? In a country such as Bangladesh, where groundwater is contaminated with arsenic, does it not make sense to ensure that aquifers are as full as possible in order to dilute arsenic so that its presence is not deathly harmful? Every year during the rainy season we channel storm water away from cities only to find ourselves under a water advisory in the dry season. Why? Because most of our water is ground water and we've failed to replenish the source through a combination of stormwater 'management' and an increasingly hardened environment where impermeable concrete and asphalt have helped create the 'stormwater problem' in the first place.

To create an integrated system brings us back to capacity: human resources, finances, technology and, most importantly, the political willingness to depart from the 'beaten path'. In light of extreme events, heightened variability and climate change, it is time for a revolution in urban planning.

So What Have We Learned?

Urban Water Security may be defined as citizens' freedom from want (i.e. having adequate amounts of water of appropriate quality for daily consumptive (household, economic) and non-consumptive (e.g. recreational, spiritual) needs; and citizens' freedom from undue risk from natural hazard and human use outcomes. To ensure urban water security for all, steps must be taken to (i) reduce risk (from external events); and (ii) reduce vulnerability (enhancing the character and strength of the people and the built environment). For example:

Reducing risk through appropriate individual and collective action

- Due to shortage (ensuring adequate supply)
- Due to pollution (ensuring fail safe systems of conveyance)
- Due to extreme events (improving the built environment)

Reducing vulnerability through appropriate individual and collective action

- Through improved management of existing systems (at different scales)
- Through better governance and systems oversight (legal and institutional arrangements)
- Through adoption of new technologies (appropriate and affordable)
- Through knowledge mobilization and effective communication (learning from others)

There are many examples of 'best practice' across the world's cities, including, for example:

- Low impact development
- Sponge cities
- 'Pop-up' infrastructure and other community-centred approaches to service delivery
- Public-private-community partnerships
- Infrastructure upgrades

In terms of the politics of urban water security, one can glean several factors to understand how 'best practice' emerges:

- Creative coalitions (citizen-led)
- 'No opting out' due to collective effective of impending crisis
- Pressure from citizen groups
- Enlightened leadership
- Available finance
- Peer pressure (city to city; global governance systems)
- Smart partnerships

In relation to the politics of water for cities, the review of water in development and in human settlements reveals the following:

- Water use mirrors society back to itself. It is therefore unrealistic to expect equitable access to water, indispensable though it may be, in highly unequal societies.
- As cities continue to grow, there will be no substitute for supply-side solutions to scarcities and uncertainties; rather than moving away from 'Man over Nature' approaches to resource management, we continue to reinforce these high-modern, 'hydraulic mission' approaches.
- Demand-side management as well as improvements to existing systems of supply can greatly enhance the urban water endowment but these are politically sensitive, especially when asking citizens – some of whom already have limited access – to 'want less'.
- Authoritarian/Totalitarian political systems (where civil society is weak) provide equal space for misguided projects (e.g. Three Gorges Dam; Ilisu Dam) as well as creative innovation (e.g. large-scale desalination; 'sponge cities').
- Democratic political systems are prone to compromise and path dependence (e.g. urban sprawl that generates new revenue mixed with minor innovations such as green belts) due to financial limitations, social pressure and politicians' general unwillingness to take risks (that may have impacts at the ballot box).
- In the Global South, 'big infrastructure' draws together political, economic and social power, squeezing out less influential groups, in particular the poorest citizens.
- In the Global South, where the urban poor are included it is because they have forced themselves into the public space through a combination of activism and external (NGO, IGO) support.

One conclusion to be drawn from this review is that cities are deeply divided across a number of socio-economic fault lines. These divisions make every water related decision inordinately political. How then to move toward improved practices and outcomes? Since 2000, when the Prince of Orange declared the world water crisis a 'crisis of governance', there has been concentrated efforts along two fronts: improved governance (including exposing and rooting out corruption; updating water laws; developing water resource development and management strategic plans) and improved management (specifically integrated water resources management with a focus on the river basin as the geophysical unit of water use decision making). These efforts have been coordinated by a number of global and regional bodies, such as UN-Water. Donor states and international financial institutions have attempted to integrate these best practices into lending policies. On several occasions they have made very wrong turns – with privatization of urban water systems being the prime example.

There is no escaping the politics of water. It is manifest in decisions regarding reforms to governance and management. It is manifest in decisions regarding appropriate technologies. Some regard the widespread turn toward desalination to be a consequence of the fact that the endless ocean waters are not hemmed in by land tenure, communal rights, and contentious trade-offs between stakeholders as are land-based (surface and ground) water resources. Yet disposal of the brine effluent has ecological consequences which will no doubt have socio-political and economic consequences as well. Cities, through global processes such as Agenda 2030 and UNFCC COP, learn from each other. Moreover, these are collective social spaces occupied by civil society organizations who share strategies and tactics, and the private sector, who compete for markets and contracts. It is these groups coming together who will determine who gets what water, when, where, and how. It is our job as academics to understand why, and as activists to fight for the outcomes we believe in.

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